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The Inter-Governmental Maritime Consultative Organization (IMCO) and maritime development ■ A study of the economic and social classification of the Latin American countries

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EXPLANATION OF SYMBOLS

Three dots (. . .) indicate that data are not available or are not separately reported.

A dash (—) indicates that the amount is nil or negligible.

A minus sign (−300) indicates a deficit or a decrease.

A stroke (/) indicates a crop year or a fiscal year, e.g., 1954/1955.

An asterisk (*) is used to indicate partially or totally estimated figures.

"Tons" and "dollars" are metric tons and United States dollars, respectively, unless otherwise stated.

Minor discrepancies in totals and percentages are due to rounding.

THE INTER-GOVERNMENTAL MARITIME CONSULTATIVE ORGANIZATION (IMCO) AND MARITIME DEVELOPMENT*

1. *Development of maritime transport*

1.1 *Introduction*

World trade has more than tripled in the last twenty years,[1] and it now represents a very large volume of goods. The world tonnage of merchant ships has also increased, and the number of vessels under construction or on order indicates that no decline in its rate of growth is to be expected in the next few years.[2] This increase in the total tonnage of the world merchant fleet has been accompanied by a concomitant increase in the size of ships,[3] and the steady growth in both overall and unit tonnage is giving rise to many technical problems as well as necessitating the adoption of further safety measures to protect persons and goods carried by sea. These safety measures are subject to international regulations which take into account the development of modern technology.

IMCO's main objective is to facilitate and develop international co-operation with a view to perfecting shipping safety measures. It also studies the various legal problems arising in the use of ships as a means of transport and helps developing countries to solve maritime problems that come within its competence.

1.2 *Types of ships*

Ships are classified according to the traffic in which they are engaged and the type of cargo they carry. In each broad category of vessel there are various sub-categories—sometimes broadening and overlapping—established in the light of the specialized nature or application of the vessels concerned, but certain global trends are to be observed, such as increased size, increased speed and a higher degree of automation of operations.

The main types of vessels are cargo ships, bulk carriers, oil and liquid gas tankers, and passenger vessels.

Cargo vessels

This type of vessel is used to transport general cargo. On certain lines, they may carry ore or grains, even though there are specialized ships for this traffic. To compete with air traffic, which has certain advantages in the transport of valuable products, cargo vessels have had to improve their services with regard to speed, punctuality and safety.

Cargo vessels may be either specialized or general-purpose ships, but in both cases technological development has resulted in a steady improvement in cargo handling (bigger cargo hatches, speedier and more automatic cargo-handling facilities, holds which are as nearly parallel-sided as possible, unitization of cargo, etc.) and in a saving in crew costs through the automation of ship operation.

The increasing specialization of certain types of cargo vessels seems to have been one of the determining factors in enabling optimum operational efficiency to be achieved on certain shipping lines, using such new types of cargo vessels as container ships, roll-on/roll-off ships, barge-carrying (LASH) vessels and car ferriers. Such specialization is not always absolute, however, since in certain cases these vessels can fulfil more than one function so that they need not return empty or soon become obsolete.

Bulk carriers

These vessels can be divided into three main groups: ore-carriers, ore/oil (OO) and ore/bulk/oil (OBO) carriers, and bulk carriers of various types. The latter represent the major proportion of the existing merchant fleet.

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* The ECLA secretariat has pleasure in publishing in the present issue of the Bulletin this study prepared as a further contribution to co-operation among the agencies of the United Nations Family by the secretariat of the Inter-Governmental Maritime Consultative Organization (IMCO).

This article reports at some length on the latest advances in maritime transport—a subject of great importance to this region—and on IMCO's technical and legal objectives and role in the development of maritime activities.

[1] See United Nations, *Statistical Yearbook*, 1969.

[2] Lloyd's Register of Shipping, *Annual Report, 1969*.

[3] *Ibid.*

The three types of bulk carriers differ in construction, being designed to carry one or more specific types of goods. The main features in their development have been the significant increase in their size and the search for new cargo-handling methods.

Oil tankers

Oil tankers have also grown appreciably larger, and those now being planned (vessels of nearly 500,000 tons) are raising serious technical problems in connexion with their construction and means of propulsion. They also involve considerable investment in building and maintenance facilities, require special port installations and raise serious problems in connexion with marine pollution.

Carriers for liquid gas and other chemical products

Other liquid products besides oil which are transported in bulk include liquefied gas and chemical products. The vessels carrying liquefied natural gas (LNG) at 160 degrees centigrade below zero and at atmospheric pressure are of comparatively recent design, but even so considerable developments are at present taking place in their size (the largest have a capacity of 120,000 cubic metres) and in the techniques used. These ships, like those which carry liquefied petroleum gas (LPG), involve substantial investments and must comply with strict safety measures because of their size and type of cargo.

The growing traffic in chemical products (phosphoric acid, sulphuric acid, liquid sulphur, etc.) has led to new types of specialized bulk carriers, although these vessels are frequently designed to carry several types of products. These ships are still of relatively modest size, but they nevertheless create problems in port because of their dangerous cargoes, which are a potential source of pollution.

Passenger ships

It is this type of vessel that is most severely threatened by the progress of air transport: thus, conventional liners have been taken off their regular routes and put into service as cruise ships (with or without facilities for transporting the passengers' vehicles), or alternatively higher speeds are being sought by using new types of vessels such as hydrofoils, hovercraft, etc. These are fairly small vessels, but they have proved their worth and plans for building larger vessels are afoot.

1.3 *Bulk carriers*

The composition of the present world fleet and the vessels on order in shipyards (ore, mixed cargo and other bulk carriers) clearly shows the trends in this field. The present fleet for the transport of ore consists mainly of ships of 10,000 to 80,000 tons deadweight, while most of the units on order range from 80,000 to 150,000 tons and are capable of speeds of around 15 knots. The existing mixed cargo vessels are of 50,000 to 150,000 tons deadweight (mostly 60,000 to 100,000), while those on order are from 80,000 to 270,000 tons (mostly over 150,000 tons), with speeds of around 16 knots. The other types of bulk carriers in service are from 10,000 to 60,000 tons, while those on order in the same category cover the whole range from 18,000 to 150,000 tons deadweight. Thus, in all types of bulk carriers there is a clear trend towards bigger units, especially in the case of ore carriers and mixed bulk carriers.

The desire to reduce maritime freight rates, which, if loading and discharging costs are included, account for a considerable proportion of the total transport costs per ton of ore, is the reason for increasing the ships' tonnage, thus permitting considerable savings through improved loading and discharging conditions and greater cleanliness. This trend has also been strengthened by the preference for locating steelworks in coastal areas and by the development of international trade, which permits the profitable use of large dry bulk carriers.

The profitability of ships of ever-increasing capacity, speed and degree of specialization is in direct proportion to the distances covered, but there is still a need for medium-sized ships that can carry cargo on two legs of a triangular run and are capable of putting in at ports which are not accessible to larger vessels, and this explains the steady demand for medium-sized ships in the category of "other bulk carriers".

With the object of reducing the risks arising from possible changes in chartering requirements and as far as possible ensuring that ships will travel fully loaded on both the outward and the return journey, shipbuilders have designed types of vessels that can carry all kinds of dry or liquid products. Ore/oil (OO) and ore/bulk/oil (OBO) carriers fulfil this requirement.

Dry-bulk carriers have enormous cargo space and are especially suitable for low-den-

sity cargo such as grains, bauxite or coal. The cross-section of the ship is octagonal and there are wing ballast tanks at the top and bottom of the holds, as well as a double bottom for ballast or fuel. The bulkheads of the holds are not reinforced, and it is not possible to carry liquid cargo. Large hatches facilitate cargo-handling operations.

Ore carriers are very different in construction. They have lengthwise bulkheads forming two large wing ballast tanks and a smaller central hold, directly accessible through wide hatches in the deck. Ballast can also be carried in the double bottoms, which are very deep. In spite of the small capacity of the hold, such vessels reach their maximum permissible loading when carrying high-density ores. Owing to the high degree of specialization, the profitability of this type of vessel cannot always be assured.

Ore/oil carriers are basically tankers. They have two bulkheads running lengthwise, and the central tanks thus formed, which have hatches in the deck and deep double bottoms, can be used for either oil or ore. Oil can also be carried in the wing tanks and the tanks in the double bottom of the ship beneath the central holds. Few of these ships can carry a full load of oil, since the arrangement of the holds for carrying ore reduces the capacity for oil, while the holds themselves, being relatively small, prevent a full load of ore from being carried except when high-density ore is being shipped, since the two longitudinal bulkheads impede access through the large deck hatches to all but the central holds.

Ore/bulk/oil carriers are different in structure and can carry high-density ore, low-density bulk cargo or oil, while assuring the stability of the liquid cargo. They are so designed that the entire disposable capacity can be utilized to carry ore, bulk cargo, or petroleum and light petroleum products, and they can therefore take a full load of light products (grains, fertilizers, coal) or a full load of petroleum products.

Stability is ensured by the installation of wing ballast tanks in the tops of the cargo tanks. Similar ballast tanks are also installed in the tank bottoms, so that the main tanks are of octagonal section, with large hatches in the tank tops. When liquid cargoes are being carried, the central tanks must be either completely full or completely empty; when the cargo is iron ore, every alternate hold is left empty, but when coal or grain is being carried all the holds are used.

In both ore/bulk/oil and ore/oil carriers, a special heating and ventilation system is necessary for the tanks. Cleaning the tanks is an easy matter and takes less time than in a conventional oil-tanker.

The structure of dry-bulk carriers and ore/bulk/oil carriers, with their wide hatches and no longitudinal bulkheads, makes it difficult to work out how to give sufficient strength to the hull, and the very large size of these vessels consequently makes it necessary to build them with a double hull and double bulkheads, thus significantly reducing their cargo capacity and raising building costs.

Obviously, the increase in tonnage of bulk carriers has led to increase in their length, beam and draught, although not in the same proportion since it is cheaper to increase the draught than the length. Therefore, the considerable increase in tonnage is reflected in a fairly moderate increase in length and much greater draught, which soon leads to serious port problems, for vessels of 150,000 to 270,000 tons deadweight have a draught of up to 20.5 metres, which prevents their putting in at a large number of ports.

Since port dredging operations and the construction of piers in deep water are very expensive, other solutions have been sought so that these large vessels can be anchored or moored in accessible places during loading and unloading operations. Thus, in some cases smaller vessels with appropriate cargo-handling equipment draw alongside the big ships, discharge their cargo and deliver it at the various ports of destination, in other cases, towed lighters are used, while in others ore-loading stations are set up next to deep water where they are accessible to large bulk carriers.

The structure of bulk carriers facilitates unloading, but their cost makes it imperative to find ways of speeding up this operation. The equipment required is expensive (large grabs, etc.) and to be profitable it must as far as possible be installed on land. Some ships have conveyor belts in the holds for discharging their own cargo.

A new system used particularly for handling iron ore consists in injecting water into the ore and thus rendering it sufficiently fluid to be pumped into the holds. The excess water is then pumped out so as to prevent shifting of the ore during the voyage. Upon arrival at the port of destination water under pressure

is again injected into the ore, which is then pumped out in liquid form. Using this system, which considerably speeds up loading and discharging operations and reduces air pollution, terminals can be installed out at sea and linked to the ports by underwater pipelines. This solves the problem of deep-draught vessels and makes it possible to build bulk carriers of even greater tonnage, possibly as large as the big oil-tankers.

In its set of safety measures for bulk transport, IMCO provides information on the moisture problems presented by some types of cargo which, if they became fluid, could endanger the ship's stability.

1.4 *Oil and gas tankers*

Keener competition and higher costs of labour and materials have forced shipowners to seek ways of reducing transport costs by a proportional reduction in investment. The increased size of vessels, especially for the transport of oil, fulfils this objective inasmuch as the increase in hull weight, power, and consequently fuel consumption, is less than the increase in payload (the hull weight/payload coefficient for a 275,000-ton vessel is only 70 per cent that of a 32,000-ton vessel). Moreover, crew costs do not change much with the increased size of the vessel and are thus proportionally smaller, the more so as automation of various aspects of ship operation is becoming more general. Lastly, building costs per ton decline with increased size of ship due to greater rapidity of construction (especially through increased prefabrication possibilities).

This trend is clear from a comparison of the composition of the present fleet of tankers with the orders being received by the big shipyards. Most of the existing vessels range from 20,000 to 200,000 tons deadweight, but the ships recently delivered or on order are either in the 100,000 to 150,000 tons deadweight class or, most frequently, over 200,000 tons. Among the latter, ships of 250,000 tons now seem quite commonplace, since there are vessels of 300,000, 370,000 and even 400,000 tons deadweight in use, under construction or on order. The building of ships of 1 million tons deadweight is under study, and building or repair facilities for such vessels are already in service or under construction in the shipyards.

This increase in size (the average deadweight tonnage of vessels in service has doubled in the last ten years and will more than double in the next decade) raises serious problems with regard to the design of such ships, building techniques, safety measures, pollution, draught, navigation, infrastructure, finance, insurance, etc. Because of all these factors, as well as the present development of the supply of power and the geographical location of oil reserves, these big ships operate on a few specific routes which naturally impose certain limits on their size.

The draught of these giant vessels is 20 metres for those of 200,000-250,000 tons deadweight and will be 27 metres for 370,000-ton vessels. This trend towards deeper draughts is due to the attempt to obtain minimum hull weight and building costs by increasing the draught, reducing the L/B ratio, and increasing the block coefficient, but it will be appreciated that the very deep draughts of the biggest tankers make it difficult or even impossible for these vessels to navigate in certain areas. Moreover, since costly port works would have to be undertaken to permit their access, there are many ports where they cannot put in.

In shallow loading ports one solution would be the single mooring point. However, this would mean building port installations far out from the coast, thus giving rise to problems of connexion with land installations, provisioning at sea, etc. At ports of discharge the problems are not so serious. The classic solution is to deepen the access channels and mooring places. An enormous amount of room is needed to manoeuvre such ships, however, since they require at least three times their own length for docking or turning, and with this type of ship this may be as much as 1,000 metres. Consequently, dredging costs are exceptionally high.

Another solution is to reduce the draught of tankers before their entry into port by discharging part of their cargo into several smaller vessels which then proceed to other destinations. Artificial reception points may be established for this purpose in areas with the necessary depth of water, and some projects even envisage the creation of artificial islands directly linked to refineries by underwater pipelines or inflatable polythene tubes floating on the sea. Eventually, the choice of places for discharging ships may no longer be linked with the existence of a port, but may depend rather on the possibilities of creating artificial reception points with storage facilities or refineries in the vicinity. This is an essential con-

sideration, since the possibility of discharging 250,000 tons of oil depends on the existence of adequate storage facilities with provision, *inter alia*, for storing the different qualities of oil separately. Oil refineries, too, must be capable of handling huge quantities of oil. It is generally estimated that the cargo of a ship delivering directly to a refinery should not exceed one-third or one-quarter of the latter's monthly refining capacity, or half its capacity for storing crude. This means that ships of 200,000 tons deadweight are perfectly adequate for supplying establishments refining 7 to 8 million tons annually.

Ever since the first 200,000-ton ships were built there have been problems in connexion with hull strength, and hulls had to be reinforced when certain structural stress phenomena became evident, such as the predominance of shearing stress over bending moment in the generation of fatigue and local concentrations of fatigue. This may make it necessary to give up the present structure based predominantly on longitudinal members and adopt a predominantly transverse structure, supplemented with an axial longitudinal bulkhead of high-resistance (HR) steel. These various factors, which increase the weight of the hull, may set limits on future increases in the size of ships, since benefits from increased size would be minimized by increased cost.

There are other technological considerations, particularly in regard to propulsion, which at present limit the maximum size of tankers. Ships of 470,000 tons deadweight require a motive force of close on 50,000 horsepower to attain a speed of 16 knots. Such power could be provided by slow-speed diesel engines, gas turbines, or possibly nuclear power plants, but the manufacture of the very large propellers required raises awkward problems in connexion with homogeneity of the castings and their handling during fabrication, while the bigger propellers become, the slower they must rotate in order to improve their intrinsic efficiency. This causes designers to resort to solutions such as the use of twin screws or contra-rotating screws which increase building costs and reduce the benefits obtained from the increased efficiency because of the rise in maintenance and personnel costs.

Moreover, in spite of the new technique of welding together prefabricated ship sections while afloat, thus avoiding the construction of giant docks, the building of very large units still entails enormous investments, since this new technique is not used for repairs and dry docks large enough to receive these vessels must therefore be constructed nevertheless.

In addition, the general problems affecting tankers, such as marine pollution, safety of navigation, risks of explosion, fire detection, design of equipment, etc., become considerably more acute with the increase in the volume of cargo. IMCO is currently drawing up appropriate regulations on these matters.

Considering the tonnage of the ships planned or under construction and the reasons for selecting such ships, the possibilities of obtaining the desired efficiency will depend on considerable simplification and standardization of ship operation to permit greater automation and simplify the rotation of crews. It is also necessary to improve the facilities for supplying navigational data by making use of automatic data loggers, computers, satellite navigation systems, teletransmission of data, etc.

The level of world consumption of natural gas and petroleum gas and the geographical location of their sources of supply necessitate the transport of increasing quantities by sea. This demand has led to the development of various transport techniques and given rise to studies aimed at reducing the cost of the facilities required and increasing the unit capacity of the ships transporting these products.

Natural gas

This is carried in liquid form at atmospheric pressure by reducing the temperature to –160 degrees centigrade. Although there are projects for carrying this product in gaseous form, this is a very difficult proposition on account of the huge capacity that the ships would require and the weight of the metal plates that would be needed to withstand the heavy pressure. Two very different storage systems are used for liquefied gas at present: self-supporting tanks and integral tanks.

(1) Under the first system, the liquefied gas is carried in tanks which are installed on the ship's bottom and have the necessary structural strength to serve as independent containers. An initial drawback of this system was that it required the use of very heavy metal structures, but some improvements have since been introduced. A first solution was to build parallel-sided self-supporting aluminium tanks insulated with polyurethane and provided with a second sheathing of plywood, directly in contact with the ship's hull, to prevent any leakage of methane. This system, which per-

mits a high degree of prefabrication, helps to reduce building costs.

A second solution which is under study (a model has already been built and orders have been placed) provides for the installation of spherical tanks made of steel with a small content of nickel, without any second sheathing. The manufacture and insulation of these tanks present no particular problem, but they must be carefully fixed to the hull if they are to avoid being affected by the forces acting on the latter. Various ways of overcoming this problem are being explored, one of them being the suspension of the spherical tanks by means of three large specially pivoted rings.

(ii) Under the second system, the tank is simply a thin, flexible airtight membrane which espouses the form of the hull and is insulated from it by a rigid supporting sheathing. The deformations of the hull while the ship is moving are transmitted directly to the tank, which must be able to withstand them without any risk of rupture. There are two solutions to the problem of the construction of the tank, both of them calling for special alloys.

First, the tank proper (or first skin) is of rustless metal sheeting, corrugated at right angles to give a certain degree of flexibility. The second sheathing consists of a plywood skin to prevent any leakage of methane, which supports the tank through balsawood blocks. All this rests on a thicker plywood bed supported on the hull by pinewood beams.

The second solution uses "invar" (a steel alloy with 35 to 36 per cent nickel), one of whose main properties is that it has an extremely low coefficient of expansion and can thus withstand the big temperature changes without difficulty. The tank is made of a sheet of invar 1 millimetre thick and rests on insulating plywood boxes filled with perlite. All this is entirely enclosed in a second tank which is joined to the ship's hull by other insulating boxes.

Like most of the other types of vessels, those carrying methane have increased rapidly in size. Many ships of 120,000 cubic metres capacity are now on order, and studies for vessels ranging from 160,000 to 200,000 cubic metres are well advanced. For ships of this size the membrane and integral tank systems seem, at least for the present, to be the most suitable, while the spherical self-supporting tanks appear to be best for ships of less than 100,000 cubic metres. In vessels of greater capacity than this spherical tanks would have to be so large that the thicknesses required and the consequent weight of the plates would be prohibitive.

Needless to say, ships built according to the various techniques described above are generally very expensive, both because of the materials used and because of the difficult technical problems which their construction involves (welding, finishing of flat surfaces, etc.). Moreover, the terminal ports of lines carrying methane have to be provided with safety devices and facilities for liquefying, regasifying and storing the methane.

Liquefied petroleum gas

This product can be transported in three ways: under pressure, at atmospheric pressure after refrigeration, or under combined pressure and refrigeration. The temperatures do not go below –40 degrees centigrade, and the gas can therefore be carried in self-supporting tanks of light steel alloys. Most of the vessels carrying this gas are equipped with refrigeration facilities, while the gas is generally stored under pressure on land. The largest of the ships on order can take 100,000 cubic metres of liquefied petroleum gas.

1.5 *Container ships*

Container ships appear to be very promising, since the loading and unloading of 100,000 tons of cargo requires 11,000 hours in a conventional vessel and 600 in a container ship.

Containers are metal-framed rectangular cases of standardized dimensions, basically designed to allow easy and rapid transfer from one means of transport to another (maritime, river, road, rail), avoiding splitting-up of the consignment and consequent extra costs of handling, damage, etc.

The first container ships appeared very recently, but their numbers have increased rapidly, for at the beginning of 1969 there were only 29 container ships proper in the world, of which only three could load more than 1,000 containers, while at the end of 1969 the total capacity had reached around 3 million tons deadweight and there were 63 pure container ships, around 20 of which were able to transport between 1,000 and 1,300 containers.

As the size of the fleet of container ships has increased, there has also been a considerable increase in their size, deadweight tonnage and speed. The pure container carriers coming into service in 1971 and 1972 have

a displacement when loaded of more than 30,000 tons, a capacity of more than 2,000 twenty-foot containers, engines of around 80,000 or more horse-power, and speeds of between 28 and 30 knots. Taking into account the increased volume transported and the reduced stay in port, it is calculated that each container ship is the equivalent of at least four conventional cargo vessels.

Depending on the type of container ships involved (i.e., whether they employ horizontal or vertical handling), ports may have to be equipped with appropriate large-scale cargo handling facilities. In either case, however, they must have available large storage areas, excellent surface or river transport facilities, and space where containers with goods coming from or going to a number of different places can be emptied or loaded. Investment in harbour facilities is thus a very large and expensive item. Vertical cargo handling container ships are not usually equipped with their own gantry cranes, since these are so costly that is is more profitable to install them in the actual harbours, where they are used much more frequently, instead of standing idle for long periods on board the container ships, which only stay a short time in port.

The organization of conventional sea transport has undergone appreciable changes since the appearance of containers. Container transport increases productivity, speeds up distribution, regularizes traffic and gives better protection to the cargo, but also requires a whole chain of ships to ensure the frequency and regularity of the service. Container transport can only be developed properly on routes whose terminal points fulfil a certain set of conditions, which include a privileged geographical situation in the heart of a rising industrial region, for containers are used primarily to transport finished or semifinished industrial products which must be grouped and distributed at minimum cost around the centre of gravity of the final loading and unloading points, and these terminal points must also have direct connexions with other types of large-capacity rail, road or river transport.

In order to provide the quality of service required, shipping companies and consortia should adopt administrative systems which include on the one hand a central administration to draw up general policy, carry out market studies, organize routes, fix itineraries, administer container stocks, etc., while also including a set of general agencies in each geographical area to promote container traffic in that area, draw up contracts with road or river transport enterprises, etc. Such systems require intensive use of information and computer techniques both in the central administration and in the general agencies. In a sense, the actual marine transport of containers is only one link in the chain of the overall transport system, and its influence is of decreasing importance.

1.5.1. *Types of container ships*

Container ships are of two main types—pure container ships and intermodel or mixed-cargo ships.

Pure container ships

These ships can be of two types: *roll-on/roll-off ships* with horizontal loading, which have a double hull, divided horizontally by the decks, and, although obviously less economic over long distances, because of the space wasted between decks, have the advantage of not requiring harbour facilities such as gantry cranes, but only sloping access ramps and a good supply of tractors and trailers. *Cellular lift-on/lift-off vessels* divided vertically by transversal bulkheads. The decks are completely open, and each vertical hold is divided into groups of cells into which the containers are piled, using vertical parallel guides. These vessels can only ship containers below deck which are of the same measurements as the cells, although it is possible to change the position of the guides to fit in cargo of different sizes. Loading and unloading is effected by means of special 100-ton portal cranes, which may be installed on board.

Container carriers are low-draught vessels (around 10 metres for a length of 280 metres), of high engine power, although they have slow-revolving propellers. The vessels planned to carry 2,000 containers at speeds of 26 knots will have twin screws, each driven by 30,000 to 40,000 horsepower. Some designs provide for the installation of gas turbines of this capacity.

Studies are being made for vessels designed to be propelled at speeds of 30 to 32 knots by 140,000 horsepower engines driving two or four propeller shafts. New types of propulsive machinery will be required for this purpose, and it is considered that atomic energy may be the answer for capacities of this magnitude.

Combined container and roll-on/roll-off ships

Cargo which cannot be loaded in containers can often be loaded easily on trailers or trucks, so some vessels have a part of their afterholds fitted up for the entry and exit of vehicles. A door towards the stern gives access to the holds located over the engine-room, which are connected with the shore by gently sloping ramps. These vessels present difficult design problems, since the main member of the ship must be continuous all along its length from the forward section, kept rigid by the longitudinal bulkheads of the container cells, to the after section, which is sustained by a central structure.

Under normal loading conditions, these vessels require a good deal of ballast in order to achieve adequate stability, owing to the weight of the loaded trailers up above and that of the containers stowed on deck.

This type of vessel, being large and powerful, needs two propeller shafts to avoid risks of stern vibration, including the access door, or of propeller cavitation when the ship is riding high in the water.

In both types of container ship described, specialized areas such as cold rooms have been eliminated and replaced by refrigerated containers which work off the ship's electric system.

Every effort is made to cut down appreciably the time spent by the vessels in port on cargo handling. This is mainly achieved by increasing the volume and weight of cargo units (i.e., containers and palletized cargo). As container traffic is basically linked to the existence of major road, rail and river networks, this system cannot be applied everywhere, but in many cases barge traffic can be used along coasts or on natural waterways. In order to avoid breaking bulk, vessels which can transport the barges without unloading them must be available, or else the lighters or barges must be capable of being towed or pushed over long distances (seagoing barges).

1.6 *Lighter-carriers*

Lighter-carriers are designed to take barges or lighters of several hundred tons, specially adapted for the different kinds of traffic they engage in (liquid cargo, refrigerated cargo, transport of cars, etc.).

At present, two types of lighter-carriers are in operation or on order: the LASH (Lighter Aboard Ship) and the Sea Bee types. In both systems, the lighters are stowed within a watertight hull. Other projects, however, envisage placing the stowed and trimmed barges in direct contact with the sea, so that they will act like an additional part of the mother ship's bottom.

LASH-type lighter carriers bring the barges on board aft with cranes and then stow them athwartships. They are able to transport small lighters of 550 m^3 or 400 tons deadweight capacity or standardized 20-foot containers. Handling is very rapid, since 1,500 tons can be loaded or unloaded in one hour. Vessels of this type now on order have engine capacity of 26,000 horsepower, a draught of 11.25 metres, a displacement of 43,500 tons and a speed of up to 20 knots. The lighters have a draught of 2.60 metres and are so designed as to be able to operate in waves of up to 1.20 metres, so that they present no problems in sheltered roadsteads. They can be handled by one man.

Sea Bee lighter-carriers are designed to load the lighters aft, using a platform-lift, and then stow them lengthwise. The lighters used can have a capacity of up to 1,140 m^3 or a maximum of 800 tons deadweight: i.e., they can be almost twice as big as those used on board the LASH carriers. These vessels can also be used to transport various types of cargo units of different sizes, the size and weight limits being the same as those indicated above for the lighters. Cargo handling is by means of a vertically-moving platform at the stern which can lift 2,000 tons, i.e., two vessels of 800 tons deadweight simultaneously. Lighters are towed on to the platform by a tug and then raised up to the deck, where a horizontal-type transporter stows them lengthwise, but the platform can also be set at quay-level to allow the loading of roll-on/roll-off wheeled vehicles. Sea Bee vessels can carry lighters at three different levels, stowed in two rows per level. There are fewer independent cells than in the LASH carriers, which means reduced flexibility of utilization.

Vessels 225 metres long, with a beam of 32 metres and a draught of 10 metres can take 38 lighters, i.e., around 30,000 tons of cargo. Engines of 36,000 horsepower give a speed of 21 knots. Beneath the lower deck, Sea Bee ships are built like petrol tankers and allow for a considerable amount of ballast (37,000 m^3) or for the transport of petroleum in a system of tanks. Above the lower deck

the vessel is double-hulled, which means that this part of the hull can be used in the same way as the bottom.

The handling of these vessels is very rapid: they can be loaded or unloaded at a rate of 3,000 to 4,000 m^3 an hour thanks to the mechanization and remote control of all operations. Sheltered roadsteads are necessary for cargo handling, as in the case of the LASH carriers. There are projects for loading systems using side doors, protection from the swell being afforded by the vessel's hull. If standardization studies are carried out during their construction, these three types of vessels can easily be converted into container ships, but it should be borne in mind that a converted vessel works out more expensive than a container ship designed as such.

Lighter-carriers usually carry out loading and unloading operations without making use of a quay and do not require mooring facilities like constant-tension capstans; they must, however, have lateral stabilizers to reduce platform movement, and possibly also auxiliary propulsion facilities.

The number of lighters required to make the best use of a vessel depends basically on the characteristics of the route it serves, and can thus vary very considerably. Values of from 1.6 to 3.2 times the capacity of the vessel have been worked out for different routes which are in use or projected. The management of the stock of lighters requires careful attention in order to avoid delays to the carrier and to ensure full cargoes.

Both LASH and Sea Bee carriers can unload without having to tie up at a quay, thus diminishing the need for harbour facilities, but they do require a sufficient number of tugs for towing or pushing trains of lighters to and from the ship, and they also require sufficient piers and water space to take all the lighters transported by the carrier. Another factor which must be taken into consideration is the considerable shift in trim of the vessel during loading and unloading, which means that a certain extra depth is required in roadsteads which take lighter-carriers (a vessel with a draught of 10 metres needs a depth of around 14 metres). Lighter-carriers require fewer harbour facilities and can serve places with scanty road and rail systems, but such places must have a river network with a large traffic capacity linked directly with the users or suppliers of the goods transported.

This type of transport can handle various types of cargo, and the length of stay in port is considerably reduced, so that only a small number of vessels are required to make up a fleet. These considerations show that lighter-carriers could well have a useful role in some developing countries, essentially as an anticipatory stage to container transport.

1.7 *Roll-on/roll-off vessels*

With the aim of increasing the profitability of their vessels and the quality of the service offered, fleet owners have devised another type of specialized vessel. The development of road and rail transport has led them to design vessels which in most cases avoid the need for breaking bulk, with the result that trucks or trailers can carry the cargo from the starting-point to the final destination. This cuts out handling with cranes and reduces the risk of damage caused by successive transhipments of cargo. Loading and unloading operations are thus exceedingly rapid.

In order to reduce on-board manoeuvres to a minimum, roll-on/roll-off ships have large doors in the stern, bow and sides. They are particularly suitable (provided they have excellent ventilation in order to eliminate exhaust gases) for transporting new vehicles, tourist vehicles (to supplement car ferries in periods of heavy tourist traffic), trucks, trailers, small containers and palletized cargo. They can also easily transport very bulky and heavy cargo loaded on trailers, and are suitable for "trailer-to-trailer" operations.

Since hoists and derricks are not required on board, nor cranes on land, the costs associated with these vessels are low. Other factors, however, must be taken into account, since they constitute an important part of building and operating costs of roll-on/roll-off vessels. Thus, since these ships take on vehicles with wheels of different spacings, the waste of useful space on board is considerable. The full use of the holds is also difficult, because vehicles require ramps with a very slight slope (this constitutes a big waste of space), or the use of slow and expensive lifts. The difficulty of using the holds results in concentration of the heavy cargo on the decks most easy of access from the quay, i.e., fairly high in the vessel, and this raises problems of stability. Lastly, the structure of the vessels (completely clear decks, replacement of watertight compartments by a double hull so as to facilitate the installation of ramps and large bow and stern doors)

is expensive on account of the consequent greater weight of the hull of the vessel, while this type of vessel also has a low deadweight and, depending on the distribution of the cargo, may require a great deal of ballast. Small vessels require rapid ballasting in order to compensate for the changes in fore and aft trim produced by the loading or unloading of heavy cargo.

The harbour and land traffic problems raised by these vessels are aggravated by several factors. The cargo must arrive in port in vehicles which drive straight on to the vessel, in which case a return journey with cargo must be arranged for, or it can arrive in vehicles which do not go on board, but this naturally involves transhipment. The harbours must be provided with sloping loading platforms to accommodate tidal changes, adequate storage space, and powerful tractors and trailers to move the cargo in the port area.

The foregoing considerations indicate that roll-on/roll-off vessels are particularly suitable for specific kinds of traffic. The higher cost of construction in comparison with a conventional vessel must be compensated for by more rapid turn-around, which can be achieved by the reduction in the time spent on loading and unloading (these ships are usually fitted with bow-propellers for more precise berthing). They are particularly suitable for transporting fragile or valuable goods because of the lower risk of damage and the lesser importance, in the case of such goods, of the cost penalty represented by the immobilization of a trailer or truck. Lastly, since the waste of useful space is a serious handicap, experience shows that these vessels can be operated more profitably over short distances and between ports with heavy traffic.

1.8 *Passenger vessels*

Passenger transport is undergoing large-scale changes involving an appreciable reduction in the number of passenger liners and concentration on cruise-ships and car-ferries. For short distances, new means of transport (hovercraft and hydrofoils) have been introduced to carry passengers faster and, if necessary, accompanied by their cars.

Conventional vessels, limited to speeds of 20 to 30 knots, continue to be the most economical form of transport up to that speed range, since the only force they have to overcome is the resistance to forward movement caused by wave-formation, but above a certain threshold, which depends on the characteristics of the vessels themselves, the resistance to forward movement increases sharply. An attempt has therefore been made to free vessels from part of this resistance by enabling them to move through the air rather than through the water (or over the ground).

Hovercraft

Two different techniques are at present being studied to achieve the over-pressure, or air-cushion, needed to keep the vessel at the required height above the surface of the water:

(i) Air is driven violently downwards, in the form of a circular jet, around the edge of the vessel;

(ii) Air under pressure is admitted to chambers underneath the vessel, formed by the vessel's hull and a lateral skirt round the edge of the vessel.

These two methods have been applied to various different types of vessel, some of which are already operating regular services, transporting 250 passengers and thirty cars at 40 knots in one case, and 90 passengers at 55 knots in another.

The first technique uses a single peripheral skirt, while the second has several inner chambers whose walls constitute internal skirts, the whole being enclosed by a peripheral skirt which is supplied in part by air escaping through the internal skirts. In both cases, the air supporting the vessel escapes through the space between the lower part of the peripheral skirt and the surface of the sea. The skirts are made of a flexible rubber-based material so that the vessel can cope with obstacles higher than its flight height, which is very low (10 centimetres or so for a 30-ton vessel). Waves a metre high can thus easily be crossed.

The installed engine power is around 60 to 100 horsepower per ton. Gas turbines are employed, one-third of the power being used for the air-cushion, the pressure of which is very low, while the remaining two-thirds are used for actual propulsion, which is affected by means of aircraft propellers. Since these vessels have some points in common with aeroplanes, aircraft techniques are used in their construction. The useful load is one-third of the total weight.

The limits for coping with waves and remaining seaworthy depend directly on the size of the hovercraft. In order to make hovercraft

safer and more comfortable, and to avoid interruptions in traffic due to weather conditions, their size must be increased. This raises no special technical problems, and vessels of 1,500 and even 4,000 to 5,000 tons, which could cross the Atlantic, are being studied. The operating costs of the hovercraft at present in service are higher than those of conventional ships, but conspicuously lower than those of planes. Bearing in mind their speed, they would appear to be particularly useful for distances of a few dozen miles.

These vessels are amphibious, and since they operate rather like aircraft they require facilities more on a par with airports than with harbours for ships. The location of loading and unloading points is easy, since all that is required is a gently sloping access ramp to the sea, close to good road or rail transport facilities. Hovercraft do not necessarily have to be amphibious, however, since the peripheral skirts can be replaced by rigid side walls actually in the sea. This allows a reduction in the power needed to keep the vessel above the surface, reduces air loss from the air cushion, and means that, in addition, highly efficient water-jet propulsion gear can be installed. This system is being studied at present with a view to its use for high-tonnage vessels. The docking problems of such side-wall vessels are very similar to the problems of conventional vessels.

Hydrofoils

A first type of these vessels uses V-shaped hydrofoil planes located at the bow of the vessel, which is naturally stable because of the variations in the supporting surface in contact with the water. In rough water, however, such vessels suffer from sharp vertical accelerations which make sailing uncomfortable and difficult.

In order to overcome these drawbacks, another type of hydrofoil has recently been designed with the planes completely under water. Unlike the first type, these vessels are not inherently stable and require complicated automatic electronic control mechanisms. They are therefore much more expensive and their commercial operation is not yet widespread. Indeed, the commercial use of this type of vessel may well have an uncertain future.

The basic advantages of hydrofoils, apart from their greater speed in comparison with other craft, lie in the fact that their speed is not noticeably affected by a rough sea and that they are less noisy than hovercraft. There is, however, a risk that they may damage their supporting planes against floating objects, and this increases maintenance costs.

An increase in the size of hydrofoils, which is desirable from a commercial point of view, raises technical difficulties inasmuch as the supporting planes and masts must stand up to ever-increasing stresses.

2. *The Inter-Governmental Maritime Consultative Organization*

2.1 *Establishment*

The United Nations Maritime Conference, which met in Geneva in 1948, adopted a Convention setting up the Inter-Governmental Maritime Consultative Organization (IMCO). This new organization was to be concerned with shipping in general and was to provide machinery for inter-governmental co-operation on technical matters relating to international commercial shipping activities, with special attention to the protection of human life at sea.

The Convention establishing IMCO required ratification by twenty-one States, seven of which had to have a total tonnage of at least one million tons, in order for the Organization to enter into operation. That condition was fulfilled on 17 March 1958, and the Assembly of IMCO met in London on 6 January 1959. The first permanent international maritime organization had been born.

As at 15 January 1971, the Organization had seventy-two member States, including one associate member.

2.2 *Principal organs of IMCO*

The principal organs of IMCO provided for in the Convention are: the Assembly, which is the supreme policy-making body and is made up of representatives of all the member States; the Council, made up of representatives of sixteen nations (subsequently increased to eighteen) which is the executive organ of the Organization between the sessions of the Assembly, and lastly, the Maritime Safety Committee, made up of representatives of fourteen nations (subsequently increased to sixteen), which is the principal technical organ of IMCO. This Committee has a number of non-permanent sub-committees which are set up as appropriate to deal with specific problems.

Up to May 1967, IMCO's programme of work included no studies of a purely legal nature, but the loss of the *Torrey Canyon*

oil tanker brought home to IMCO the need for a study on general maritime law, with a view to possible changes, and the Council therefore set up a Legal Committee in 1967.

In 1965 IMCO entered the field of technical assistance, and in 1969 the Council created a body which has become the Committee on Technical Co-operation. The Organization now participates in the United Nations Development Programme (UNDP) as a specialized agency, and is represented on the Inter-Agency Consultative Board in the same capacity.

2.3 *Functions of IMCO*

Even before the Convention was finally ratified, IMCO was entrusted with a number of tasks. Some of these came within the framework of the International Convention for the Safety of Life at Sea, which replaced earlier treaties and was drawn up in London in 1948 at another international Conference held shortly after the Maritime Conference in Geneva, while others were carried out under the International Convention for the Prevention of Pollution of the Sea by Oil, which was concluded in 1954. IMCO was also entrusted with the work of revising the International Code of Signals and with the delicate task of studying a unified system of tonnage measurement.

Since its establishment, IMCO has convened the following international conferences:

International Conference on the Safety of Life at Sea, 1960;

International Conference on Prevention of Pollution of the Sea by Oil, 1962;

International Conference on Facilitation of Maritime Transport and Travel, 1965;

International Conference on Load-Lines, 1966;

International Conference on Tonnage Measurement of Ships, 1969;

International Legal Conference on Marine Pollution Damage, 1969.

These Conferences (with the exception of the second, which approved amendments to the 1954 Convention for the Prevention of Pollution of the Sea by Oil) adopted the following conventions, which are deposited with the Organization:

(i) International Convention for the Safety of Life at Sea, 1960

(ii) Convention on Facilitation of International Maritime Traffic, 1965

(iii) International Convention on Load-Lines, 1966

(iv) International Convention on Tonnage Measurement of Ships, 1969

(v) International Convention Relating to Intervention on the High Seas in cases of Oil Pollution Casualties, 1969 (Public Law)

(vi) International Convention on Civil Liability for Oil Pollution Damage, 1969 (Private Law)

2.4 *Maritime Safety Committee*

The work of the Maritime Safety Committee and its sub-committees covers the following fields: navigational aids; construction and equipment of ships; regulations for preventing collisions at sea; carriage of dangerous goods; investigation of accidents at sea, search and rescue operations, and all other matters directly related to maritime safety. It is also concerned with the prevention of marine pollution.

2.4.1 *Fire safety and prevention*

(a) *Fire prevention measures for tankers. Code for construction and equipment*

The Sub-Committee on Fire Protection is studying fire prevention measures applicable to the construction and equipment of new tankers. In view of the importance of the problem, a working document based on proposals by various countries was prepared for submission to the Sub-Committee, with a view to enabling the latter to formulate recommendations applicable to all new tankers for the transportation of crude oil and petroleum products having a closed-vessel flash-point not exceeding 60°C (140°F) and a Reid vapour pressure below atmosphere pressure.

The study is particularly concerned with: (*a*) effective separation of accommodation spaces from the tank deck by means of bulkheads; (*b*) means of keeping deck spills from penetrating into accommodation spaces (provision of a structural fire barrier over the accommodation space to the side of the ship at a suitable height); (*c*) the type of external bulkheads to be provided for superstructures and deck-houses or accommodation spaces giving onto the tank deck; (*d*) prohibitions regarding openings (doors) in such bulkheads and regulations regarding the type of portholes to be used in them; (*e*) measures to be taken with regard to openings in the tank deck in order to prevent the possibility of gas penetrating into enclosed spaces containing a

source of ignition; (f) the positioning of air intakes, ventilation of pump rooms, type of bulkheads to be used between accommodation spaces and engine, boiler and pump rooms, and type of bulkheads to be used within accommodation and service spaces; (g) ventilation ducts, deadlights in engine rooms, deck foam extinguisher systems, etc.

Explosion hazards on board large tankers. The International Chamber of Shipping (ICS) has drawn up an interim report on the recent explosions that have taken place on large tankers, and has formulated a set of provisional recommendations on the cleaning of tanks of more than 10,000 cubic metres capacity used for the carriage of crude oil.

Studies are being continued with a view to the drafting of a recommendation for possible submission to the Assembly of IMCO.

Operating standards. The International Chamber of Shipping has published a Tanker Safety Guide, and the Maritime Safety Committee has recommended Member Governments to use this Guide, which should greatly contribute to the improved operational safety of tankers.

Safety measures in port. The International Oil Tanker Terminal Safety Group has published an International Oil Tanker Terminal Safety Guide.

(b) *Fire test procedures*

Deckhead linings. A provisional code has been adopted regarding fire test procedures applicable to this type of lining; this code is to replace that outlined in resolution A.165 (ES.IV). The recommended procedure is intended to provide criteria for determining whether deckhead linings satisfy the regulations in Chapter II of the 1960 Convention. It deals with the preparation and conditioning of the sample and describes the test furnace, temperature measurement and regulation, the test flame, measurement of the obscurement of light, and the tests proper.

Flame propagation characteristics of materials. A technical committee of the International Organization for Standardization (ISO) is currently studying a test procedure that would make it possible to determine internationally acceptable flame propagation levels.

Combustibility tests. A draft recommendation is under study on a method of determining whether a marine construction material is combustible or not. The draft describes a test method designed to discover whether a given material meets the definition of incombustible materials given in Regulation 35 of Part D and Regulation 94 of Part H of Chapter II of the 1960 Convention. The draft deals with sampling, the apparatus to be used, the test procedure, and the presentation of results.

Measurement of emission of smoke and toxic gases. Studies are being carried out on the development of a test procedure for measuring the emission of gases caused by the decomposition of materials. The various methods considered so far involve the use of either an instrument for measuring flame-spread characteristics or equipment specially designed to measure emissions of gases.

It is considered that any decision on admissible levels of smoke or other gases should take account not only of the obscurement of light but also of the physical effects of concentrations of gases on human beings.

(c) *Fire prevention on board cargo ships*

Studies are under way on the principles and methods of fire prevention on board cargo ships. These studies could lead to the elaboration of regulations which would initially take the form of recommendations and would subsequently be presented as amendments to Regulation 54 of Chapter II of the 1960 Convention.

(d) *Fire prevention measures for specific types of ships*

Fire prevention on board ships with automated control. A draft recommendation has been drawn up for the prevention of fires on ships with unmanned engine rooms. The recommendation applies basically to machine rooms that would have personnel on watch in conventional ships but are not manned on the type of ship in question because the engines are under automated control.

The draft provides in particular for:

(i) An effective fire detection system in all engine rooms operating under automatic control, with audio and visual alarms distinct from those used in connexion with other devices;

(ii) Fire extinguishing installations in every space of the ship, even when not required by the Convention;

(iii) Immediate availability of water at suitable pressure in the fire main;

(iv) Special attention to certain provisions relating to engines, turbines, boilers, lubrication systems, electrical installations, auxiliary machinery, etc.; and

(v) Systematic inspection, with adequate routing checks and maintenance.

Fire safety measures for containers, portable tanks and container ships. The Sub-Committee on Fire Protection is studying this question, and has before it a number of proposals for safety measures in containers, portable tanks and container ships in general. These studies could lead to the formulation of a recommendation on the subject.

Fire safety measures for hovercraft. The Sub-Committee on Fire Protection has prepared a preliminary draft project on this question which has been sent to the Governments of member States for study and comment.

The aim of this draft is to give hovercraft a degree of security equivalent to that provided by the regulations on fire safety aspects of design and construction and the regulations on fire extinction contained in Parts C to H of Chapter II, of the 1960 Convention.

The code is intended to apply only to new hovercraft carrying out international journeys with a minimum of twelve and a maximum of 200 passengers, not more than 50 inches from sheltered waters, and using fuel with a flash-point of at least 37.8°C (100°F).

In view of the fact that technical developments are taking place rapidly in vessels of this type, the code can only be considered as provisional, and it will be subject to revision in the light of further experience in this field.

2.4.2 *Safety of fishing vessels*

(*a*) The Committee on Conditions of Work in the Fishing Industry, which was convened by the International Labour Organisation in December 1962, recommended that an international compilation should be made of practical standards and requirements regarding safety of navigation, fishing operations and the occupation of fisherman. The Committee also requested the ILO, in collaboration with the United Nations Food and Agriculture Organization (FAO) and the Inter-Governmental Maritime Consultative Organization (IMCO), to look into the possibility of setting up a suitable body to prepare such a compilation, which eventually appeared as the Code of Practice for Safety on board Fishing Vessels.

In order to ensure co-ordination of their respective fields of competence, so that the proposed Code would cover all aspects of the safety of fishermen and fishing vessels, the three organizations agreed on a set of principles to govern their collaboration and defined their respective spheres of interest and responsibility as follows: fishing in general (FAO); working conditions in the fishing industry (ILO); and the protection of human life at sea and the safety of ships and their crews (IMCO). In the context of this agreement, FAO, ILO and IMCO drew up draft contributions and decided that the Code should comprise two parts: Part A for the use of skippers and crew and Part B for the use of shipbuilders and shipowners.

The texts drawn up by the three organizations to form Part A of the Code were combined in a single draft by the representatives of the three secretariats, meeting at IMCO Headquarters in London in January 1968, and the final version of Part A of the Code was adopted at a joint meeting of FAO/ILO/IMCO advisers on the safety of fishing vessels, held at ILO Headquarters in Geneva from 4 to 13 September 1968. At this meeting it was also considered that it would be advisable for ships equipped with hospital, life-saving, repair and meteorological equipment to be stationed in the main fishing areas.

Part B of the Code, which deals with safety and health requirements to be complied with in the construction and fitting-out of fishing vessels, will be the subject of a text to be drawn up jointly by FAO, ILO and IMCO in the near future. A special IMCO working group drew up a third version of Part B in November 1970 and this was studied by the competent Sub-Committee in March 1971.

Part A contains provisions on navigation, ship safety, safety on deck, safety in fishing operations, engine-room safety, life-saving appliances, fire prevention and fire-fighting, safety and health of the crew, abandoning ship, survival and rescue. All these items are considered from the point of view of the crew. Part B contains provisions on the same subjects, but looked at from the point of view of the construction and equipment of the ship (hull, freeboard, watertightness and freeing ports; stability; electrical machinery and installations, fire protection, detection and extinction; protection of the crew, live-saving appliances, radiotelephony and radiotelegraphy, navigational equipment, crew accom-

modation, etc.). These studies could be used as the basis for a conference to be held in 1973 or later, or they could be introduced in the form of amendments to the 1960 Convention for the Safety of Life at Sea.

(*b*) There are two aspects to the study of regulations and practices in respect of ice-formation on the structure of fishing vessels:

(i) The necessary information must be obtained from the skippers of fishing boats to enable an analysis to be made of the real icing conditions in the various maritime zones;

(ii) Research is needed into the whole subject of icing, the rate of accumulation of ice under various hydrometeorological conditions, means of forecasting ice formation, and preventive measures.

A recommendation on means of tackling the problem of icing is to be prepared for the use of fishermen, but after considering all the available information on the real conditions of ice formation, the relevant Sub-Committee of IMCO concluded that more information should be collected on all the maritime zones where there is a risk of this problem arising. Since the observation and forecasting of ice formation is equally of concern to the World Meteorological Organization (WMO), it was decided to invite that organization to collaborate in a study designed to collect as much information as possible on this subject. Moreover, WMO was requested to furnish the results of the studies that it has carried out up to now on the meteorological conditions under which icing can take place, as well as any information on icing of ships that might be of use.

(*c*) IMCO is also carrying out work on the freeboard of fishing vessels, based on theoretical studies on pseudo-static angles of heel, bearing in mind the accumulation of water on the deck, and on the calculations applied to existing boats.

A recommendation is also being prepared on the construction of fishing vessels from the point of view of safety of the crew and stability. This recommendation, which will replace annexes VI and VII of the present resolution A.168 (ES.IV), deals particularly with devices to prevent the entry of water, freeing ports, the protection of the crew, lashing down of cargo on the deck, etc.

In October 1970 the Maritime Safety Committee adopted and transmitted to the Assembly a recommendation regarding a provisional simplified criterion of stability applicable to fishing boats under 30 metres in length. This simplified criterion is not intended to replace the basic criterion used by IMCO as set out in resolution A.168 (ES.IV), but to provide a simple criterion for use when no data are available on the stability and design of the hull. This recommendation is of special interest to the member States of the Food and Agriculture Organization (FAO).

2.4.3 *Stability and subdivision*

(*a*) The Sub-Committee on Subdivision and Stability has for some years been studying ways of improving existing regulations concerning the subdivision of passenger ships into watertight compartments and the stability of such ships after suffering damage. These studies have resulted in the formulation of draft amendments to the 1960 International Convention for the Safety of Life at Sea. The general principles of these amendments are based on the assessment of the probability of survival, but important problems have yet to be overcome, especially as regards the parameters of stability of ships after damage.

(*b*) Subsequently, a similar study will be undertaken on the problem of the subdivision and stability of cargo ships after damage. Use of the probability method has been envisaged in this connexion.

(*c*) The Sub-Committee has adopted amendments to the Recommendation on Intact Stability of Passenger and Cargo Ships under 100 metres in length (resolution A.167 (ES.IV)) for ships carrying deck cargo (especially timber). The amendments take into account, *inter alia*, the permeability and water absorption capacity of deck cargo and/or the possibility of accumulation of ice on exposed surfaces.

(*d*) The Sub-Committee is also studying the problems of subdivision, stability and load lines for special types of ships such as container ships, hovercraft, hydrofoils and drilling rigs.

An *ad hoc* working group has prepared a set of draft recommendations on the subject for hovercraft. IMCO is studying the more general question of whether, and if so to what extent, existing conventions should be modified to take account of new types of ships, or whether it is preferable to draw up a completely new set of rules.

(*e*) Another *ad hoc* working group made up of experts and representatives from a number of international organizations (IMCO, UNESCO (IOC), WMO, etc.) has been entrusted with carrying out a study of the external forces affecting ships. The group has presented a wind profile formula (speed as a function of height) which could lead to the establishment of an improved criterion of stability taking account of the overturning moment set up by the wind, and it is continuing its research into squalls and bulk transport. The group will also make an exhaustive analysis of the records of accidents caused by inadequate stability, using *a posteriori* meteorological and forecasting techniques. Lastly, the group is considering problems relating to the assessment of the steepness of waves, using wave measurements, stereoscopic photographs and other sources, and studies of wave spectra in different maritime zones.

2.4.4. *Design and equipment of ships*

The 1960 Convention for the Safety of Life at Sea laid down safety standards for both passenger and cargo ships.

The regulations in respect of cargo boats are less detailed than those for passenger ships, since they refer to all cargo ships, whatever their type. As there is currently ever-increasing specialization in the design of cargo ships for the carriage of bulk chemicals (often of a dangerous nature), hydrocarbons, liquid gas and containers, however, the Sub-Committee on Design and Equipment has had to work on a large number of special regulations for these types of craft with a view to ensuring their safety and limiting the damage that they could cause by marine pollution in the event of serious accidents.

(*a*) For the transport of chemicals in bulk, a set of regulations applicable to existing ships has already been prepared, while a second and more detailed code applicable to the construction of new ships is under preparation.

(*b*) A code for carriers of liquefied petroleum gas and natural gas will be drawn up in the near future.

(*c*) A great deal of work has been done on the establishment of regulations for oil tankers, aimed at reducing the risk of accidents (collisions, running aground) and of consequent leakage of oil.

The methods adopted for reducing the risk of accidents include:

(i) Improving the manoeuvrability of large ships;

(ii) Studying the effect of limiting the size of tanks, i.e., increasing the degree of subdivision in tankers.

(*d*) IMCO is also studying design and construction criteria for certain types of new craft (hovercraft, drilling rigs, etc.).

2.4.5. *Nuclear ships*

In collaboration with the International Atomic Energy Agency (IAEA) and the Government of the Federal Republic of Germany, IMCO organized a Symposium on Nuclear Ships held in Hamburg in May 1971. The Symposium dealt with the technical, legal and economic problems connected with nuclear ships, and the following were the main topics considered:

(a) *Examination of national programmes and plans*

Short summaries of national programmes were presented, covering in particular the main research and development activities, short- and long-term plans for the construction of nuclear merchant ships, and the role of such ships in international maritime transport. Regional and international organizations also presented their programmes of activities connected with nuclear ships.

(b) *Special problems in the design of nuclear ships*

The Symposium had before it documents describing special considerations and provisions with respect to the construction of different types of nuclear ships and associated installations, especially, regarding the location of the reactor on board such ships, the adaptation of different components to suit the reactor (motors, steering gear, propellers, etc.), and the necessary auxiliary systems. Consideration was given to the shore services and related installations required (such as installations for recharging the reactor), to new types of ships especially adapted for nuclear propulsion, such as ships with multiple hulls (catamarans) and submarine tankers, and to expected developments in the size and speed of new nuclear ships.

(c) *Nuclear propulsion equipment for ships*

In this field, consideration was given to criteria governing the selection of propulsion

systems (pressurized-water, boiling water or gas-cooled reactors), and to the special characteristics that must be taken into account in the design and manufacture of nuclear components and systems.

(d) *Experience in the construction and operation of nuclear ships*

Consideration was given to documents summarizing the experience acquired in the construction, operation and maintenance of nuclear ships; their characteristics and performance; and experience of major components, especially fuel, control gear, and auxiliary systems.

(e) *Safety of nuclear ships*

The Symposium considered documents relating to safety in the design, operation and maintenance of nuclear ships under normal and abnormal conditions and to the experience acquired in this field. The documents covered such questions as: manoeuvring, prevention of collisions and shipwrecks, the reactor casing, mechanical systems of protection; training of the crew; radiation protection, and methods of classification.

(f) *Entry into port of nuclear ships*

Consideration was given to the general question of the use of ports by nuclear ships, especially the measures that must be taken prior to entering port, regulations for transit to or from the berth, presence in the berth, mobility of the ship, control of radioactivity in the port and administrative regulations in respect of accidents. The Symposium also studied the international legal status of nuclear ships and the possible standardization of documents and procedures.

(g) *Responsibility and financial coverage of nuclear-powered ships*

An examination was made of the application of the principles of third-party responsibility of persons operating nuclear-powered ships (1962 Brussels Convention), the principal common features in certain countries' national legislation relating to the financial coverage of nuclear ships, and the problems of insuring such ships.

(h) *Economic problems arising in connexion with the use of nuclear ships*

General considerations were studied regarding the economic viability of nuclear ships, especially the economic criteria used, classic procedures and methods for analysing risks when assessing economic viability and non-financial factors, economic viability of different types of nuclear ships and related installations, and special routes and missions for nuclear ships.

2.4.6. *Safety of navigation*

A considerable effort has been made to introduce measures and regulations concerning the obligation to equip vessels with navigational aids.

Measures to improve the organization and separation of traffic lanes. In 1961, the national maritime organizations of France, the Federal Republic of Germany and the United Kingdom undertook a study of suitable measures for separating traffic in the English Channel and, subsequently, in other areas where statistics point to a serious risk of collision.

IMCO has continued work in this field, extending the basic idea of separating traffic moving in opposite directions to many areas throughout the world, and it recently published information on general principles for the organization of traffic, the methods utilized and the areas where traffic-separation measures have been adopted.

Numerous navigation routes have been recommended, especially in the Baltic Sea, the Mediterranean, the Black Sea, the Indian Ocean, and around Southern Africa and America (Atlantic and Pacific coasts), while many other routes and improvements to existing routes are currently being studied by the Sub-Committee on Safety of Navigation.

Performance standards for shipborne navigational equipment. The standardization of the controls of radar equipment and plotting devices is being studied by the Sub-Committee on Safety of Navigation in collaboration with the International Radio-Maritime Committee which is also working on the subject.

IMCO Assembly resolution A.146 (ES.IV) states that facilities for plotting radar information must be available on the bridge. Recommendations have also been adopted by the Assembly regarding the presence on board of electronic position fixing equipment (gyro-compass, automatic pilot, direction finder, echo-sounder, radar), and the utilization and testing of shipborne navigational equipment in general.

Certain amendments are to be made to the recommendations regarding radar equipment

specifications drafted in the past by the Sub-Committee, and recommendations concerning gyrocompasses and echo-sounders, as well as a document on "International Performance Standards for Shipborne Navigational Aids" will be completed in the near future.

Revision of regulations for preventing collisions at sea. At its seventeenth session in April 1968, the IMCO Maritime Safety Committee requested the Sub-Committee on Safety of Navigation to carry out a detailed study of the regulations for preventing collisions at sea with a view to their possible revision.

Since the adoption of the regulations in 1960, many measures have been adopted by the organization on matters having an actual or potential connexion with the regulations and their revision, including the following:

(*a*) Identification lights for oceanographic stations;

(*b*) Lights and signals for tugs and for vessels being towed;

(*c*) Recommendations concerning shallow-draught vessels;

(*d*) Recommended lights, marks and visible and sound signals for fishing boats;

(*e*) Special light signals for vessels requesting pratique;

(*f*) Interpretation of certain regulations for preventing collisions at sea.

This list, however, is not exhaustive and many other matters are being studied.

At its eighteenth session in October 1968, the Maritime Safety Committee confirmed its decision to devise an amendment procedure taking account of the amendments of substance that it might be desirable to make to the existing regulations, which, although amended in the past, no longer properly reflect current needs and do not take full account of present navigating conditions.

The reasons invoked for modifying or revising some of the existing regulations include the following:

(*a*) The appearance of new types of craft, such as hovercraft, etc.;

(*b*) The appearance of high-speed, highly manoeuvrable vessels such as container ships;

(*c*) The existence of large, deep-draught ships of moderate speed and limited manoeuvrability, sometimes carrying potential pollutants, which find it particularly difficult to comply with certain existing regulations;

(*d*) The development of drilling rigs and production platforms that may require special signals or the adoption of special regulations;

(*e*) The development of oceanographic stations which are so varied in nature that they pose problems of classification and signalling;

(*f*) The adoption of recommended routes and traffic-control measures in areas of intense or particularly difficult navigation that may require the adoption of a separate code, the prohibition of fishing, or the study of special provisions for ships crossing the main route;

(*g*) The new practice of using helicopters instead of launches to transport pilots.

An international conference is scheduled in principle for the end of 1972 to draft the new regulations.

2.4.7 *Space radiocommunications*

The Sub-Committee on Radiocommunications has studied the requirements of the maritime mobile service in respect of the use of space techniques.

The projected international satellite system should permit both the transmission of telephone, telegraph and facsimile messages and the fixing of position by radio, and its purpose would be to improve the effectiveness of safety provisions, facilitate the exchange of information to secure more economic use of ships, and permit public communications. IMCO has therefore proposed certain amendments to the International Telecommunication Union's frequency distribution table, while a number of recommendations regarding pilotage, harbour services, electronic positioning equipment and signal lights to warn deep-draught vessels navigating in relatively shallow waters are directed at Governments.

2.4.8 *Radiocommunications*

The relevant international text is Chapter IV of the 1960 London Convention drafted under the auspices of IMCO. This chapter governs the installation of radiotelegraphy and radiotelephone stations on board ship and the use of such stations in accordance with the ITU's international radiocommunication regulation.

Since 1960, several studies have been undertaken by IMCO with a view to promoting and regulating the use of radiocommunications at sea so as to improve the safety of navigation, while several recommendations have been adopted and various amendments made to the original text of the 1960 London Convention.

The studies have dealt mainly with improving the distress call system, specifications for ship-borne equipment, provisions governing new types of ships (hydrofoils, hovercraft, etc.), direction finding, and communications between ships and aircraft.

The appropriate specialized IMCO sub-committee played an active part in the preparation of documents submitted to the world conference on the administration of space radiocommunications which was held in Geneva in June 1971 under the auspices of ITU.

At its fourth session, the IMCO Assembly adopted a new International Code of Signals, designed to allow vessels to communicate rapidly and without language difficulties, which came into effect in 1969. IMCO will continue its constant efforts to improve the contents of the code.

2.4.9 *Safety of human life at sea*

With regard to the safety of human life at sea, the organization is studying the revision of existing regulations, recommendations applicable to special ships, and provisions governing lifeboats on tankers. It has also defined methods for testing and approving lifejackets.

Revision of existing regulations. Certain amendments to existing regulations are being studied with a view to standardizing the number of lifeboats and other items of life-saving equipment in the light of the changes suggested following the amendment of Chapter II abolishing the relationship between the number of subdivisions on a ship and the lifeboat capacity.

Other projects are being studied in connexion with lifeboats on passenger ships holding short-sea certificates but able to travel up to 1,200 miles provided they satisfy the subdivision standard designed to ensure stability following any damage. In such cases, division into two watertight compartments is set as a minimum standard.

Life-saving equipment for special ships. The organization is studying the recommendations applicable to special ships not covered by the 1960 Convention, such as hydrofoils, hovercraft and drilling rigs, and regulations have been prepared regarding the life-saving equipment to be maintained on board. The Maritime Safety Committee has also approved the recommendations concerning safety gear of manned Ocean Data Acquisition Systems (ODAS).

Studies are currently being conducted on life-saving equipment on large vessels (location, disposition and accessibility) and on life rafts equipped with hydrostatic launching devices.

Fire-resisting lifeboats. Recommendation 20 of annex D of the 1960 Convention requires the Contracting Governments to study the provisions applicable to lifeboats on board tankers.

Since such ships have to be equipped with fire-resisting lifeboats, the study should cover construction materials, sprinkler devices, and protection measures against flames, high temperatures and smoke.

Although studies have been undertaken by several countries, the use of special lifeboats on tankers has not yet been made compulsory. The Maritime Safety Committee nonetheless expressed the view that studies should be pursued on the following main points: design and fittings of lifeboats; performance and requirements in use; launching devices and methods; protection of the area where the lifeboats are installed.

2.4.10 *Training of masters, officers and seamen*

A joint IMCO/ILO committee has been given responsibility for keeping permanently up to date, in the light of improvements in techniques, a document designed to serve as a guide for the training of masters, officers and seamen. The document is circulated by the two organizations to their member States, which are required to distribute it as widely as possible among bodies and institutions engaged in the training of mariners. The manual deals with the following technical problems: use of radar; international regulations of preventing collisions at sea; navigation at sea; electronic position-finding systems and echo-sounders; electronic direction-finding; navigational aids (beacons, lightships, etc.); adequate knowledge of meteorology; magnetic compass and gyrocompass; knowledge and use of the International Code of Signals; fire-prevention and firefighting devices; use and maintenance of life-saving appliances; knowledge of emergency procedures for ensuring the safety of the ship, crew and passengers, and ability to implement them; knowledge of ship manoeuvres in harbour and at sea, and measures to be taken to ensure the ship's safety in bad weather; general knowledge of the construction of ships and ability to use stability data; knowledge of safe methods of handling and stowing cargo;

medical matters; search and rescue; and prevention of pollution of the sea.

IMCO has also prepared a Merchant Ship Search and Rescue Manual (MERSAR) containing instructions for members of the crew of the vessel in danger and for those participating in the search and rescue operations, and describing how such operations should be carried out.

2.4.11 *Prevention of pollution of the sea*

In 1959, IMCO took over the tasks deriving from the 1954 Convention for the Prevention of Pollution of the Sea by Oil which had previously been carried out by the Government of the United Kingdom. At the same time, it assumed the responsibility, hitherto incumbent upon the United Nations, of compiling and distributing technical data on pollution by oil. The following year, in connexion with an international conference on the subject, IMCO conducted an extensive study on the extent of pollution of the sea by oil, on port facilities for the disposal of oil discharged from ships, and on the progress made in research into ways of combating this danger. A survey modelled on an earlier United Nations study was made, and the replies formed part of the documentation for the international conference convened by IMCO on the prevention of pollution of the sea by oil.

The latter Conference drafted the 1962 Convention which is now in force on the prevention of pollution of the sea by oil. This convention, which became effective on 27 June 1967, extended the scope of the 1954 convention and established stricter provisions. In 1965, however, as the question of oil pollution continued to preoccupy IMCO, a Sub-Committee on Oil Pollution (later known as the Sub-Committee on Marine Pollution) was established to continue studying the problem of pollution by oil and other pollutants.

Following the *Torrey Canyon* disaster in 1967, IMCO took immediate steps to improve the situation, and an 18-point programme covering technical and legal aspects was implemented. Towards the end of 1968, an IMCO Assembly specially convened to examine the *Torrey Canyon* programme, adopted measures designed to reduce the danger of a repetition of such an incident and to promote the adoption of rapid and effective measures to cope with any recurrences. The measures included recommendations for fostering closer national and regional co-operation in the fight against pollution, introducing effective systems for detecting the escape of large volumes of oil, and applying both the clauses dealing with the detection of infractions and the provisions of the 1962 Convention for the Prevention of Pollution of the Sea by Oil.

The Assembly also adopted a number of practical measures for preventing such accidents and for protecting human life at sea in general, it approved amendments to the 1960 Convention on the latter subject, to the effect that navigational aids employed by ships must conform to certain requirements, and it approved a large number of provisions concerning the separation of traffic in areas of high shipping density.

At its sixth session in October 1969, the Assembly adopted far-reaching amendments to the 1954 International Convention for the Prevention of Pollution of the Sea by Oil. These amendments, which were circulated to the Contracting Parties for their approval, are designed to base the Convention, with certain exceptions, on the principle of the total prohibition of discharging oil from ships, and will facilitate the task of the authorities responsible for applying it. Current arrangements for signalling oil pollution are being revised with a view to drafting suitable recommendations.

In accordance with United Nations General Assembly resolution 2414 (XXIII) and 2467 (XXIII), IMCO is at present studying the technical and legal possibilities of drafting, in collaboration with other United Nations institutions, appropriate international conventions or agreements on the prevention and control of pollution of the soil, sea and atmosphere by ships or any other kind of maritime equipment. In this connexion, the IMCO Assembly has decided to convene an international conference in 1973 for drafting an international agreement on pollution of the sea.

As a member of the Group of Experts on the Scientific Aspects of Marine Pollution (GESAMP), IMCO is studying in collaboration with the United Nations and its specialized agencies, the scientific and technical aspects of the prevention and control of pollution. It also took part in the preparation for the June 1972 United Nations Conference on the Human Environment in Stockholm.

2.4.12 *Dangerous goods*

The transport of dangerous goods has been the subject of national regulations in maritime

countries that have frequently been difficult to reconcile at the international level.

It was therefore particularly appropriate that IMCO should establish a set of regulations standardizing the requirements in respect of the international transport of dangerous goods, and the International Maritime Dangerous Goods Code thus undertaken is now practically completed. The Code will be brought up to date periodically by means of additional circulars on new products that can be transported by sea.

Besides providing data on the products themselves, the Code gives all necessary details regarding the packing, labelling and stowing of dangerous goods and methods of combating fires on board ships transporting them. The Code accordingly:

(*a*) Divides dangerous goods into nine classes[4] and provides precise definitions for their classification;

(*b*) Indicates the need to designate the goods accurately, the way this should be done, and the appropriate way the packing should be marked;

(*c*) Recommends packing that has demonstrated a high level of safety and describes the strength tests that should be carried out;

(*d*) Deals with packages of dangerous goods packed in containers and with the appropriate safety precautions to be taken;

(*e*) Recommends certain standards regarding the stowing of dangerous goods and distinguishes between two categories of ship, according to the number of passengers carried;

(*f*) Stresses the need to separate substances that might have dangerous chemical reactions when in contact with other substances and indicates the standards to be applied;

(*g*) Describes the steps to be taken to prevent fires in dangerous cargoes and how to combat such fires when they occur.

Furthermore, at the suggestion of the Economic Commission for Asia and the Far East (ECAFE), the Maritime Safety Committee, together with ILO and the International Cargo Handling Co-ordination Association (ICHCA), is studying the handling of dangerous goods in ports.

[4] The nine classes of dangerous goods are: explosives; inflammable gases; inflammable liquids; inflammable solids; spontaneously combustible substances and substances which are dangerous when wet; oxidizing agents and organic peroxides; poisons; radioactive substances; corrosives, and miscellaneous dangerous substances.

2.4.13 *Transport of products in bulk*

The loading and stowing of bulk products have a considerable bearing on safety of navigation, particularly as regards stability. The 1960 London Conference devoted Chapter IV of the Convention for the Safety of Life at Sea to this subject.

Subsequently, IMCO studied the transport of a number of bulk products and compiled a set of recommendations for ships' masters. The regulations on the subject are periodically reviewed in the light of the experience gained in maritime transport and are modified as necessary.

Other studies have been conducted on the transport of concentrated minerals and on their humidity level. It is important to determine this level at the time of loading since, if it is excessive, the cargo could become sufficiently liquid during the journey to threaten the stability of the ship.

2.4.14 *Container transport*

The question of maritime transport in containers was considered for the first time by the Maritime Safety Committee at its eighteenth session in March 1968, when it requested the Sub-Committee on Containers and Cargoes to prepare a draft proposal covering all the safety aspects of the maritime transport of containers.

Statistical surveys were undertaken on accidents and damage connected with containers, and it was shown that containers offered a high degree of safety during both shipment and handling. Subsequently, with a view to establishing minimum standards to maintain safety at a high level, the first draft was prepared of an international Convention for Safe Intermodal Transport of Containers. The draft covers the following points:

(*a*) Minimum technical requirements for containers (strength, construction, load factors and testing);

(*b*) Certificates and plates indicating acceptability from the safety point of view;

(*c*) General principles applicable to the maritime transport of containers;

(*d*) Stowage of cargo inside containers;

(*e*) Handling of containers.

IMCO is also studying other aspects of the transport of containers:

(*a*) Structure of container ships;

(*b*) Stability of ships transporting containers;

(*c*) Fire prevention aboard such ships;

(*d*) Transport of dangerous goods in containers.

The United Nations and IMCO are to hold a Conference, in Geneva in November 1972 to consider the technical, administrative and legal aspects of International Container Traffic.

2.5 *Facilitation of maritime travel and transport*

Most of IMCO's work in this field is of a technical nature. The only administrative issue studied so far has been how to simplify existing formalities. In 1961, the IMCO Assembly recognized that it was necessary to simplify and reduce the number of official documents and formalities required for ships entering or leaving ports. As a result, it approved a proposal by the Council to set up a Group of Experts to study how to facilitate travel and transport.

The Group of Experts began its work in 1962 and set up three Sub-Groups responsible for considering customs, health and immigration aspects with a view to reducing the paperwork involved in international navigation. In January 1965 its work culminated in the preparation of a draft convention.

In 1965, the International Conference on Facilitation of Maritime Traffic, sponsored by IMCO, approved the Convention on Facilitation of International Maritime Traffic, which entered into force in 1967. The Convention sets out recommended practices and standards which Governments are called upon to comply with, reduces to eight the number of official documents (as opposed to commercial documents) that ships are obliged to present, and simplifies the formalities required.

The Conference recommended that international consultations should be held periodically to ensure that the recommended standards and practices remain in line with modern techniques and genuinely facilitate port traffic. An *Ad Hoc* Working Group on Facilitation, consisting of experts from the Governments which have signed the Convention, meets regularly at IMCO headquarters. In 1967, the IMCO Assembly approved six of the standard forms provided for under the Convention and proposed by the Group (General Declaration; Cargo Declaration; Ship's Stores Declaration; Crew's Effects Declaration; Crew List; Passenger List).

2.6 *The Legal Committee*

In 1967, the IMCO Council established the Legal Committee to consider the legal problems arising out of the loss of the *Torrey Canyon* and subsequently to examine all legal problems put before the Organization.

2.6.1 *International Legal Conference on Marine Pollution Damage*

In the autumn of 1969 IMCO convened the International Conference on Marine Pollution Damage, which at the invitation of the Belgian Government, was held in Brussels. The Conference's discussions were based on draft conventions prepared by the IMCO Legal Committee. The Conference approved and opened for signature the following two Conventions:

(*a*) International Convention Relating to Intervention on the High Seas in Cases of Oil Pollution Casualties (Public Law).

(*b*) International Convention on Civil Liability for Oil Pollution Damage (Private Law).

The first of these Conventions deals with the right of a coastal State to intervene and take measures to protect its coastal and other related interests when a casualty which may be reasonably expected to result in grave and imminent danger to those interests occurs on the high seas.

The second Convention aims at ensuring that adequate compensation is available to persons who suffer oil pollution damage resulting from maritime casualties involving oil-carrying ships. The Conference noted that, although it lays down the principle of strict liability and provides for a system of compulsory insurance or other financial guarantee for ships carrying oil in bulk as cargo, the Convention does not afford complete protection for victims in all cases.

The Conference therefore recommended that IMCO, through its Legal Committee and other appropriate legal bodies, should elaborate a draft convention on the creation of an international compensation fund for oil pollution damage, and should convene an international conference no later than 1971 to examine and adopt the draft.

The Conference decided to limit the scope of the two Conventions to oil, but recognized that the question of pollutants other than oil was of considerable importance and needed to

ɔe studied as soon as possible. The Legal Committee decided to undertake this study at a ater stage, in the light of technical and other nformation which might become available as a result of studies currently being carried out in collaboration with other organizations in the United Nations system.

2.6.2 *Topics for study*

The Legal Committee is also studying the following topics:

(a) *Legal status of manned and unmanned devices used in oceanographic investigation (Ocean Data Acquisition Systems).* At its sixth session the IMCO Assembly invited the Legal Committee to give priority to consideration of a draft for a convention on the legal status of Ocean Data Acquisition Systems (ODAS). The results of its consideration are to be communicated to Governments and interested agencies prior to the convening in 1972 of a meeting of governmental experts sponsored by IMCO and the International Oceanographic Commission (IOC) of UNESCO. This meeting will prepare a series of final drafts of provisions for submission to a diplomatic conference also to be sponsored jointly by IMCO and UNESCO (IOC), in 1973.

(b) *Legal aspects relating to the combined transport of goods and in particular the intermodal transport of containers.* The Legal Committee has participated actively in the preparatory work on the draft Convention on Combined Transport, in collaboration with the International Institute for the Unification of Private Law (UNIDROIT), with which IMCO has signed an official co-operation agreement, and with the Comité Maritime International. In 1972, a joint United Nations/IMCO conference is to be held on international container traffic.

(c) *Legal problems relating to the maritime carriage of nuclear substances.* At its sixth session in April 1971 the Legal Committee examined a draft convention aimed at filling gaps and resolving contradictions in the various conventions covering civil liability for nuclear damage and in certain conventions on maritime transport in general.

This issue is also of concern to the International Atomic Energy Agency (IAEA) and to the European Nuclear Energy Agency of the Organization for Economic Co-operation and Development (OECD).

(d) *Questions relating to the removal of wrecks and general aspects of salvage and rescue.* The Committee decided to continue studying these issues in the light of the results of its work. At its September session, it considered a preliminary draft of a convention on the removal of wrecks or wreckage on the high seas. This draft was prepared by Professor Yzal of Spain, and has been communicated to Governments by the Comité Maritime International.

(e) *Legal questions relating to conditions of transport and in particular liability for shipborne passengers and baggage.* The Legal Committee may study these questions in the near future in collaboration with the Comité Maritime International, which has prepared a draft Convention on passengers and baggage.

(f) *Work deriving from collaboration between IMCO and other United Nations organs and agencies in matters of interest to IMCO.*

(i) Legal problems deriving from the work of the United Nations Committee on Peaceful Uses of the Sea-Bed and the Ocean Floor beyond the Limits of National Jurisdiction.

(ii) Legal problems relating to the protection of the human environment, deriving from the work of the United Nations Conference on the Human Environment.

(iii) Aspects of maritime law and associated international maritime legislation that may require examination as part of co-operation between IMCO, UNCTAD and UNIDO.

(g) *Comparative study of IMCO Conventions and similar Conventions of the International Civil Aviation Organization (ICAO), the World Health Organization (WHO) and the World Meteorological Organization (WMO).* At its twenty-second session, the IMCO Council approved a recommendation by the Working Group on IMCO's Objectives and Methods inviting the Legal Division to undertake a comparative study of the Conventions of which IMCO is the depositary and the Conventions falling within the purview of other United Nations agencies, such as ICAO, WHO and WMO. The Legal Division began this study in 1971.

2.7 *Technical assistance*

In 1965, IMCO began to move into the field of technical assistance. It participates as a specialized agency in the United Nations Development Programme (UNDP), and as such is represented on the Inter-Agency Consultative Board.

At its twentieth session in May 1968, the Council requested the Secretary-General to undertake a survey of the technical assistance needs of the developing countries and of the resources that are available or are required to meet those needs.

At an extraordinary session held in March 1969 exclusively to discuss problems of technical assistance, the Council studied the results of this survey and other documents and expressed the desire that IMCO should play a greater role in providing technical co-operation in fields within its purview, in collaboration with other organizations of the United Nations system.

2.7.1 *Working Group on Technical Co-operation*

At its March 1969 extraordinary session, the Council set up a Working Group on Technical Co-operation to advise and guide its work, with the following mandate:

(*a*) To examine and evaluate progress achieved in the implementation of UNDP technical assistance projects for which IMCO is the executing agency and in other aspects of IMCO's technical assistance activities in matters within its competence;

(*b*) To keep under review:

(i) The work of the secretariat in connexion with technical co-operation programmes;

(ii) The studies undertaken by the secretariat to identify the problems encountered by the developing countries in implementing IMCO's recommendations and the Conventions of which IMCO is the depositary;

(iii) The measures taken to solve the problems mentioned in point (ii) above, using technical co-operation resources.

The Working Group meets twice a year and reports to the Council. At its first session, the Working Group noted with particular interest, and unreservedly approved, a report by a technical assistance consultant on the problems encountered in some Latin American countries in the application of the provisions of IMCO's recommendations and the Conventions of which IMCO is the depositary. Representatives considered that IMCO's work should be better known in Latin America. The report noted that one of the main reasons why IMCO was less well known in Latin America than other United Nations agencies was that Spanish was not a working language of IMCO. Moreover, the competent authorities in the Latin American countries had often pointed out that the lack of working documents in Spanish made it difficult to apply IMCO recommendations.

The Working Group considered that this was a matter of great importance. The Council, after considering this conclusion, decided that the reports of the principal organs of IMCO should be reproduced in Spanish. The financial implications of this decision were considered at the next IMCO Assembly, and appropriate provision was made in the 1972/1973 budget.

After examining the reports of the Working Group, the Council took a number of other decisions. At its twenty-fourth session it requested the Secretary-General to invite member States to submit to IMCO any technical assistance requests that for some reason had not met UNDP requirements, as well as requests that had not been submitted to UNDP. IMCO would evaluate such requests and channel them to donor countries so that the projects might be implemented through regular programmes of bilateral aid to developing countries.

At its session in May 1972, the Council decided to raise the status of the Working Group on Technical Co-operation, renaming it the Committee on Technical Co-operation, and re-open the membership to all IMCO Member States.

2.7.2 *Technical Co-operation Division*

The Technical Co-operation Division, is concerned with IMCO's participation in UNDP activities and also with assistance to developing countries regarding maritime transport. Such assistance is provided in the form of experts, fellowships and a modest amount of equipment. IMCO helps Governments to prepare and implement their programmes and to formulate their requests for assistance to the United Nations Development Programme (UNDP).

IMCO provides experts and fellowships in such fields as: legislation and regulations applicable to ships and maritime transport; safety of navigation; ship design; technical aspects of naval architecture; specialized ships and offshore constructions; transport of cargoes; administrative functions connected with the safety of ships; ports; pollution caused by ships; measures to facilitate travel and transport; and personnel training.

IMCO has set up an Interregional Maritime Training Centre in the Greek Governmental School for Electronic Aids to Navigation, at the port of Piraeus in Greece. Its basic aim is to train masters, officers and seamen in the use and proper maintenance of electronic aids to navigation, such as radar, Decca and lovan equipment, gyro-compasses, direction-finders, echo-sounders, electrical logs, and radiotelephone equipment.

IMCO is the executing agency for a UNDP (Special Fund) $1.2 million project to train Brazilian merchant marine personnel. In co-operation with the United Nations and UNCTAD, IMCO helped the Governments of the Arab States to prepare a request for a project to train land- and sea-based maritime personnel and to the executing agency for a $2.3 million Arab States Regional Maritime Transport Institute which is being set up as a result. IMCO is also the executing agency for the development of a Ship Research and Design Institute in Bulgaria to which UNDP has contributed $1.3 million. In addition, IMCO is collaborating with ILO and UNCTAD in a project for which ILO is the executing agency regarding the reorganization of the port of Conakry in Guinea, and it also has a number of other projects currently under study.

A STUDY OF THE ECONOMIC AND SOCIAL CLASSIFICATION OF THE LATIN AMERICAN COUNTRIES

I. INDICATORS AND CLASSIFICATIONS

1. *Introduction*

The typology and classification of Latin American countries presented in this paper do not represent a finished undertaking, and still less a formal proposal, but rather a contribution to the studies which have been made on the identification of levels and types of development. A start has also been made on a systematic analysis of the basic indicators, in view of their importance in work on the evaluation of development.

It has been considered desirable to try to work out types or classes of countries on the basis of a wide variety of economic and social indicators representing the level of living and the structure and dynamic aspects of the economies of the countries under examination, even though more easily interpreted results could have obtained by confining the study to purely economic indicators or, even more narrowly, to indicators of industrial development or other well-defined variables.

The following are the main general objectives of the classification and typology of the Latin American countries:

(*a*) Grouping the countries of the region according to their similarities and differences, so as to facilitate the formulation of action strategies for the accelerated economic and social development of kindred countries;

(*b*) Carrying out analyses, diagnoses and prognoses for various classes or types of countries, pointing out suitable lines of comparison and evaluation in connexion with the Second United Nations Development Decade;

(*c*) Examining other possible uses of the classifications in question, either of a substantive nature, such as the identification of homogeneous or complementary areas to aid in the study of economic integration, or of a methodological nature, such as the grouping-together of countries to be studied in the execution of projections, or other research work.

(*d*) Establishing grades or levels which reflect the situation and growth capacity and potential of the countries.[1]

The method used in the analysis is that of the simultaneous consideration of several characteristics or indicators, rather than their combination into a single global index. One or more global indices may be obtained as a by-product of the classification, and a number of experiments involving the determination of such indices and their use as a basis for other classifications have been made, without, however, losing sight of the fact that one of the aims of the study is to establish classes or groups of countries, not necessarily arranged in order.

In the present study an attempt is made to express levels of development both from the economic point of view, using such indicators as the per capita gross national income, and from the social point of view, in all its different aspects, which correspond to a broader concept than the mere production of goods. Some of the elements considered relate to a prerequisite for attaining an adequate level of living, and appear as such among the components of the level of living index prepared by the United Nations Research Institute for Social Development.[2] This index also covers other aspects such as security, leisure and recreation, etc., which are not considered in the present study owing to paucity of information, but

[1] For instance, the Committee for Development Planning, at its sixth session held in New York from 5 to 16 January 1970 (E/4776, para. 50), proposed the introduction of an intermediate group of countries, neither developed nor developing, which would neither give nor receive financial aid. The classification given to a country could obviously have an important effect on its rights and obligations during the Second United Nations Development Decade.

[2] See Jan Drewnowski and Wolf Scott, United Nations Research Institute for Social Development, *The Level of Living Index*, Report No. 4, Geneva, September 1966. Henceforth footnotes containing author references will include only the year of publication, all other information being contained in the bibliography at the end of the document.

which should be taken into account in future studies, together with such questions as pollution of the atmosphere, delinquency, etc.

2. *Characteristics or indicators used as a basis for the classification*

The objectives in the selection of the characteristics or indicators was that, subject to the availability of indicators, each one should as far as possible, reflect a different concept. Only those Latin American countries for which there was a homogeneous supply of information covering the different indicators selected were included in the classification.

The classifications made in the first stage take no account of the structural characteristics of the economies of the countries considered or of certain representative values such as mean coefficients, propensities and elasticities. In the second stage, however, the classifications do take account of these aspects and are compared with the results obtained in the first stage in order to ascertain the degree of correspondence between the two sets of results.

The indicators used include those considered by the Committee for Development Planning to be necessary for an overall assessment of development, namely: (*a*) total production and sectoral production; (*b*) employment; (*c*) levels of living; (*d*) investment and saving; and (*e*) foreign trade and the balance of payments.

In subsequent studies it would be desirable to consider not only indicators of what has actually been achieved, but also indicators which permit evaluation of the effort made by the countries of Latin America during the Second United Nations Development Decade.

The 23 characteristics or indicators of the level of living used in the first stage are as follows:[3]

Group I. *Level of income*

- (*a*) Per capita gross national income

Group II. *Health and nutrition*

- (*a*) Life expectancy at birth
- (*b*) Number of hospital beds per 1,000 inhabitants
- (*c*) Per capita calorie intake
- (*d*) Per capita intake of proteins

Group III. *Education*

- (*a*) Percentage of literate persons in the over-15 section of the population
- (*b*) Ratio of number of persons with secondary education to the total population
- (*c*) Ratio of primary school enrolment to the population of school age
- (*d*) Ratio of secondary vocational enrolment to the 15-19 section of the population
- (*e*) Number of university graduates per 100,000 inhabitants
- (*f*) Public expenditure on education as a percentage of national income

Group IV. *Housing*

- (*a*) Average number of persons per room
- (*b*) Percentage of dwellings with piped water facilities
- (*c*) Percentage of dwellings with main drainage facilities
- (*d*) Percentage of dwellings with electric light

Group V. *Consumption*

- (*a*) Apparent per capita energy consumption
- (*b*) Apparent per capita consumption of newsprint
- (*c*) Apparent per capita consumption of cement
- (*d*) Apparent per capita consumption of rolled products
- (*e*) Motor vehicles per 1,000 inhabitants
- (*f*) Radio receivers per 1,000 inhabitants
- (*g*) Telephones per 1,000 inhabitants
- (*h*) Television sets per 1,000 inhabitants

[3] These indicators were selected in the light of discussions and consultations with officials of various specialized divisions and bodies. All information on the sources and preparation of the indicators will be found in Annex 1.

Next, new indicators relating to the structure and growth of the economy were considered. These indicators correspond basically to two periods, one extending from 1950 to 1959 and the other from 1960 to 1969.[4]

The indicators selected represent some of the main economic and social aspects of the Latin American countries, such as the growth and composition of the product, the size of each country's domestic market, employment of labour, the degree of urbanization, the growth rate of the population, the degree of openness of the economic system to external trade, the effects of the terms of trade, and the level of external debt payments and remittances of profits and interest.

Unlike other classification projects, this study was not based on a specific conceptual scheme with which the classification was kept in strict conformity; instead, various aspects were considered very fully so that the basis of the classification would cover the actual economic and social situation in a broader and more general manner.

Obviously, most of the indicators are descriptive and do not in themselves reveal the causes and processes that gave rise to the situations that they reflect, so that the resultant classifications, which represent typologies of situations rather than of causes, can only be interpreted in the light of these limitations. The simultaneous consideration of as many aspects as possible, is therefore important, because it dilutes the possible effect on the final result of a specific indicator or set of indicators, that relate only to a partial factor, although if required there would be no difficulty in specially adapting the method for application to a more limited objective.

It is very important to bear this in mind, since it may often happen that, when evaluating the results of a given classification, factors that were not included among the indicators used may unknowingly be considered.

The indicators used for the classification according to structural and dynamic aspects of the economy are as follows:

I. *Demographic aspects*

(*a*) Total population (according to census results for around 1960)

The following indicators are expressed as percentages of the total population recorded in the 1950 and 1960 censuses:

(*b*) Economically active population employed in agriculture

(*c*) Economically active population employed in mining

(*d*) Economically active population employed in industry

(*e*) Economically active population employed in services

(*f*) Total economically active population employed

(*g*) Urban/rural distribution of the population: ratio of urban population to total population

(*h*) Growth rate of the population (Average annual growth rate for the intercensal period and the period 1976–1980)

II. *Structure of the gross domestic product (in terms of the average of the percentage contribution to the gross domestic product for the periods 1950–1959 and 1960–1969 by the following sectors)*

(*a*) Agriculture, forestry, hunting and fishing

(*b*) Mining

(*c*) Manufacturing

III. *Foreign trade and the balance of payments (averages for 1950-1959 and 1960-1969)*

(*a*) Export coefficient (percentage of gross domestic product)

(*b*) Terms-of-trade effect in relation to total exports

(*c*) Net factor payments to the rest of the world (profits and interest payments) as a percentage of total exports

(*d*) Volume of amortization and depreciation (as a percentage of total exports)

IV. *Growth aspects (period 1950-1960 and 1960-1969)*

(*a*) Average annual growth rate of the gross domestic product

(*b*) Average annual growth rate of manufacturing

(*c*) Average annual growth rate of mining

[4] Twenty variables are considered for both periods, as well as the total population in 1960, thus giving a total of forty-one indicators.

(*d*) Average annual growth rate of agriculture, forestry, hunting and fishing

(*e*) Average annual growth rate of exports

V. *Other values reflecting the economic structure that were used as a basis for the projections (1950-1969)*

(*a*) Marginal product/capital ratio

(*b*) Marginal propensity to save

3. *Some observations on the indicators*

The per capita gross national product was selected because of its importance as a general indicator of the level of growth or development,[5] which will be considered later. The remaining indicators reflect various different aspects, each group in the first stage of the classification referring to needs, whose satisfaction is considered essential to the development process.

It may be objected that some of the indicators are of doubtful quality. However, their usefulness should be considered not only in the light of the present results but also in the light of the contribution they can make to the future systematization and consequent improvement of the information.

As already noted, these indicators do not fully cover all aspects of the development process (such as institutional or cultural changes, etc.) many of which are not adequately represented by indicators, but the method used enables them to be introduced later as more and better information becomes available.

(a) *Indicators for classification by level of living*[6]

Per capita gross national income. This indicator represents the total of domestically produced goods and services that are available to the country. Consists of the gross domestic product corrected for the terms-of-trade effect and external factor payments, measured in dollars at constant 1960 prices. It may be considered as representative of economic development in so far as it reflects the results of the productive effort made. Its use as an indicator derives from the implicit recognition that an increase in the production of goods and services for domestic use is one of the objectives of development. Several authors, including M. Lipton (1968), consider that the growth of the product is the best global indicator of progress in the poorer economies, since it covers all kinds of resources which may make possible the improvement of working conditions, support for the arts and for scientific research, and increased productivity. P. Heinz (1968) and S. Schwartzmann (1968) also consider per capita income as an indicator of development in the broad sense.

This indicator has been used in many studies because of its easy availability and because it has the advantages of representing quite a clear concept and permitting a classification by quantitative levels.

It is no longer possible, however, in view of the various modifications that the concept of development has undergone to look at the question only from the purely economic angle of the volume of goods available. Account must also be taken of the social, political and institutional aspects, which are important enough to upset the primacy of strictly economic factors.

In view of this broader concept, per capita gross domestic income is obviously an inadequate indicator for reflecting all the processes and changes implicit in the concept of development.

The separate inclusion of this indicator will make it possible to analyse: (*a*) how far this indicator can be considered representative of other social aspects, particularly those for which indicators are also available, and (*b*) if it is not sufficiently representative, what other aspects should be taken into account in order to describe with an adequate number of types the characteristics of development as currently witnessed in Latin America. As a process of economic and social change, development does not follow the same pattern in all countries, nor can its structural characteristics be established along more or less rigid lines according to increases in the product. Although the development process may have external manifestations such as dynamic growth of industry, introduction of technology, increased literacy, etc., which are more or less similar everywhere, it is also profoundly affected by the particular characteristics of each individual country, which can only be detected by analysing their historical evolution to identify the origin and present significance of the prevailing economic, social and institutional structures.

[5] The differences between the concept of growth, development, etc., will not be discussed at this stage.

[6] See table 1.

Tab

INDICATORS USED IN THE FIRST STAGE OF TH

	Argentina	*Bolivia*	*Brazil*	*Colombia*	*Costa Rica*	*Chile*	*Ecu dor*
Per capita income	916.8	199.5	353.3	358.9	528.5	645.3	299.
Life expectancy at birth	67.4	45.3	60.6	58.5	66.8	60.9	57.
Population per hospital bed	160	435	350	400	268	253	440
Calorie intake	2,920	1,980	2,690	2,200	2,610	2,830	2,020
Intake of proteins	88.0	48.0	66.3	52.3	70.0	76.0	56.(
Percentage of literacy	91.4	39.8	60.6	72.9	85.8	88.8	72.(
Average level of educational attainment	12.5	5.21	3.70	7.33	8.05	18.0	7.5
Primary enrolment	104.6	84.77	114.34	84.67	110.88	116.7	90.2
Secondary enrolment	38.5	26.4	27.8	26.6	20.4	24.3	27.1
University enrolment	72	12	22	20	41	70.0	10
Public expenditure on education (Percentage of income)	3.2	2.2	1.1	3.1	4.6	3.2	2.2
Density of occupation of dwellings (average number of persons per room)	1.4	—	1.3	1.9	1.5	1.7	2.5
Percentage of dwellings with:							
Water	62.3	10.2	23.0	45.1	63.6	43.4	26.8
Main drainage	45.0	40.4	54.5	61.4	29.7	44.8	52.8
Electricity	77.6	—	38.7	68.2	54.6	70.6	32.3
Apparent per capita consumption of energy	1,218.0	183	354.0	506.0	255.0	1,020.0	192
Apparent per capita consumption of cement	137.1	14.2	69.6	95.3	85.5	146.4	52.3
Apparent per capita consumption of newsprint (tons per 1,000 population)	8.9	0.6	2.5	2.5	3.8	4.7	1.9
Motor vehicles per 1,000 population	50.0	5.7	17.9	7.3	18.7	12.6	3.6
Radio receivers in use per 1,000 population	308.0	142	95	118.0	91.0	187.0	122
Telephones per 1,000 population	66.8	7.8	17.2	38.3	17.3	31.7	8.2
Television sets per 1,000 population	82.0	—	30	21	44	6.0	10.0
Approximate consumption of rolled products per 1,000 population	70.2	8.1	31.5	20.7	32.3	52.4	10.4

SOURCE: See Annex 1 for information on the sources consulted and the qualification of indicators.

The development patterns followed by the most highly developed countries do not necessarily determine the lines to be followed by the other countries, so the typologies that may be established at a given moment are not permanently valid. Hence the undesirability of using this one indicator to represent the whole complex process of change.

Nor can the per capita national income be considered as an indicator of well-being for although it represents the volume of goods and services theoretically available per head of the population, it does not take into account their distribution, nor, consequently, their marginal utility to the population of the country. Moreover, the availability of goods and services may also be increased or reduced by trade balance surpluses or deficits. A country with a lower per capita gross national income than another country may show higher levels of consumption and investment over a given period as a result of a larger inflow of imports (another factor that could modify the supply of goods is variation of stocks). In such a case, this indicator would not adequately express the volume of goods actually available. Nor does it provide information on the extent to which the country under consideration uses its resources—an indicator which some authors regard as essential for measuring the level of development. For the purposes of this classification, however, greater weight has been given to the level of availability of goods and services than to the level of utilization of resources, the latter factor may be analysed

1

CLASSIFICATION (CLASSIFICATION BY LEVEL OF LIVING)

El Salvador	*Guatemala*	*Haiti*	*Honduras*	*Mexico*	*Nicaragua*	*Panama*	*Paraguay*	*Peru*	*Dominican Republic*	*Uruguay*	*Venezuela*
330.8	330.0	97.5	248.7	628.5	354.6	640.0	275.6	419.7	237.4	698.5	627.2
54.9	51.1	44.5	48.9	62.4	49.9	63.4	59.3	58.0	52.1	69.2	63.7
457	420	1,400	480	500.0	430	318	440	418	391	158	315
1,840	2,220	1,580	2,010	2,550	2,350	2,500	2,520	2,340	2,290	3,170	2,490
47.0	56.8	37.4	58.0	65.7	59.0	64.7	65.5	54.0	54.0	116.0	67.5
50.8	37.9	18.8	47.0	65.4	49.8	78.3	69.0	67.0	53.1	89.4	85.0
4.45	3.19	1.84	3.71	4.98	4.44	14.16	4.59	8.23	6.58	13.0	6.5
82.10	54.57	39.12	76.20	93.96	68.78	108.94	102.47	127.96	81.56	119.0	91.4
20.4	11.3	7.4	12.2	24.0	16.6	50.2	17.4	39.6	20.9	56.6	43.0
9	5	8.0	8	13	14	32	17	40	17	29	34.0
3.1	1.8	1.4	2.3	2.3	1.7	4.8	1.9	4.9	3.9	2.0	4.3
2.2	2.6		2.4	2.9	2.8	2.4	2.6	2.3	2.0	—	1.6
23.6	12.1	3.1	21.1	40.5	16.8	44.4	6.0	21.5	22.7	58.0	68.0
39.0	30.3	—	50.5	70.4	21.9	59.0	22.8	57.3	17.2	47.7	42.6
—	22.0	2.5	14.6	28.6	32.9	44.0	13.2	26.0	20.0	79.2	78.4
148	178	35.0	152	942.0	224	816.0	103	537.0	173	822.0	2,620.0
37.8	36.7	6.1	22.5	92.6	37.2	128.0	13.2	80.9	60.9	143.6	207.8
2.6	1.0	0.1	0.7	2.8	1.6	2.8	0.6	3.0	0.9	8.3	4.6
9.6	7.1	1.5	4.6	20.1	7.1	26.3	3.0	15.8	7.4	51.7	48.1
130	—	14.0	59	224.0	62	401	89	186.0	40	364.0	185.0
12.0	7.4	0.9	4.2	22	7.4	43.5	7.4	12.3	8.8	70.1	35.0
12.0	13.0	2.0	4.0	42	11.0	60	—	23	17.0	74.0	75.0
9.6	12.4	—	10.0	43.6	18.2	19.9	6.4	20.0	2.9	28.5	65.0

when the structural aspects of development are considered.

It is very difficult, however, to conceive of a process of economic development that is not accompanied by an increase in the production and distribution of goods and services (a condition which is necessary but not sufficient in itself), whatever the composition of this increase may be. Hence, the usefulness of this indicator lies in the way it reflects or measures productive effort, corrected in this instance to take account of two factors which are of particular importance in Latin America, namely, the terms-of-trade effect and external factor payments. The first factor measures, in relation to the base year, the increase or decline in the purchasing power of exports as a result of fluctuations in the prices of exports and imports, while the second factor reflects payments which countries must make in respect of investments or loans received.

It is not necessary to stress the difficulties of calculating the gross domestic product, which frequently lead to errors in the final figures but for which there is no easy and practical method of making corrections.

Another criticism that is frequently levelled at these indicators concerns their conversion into a single currency of stable purchasing power, in this case dollars at 1960 prices. This procedure is necessary in order to make the indicators comparable, for if they were expressed in the currency of each country,

they could only be used for domestic calculations and estimates. The biggest difficulty concerns the selection of the exchange rate to be used. The official exchange rate often fails to reflect the true relationship between the purchasing power of the two currencies, resulting in the under—or over—estimation of income. In many cases, too, it is not possible to speak of a single exchange rate because there are tariffs, taxes and subsidies which mean that in actual fact there are different exchange rates according to the use to which the foreign exchange is put. Nor is it advisable to take the free exchange rate in cases where exchange controls exist, since few transactions are carried out using this rate. Such situations give rise to distortions which seriously affect the results. The present work uses exchange rates based on the purchasing power equivalents established by ECLA, which are based on the formula of the geometric mean of the prices prevailing in June 1960 for a given basket of goods in Latin America and the United States.[7]

Health and nutrition. These primary objectives of development are considered together because they are closely interrelated. This is not to discount the influence of other factors, however, such as housing conditions, which are dealt with separately under other headings.

The following are some of the health and nutrition indicators used:

(i) *Life expectancy at birth, 1965-1970.* This is the average duration of life or the average number of years that children born between these years are expected to live.[8] It is not affected by age structure and gives a general reflection of health conditions.

(ii) *Number of inhabitants per hospital bed.* This measures the availability of medical attention, although it does not reflect the efficiency with which it is dispensed. Similar numerical values could reflect different situations, since greater efficiency could increase the number of patients treated per hospital bed.

(iii) *Daily per capita calorie intake.* This indicator is not strictly comparable between countries because calorie requirements differ according to the composition of the population by age and sex, the normal and desirable weight of individuals, and the annual average temperature in the country.[9] However, as the difference between minimum and maximum requirements amounts to only 13 per cent, it was preferred to use the consumption index directly without modification. Apart from the unreliability of general consumption data, it must be borne in mind that distribution may be unbalanced even within a single family.[10]

Education. Education not only contributes to the satisfaction of cultural needs, which is why it is included among indicators of the level of living, but it is also an investment which is continually growing in importance because of the need for the assimilation and introduction of new technologies and the possibility of instituting new procedures adapted to the availability of resources in the underdeveloped countries.

This dual nature gives education a special place, since it is not only an integral part of the objectives to be satisfied by the development process, but also a form of investment, with long-term effects.

Indicators of education were introduced at this stage of the classification work because of their function as objectives to be satisfied by the development process. The following are some of the educational indicators used:

(i) *Percentage of literates with respect to total population aged 15 and over.* This indicator measures the level of education of the population at a given time. The lower age limit was fixed so as not to include age groups covered by indicators of primary school enrolment. As well as establishing a certain minimum level of efficiency of the educational system in operation, it measures the results of the educational policy pursued in the past.

(ii) *Number of inhabitants with secondary education in relation to the total population.* As this indicator is based on information gathered from censuses, there is great disparity in the dates to which the information refers. Persons with an unknown level of education were not considered in the total population.

[7] See "The measurement of Latin American real income in U.S. dollars", *Economic Bulletin for Latin America*, vol. XII, No. 2, and "Criteria for the conversion into dollars of income figures expressed in terms of Latin American currency units", *Economic Survey of Latin America*, 1968, United Nations publication, Sales No. E.70.II.G.1.

[8] "Multilingual Demographic Dictionary", June 1954 edition: *Population Studies No. 19*, United Nations, New York, 1954.

[9] United Nations, *Compendium of Social Statistics*, New York, 1968.

[10] See, for instance, H. A. Osborn (1970).

It would have been best if a complete educational profile had been available for each country, as this would have made it possible to specify the levels of educational attainment of the population: i.e., to indicate not only average values, but also the number or proportion of inhabitants at each educational level.

(iii) *Primary enrolment in relation to the population of school age.* This indicator, which measures the relationship between total enrolment and the population of primary school age, is usually calculated in respect of the population aged 5-14 but this age group does not correspond to the years of primary schooling in every country. For this reason the calculations have been adjusted by using an estimate of the school-age population of each country.

This indicator has to be analysed very carefully, as it may reflect several different factors. Thus, while a low index does point to an ineffective education policy which does not permit the total absorption of the population of school age, if the index is higher than 100 this reflects the inefficiency of a system that generates a mass of pupils who are apparently unable to finish their schooling in the normal period. The existence of double enrolment at the beginning of the school year may also distort the figures, so that the best course would be to consider the figures for the number of pupils who regularly attend school, rather than the enrolment figures.

(iv) *Secondary and vocational enrolment as a percentage of the population aged 15-19.* As with primary education, it would have been desirable to relate this figure to the population of school age, but in this case the limits are not so precise, this indicator was determined for the population aged 15-19.

The structure of enrolment was not analysed in order to determine the make-up of the instruction given, since the overall indicator was considered sufficient, at least at this stage, in the light of the objectives of the classification.

If this indicator is considered in conjunction with that for primary enrolment, it will be seen that there is a gap between the upper limit of the population of primary school age and the lower limit of the age group considered for this indicator (15 years).

(v) *Number of university graduates per 100,000 inhabitants per annum.* In this indicator it is not the enrolment figures that are considered, but the number of graduates in relation to the total population, so that the annual output of university graduates is measured rather than the actual access to university education.

Housing. The housing shortage is one of the most serious obstacles to the process of development in the Latin American countries. The problem is of such magnitude that not only is it impossible to find an immediate solution, but even a long-term solution is difficult.

It is difficult to make an objective examination of the problem because of the poor quality of the indicators that are available and the difficulty of making comparisons owing to difference in climate, differing family structures, the influence of tradition, etc.

The indicators used enable only a partial picture of the general housing situation to be gained. The index of occupation density ("average number of persons per room in occupied houses") does not tell us anything about the housing shortage or the actual housing conditions, although to some extent the latter aspect is reflected, albeit incompletely, by the remaining three indicators on housing services.

Lastly, it should be noted that housing should be considered within the urbanistic context, in the light of all the services needed to meet minimum satisfactory housing conditions, which include not only water, lighting and sewerage facilities, but also shops and markets, parks and community services such as schools, dispensaries, etc. A fuller treatment is not possible on the basis of the statistics currently available, however.

Consumption. In this group, a number of indicators relating to different aspects of consumption, have been included, but it is not pretended that the entire field has been covered.

There are no indicators on food and clothing. Food is covered implicitly by the group "health and nutrition", though without any consideration as to the quality of the nourishment.

Two basic types of indicators have been used: those relating to the apparent consumption of certain selected representative products (energy, newsprint, cement and rolled iron and steel products) and those representing more complex products for which demand tends to accelerate as the level of development rises (numbers of motor vehicles, radio receivers,

telephones, and television sets per 1,000 inhabitants).

However, this is not to say that there is a rigid connexion between the achievement of high rates of consumption of these products and high income levels.

Although it is natural to associate economic growth with the availability of a greater number of goods, this does not necessarily mean that there are strict patterns of composition of consumption. There may be differences not only in the choice between consumption and investment, but also as regards the priorities allotted to the various elements of consumption.

Nor do these indicators purport to reflect the level of well-being, since this would depend not only on the type of goods consumed, but also on internal patterns in respect of the level and importance of needs. Even so, these indicators could contribute to a more precise definition of the characteristics of the resultant groupings, taking particular account of the possible importance of the introduction of new lines of consumption for the development strategy of each country.

Among the selected indicators that record apparent consumption, there are two that are linked with both consumption and investment (energy and rolled iron and steel products) and one that is more directly linked with investment (cement). At the same time, however, they represent product lines whose expansion is bound up with an increase in consumption represented by the other four indicators: motor vehicles, radio receivers, telephones and television sets. Thus, housing construction and increased energy output promote the sale of household appliances, while the production of rolled products is bound up with the production of motor vehicles.

Other social indicators. The foregoing indicators, as the sub-heading at the beginning of the section indicates, describe the essential or minimum aspects of well-being grouped under the generic title "level of living". They describe from different angles both the flow of goods that the inhabitants of a specific country receive to satisfy their periodic needs (consumption and production of different goods, number of university graduates per annum, etc.), and the principal social variables (life expectancy at birth, proportion of inhabitants with secondary education, average number of persons per room, etc.). However, there are other important aspects which need to be reflected to express the characteristics of a developing society and the changes it undergoes, and indicators likewise exist for these.

Some of these indicators reflect aspects of social behaviour that undergo changes with time and represent both special characteristics and traditions of the nations concerned, as well as the changes in the social apparatus, caused by the new living conditions made possible by the development process. One example of such indicators is the early marriage rate which can either be considered as representing a prosperous and healthy society, or as reflecting poor birth control and a consequent increase in forced marriages. Similarly, the divorce rate could be considered as an indication of an advanced society, or as a reflection of social tension.

Other indicators reflect negative aspects that seem to have become intensified in the developed countries, but which should not for that reason be considered as inevitable characteristics of development. These indicators include those for criminality, deaths caused by road accidents, or pollution of the human environment.

These aspects, which may represent changes in standards of conduct or the emergence of negative situations that may to some extent jeopardize the improved levels of well-being pursued in the development process, are changes that normally accompany economic and social development. Their inclusion in the work would undoubtedly have improved the description of the respective levels of living, through the incorporation of changes in the human and social environment, but this was not possible because suitable data on these aspects are not available. Moreover, the ambiguity of some indicators reflecting changes in patterns of conduct makes it difficult to link them satisfactorily with general development indicators, while as regards problems of pollution there are as yet no definitions that would enable homogeneous indicators for different regions or countries to be established.

All the same, in some recent works a tendency to try to include such indicators is to be noted. One example is the classification of nine developed countries[11] according to levels of well-being, using the following social indicators: population density, divorce rate, early marriage rate, population per doctor, deaths from road accidents, murders, infant mortality, ratio of cars to people, proportion of 17-year-olds at school, proportion of dwel-

[11] *The Economist* (25 December 1971), page 15.

lings with baths, ratio of telephones to people and taxes on 2,000 pounds (all figures are per 1,000 inhabitants). In this case, the divorce rate was considered as a negative aspect, while the early marriage rate was considered a positive feature.

It is obvious that, insofar as development is considered not as an automatic and uniform phenomenon but as a process in which the selection of definite objectives may make a decisive contribution to differences in the style of development, the use of these indicators will be of major significance. They will help to bring out more clearly the effects on the evolution of social variables that the use of different strategies and policies will have. Thus, the possibility of their subsequent inclusion has not been discounted, especially since the methodology adopted permits this to be done without undue complications.

b) *Indicators for classification according to structural and dynamic characteristics of the economy*[12]

Population. There is no need to underline the importance of this variable and its incidence on many economic, social and political aspects of a country. Mention need only be made, for example, of its immediate significance as regards the size of the domestic market, diversification, economic potential and self-sufficiency.

Demographic aspects. Apart from the total population, which is the first variable mentioned above, population variables representing major sectors of the economy are also included as a basic contribution to manpower studies. The urban-rural distribution of the population is also considered because of its intrinsic importance and its key role in studies of social tension, as is the growth rate of the population, which supplements the quantitative indicator of the population level and has a direct influence on the values of the per capita produced and consumption and other economic and social factors.

Structure of the gross domestic product. This variable is the direct expression of the sectoral composition of the economy of the country. It not only permits a comparison to be made of the situations in different countries, but also acts as an indicator of the development of a specific country during different periods, thus facilitating the task of evaluating economic and social progress to which such great importance is attached for the Second United Nations Development Decade.

Foreign trade and the balance of payments. The key position of the external sector in any development strategy has been underlined in numerous studies and is one of the most frequent subjects of studies relating to the Second United Nations Development Decade. The variables in this field include not only exports, which are one of the most effective prime movers of development, but also the balance-of-payments deficit or gap, which is one of the principal obstacles to economic expansion.

Dynamic aspects. The above indicators of quantitative levels are complemented by indicators of growth rates relating to development potential, which represent a fundamental, element in the determination of the characteristics of countries. In addition to the growth rates of the product and the various sectors of production, targets which have been set by the United Nations Committee for Development Planning, and the growth rate of exports, the growth rate of the population also needs to be included.

Values representative of the structure of the economy. The marginal product/capital ratio and the marginal propensity to save have been considered as the most important of these indicators. Both play an essential part in development strategies and in analyses of the internal efforts deployed by the countries. The way is also open, however, for the inclusion of other indicators representing aspects of the economic structure, such as the existence or non-existence of balanced development (see P. S. Swamy, 1967), etc., which should be selected in the light of the availability of data, their specific significance, and the need to limit the number of indicators that serve as a basis for the classification of countries.

4. *Results of the classifications*

This section deals with the results of the classifications obtained successively on the basis of the following four indicators or groups of indicators: (*a*) per capita income; (*b*) the 23 level-of-living indicators, including per capita income; (*c*) the 23 level-of-living indicators and the 41 indicators of structure and dynamic aspects, i.e., 64 indicators; (*d*) 4 indicators: total population, per capita income, literacy and urbanization.

[12] See table 2.

Table

INDICATORS USED IN THE SECOND

Country	I. Total population according to census results for 1960 period (thousands of inhabitants)	II. Structure of gross domestic product (average percentages GDP)							
		Agriculture, forestry, hunting and fishing		Mining		Manufacturing		Agriculture	
		1950-59	1960-69	1950-59	1960-69	1950-59	1960-69	1950	1960
Argentina	20,010.5	19.3	16.7	0.7	1.5	30.3	33.7	10.2	6.8
Bolivia	3,304.8	29.6	27.8	16.0	11.3	12.8	12.7	36.0	—
Brazil	70,119.1	25.3	21.5	0.3	0.6	19.5	23.3	19.0	16.7
Colombia	17,484.5	36.6	32.0	3.6	3.5	15.6	17.9	18.0	13.9
Costa Rica	1,336.3	31.2	25.1	—	—	16.0	17.6	18.6	14.5
Chile	7,374.1	—	11.0	—	10.0	—	25.4	10.9	9.0
Ecuador	4,476.0	38.8	34.9	2.1	2.2	15.4	16.4	19.1	17.9
El Salvador	2,511.0	34.5	29.6	0.4	0.2	13.0	15.8	22.2	19.4
Guatemala	4,209.8	31.2	28.9	0.2	0.1	10.2	11.8	23.6	20.5
Haiti	3,784.2	49.5	46.8	1.8	—	11.5	13.1	46.9	—
Honduras	1,884.8	46.2	42.8	1.5	1.7	10.7	14.1	39.3	20.1
Mexico	34,923.1	17.8	14.9	4.2	4.4	18.9	20.4	18.7	17.6
Nicaragua	1,535.6	38.5	33.2	1.9	1.6	8.8	11.2	21.1	18.4
Panama	1,013.4	28.4	22.8	0.3	0.6	10.7	15.6	17.6	15.4
Paraguay	1,819.1	40.2	37.5	0.1	0.2	17.7	17.9	17.6	17.6
Peru	9,906.7	24.2	20.8	6.0	7.1	16.1	19.9	17.8	15.7
Dominican Republic	3,047.1	29.8	27.5	0.4	1.6	12.5	13.0	21.8	16.5
Uruguay	2,595.5	22.2	20.8	—	—	20.0	21.2	—	7.1
Venezuela	7,524.0	7.6	7.6	26.9	25.6	9.8	12.2	14.0	10.1

INDICATORS USED IN THE SECOND

Country	IV. Foreign trade and balance of payments							
	Exports (percentage of GDP)		Terms of trade effect in relation to total exports		Net external factor payments (percentage of exports)		Foreign capital servicing (percentage of exports) (amortization and depreciation)	
	1950-1959	1960-1969	1950-1959[a]	1960-1969[a]	1950-1959	1960-1969	1950-1959	1960-1969
Argentina	7.3	7.5	−3.7	5.4	2.4	8.2	7.8	24.1
Bolivia	12.9	10.8	−5.0	39.3	0.7	7.3	12.5	17.0
Brazil	7.9	6.4	19.2	−5.9	8.9	14.0	19.1	32.9
Colombia	11.9	10.5	19.5	−5.2	4.9	12.1	10.4	23.8
Costa Rica	19.5	20.0	20.1	−2.4	10.7	8.0	4.6	20.3
Chile	—	12.9	−5.4	12.8	14.1	17.5	18.2	32.6
Ecuador	11.2	13.0	22.3	−4.7	13.8	12.6	5.0	9.6
El Salvador	16.6	20.5	17.4	−7.3	2.7	4.3	2.8	7.0
Guatemala	9.9	15.6	27.9	−13.9	1.1	8.1	1.5	15.2
Haiti	10.1	10.2	28.6	−2.9	7.0	9.0	6.1	7.4
Honduras	18.1	21.5	24.5	16.1	12.9	8.9	3.5	6.3
Mexico	8.5	6.9	0.5	−6.6	10.5	19.0	8.0	20.7
Nicaragua	18.7	23.3	13.1	9.1	7.4	9.0	6.9	7.7
Panama	25.5	29.6	11.1	4.0	16.4	8.5	3.8	2.0
Paraguay	8.1	9.4	30.6	5.4	2.4	6.3	11.6	10.7
Peru	11.2	14.0	11.0	19.4	8.6	13.7	5.7	12.9
Dominican Republic	20.2	18.0	34.3	34.3	8.2	10.5	7.1	16.0
Uruguay	11.2	11.1	1.2	−0.6	3.1	6.9	7.8	19.7
Venezuela	45.8	42.5	21.9	−21.5	29.1	26.5	5.2	8.4

[a] For operational purposes, the following conversion is applied to those indicators which have negative values:

2
STAGE OF THE CLASSIFICATION

III. Demographic aspects

Economically active population by sectors and total (Percentages of total population)								*Urban-rural distribution*			
Mining		*Industry*		*Services*		*Total economically active population*		*Urban population (%)*		*Population growth rate (intercensal)*	
1950	*1960*	*1950*	*1960*	*1950*	*1960*	*1950*	*1960*	*1950*	*1960*	*1950-60*	*1965-70*
0.2	0.2	9.0	9.4	16.7	15.4	40.6	37.6	62.5	73.8	1.7	1.5
1.6	—	4.1	—	7.0	—	50.3	—	35.0	40.5	2.1	2.4
0.9	0.8	4.3	2.9	8.6	7.6	33.0	32.3	36.2	46.3	3.0	2.8
0.5	0.5	4.1	3.8	8.4	9.0	33.4	29.4	38.9	52.8	3.4	3.4
0.1	0.1	3.7	3.4	9.1	9.4	34.0	29.6	33.5	34.5	4.1	3.8
1.7	1.2	6.9	5.8	13.8	12.5	36.9	32.4	60.2	68.2	2.6	2.3
0.2	0.1	9.2	4.7	7.6	7.5	38.6	32.2	28.5	36.0	2.8	3.4
0.1	0.0	4.0	4.1	6.7	7.0	35.2	32.1	36.5	38.5	2.8	3.3
0.1	0.0	4.0	3.6	5.9	6.2	34.7	31.3	25.0	34.0	3.0	2.8
0.0	—	2.8	—	4.8	—	56.4	—	12.2	14.9	2.0	2.4
0.2	0.1	2.7	2.3	3.3	5.6	47.3	30.1	31.0	23.2	3.0	3.4
0.4	0.4	3.8	4.5	7.0	8.6	32.4	32.4	42.6	50.7	3.1	3.4
0.3	0.3	3.6	3.6	5.4	7.5	31.2	30.9	34.9	40.9	2.9	3.0
0.1	0.0	2.7	2.5	9.8	10.9	35.0	33.3	38.3	44.0	3.0	3.2
0.0	0.0	5.1	4.9	8.1	7.9	32.6	32.2	34.6	35.8	2.7	3.4
0.7	0.7	4.4	4.1	7.9	8.7	32.7	31.5	41.2	47.4	2.2	3.1
0.0	0.1	2.7	2.2	5.8	5.6	38.7	26.9	23.8	30.3	3.6	3.4
—	0.1	—	8.4	—	17.8	—	38.2	77.5	80.8	1.4	1.2
0.9	0.7	3.4	3.8	10.9	13.1	33.9	31.3	53.8	67.4	4.0	3.3

STAGE OF THE CLASSIFICATION

V. Dynamic aspects (average annual growth rates)

GDP		*Manufacturing*		*Mining*		*Agriculture, hunting and fishing*		*Exports*		*VI. Structural values*	
										Product/capital ratio	*Propensity to save*
1950-1960[a]	*1960-1969[a]*	*1950-1960[a]*	*1960-1969[a]*	*1950-1960[a]*	*1960-1969[a]*	*1950-1960[a]*	*1960-1969[a]*	*1950-1960[a]*	*1960-1969[a]*	*1950-1968*	*1950-1968*
3.1	3.6	4.0	4.2	10.4	8.0	2.1	2.0	2.0	3.7	0.169	0.260
−0.4	5.7	0.4	6.6	−4.4	6.6	−0.1	2.8	−3.5	6.7	0.339	0.174
6.8	5.5	9.1	5.6	16.4	8.5	4.4	3.8	2.6	6.4	0.359	0.182
4.6	5.0	6.5	5.1	5.6	2.7	3.1	3.4	4.5	4.7	0.290	0.170
7.1	6.9	8.0	7.9	—	—	4.4	4.9	4.7	9.3	0.378	0.135
3.8	4.5	—	5.3	—	3.9	—	2.3	1.9	4.5	0.285	0.219
4.9	4.5	4.7	4.9	5.7	3.3	4.1	2.5	7.0	3.1	0.365	0.096
4.7	5.5	5.5	8.0	−9.4	2.7	3.3	2.4	4.3	7.7	0.418	0.132
3.8	5.2	4.6	7.0	2.3	0.5	2.9	3.5	4.9	10.9	0.437	0.170
1.9	1.4	2.7	2.3	5.9	5.2	1.3	0.8	3.6	−1.5	—	—
3.3	5.2	7.0	7.8	−1.2	13.5	2.0	3.6	2.0	8.7	0.318	0.169
5.8	6.8	6.2	7.6	6.3	5.2	4.5	3.4	4.1	5.6	0.381	0.201
5.3	6.9	7.3	9.7	2.7	1.4	3.0	4.7	6.4	8.2	0.321	0.121
4.8	8.1	8.8	10.7	6.4	14.2	2.5	5.5	4.3	8.7	0.444	0.201
2.4	4.3	1.9	5.1	21.0	0.1	2.0	2.7	3.2	5.3	0.265	0.11
5.3	5.1	7.3	6.7	10.0	3.1	4.8	1.6	9.6	4.1	0.275	0.171
5.7	3.4	7.4	2.0	1.5	3.2	5.6	1.1	8.1	−0.3	0.224	0.135
2.1	0.8	3.9	1.2	—	—	−0.1	1.6	−3.5	4.3	0.235	—
7.6	4.5	9.7	6.2	7.9	2.2	5.9	4.9	7.0	2.9	0.277	0.102

$\frac{x_i - \min_i (xi)}{\max_i (xi) - \min_i (xi)}$, where x_i is the value of the indicator corresponding to the i-th country.

Two measurements of the heterogeneity or "distance" (in a broad sense) between pair of countries, were successively applied to each of these groups of indicators. These measurements are defined in chapter II and indicated in abbreviated form as heterogeneity ratios 1 and 2 in the tables.

(a) *Classification by level of per capita income*

Since in this case a single indicator is used, the countries can be arranged in descending order of their income levels and groups of countries can be identified accordingly. Table 3 (see also dendrogram 1) shows a group of countries with high income, a group with medium and low incomes, and a third group with incomes much lower than all the rest. These denominations ("high", "medium", etc.) are based on the countries' places in the Latin American income scale.

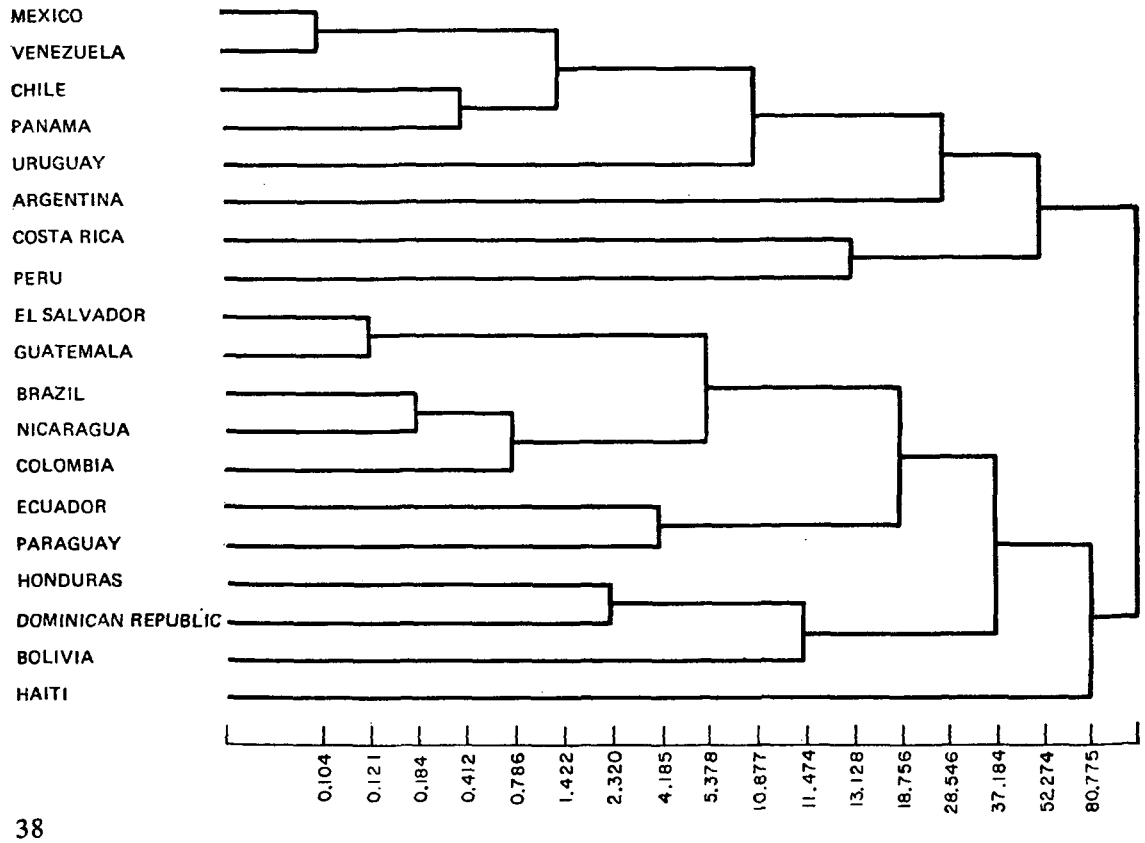
Table 3

LATIN AMERICA: CLASSIFICATION OF COUNTRIES ON THE BASIS OF LEVEL OF PER CAPITA INCOME, USING HETEROGENEITY RATIO 1[a]

I.	(*a*) Argentina	916.8
	(*b*) Uruguay	698.5
	Chile	645.3
	Panama	640.0
	Mexico	628.5
	Venezuela	627.2
	(*c*) Costa Rica	528.5
	Peru	419.7
II.	(*a*) Colombia	358.9
	Nicaragua	354.6
	Brazil	353.3
	El Salvador	330.8
	Guatemala	330.0
	Ecuador	229.7
	Paraguay	275.6
	(*b*) Honduras	248.7
	Dominican Republic	237.4
	Bolivia	199.4
III.	Haiti	97.5

[a] Formula (1), chapter III.

DENDROGRAM I LATIN AMERICAN COUNTRIES : CLASSIFICATION ON THE BASIS OF PER CAPITA NATIONAL INCOME, USING HETEROGENEITY RATIO I



In the first group Argentina is in a sub-group of its own, with an income higher than those of the next sub-group, which range from 627.2 (Venezuela) to 698.5 (Uruguay). The bottom sub-group includes Costa Rica and Peru.

The middle-income group is divided into two sub-groups: the first includes countries as dissimilar as Brazil and Colombia on the one hand and some Central American countries on the other while the other sub-group comprises Bolivia and two Central American countries. The lowest-income group contains only Haiti.

(b) *Classification based on level-of-living indicators*

If in addition to the average per capita income indicator, the rest of the indicators for the first stage are used and heterogeneity ratio 1 is applied,[13] it will be noted that—bearing in mind that it is no longer possible to arrange the countries in order on the basis of a single indicator—some countries change position in relation to the above-mentioned groups. This would appear to indicate that the level of per capita income alone is insufficient to represent the different facets of the situation of the countries concerned (see table 4 and dendrogram 2).

[13] Formula (1), chapter III.

DENDROGRAM 2 LATIN AMERICA : CLASSIFICATION OF COUNTRIES ON THE BASIS OF LEVEL-OF-LIVING INDICATORS (FIRST STAGE), USING HETEROGENEITY RATIO 1

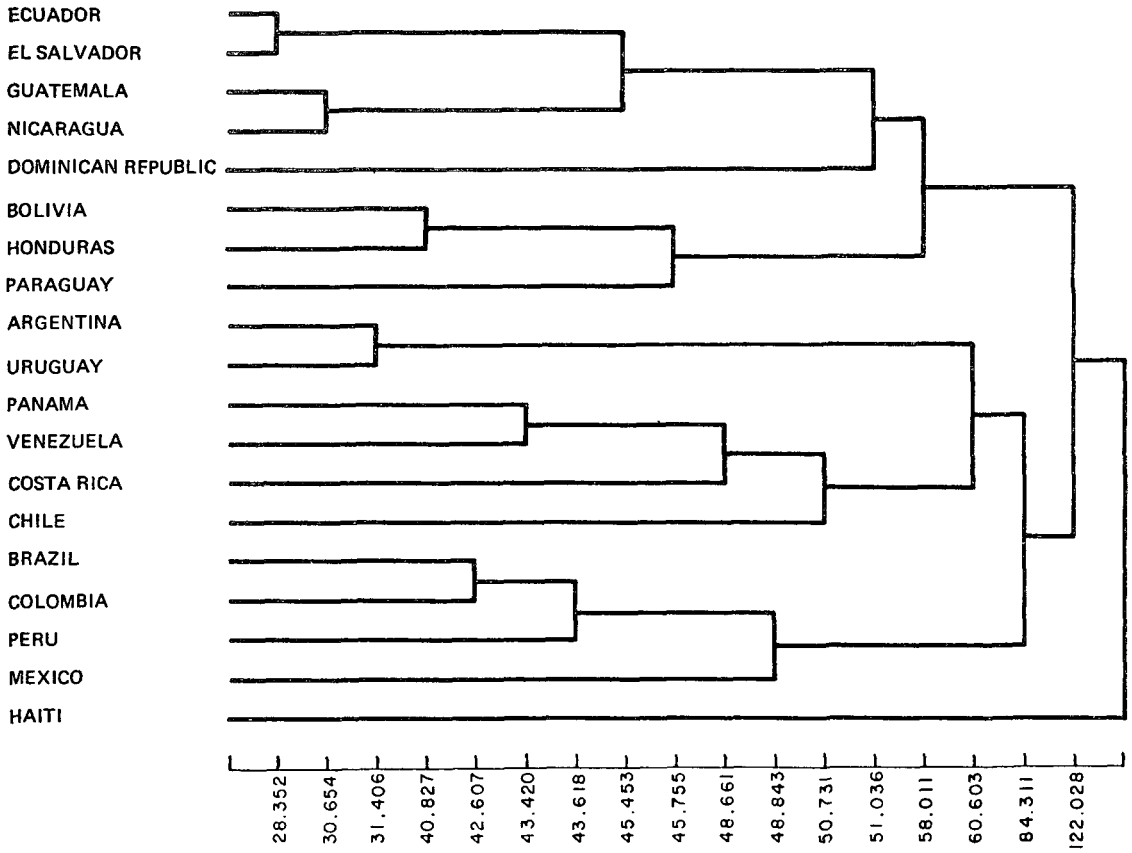


Table 4

LATIN AMERICA: CLASSIFICATION OF COUNTRIES ON THE BASIS OF LEVEL-OF-LIVING INDICATORS, USING HETEROGENEITY RATIO 1[a]

I.	(*a*)	Argentina
		Uruguay
	(*b*)	Chile
	(*c*)	Panama
		Venezuela
	(*d*)	Costa Rica
II.	(*a*)	Mexico
	(*b*)	Peru
		Colombia
		Brazil
	(*c*)	Nicaragua
		El Salvador
		Guatemala
		Ecuador
	(*d*)	Paraguay
	(*e*)	Honduras
		Bolivia
	(*f*)	Dominican Republic
III.		Haiti

SOURCE: ECLA.

[a] Formula (1), chapter III.

The following are some of the more important changes which thus take place:

(i) The inclusion of Uruguay in the same sub-group as Argentina, because of the greater homogeneity in "health and nutrition", "education" and other sectors, which outweighs the differences in per capita income levels.

(ii) The shift of Mexico and Peru to a group of countries with lower per capita incomes which includes some of the biggest countries in terms of area.

(iii) The division into a larger number of sub-groups, which makes for a clearer separation of the Central American countries.

(iv) The separation of the Dominican Republic from the sub-group which it shared with Bolivia and Honduras.

The results of using heterogeneity ratio 2[14] is a different grouping of the higher-income countries. The weighting obtained by determining the Ivanović coefficients is not very different for the various indicators, from which it may be inferred that in this case the most numerous groups of indicators —"education" and "consumption"—have most influence in determining the heterogeneity ratio (see table 5 and dendrogram 3).

[14] Formula (6), Chapter III.

DENDROGRAM 3 LATIN AMERICA : CLASSIFICATION OF COUNTRIES ON THE BASIS OF LEVEL-OF-LIVING INDICATORS (FIRST STAGE), USING HETEROGENEITY RATIO 2

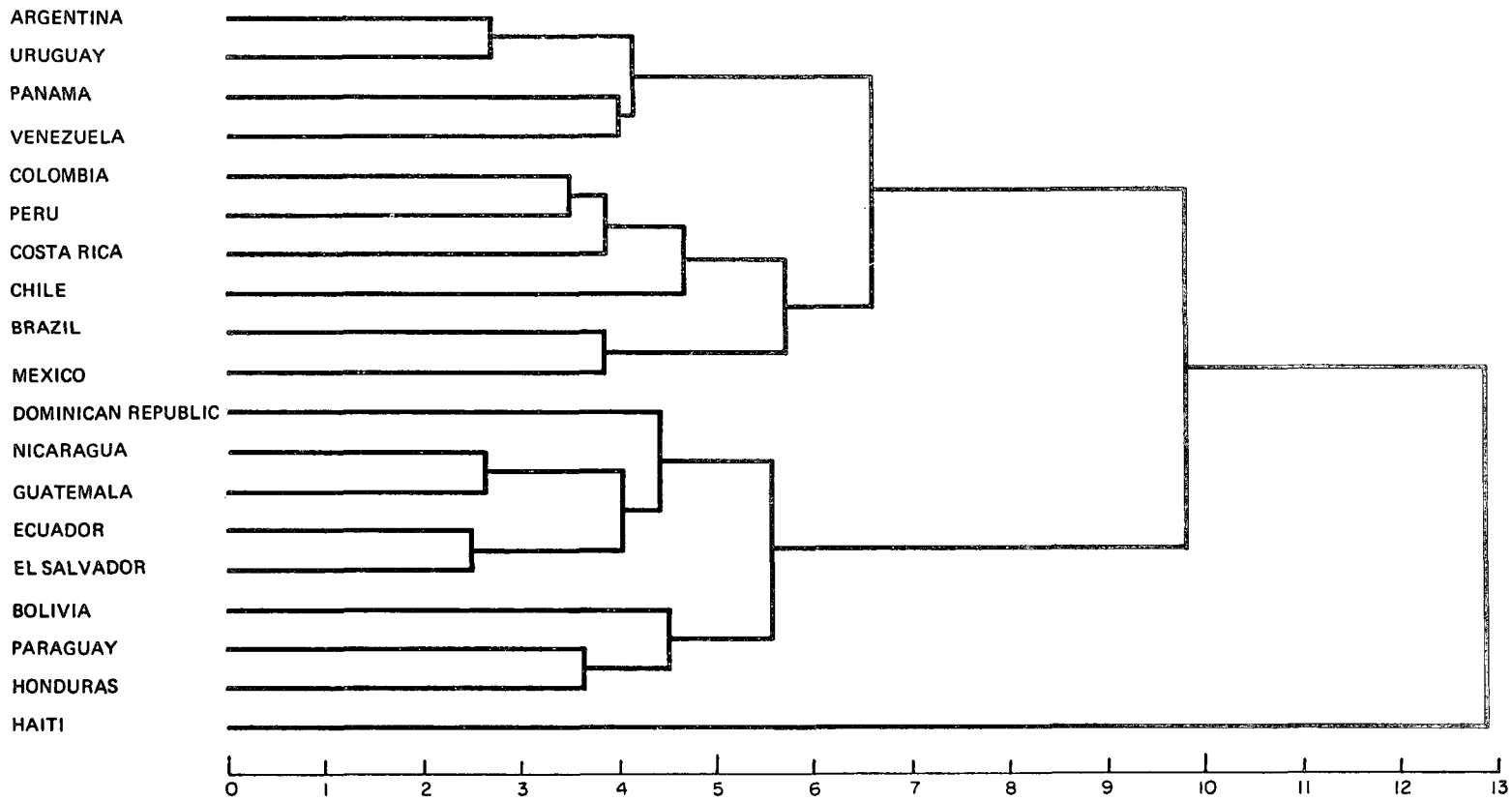


Table 5

LATIN AMERICA: CLASSIFICATION OF COUNTRIES ON THE BASIS OF LEVEL-OF-LIVING INDICATORS, USING HETEROGENEITY RATIO 2[a]

I.		Argentina
		Uruguay
		Panama
		Venezuela
II.	(*a*)	Colombia
		Peru
		Costa Rica
	(*b*)	Chile
	(*c*)	Brazil
		Mexico
III.	(*a*)	Dominican Republic
	(*b*)	Nicaragua
		Guatemala
		Ecuador
		El Salvador
	(*c*)	Bolivia
	(*d*)	Paraguay
		Honduras
IV.		Haiti

SOURCE: ECLA.
[a] Formula (6), chapter III.

It is important to note the appearance as a result of the application of heterogeneity ratio 2 of an intermediate group which was not present in the classification obtained through the use of heterogeneity ratio 1, and the appearance of a compact group, with no sub-groups, made up of some of the countries with the highest per capita income levels.

From a comparison of the latter two results with that obtained initially it is interesting to note that the introduction of the various level-of-living indicators produces a much clearer separation between the larger countries in terms of area (Brazil, Colombia) and some of the Central American countries.

(c) *Classification based on all the indicators together*

The result of using heterogeneity ratio 1 is fairly similar to that obtained by using the per capita income indicator. The number of group is the same, but the difference is that Brazil and Colombia are now included in the group of higher-income countries (see table 6 and dendrogram 4). The majority of the Central American Countries are included in the same group as Paraguay, Ecuador and Bolivia.

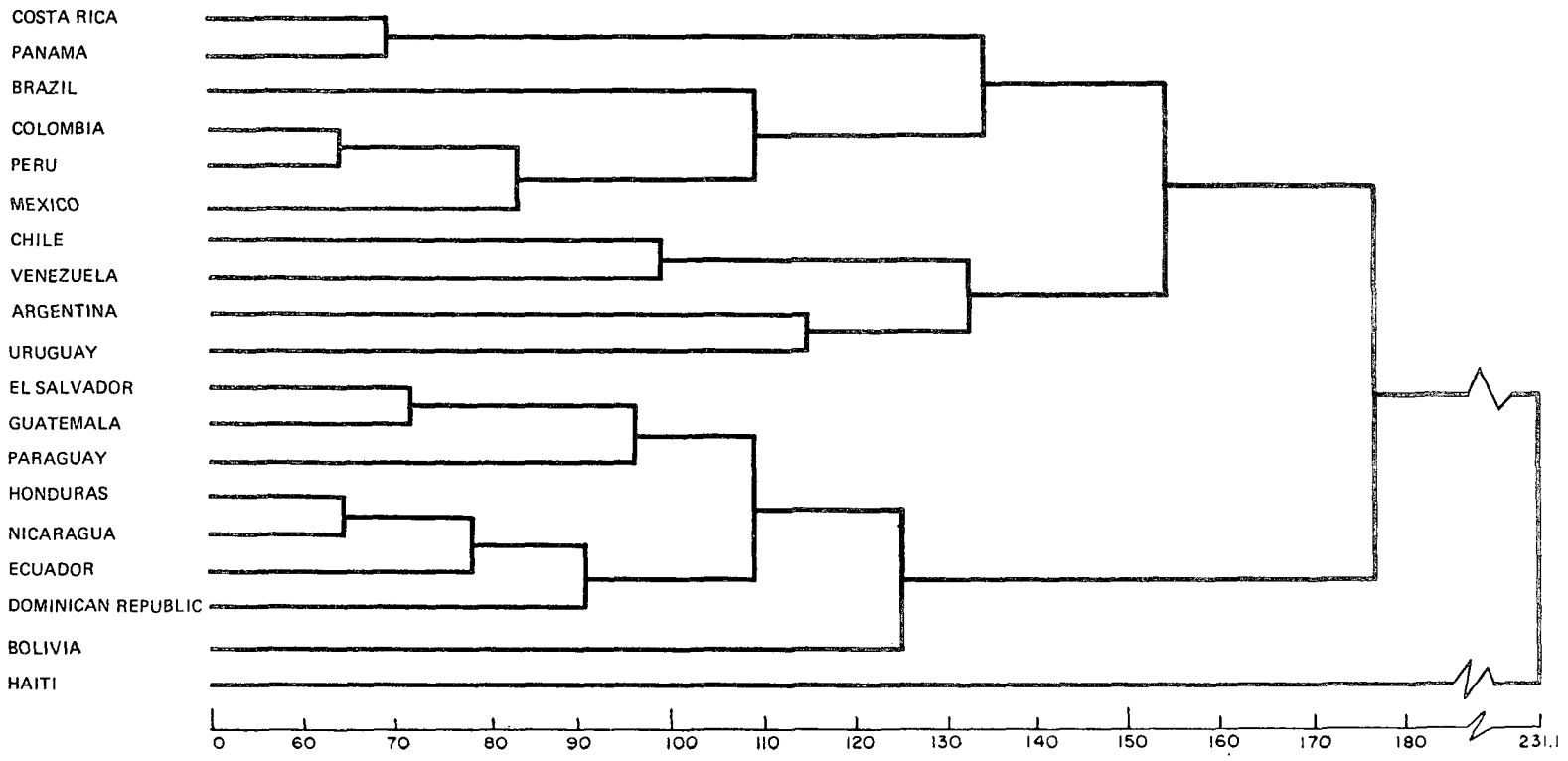
Table 6

LATIN AMERICA: CLASSIFICATION OF COUNTRIES ON THE BASIS OF INDICATORS OF LEVEL OF LIVING, STRUCTURE AND DYNAMIC ASPECTS, USING HETEROGENEITY RATIO 1[a]

I.	(*a*)	Argentina
I	(*b*)	Uruguay
	(*c*)	Chile
		Venezuela
	(*d*)	Costa Rica
		Panama
	(*e*)	Brazil
	(*f*)	Colombia
		Peru
		Mexico
II.	(*a*)	El Salvador
		Guatemala
		Paraguay
		Honduras
		Nicaragua
		Ecuador
		Dominican Republic
	(*b*)	Bolivia
III.		Haiti

SOURCE: ECLA.
[a] Formula (1), chapter III.

DENDROGRAM 4 LATIN AMERICA : CLASSIFICATION OF COUNTRIES ON THE BASIS OF LEVEL-OF-LIVING INDICATORS (FIRST AND SECOND STAGES), USING HETEROGENEITY RATIO I



The use of heterogeneity 2 (see table 7 and dendrogram 5) introduces some changes, the most noteworthy being the isolation of Uruguay and Bolivia as separate groups.

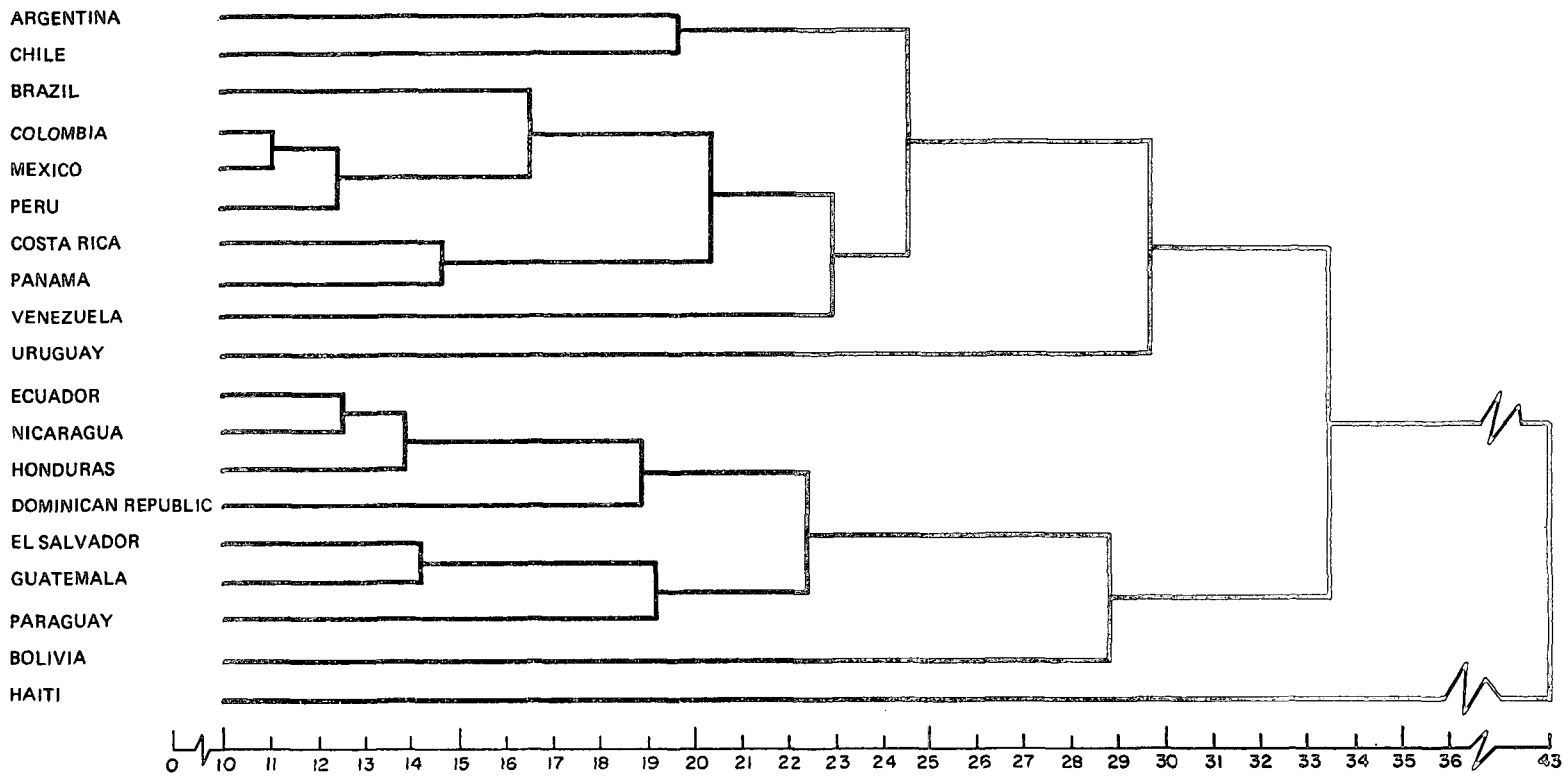
Table 7

LATIN AMERICA: CLASSIFICATION OF COUNTRIES ON THE BASIS OF INDICATORS OF LEVEL OF LIVING, STRUCTURE AND DYNAMIC ASPECTS, USING HETEROGENEITY RATIO 2[a]

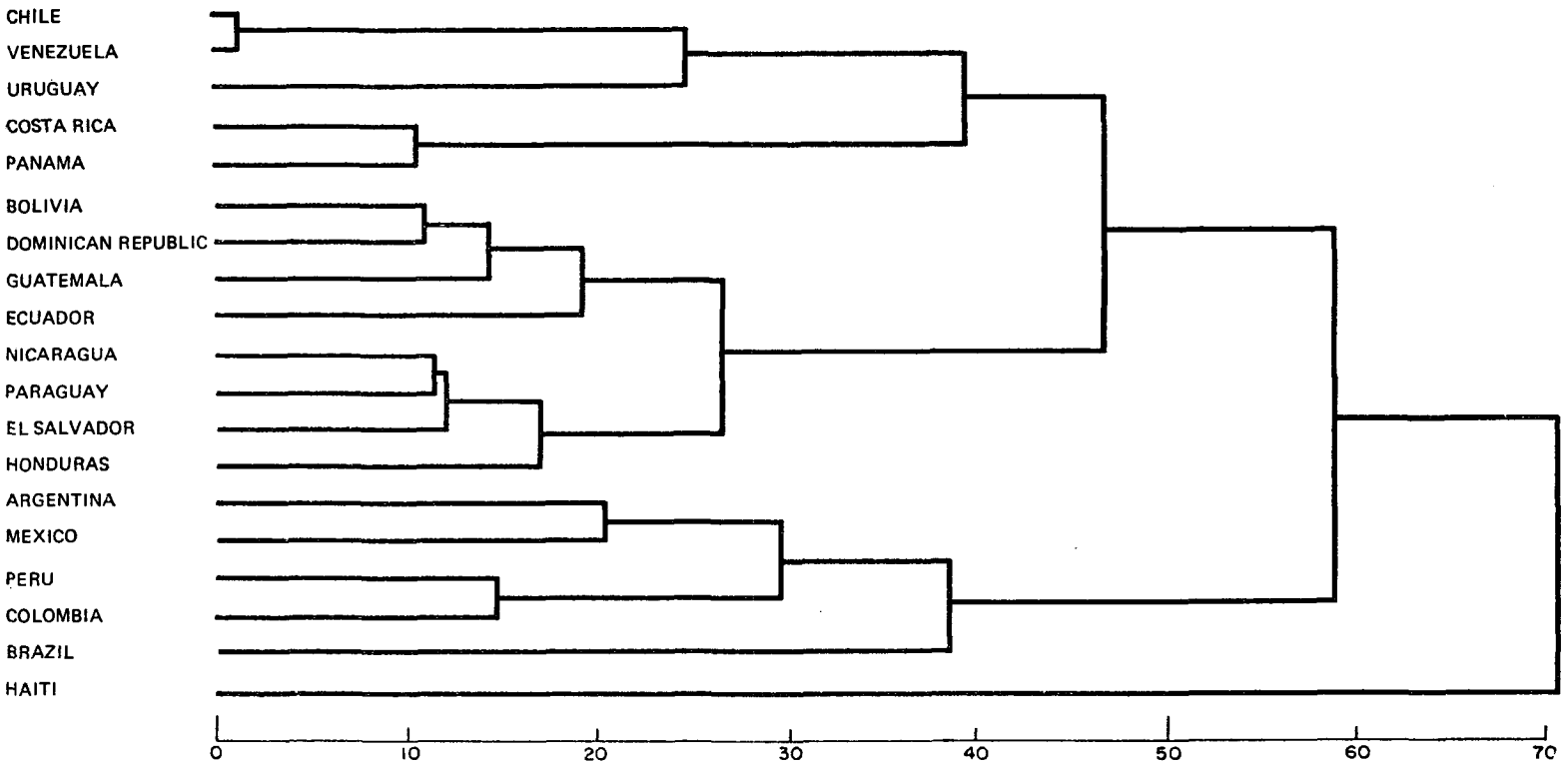
I.	(*a*)	Argentina
	(*b*)	Chile
	(*c*)	Costa Rica
		Panama
	(*d*)	Venezuela
	(*e*)	Mexico
		Peru
		Colombia
		Brazil
II.		Uruguay
III.	(*a*)	El Salvador
		Guatemala
		Paraguay
	(*b*)	Ecuador
		Nicaragua
		Honduras
		Dominican Republic
IV.		Bolivia
V.		Haiti

SOURCE: ECLA.
[a] Formula (6), chapter III.

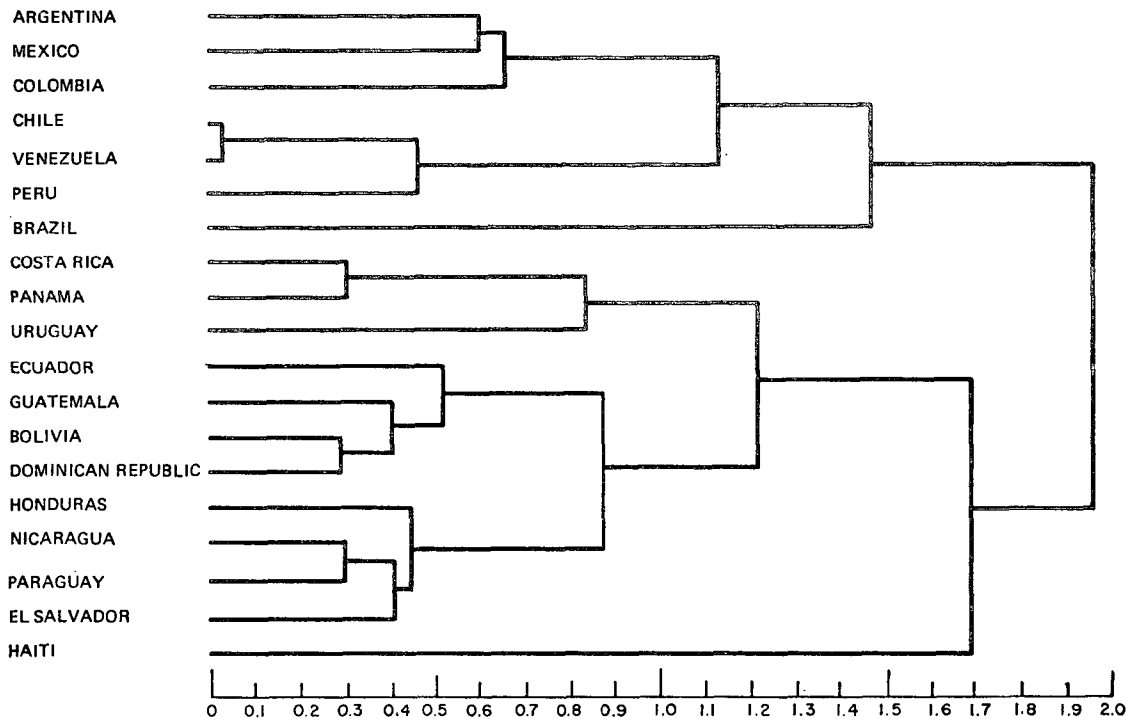
DENDROGRAM 5 LATIN AMERICA: CLASSIFICATION OF COUNTRIES ON THE BASIS OF LEVEL-OF-LIVING INDICATORS (FIRST AND SECOND STAGES), USING HETEROGENEITY 2



DENDROGRAM 6 LATIN AMERICA : CLASSIFICATION OF COUNTRIES ON THE BASIS OF INDICATORS OF POPULATION, PER CAPITA INCOME, LITERACY AND URBANIZATION, USING HETEROGENEITY RATIO I



DENDROGRAM 7 LATIN AMERICA : CLASSIFICATION OF COUNTRIES ON THE BASIS OF INDICATORS OF POPULATION PER CAPITA INCOME, LITERACY AND URBANIZATION, USING HETEROGENEITY RATIO 2



(d) *Classification based on four indicators, (population, per capita income, literacy and urbanization) (tables 8 and 9)*

Table 8

LATIN AMERICA: CLASSIFICATION OF COUNTRIES ON THE BASIS OF INDICATORS OF POPULATION, PER CAPITA, LITERACY URBANIZATION, USING HETEROGENEITY RATIO 1[a]

I.	(*a*)	Argentina
	(*b*)	Mexico
	(*c*)	Peru
		Colombia
	(*d*)	Brazil
II.	(*a*)	Chile
	(*b*)	Uruguay (rather markedly separated from the other two countries)
III.	(*a*)	Costa Rica
		Panama
IV.	(*a*)	Bolivia
		Dominican Republic
		Guatemala
		Ecuador
	(*b*)	Nicaragua
		Paraguay
		El Salvador
		Honduras
V.		Haiti

SOURCE: ECLA.
[a] Formula (1), chapter III.

Table 9

LATIN AMERICA: CLASSIFICATION OF COUNTRIES ON THE BASIS OF INDICATORS OF POPULATION, PER CAPITA INCOME, LITERACY AND URBANIZATION, USING HETEROGENEITY RATIO 2[a]

I.	(*a*)	Argentina
	(*b*)	Mexico
	(*c*)	Colombia
II.	(*a*)	Chile
		Venezuela
	(*b*)	Peru
III.	(*a*)	Costa Rica
		Panama
	(*b*)	Uruguay
IV.		Brazil
V.	(*a*)	Ecuador
	(*b*)	Guatemala
		Bolivia
		Dominican Republic
	(*c*)	Honduras
		Nicaragua
		Paraguay
		El Salvador
VI.		Haiti

SOURCE: ECLA.
[a] Formula (6), chapter III.

Some work has been done on classification systems in which the basic concept used was structural pressure, i.e., the disparity resulting from unequal progress in different aspects of development, especially the economic and social fields. The factors considered included the levels of urbanization and education.

These considerations were taken into account in choosing the four indicators, and classifications were made on the basis of both heterogeneity ratios.

The results of the two classifications show the importance of the population and urbanization factors, which permit the inclusion in the same group as Argentina of countries like Brazil, Mexico, Colombia and Peru which had never been classed with that country before, while at the same time Argentina was separated from Uruguay and other countries like Costa Rica, Panama, Chile and Venezuela which were more homogeneous as regards income levels.

As far as the rest of the Central American countries and the lower-income South American countries (Ecuador, Bolivia, Paraguay) are concerned, the fact that their population and urbanization factors are less homogeneous prevents them from being affected by these indicators in this classification variant although there are some within-group changes with respect to the previous classifications.

5. *Résumé*

In order to sum up the results presented in tables 3 to 9, the 19 Latin American countries have been divided into seven categories or types. Tables 10, 11 and 12 are based on the classifications presented in tables 3 to 9.

Table 10

FREQUENCY OF APPEARANCE IN THE SAME SUB-CLASS

	Bolivia	*Brazil*	*Colombia*	*Costa Rica*	*Chile*	*Ecuador*	*El Salvador*	*Guatemala*	*Haiti*	*Honduras*	*Mexico*	*Nicaragua*	*Panama*	*Paraguay*	*Peru*	*Dominican Republic*	*Uruguay*	*Venezuela*
Argentina													1				2	1
Bolivia						1		2		2						3		
Brazil			3			1	1	1			2	1		1	2			
Colombia				1		1	1	1			2	1		1	5			
Costa Rica													4		2			
Chile											1		1				1	4
Ecuador							4	5		2		5		2		3		
El Salvador								5		3		6		5		1		
Guatemala										1		4		3		3		
Haiti																		
Honduras												4		4		3		
Mexico													1		2		1	1
Nicaragua														4		2		
Panama																	2	3
Paraguay																1		
Peru																		
Dominican Republic																		
Uruguay																		2
Venezuela																		

Table 13

COMPARISON OF SOME CLASSIFICATIONS AND TYPOLOGIES

Title of study	*A*	*B*	*C*	*D*	*E*	*F*	*G*	*H*
Study on the economic and social classification of the countries of Latin America (ECLA)	Argentina	Uruguay	Chile Venezuela	Costa Rica Panama	Brazil Colombia Mexico Peru	Ecuador El Salvador Guatemala Honduras Nicaragua Paraguay Dominican Republic	Bolivia	Haiti
"Social change and social development policy in Latin America" (ECLA, 1969)		Argentina Chile Uruguay		Costa Rica Panama	Brazil Colombia Mexico Peru Venezuela	Ecuador El Salvador Guatemala Honduras Nicaragua Paraguay Dominican Republic	Bolivia	Haiti
"América Latina una y múltiple" by B. Cabezas (DESAL, 1968)		Argentina Chile Uruguay		Panama Venezuela	Colombia Ecuador Peru	El Salvador Guatemala Haiti Honduras Nicaragua Dominican Republic	Bolivia Paraguay	
"Análisis de tipologías" (Draft, Pan American Health Planning Programme, July 1970)	Argentina Uruguay		Chile Venezuela	Costa Rica Panama	Brazil Colombia Mexico	Ecuador Nicaragua Paraguay Peru Dominican Republic	Bolivia El Salvador Honduras	Guatemala
"Contents and measurements" (UNRISD, Geneva, 1970)	Argentina Chile Uruguay Venezuela			Costa Rica Panama	Brazil Colombia Mexico Peru	Ecuador El Salvador Nicaragua Peru Dominican Republic		Guatemala Haiti Honduras

NOTE: In order to facilitate comparison, neither Cuba nor the non-Spanish-speaking Caribbean countries were included, although they appear in several of the above classifications.

UNRISD gives an order rather than a classification of the countries, but in order to simplify the comparison successive groups of countries have been drawn up, dispensing with the order within each group.

Table 14

COMPARISON OF INDICATORS USED IN THE CLASSIFICATIONS

Indicators	*Study on the economic and social classification of the countries of Latin America*	*Social change and social development policy in Latin America*	*Pan American Health Planning Programme*	*UNRISD*	*DESAL*
Demography and Health					
Life expectancy: total	x		x	x	
men					x
women					x
Mortality rate 0-1 month					x
1-11 months					x
1-4 years			x		
Percentage deaths group A[a]			x		
from gastroenteritis					x
Persons per doctor			x		x
per hospital bed	x		x		x
per nurse					x
per dentist					x
Population	x	x			
Growth rate	x (2) [b]	x	x		
Fertility rate			x		
Percentage of population					
less than 15 years old		x	x		
more than 55 years old			x		
Nutrition					
Consumption of: calories	x		x		x
proteins	x		x	x	x
fats					x
milk					x
Education					
Percentage of literacy	x		x		x
Level of education	x				x
Primary education: leavers					x
enrolments	x		x	x	x
secondary: leavers			x	x	
enrolments	x		x		
university students	x				x
Percentage of university graduates					
Average number of pupils per teacher					x
Percentage of certificated teachers					x
Coefficient of completion of					
primary education					x
secondary education					x
Percentage of GDP spent on education	x	x			
Growth rate of this percentage		x			
National projects for improving					
education		x			

Table 14 (*continued*)

COMPARISON OF INDICATORS USED IN THE CLASSIFICATIONS

Indicators	*Study on the economic and social classification of the countries of Latin America*	*Social change and social development policy in Latin America*	*Pan American Health Planning Programme*	*UNRISD*	*DESAL*
Urbanization and housing					
Urbanization	x (2)	x	x	x	x
Growth rate of urbanization		x			x
Index of urban concentration					x
Urban marginalization		x			
Percentage of population living in cities of over 20,000 inhabitants					
Percentage of population in the various sectors		x	x		x
Active population by sectors	x (10)				x
Adolescents by sectors					x
Population with piped water	x		x		x
electricity	x				x
main drainage	x				x
owning dwellings					x
Average persons per dwelling					
per room	x			x	x
Communications, transport					
Motor vehicles	x				
Newspaper circulation				x	x
Radio receivers	x			x	x
Television receivers	x				
Telephones	x			x	
Annual number of visits to cinema					x
Other social and economic indicators					
GDP or national income: total					
Per capita	x	x	x		x
Per economically active person					x
By sectors	x (6)	x	x	x (2)	x
Growth rate of GDP of national income:					
Total	x (2)	x			
Per capita	x (2)				
By sectors	x (4)				x
Ratios, coefficients, propensities (values describing the structure: product-capital, propensities, historical and projected values)	x (2)				
Employment or unemployment					x
Primary sector					x
Inequality of distribution of income		x		x	
of regional distribution		x			
Capacity to absorb professionals and specialists		x			

Table 14 (*continued*)

COMPARISON OF INDICATORS USED IN THE CLASSIFICATIONS

Indicators	*Study on the economic and social classification of the countries of Latin America*	*Social change and social development policy in Latin America*	*Pan American Health Planning Programme*	*UNRISD*	*DESAL*
Percentage in low employment category					x
in primary sector					x
Productivity			x		
Installed Capacity					x
Cement production					x
Per capita cement consumption	x			x (3)	
Per capita energy consumption	x			x	x
Per capita newsprint consumption	x				
Consumption of rolled products	x			x	
Exports: percentage of GDP	x (2)				x
Percentage of GDP accounted for by main export product					x
Percentage of GDP accounted for by manufactures				x	
Growth rate of GDP	x (2)				
Per capita foreign trade				x	
Imports of main product					x
Terms-of-trade effect	x (2)				
External factor payments	x (2)				
External indebtedness	x (2)				x
Impact of public sector on employment and investment		x			
Planning capacity		x			
Social security: percentage of contributors					x
Beneficiaries over 64 years old					x
Widows receiving benefits					x
Capacity of public sector to increase social security services		x			
Social and political indicators					
Governments overthrown (1945-1965)					x
Participation of population in elections		x			x
Percentage of trade union members		x			x
Projects showing internal pressure for reform		x			
Publicly organized opposition					
Total number of indicators	*64*	*21*	*21*	*18*	*58*

[a] Infectious and parasitic diseases, according to the international classification of diseases (7th revision, 1965).

[b] The number of indicators used in respect of the aspect in question is shown in brackets.

(a) *Title: ECLA, "Social change and social development policy in Latin America" (United Nations publication, Sales No. E.70.II.G.3)*

Aims: To contribute to the study of the relative importance of the forces which provoke social change and the capacity of countries to apply social policies, establishing as far as possible patterns of indicators reflecting their mutual relationship.

Comments: The specialized nature of the study is such that only one-third of its 21 indicators coincide with indicators used in the present study. Moreover, they are not expressed numerically, but as "low", "medium" and "high" ratings. The typologies are set forth in advance, in accordance with preestablished concepts. It is interesting to note the high level of concordance between these types and the groups established on the basis of demographic criteria.

Comparison with the groups of the present study shows concordance in the classification of Argentina, Uruguay, Chile and Haiti, but not Bolivia. The greatest divergence concerns Venezuela, owing to the basically social approach used.

(b) *The typology prepared by DESAL—described in "America Latina—una y múltiple" by B. Cabezas de G. (Herder, Barcelona, 1968).*

Aims: To group the Latin American countries according to five aspects or facets: demographic, economic, economic and social, cultural and political.

Comments: The aims and nature of the 58 basic indicators used in this classification differ little from those of the present study, but the criteria and procedure adopted are different: thus, the substitution of a single overall index for the different indicators means that the countries can be given an ascending or descending order instead of being considered in spatial groups within which an order cannot necessarily be established.

The total range or difference between the upper and lower limits of the overall index is divided up according to a constant ratio:

$$\frac{\log \frac{x\,\max}{x\,\min}}{g} = q$$

The positions of the countries within the overall range or field of variation have to be considered in advance so as not to leave classes vacant. Despite these divergences, there are coincidences between the classifications regarding the countries of Group I. In groups II and III, the places of Peru and Paraguay are interchanged. Group IV includes Haiti in both classifications, but differs with respect to Bolivia and Guatemala.

Grouping criteria and procedure. The stages followed are:

(i) The minimum value x_1 and the maximum x_{20} are determined for the 20 countries.

(ii) Eight strata are formed whose limits are in a constant ratio. This ratio is:

$q = \sqrt[8]{\frac{x_{20}}{x_1}}$, giving the 8 strata: ($x$, xq), (x_1 q, x_1 q^2) ..... (x_1 q^7, x_1 q^8).

(iii) For each country, the number of the stratum which contains each of its converted indicators is determined.

(iv) The numbers thus obtained for all the indicators are then reduced to an arithmetic mean for each country.

(v) The above-described constant-ratio procedure is applied to the arithmetic means to form 4 strata, groups, or finite classes.

(c) *Title: "Análisis de tipologías" (Draft Pan-American Health Planning Programme, ILPES Research Programme, Santiago, Chile, July 1970)*

Aims: To group the countries of the region according to development characteristics in general and health features in particular.

Comments: The aims of this analysis are not basically different from those of the present study, although they place more emphasis on health aspects. In fact, of 21 indicators, half are connected with health, nutrition and demographic aspects. Ten of these indicators are not included in the present study because of diffculty of procurement or unreliability of the data, specialization, or the need to limit the number of indicators.

The arrival at different results can be explained by differences in the choice of indicators, the definition of dissimilarity and the grouping criterion and procedure. There are, however, substantial areas of agreement. Group I of the present study coincides with groups 1 and 2 combined of the analysis under discus-

sion, except as regards the Carribean countries which were not included in the present study. Group II coincides with groups 4 and 5, except as regards Peru, which appears in group 6. Group III coincides with groups 6, 7 and 8 combined, except as regards Peru, of course, and as regards Haiti, which appears separately in Group IV in the present study.

The grouping criterion and procedure preestablishes the number of classes g, but as various successive values of g are considered, it enables g's influence on the homogeneity of the groups to be evaluated. The directly observed values of the 21 indicators are converted by means of the following formula, which is based on the best and worst values of each indicator for the whole set of countries:

$$\frac{\text{Observed value} - \text{worst value}}{\text{Best value} - \text{worst value}} \; 100 = x$$

This method of expression standardizes the observations and is not affected by changes in origin or scale.

The measure of dissimilarity is the euclidean distance between the transformed indicators or the corresponding weighted expressions.[16]

The dissimilarity between two countries is measured by the formula:

$$d_{i,j} = \sum_{k=1}^{m} P_h \, (x_{ih} - x_{jh})^2$$

where m is the number of indicators; P_h is the weighting of the h-th indicator, the absolute value of its correlation with life expectancy, and x_{ih}, x_{jh} are values of the h-th indicator converted for the countries i and j.

(d) *United Nations Research Institute for Social Development.*[17]

Points of correspondence are established between a number of indicators (73, reduced to 18 for the study), and an attempt is made to establish connexions between groups of indicators and degree of development. A global weighting index is then calculated.

(e) *Title: "Groupement des pays par rapport a leurs profils socio-économiques". UNCTAD, Geneva, November 1971 (UNCTAD/RD/36) 72-2101*[18]

Aims: To present a list of the developing and developed countries, ordered and grouped according to economic and social profiles established for each country on the basis of 11 indicators.

Comments: The countries are arranged in order by measuring the gap between them and a hypothetical country whose profile is made up from indicators giving the worst possible situation for each of the aspects considered in it.

The grouping is effected on the basis of the idea of similarity between the social and economic profiles of the countries, calculated from the "I distance (Ivanović distance—see chapter III.2)—between each pair of countries. The smaller this distance, the greater the similarity. The corresponding dendrogram is given, but no classification is made, i.e., no "threshold" is established from which the groups are built up.

On comparing this list with the summary classification of the present study, the following points are to be observed:

(i) Argentina and Uruguay, which are separated in the classification of the Latin American Economic Projections Centre (henceforward referred to as the CPE), are separated here, too, coming together as a group only when a high "threshold" is reached.

(ii) Haiti and Bolivia which appear separately in the CPE classification, are placed in this list in the group of lower income countries.

(iii) A pairing which seems unusual if the results obtained by the CPE are taken into account is that of Costa Rica and Nicaragua.

(iv) In this listiing, Mexico is not associated with the sub-group formed by Brazil, Colombia and Peru.

Criteria and procedures. The following development indicators are used:

1. Per capita gross domestic product, at factor cost, in US dollars at current prices.

2. Share of the industrial sector in the gross domestic product at factor cost.

[16] The weighting is based on the correlation of indicators, expressed in absolute values, with life expectancy.

[17] UNRISD, *Contents and measurement of socio-economic development—an empirical enquiry*, Research Report No. 70, Geneva, 1969.

[18] See also UNCTAD, *Problème de l'identification des pays les moins avancés parmi les pays en voie de développement*, Research Memorandum No. 41, 1970.

3. Per capita consumption of energy.

4. Percentage of primary and secondary school enrolment, with respect to the population between 5 and 19 years of age.

5. Number of doctors per 100,000 inhabitants.

6. Per capita agricultural GDP.

7. Per capita export of manufactures.

8. Average life duration.

9. Percentage of illiterates in the population of 10 or more years of age.

10. Percentage of non-agricultural population in the active population.

11. Number of copies of newspapers printed per 1,000 inhabitants.

The weighting factors are: the total population in millions (for 1, 3, 4, 5, 7, 8, 9); the GDP (for 2) the population active in agriculture as against the total population (for 6) and the active population as against the total population (for 10).

The measurements of dissimilarity between countries, i, j are obtained as follows:

$$89 = \sum_{h=1}^{p} \frac{d_{hij}}{S_h} \frac{h-1}{k=1} (1 - r_{j\,i,\,1,2\,\ldots\,j-1}) \quad d_{hij} = /x_{ih} - x_{jh}/$$

In this case, the number of indicators is $p = 11$.

The countries are placed in order according to the distance of each of them from a hypothetical country whose indicators are the numerical values of each indicator for the countries considered, i.e. for the indicator h:

$$\bar{x}_h = \min \; [x_{E1}, x\,h_2 \ldots, x_{hn}] \quad h = 1,2,\ldots p$$

(f) *Other studies*

The bibliography at the end of this paper contains references to some other published works in this field.

II. PROFILES, ORDERING OF COUNTRIES AND INDEPENDENT FACTORS

1. *Economic and social profiles*

An examination of the evolution of socio-economic and per capita income indicators suggests that, far from evolving independently of one another, there is a definite relationship between them. Given this premise, it is interesting to see to what extent a link can be established between the different indicators, while at the same time trying to distinguish those characteristics related to economic and social development that could, where appropriate, serve as typological reference points.

Accordingly, each condition characterized by specific average values for each indicator would constitute an economic and social profile reflecting the corresponding "normal" or characteristic elements, and it would be possible to compare or assess the achievements of each country by reference to this profile.

In the attempts made to establish classifications of Latin American countries, the idea of linking the results to particular profiles has not been applied, because it is felt that the alternatives, whether relating to social or structural aspects of development, do not necessarily conform to patterns that are uniform for every country; indeed, there is on the contrary a possibility that such aspects largely reflect each country's autonomous economic policy decisions and its endowment in natural, human and other resources.

Furthermore, the fact that a study of the data compiled points to a simultaneous and gradual evolution of the various economic and social indicators merely demonstrates the relationship that exists between the types of development achieved by the individual countries or regions; it would be a mistake to infer from this that these patterns of evolution are immutable in the sense that they determine the future development objectives on which those countries should set their sights when they rise above their present level of development.

It must therefore be made quite clear that the profiles obtained have only an informational significance and that the link between the various indicators making up a particular profile is not invariable but is simply a way of facilitating the description of the process observed in Latin American countries and bringing out the common features observed in it.

Moreover, both the changes in the domestic and external economic and social situation of Latin American countries and the progress

made in elucidating some of the development problems they face are liable to lead to new approaches and new policies for overcoming the obstacles to development, and this may well result in changes in their economic and social profiles, reflecting new patterns or styles of growth.

The analysis was based on the groups of countries given in table 12, which summarizes the various classifications. Only level-of-living indicators were used.

Either because the data were not available on all countries or because the quality of the relevant indicator was somewhat doubtful, the following aspects were omitted: public sector in education, average number of persons per room, dwellings with main drainage facilities, television sets per 1,000 inhabitants, and consumption of rolled products. Simple mean values were used to represent each indicator for a group of countries. The results of the analysis are shown in Figure I.

As can be seen, the profiles obtained are not clear-cut, since in the case of certain groups or countries they tend to cut across one another. This shows how unsatisfactory it would have been to construct a hierarchic classification of the results. A country like Uruguay, for instance, which has the highest indicators both in health and in certain partial aspects of education and consumption, comes lower down in the other indicators, and a similar phenomenon occurs in other groups.

From what has already been stated, it would seem reasonable, generally speaking, to assume that the absence of perfectly defined profiles is due to the particular geographical, institutional and other characteristics of each country and its politico-economico-social decisions. Even so, however, the criss-crossing of profiles keeps within fairly narrow limits and only affects the groups that are closest to one another. This gave rise to the idea that a more satisfactory combination of groups might help to secure more clear-cut profiles. It was accordingly decided to regroup the countries on the basis of the combination of countries or groups of countries with the most similar average incomes:

I. Argentina, Uruguay
II. Costa Rica, Chile, Panama, Venezuela
III. Brazil, Colombia, Mexico, Peru
IV. Bolivia, Ecuador, El Salvador, Guatemala, Honduras, Nicaragua, Paraguay, Dominican Republic
V. Haiti.

With these groups, it is possible to obtain clear-cut profiles (see Figure II) and to place the countries in order.

This confirms the earlier suggestion that the mean indicators of each group of countries and their global per capita income indicators tend to evolve along similar lines.

In order to take advantage of these profiles, this classification can be combined with that given in table 12, using the groups of the latter table as sub-classes:

I. (*a*) Argentina
   (*b*) Uruguay
II. (*a*) Chile, Venezuela
   (*b*) Costa Rica, Panama
III. Brazil, Colombia, Mexico, Peru
IV. (*a*) Ecuador, El Salvador, Guatemala, Honduras, Nicaragua, Paraguay, Dominican Republic
   (*b*) Bolivia
V. Haiti.

2. *Ordering of countries*

(a) *Global development indicator*

The method previously adopted for classifying Latin American countries consisted of determining heterogeneity ratios which were then used to measure the greater or lesser distance or dissimilarity between each pair of countries. These ratios were applied to the complete set of indicators reflecting the level of development attained. It was thought that, for these data to retain their significance, they should not be reduced to a single indicator where all the facets described merged together. Accordingly, the resulting combinations of countries did not claim to represent absolute hierarchical levels of development, but simply relatively homogeneous groups whose components bore a greater similarity to one another and which could possibly stand for types of development, with separate characteristics setting them apart from other groups. A glance at the classifications arrived at shows that there is, by and large, a striking similarity between the groups based on the per capita income indicator and those based on the complete set of indicators. It can reasonably be said that the per capita income indicator is the most informative of all, and therefore, though it may usefully be completed by another or other indicators, it is the indicator most frequently

Figure 1

ECONOMIC AND SOCIAL PROFILES (LEVEL-OF-LIVING INDICATORS)

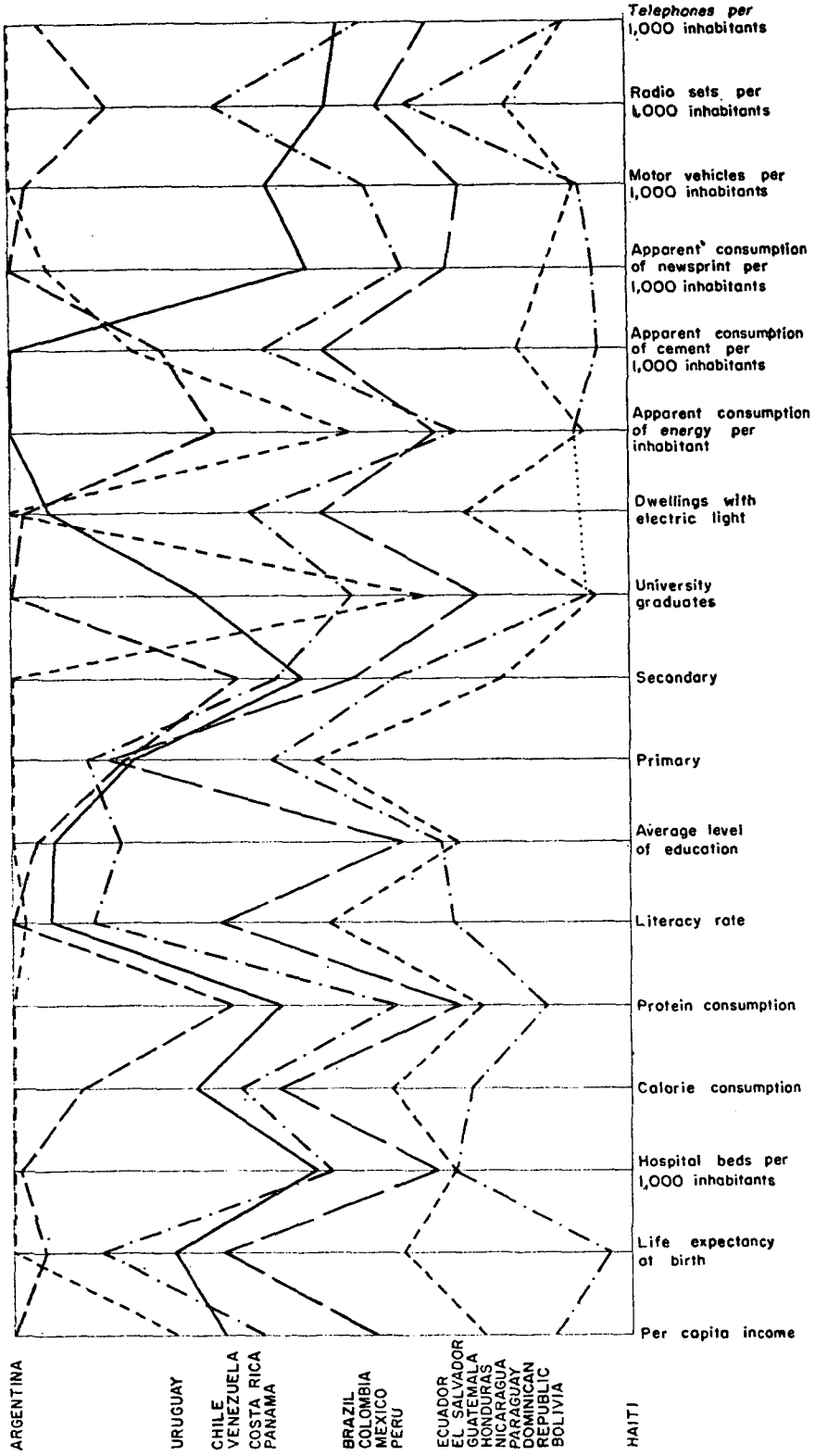
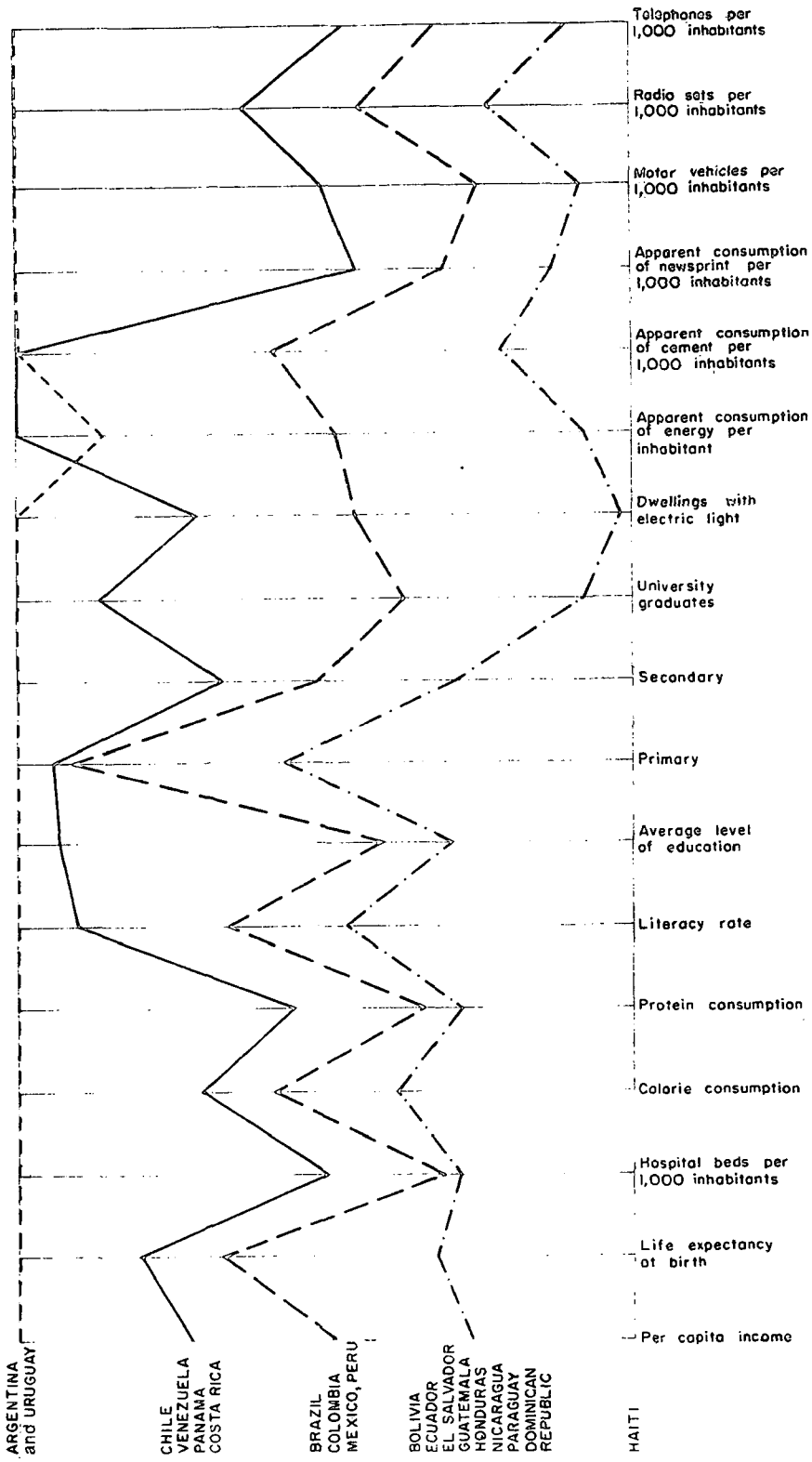


Figure II

ECONOMIC AND SOCIAL PROFILES (LEVEL-OF-LIVING INDICATORS)



employed when it is desired to represent the general level of development of countries.

The search none the less continues for an indicator which covers various aspects of development and can be used as a basis for placing countries in order.

One of the main problems is that of establishing a definition of economic and social development which is sufficiently functional to be reflected by use of the available statistical indicators. Although no satisfactory solution has yet been found, it is worth while analysing the results obtained by using global indicators that sum up a large amount of the available information. The results of the previous classification work were therefore used to establish a global development indicator.

To this end, it was decided to try to use the distance which had been established previously as a measure of heterogeneity, applying this distance now, however, only to a single reference country (quite possibly fictitious) corresponding in every respect to the minimum indicator and consequently reflecting the worst possible situation of any country. The greater a country's distance from this reference country, the greater its heterogeneity and the higher its level of development, and vice versa.

It should not be forgotten, however, that a loss of information occurs when the separate elements and indicators are reduced to a single magnitude, since the same measurement or distance may be the result of different and even opposite indicators. For example, if the position of a reference or base country is represented three-dimensionally, all points would fall on the surface of a sphere whose centre would be the reference point and whose radius would be the distance in question. Consequently, countries in quite different and even contradictory circumstances as regards one, two or even three of the indicators compared with the reference country might appear to be at the same level of development. In actual fact, the present analysis does not present such an extreme situation, and the results turn out to be quite acceptable. Even so, however, it is important not to overlook this disadvantage of establishing a global indicator, for such an indicator is bound to involve a lack of flexibility in its ability to reflect characteristics that may be present in the development process.

For the purposes of the analysis, the reference (or base country) selected was Haiti, which has the lowest per capita income and combines most of the lowest level-of-living indicators. Three types of distance were considered: heterogeneity ratio 1, heterogeneity ratio 2 (i.e., heterogeneity ratio 1 with Ivanović's correction) and Mahalanobis' distance (see chapter III, section 2). The results are given in tables 15, 16 and 17.

Table 15

ORDER OF COUNTRIES ON THE BASIS OF HETEROGENEITY RATIO 1

Argentina	30,910.6
Uruguay	30,381.7
Venezuela	28,457.4
Panama	28,101.5
Chile	27,211.1
Costa Rica	26,146.7
Mexico	24,822.8
Colombia	23,241.6
Peru	23,102.6
Brazil	21,731.6
Ecuador	19,171.5
El Salvador	18,403.4
Nicaragua	18,060.0
Dominican Republic	17,300.1
Guatemala	15,779.0
Honduras	13,651.9
Paraguay	12,732.0
Bolivia	12,291.3
Haiti	0

Table 16

ORDER OF COUNTRIES ON THE BASIS OF HETEROGENEITY RATIO 2

Argentina	12,844
Uruguay	12,601
Venezuela	12,320
Panama	12,234
Chile	12,051
Costa Rica	11,632
Peru	11,496
Mexico	11,260
Colombia	11,130
Brazil	11,026
Ecuador	9,803
El Salvador	9,656
Dominican Republic	9,239
Nicaragua	9,171
Bolivia	8,976
Guatemala	8,628
Honduras	8,190
Paraguay	7,818
Haiti	0

Table 17

ORDER OF COUNTRIES ON THE BASIS OF MAHALANOBIS' DISTANCES

Argentina	999.9
Uruguay	873.7
Chile	833.5
Panama	829.3
Mexico	819.8
Venezuela	818.8
Costa Rica	726.5
Peru	549.8
Colombia	502.7
Nicaragua	495.6
Brazil	493.5
El Salvador	454.7
Guatemala	453.3
Ecuador	397.2
Paraguay	349.2
Honduras	292.3
Dominican Republic	267.4
Bolivia	180.8
Haiti	0

In order to gain an idea of how far the incorporation of economic and social indicators modifies the results obtained, an order of countries based solely on the per capita national income indicator was also established.

Table 18

LATIN AMERICA: ORDER OF COUNTRIES ON THE BASIS OF PER CAPITA NATIONAL INCOME

Argentina	916.8
Uruguay	698.5
Chile	645.3
Panama	640.0
Mexico	628.5
Venezuela	627.2
Costa Rica	528.5
Peru	419.7
Colombia	358.9
Nicaragua	354.6
Brazil	353.3
El Salvador	330.8
Guatemala	330.0
Ecuador	299.7
Paraguay	275.6
Honduras	248.7
Dominican Republic	237.4
Bolivia	199.5
Haiti	97.5

It can be seen that the order of countries obtained on the basis of Mahalanobis' distance (table 17) is exactly the same as that based on the per capita national income indicator. The change of global indicator does, however, entail a change in the relative distance between countries. The countries comprised between Uruguay and Costa Rica inclusive come closer to Argentina, while at the lower levels (from Paraguay to Haiti) the separation becomes larger. In other words, the introduction of economic and social aspects is reflected in a modification of the relative levels.

The changes in the order of countries which result from the application of heterogeneity ratios 1 and 2 are more striking. Venezuela rises to third place, Mexico drops down the scale, while in the case of heterogeneity ratio 2, Peru moves up above Mexico. Other changes occur among the countries at a lower level of development. In both cases the closing of the distance separating the countries from Argentina is more marked in the previous example.

(b) *Classification and ordering of Latin American countries within a group of 90 non-oil-producing countries*

An interesting example of the possibilities of the methodology for establishing a single indicator is its use in placing the Latin American countries in their appropriate order within a group of 90 non-oil-producing countries.

According to the order established by UNCTAD[19] the vast majority of Latin American countries are higher in the scale of development than most of the African and Asian countries, particularly those which, like India, notwithstanding their average indicators, possess much greater potential in terms of resources (domestic market, area, level of industrial development, etc.) than the smaller Latin American countries.

The method used by UNCTAD and described in the study referred to is based on the calculation of distances from a hypothetical or reference country displaying all the bottom values of the set of indicators used. Each country is represented by a vector based on the values of the appropriate indicators, and the distance is determined by means of the Ivanović formula where a basic indicator is established and the differences arising for the rest of the indicators are weighted in inverse proportion to the correlation with the preceding

[19] *Problème de l'identification des pays les moins avancés parmi les pays en voie de développement* (UNCTAD, Research Division No. 45, 5 November 1970).

$$\text{indicators, using a factor } \pi_{j=1}^{i-1}(1-r_{ji.\,12\ldots j-1})$$

where $r_{ji.\,12\ldots j-1}$ is the coefficient of partial correlation between the indicators x_i and x_j ($j<i$). In other words the greater these coefficients of correlation with respect to the preceding indicators, the smaller will be the value of the weighting factor.

According to this method, therefore, other indicators can be added to supplement the data provided by the basic indicator only to the extent that the data they give is not contained in the previous indicators, this criterion being measured by the factor $\pi_{j=1}^{i-1}(1-r_{ij.\,1\ldots 2j-1})$.

In the study in question the initial indicator of most importance is the per capita gross domestic product. The remaining indicators are used for two kinds of classifications:

(i) a classification for 1969 in which the per capita GDP is considered separately and the other 10 indicators are grouped as follows:

Group I

(1) per capita energy consumption;

(2) gross domestic product of the economically active agricultural population;

(3) percentage of population not engaged in agriculture;

(4) Share of manufacturing in the gross domestic product;

(5) exports of manufactures;

Group II

(1) newspaper circulation per 1,000 inhabitants;

(2) number of doctors per 100,000 inhabitants;

(3) percentage of literate persons;

(4) average life expectancy;

(5) school enrolment rate.

(ii) a classification for 1965 and 1969 in which the following indicators are used, without any form of grouping:

(1) Per capita gross domestic product;

(2) Per capita energy consumption;

(3) Number of doctors per 100,000 inhabitants;

(4) Share of manufacturing in the gross domestic product;

(5) School enrolment rate;

(6) Share of manufactures in total exports.

The economic indicators used in both classifications relate to per capita levels and the structure of production with respect to the total gross domestic product.

Many countries whose future development is hampered by small markets or scanty resources are ranked in the list at levels which denote a more advanced stage of development by reason of having at present higher indicators at the unit level. Moreover, in the case of structural indicators, such as that giving the share of manufacturing industries in the gross domestic product, it will be readily appreciated that, according to the size of the gross domestic product, similar percentages may represent very different states of affairs as regards the size and technical level of the industry concerned: a factor which is of undoubted importance in assessing the stage of development reached by a country.

To overcome these drawbacks, another classification was planned on the basis of the methodology adopted in the present study, using two types of indicators simultaneously: (*a*) those relating to the level of development reached by a country (the indicators already mentioned above), and (*b*) those involving a description of the country's characteristics as regards size of market, value of product, etc.: i.e., potential factors for future development. The indicators used were selected from those which appeared in the UNCTAD study; at the same time it was recognized that it may be necessary at a later stage to include other indicators more clearly reflecting the countries' economic potential, such as the supply of different types of resources, technical training of the labour force, etc., as the availability of new information permits.

Unlike the set of indicators used in the UNCTAD classification, the inclusion of this new group of indicators would enable the development process to be considered not only as regards the attainment of given average production levels, social objectives and supply of goods, but also as regards the possibilities offered by them for carrying development to a more advanced stage.

The indicators used were divided up into the following groups:

Group I. Indicators of the level of development reached

(1) per capita gross domestic product;
(2) per capita energy consumption (kW);
(3) school enrolment rate;
(4) number of doctors per 100,000 inhabitants;
(5) share of manufacturing in the gross domestic product

Group II. Indicators of development potential

(1) total population;
(2) total gross domestic product;
(3) gross domestic product of manufacturing;
(4) total exports.

The results are shown in tables 19, 20 and 21.

Table 19

RANKING OF LATIN AMERICAN COUNTRIES IN THE LIST OF 90 DEVELOPING COUNTRIES

Less developed countries	*UNCTAD classification*			*ECLA classification (1965)*	
	11 indicators	*6 indicators*		*Without Ivanović correction*	*With Ivanović correction*
	1967	*1965*	*1967*		
1st-10th place	—	—	—	—	—
11th-20th place	Haiti	—	Haiti	—	—
21st-30th place		Haiti		Barbados Haiti	Barbados
31st-40th place	—	Bolivia	—	—	Haiti
41st-50th place	Bolivia Honduras	Honduras	Bolivia Honduras	Guyana Honduras	Guyana
51st-60th place	Ecuador Guatemala Dominican Republic Paraguay El Salvador	Ecuador Paraguay Brazil Dominican Republic	Ecuador Paraguay Dominican Republic Guatemala	Paraguay Bolivia Nicaragua	Honduras Nicaragua Paraguay Bolivia
61st-70th place	Brazil Nicaragua Colombia Peru	Guatemala El Salvador Peru Nicaragua Colombia	Brazil Peru El Salvador Colombia Nicaragua Guyana	El Salvador Guatemala Costa Rica Dominican Republic Panama Ecuador	Guatemala El Salvador Panama Costa Rica Dominican Republic
71st-80th place	Costa Rica Barbados Guyana Jamaica Cuba Mexico Chile	Guyana Cuba Barbados Costa Rica Mexico Jamaica Panama	Cuba Barbados Costa Rica Jamaica Panama Chile Mexico	Jamaica Brazil Colombia Peru Uruguay	Jamaica Ecuador Brazil Colombia Uruguay
81st-90th place	Panama Uruguay Argentina	Chile Uruguay Argentina	Uruguay Argentina	Cuba Chile Mexico Argentina	Peru Cuba Chile Mexico Argentina

SOURCE: ECLA, on the basis of UNCTAD data.

Table 20

VARIATIONS IN THE RANKING OF LATIN AMERICAN COUNTRIES IN THE LIST OF 90 DEVELOPING COUNTRIES

Country	UNCTAD classification				ECLA classification (1965)		
	11 indicators	6 indicators		Average	Without Ivanović correction	With Ivanović correction	Average
	1967	1965	1967				
Argentina	87	89	83	86.3	89	90	89.5
Barbados	73	74	74	73.7	28	26	27.0
Bolivia	49	40	41	43.3	54	57	55.5
Brazil	66	58	61	61.7	76	77	76.5
Colombia	69	69	66	68.0	77	78	77.5
Costa Rica	72	76	75	74.3	64	66	65.0
Cuba	77	73	71	73.7	81	83	82.0
Chile	80	81	79	80.0	83	87	85.0
Ecuador	56	52	55	54.3	67	73	70.0
El Salvador	60	63	65	62.7	62	62.5	62.2
Guatemala	57	62	60	59.7	63	62	62.5
Guyana	75	71	70	72.0	45	45	45.0
Haiti	18	21	18	19.0	29	33	31.0
Honduras	50	48	47	48.3	50	53	51.5
Jamaica	76	78	77	77.0	72	72	72.0
Mexico	79	77	80	78.7	85	88	86.5
Nicaragua	67	67	67	67.0	59	54	56.5
Panama	81	79	78	79.3	66	64	65.0
Paraguay	59	56	58	57.7	52	55	53.5
Peru	70	66	63	66.3	79	81	80.0
Dominican Republic	58	59	59	58.7	65	68	66.5
Uruguay	86	84	81	83.7	80	80	80.0

SOURCE: ECLA on the basis of UNCTAD data.

Table 21

CHANGE IN THE ORDER OF COUNTRIES WITH OVER 15 MILLION INHABITANTS

Country	UNCTAD classification				ECLA classification (1965)		
	11 indicators	6 indicators		Average	Without Ivanović correction	With Ivanović correction	Average
	1967	1965	1967				
Argentina	87	89	83	86.3	89	90	89.5
Spain	89	88	89	88.7	88	89	88.5
Yugoslavia	82	85	85	84.0	87	89	87.5
Mexico	79	77	80	78.7	85	87	86.0
Colombia	69	69	66	68.0	76	77	76.5
Turkey	65	61	64	62.0	73	75	74.5
Philippines	68	68	68	68.0	77	81	79.0
Brazil	66	58	61	61.7	75	76	75.5
United Arab Republic	54	51	52	52.3	72	74	73.0
Republic of Viet-Nam	39	35	33	35.7	39	41	40.0
Thailand	40	33	35	36.0	57	59	58.0
Korea	64	64	69	65.7	68	73	70.5
Pakistan	37	36	45	36.0	47	51	49.0
India	36	45	44	41.7	60	66	63.0
Indonesia	33	28	29	30.0	43	46	44.5
Democratic Republic of the Congo	26	29	31	28.7	38	45	41.5
Nigeria	17	16	16	16.7	27	30	28.5
Burma	24	4	23	17.0	31	29	30.0
Ethiopia	6	12	3	7.0	22	28	25.0
Afghanistan	14	9	8	10.3	23	22	22.5

SOURCE: ECLA on the basis of UNCTAD data.

The UNCTAD study acknowledges that since the indicators which it used related only to the level of development reached at a given moment, they do not reflect future possibilities, although the results of the classification and order of countries—i.e., the situation reached—could be used as a starting point for such a forecast.

Table 19 shows the rankings allotted to the Latin American countries within the ten-country brackets in the studies carried out by UNCTAD and ECLA.

In the UNCTAD classification, Haiti is the country from the region in the first 30 places, while Bolivia and Honduras are the only ones between the 31st and 50th places. The rest are found from the 51st place onwards, with some groups remaining constant in all three classifications, while some countries move from one bracket to another.

If the results are compared with those of the ECLA classification, it will be noted that Barbados moves from above the 70th place in the UNCTAD classification to between the 21st and 30th places, while Guyana moves from above the 60th place to between the 40th and 50th places.

The other countries which undergo considerable shifts in relation to the UNCTAD order are shown in table 20.

A total of 13 countries move to a higher position in the scale, with an average rise of 8.9 places, while 9 countries shift an average of 13.9 places downwards. In other words, Latin America as a whole covers a wider range.

Altogether the total upward and downward shifts cancel each other out, since the average shift for the whole group of countries is –0.22.

It was also considered useful to determine the regrouping effect on other countries, particularly those with higher development potential indicators. Countries with a population of over 15 million were selected for this analysis, including four Latin American countries (see table 21). It was noted that except for Spain, which dropped very slightly in the scale, all the countries moved up several places, particularly those which were in the lowest brackets of the previous scale. The 20 countries as a whole moved 11.4 places up the scale. Excluding the four Latin American countries, the average shift was 12.2 places.

In general terms, the effect of the new classification of the Latin American countries and the less developed countries, with more than 15 million inhabitants is a net negative shift by the Latin American countries. For the group comprising the countries which move to higher rankings, the difference between the average positions amounts to 3.3 places, while for the other group (the countries which move downwards) the difference is 26.1 places. Taken as a whole, the less developed countries with populations of over 15 million register a relative improvement on the level-of-development scale if the indicators reflecting development potential are included. This is particularly so in the case of the group of countries comprising Costa Rica, Panama, Uruguay, El Salvador, Nicaragua, Paraguay, Jamaica, Barbados and Guyana.

This over-all effect as regards changes in the order of countries is the result of four factors connected with the differences in the methodology used: the definition of distance used, reduction in the number of indicators of level of development, differences in the years considered, and the inclusion of indicators of development potential.

In order to isolate the effect of the last factor mentioned, the average shifts in the scale were broken down into two elements: (1) that due to the first three factors, measured by the shifts in the UNCTAD classifications resulting from the adoption of the ECLA methodology, using the first group of indicators of the level of development reached, and (2) that due to the inclusion of factors of development potential, measured by the shifts between the order established by the ECLA methodology, using the first group of indicators, and that obtained by considering this group of indicators simultaneously with the indicators of development potential (the total shifts are measured by taking the sum of the absolute values of all the shifts recorded).

The results are shown in table 22, where it can be seen that the shifts caused by the inclusion of indicators of development potential are far more numerous than those due to the other factors mentioned.

This demonstrates the important effect that the inclusion of indicators of development potential has in modifying the results obtained by the ECLA methodology, and shows that these indicators constitute an additional element to those previously considered by UNCTAD in determining aspects of underdevelopment.

Table 22

DIFFERENCES BETWEEN THE ORDER ESTABLISHED BY UNCTAD AND THAT ESTABLISHED BY ECLA

	Effect of methodology and indicators of level of development	*Percentage*	*Effect of inclusion of indicators of development potential*	*Percentage*	*Total*	*Percentage*
Group of 20 countries with over 15 million inhabitants	43	17.3	205.5	82.7	248.5	100.0
Group of 16 countries with over 15 million inhabitants (excluding Latin American countries)	30.7	14.2	185.0	85.8	215.7	100.0
Group of Latin American countries	82.4	30.9	184.5	69.1	266.9	100.0

SOURCE: ECLA, on the basis of UNCTAD data.

3. *Determination of independent factor*

Factor analysis is an attempt to reduce a given set of variables describing a phenomenon —in this case, the various aspects of the economic and social development of Latin American countries—to a smaller number of independent factors. It is hoped that by doing this the phenomenon can be more easily understood and analysed and that the main forces behind it can be given their proper relative weight. Because of the very nature of the method, once the data relating to the problem have been assembled, the results—i.e., the combination deriving from the separate indicators making up each factor—are independent of the investigator. However, while this guarantees that conclusions can be reached without the investigator subjectively controlling or influencing the data, it may give rise to sets of indicators that are difficult to interpret. Moreover, the method must be employed with great care in view of the effect which the inclusion or exclusion of particular variables may have on the formation of the factors.

The method does not pretend to establish a causal relationship between the factors deriving from it and the economic and social characteristics themselves. The relationships obtained must be interpreted as a mere association between the factors and the phenomenon in question. In this study, the objective is to estimate mutually independent factors which are associated with the combination of all the aspects representing the level of living and are consequently better able to describe it.

The grouping of indicators used in carrying out the classification took no account whatsoever of the greater or lesser degree of independence that might exist between the combinations of indicators that were established at the outset. It was therefore of interest to find out to what extent these combinations could be improved and what possible alternative groupings could be established to represent the aspects relating to the level of living.

By applying the factor analysis method to the 23 level-of-living indicators, 8 principal factors were obtained which, taken together, account for more than 85 per cent of the total variation (see table 23). The resulting factors are not always easy to interpret since they sometimes derive from a combination of indicators corresponding to different concepts. Furthermore, the per capita income indicator carries roughly the same weight in factors 1, 3, 5, 7 and 8. Since ascribing it to just one factor would therefore have been arbitrary, it was considered advisable not to include it at a later stage. The fact that this indicator has a similar linear relationship with various factors may be because, in a sense, it summarizes the entire body of information. Leaving the per capita income aside, the factors obtained are as follows:

Table 23

FACTORS MATRIX: 23 LEVEL-OF-LIVING INDICATORS

(Variation accounted for: 85 per cent)

	F_1	F_2	F_3	F_4	F_5	F_6	F_7	F_8
1 Per capita income	0.46003	0.09371	−0.38964	−0.04500	−0.33483	0.04384	0.37037	0.45940
	(0.21163)	(0.00878)	(0.15182)	(0.002025)	(0.11211)	(0.00192)	(0.13717)	(0.21105)
16 Apparent consumption of energy	0.89539	0.05121	−0.21809	0.11085	−0.01870	0.03934	−0.2639	−0.12427
17 Apparent consumption of cement	0.66792	0.12248	−0.31904	0.21667	−0.22789	0.09474	0.11399	−0.44280
23 Consumption of rolled products	0.81951	0.03760	−0.00784	−0.10762	−0.25622	0.04069	0.22570	−0.30341
3 Hospital beds per inhabitant	0.05896	0.92637	−0.12616	0.02431	−0.11374	0.01521	0.24151	−0.15797
12 Average number of persons per room	0.05817	0.96298	−0.02356	0.04447	−0.01136	0.07311	0.15262	−0.08219
9 Enrolment in secondary education	0.16562	0.14730	−0.83434	0.20036	−0.09515	0.16683	0.18020	−0.08668
19 Consumption of newsprint	0.51573	0.02773	−0.63207	−0.04762	0.06718	−0.13736	0.26111	−0.40199
20 Radio sets per 1,000 inhabitants	0.08316	0.04341	−0.84232	0.03646	−0.27379	0.22893	0.15140	−0.12571
21 Telephones per 1,000 inhabitants	0.16046	0.05761	−0.63943	−0.11887	−0.25587	−0.00028	0.16590	−0.59472
22 Television sets per 1,000 inhabitants	0.45221	−0.00113	−0.59296	0.08829	0.16596	−0.06403	0.26774	−0.45538
11 Public expenditure on education	0.07080	0.05228	−0.07866	0.88635	−0.12635	−0.06038	0.02092	−0.07064
7 Average level of education	−0.00417	0.12189	−0.32417	0.13665	−0.82288	0.05065	0.13305	−0.21848
10 Enrolment in universities	0.34480	0.01965	−0.00468	0.08473	−0.77675	−0.05564	0.29470	−0.16896
14 Dwellings with main drainage facilities	0.05791	0.07339	−0.16264	−0.06000	0.00348	0.91910	0.04993	−0.05630
2 Life expectancy at birth	0.20608	0.13577	−0.23223	0.16229	−0.06781	0.16036	0.68078	−0.50683
4 Calorie consumption	0.16801	0.26958	−0.23160	−0.15997	−0.22070	−0.11298	0.74413	−0.25453
5 Protein consumption	0.01871	0.15272	−0.40824	−0.23076	−0.11869	−0.19265	0.59467	−0.40674
6 Literacy rate	0.21301	0.31381	−0.13861	0.24542	−0.33159	0.17341	0.52925	−0.48377
8 Enrolment in primary education	0.04247	0.31535	−0.18707	0.24841	−0.27381	0.27567	0.69795	0.11761
13 Dwellings with running water	0.42983	0.12481	−0.17750	0.25149	−0.08847	0.09299	0.18173	−0.75038
15 Dwellings with electric light	0.37113	0.20477	−0.16694	0.01994	−0.29077	0.04552	0.12565	−0.75649
18 Motor vehicles per 1,000 inhabitants	0.27172	0.06085	−0.43602	−0.15183	−0.29243	−0.09911	0.34419	−0.58876

Factor 1: Represents the consumption of energy and of certain basic products such as cement and rolled products. The relationship of this factor to the level of living is indirect, since it involves intermediate products whose final destination depends on the use to which they are put in the economic system where they are employed. It is nevertheless obvious that the availability of certain types of goods, such as consumer durables and housing, which are connected with the intermediate products covered by this factor, does imply a raising of the level of living.

Factor 2: Reflects both overcrowding and one aspect of medical attention. The two may obviously be related, but not sufficiently to justify their inclusion in a single factor.

Factor 3: Includes an indicator on secondary education, another on the availability of telephones, and three on mass media (press, radio and television). This factor is thus based on means of communication as a reflection of the modernization of society. Even though receptivity to such media may require a certain minimum of education, there is no clear link with secondary education, independently of other educational factors.

Factors 4 and 6: It is interesting to consider these factors together, since each is composed of a single indicator. However, their use is questionable both because of the provisional nature of certain estimates of public expenditure on education and because the provision of main drainage facilities concerns the urban population, whose proportion of the total population varies widely from country to country. It was accordingly deemed advisable not to include them in the rest of the analysis.

Factor 5: Represents both the average level of education of the population and the efficiency of university education. It indicates the connexion that exists between the educational level of the population and university education, since the higher the former the greater the possibility of access to the latter.

Factor 7: Implies the existence of two clear-cut and distinct aspects. The first of these aspects has to do with health and nutrition: life expectancy at birth reflects the combination of all the factors affecting the prolongation of the length of life, particularly medical attention and nutritional possibilities, so it seems natural that it should be included along with aspects relating to the consumption of calories and proteins.

The other aspect covered by this factor has to do with primary education and the literacy rate, which together represent the most basic level of education.

It should be noted that whereas the over-all literacy rate is the result of the educational policy pursued in the past, the primary education indicator is a reflection of current policy in educational matters.

Factor 8: Includes aspects relating to the quality of housing (availability of water and electric light) and an indicator on the existence of motor vehicles. Here again, this factor cannot be taken as representing a precise functional concept directly relating to the level of living.

One of the consequences of this initial analysis is the impossibility, in some cases, of identifying factors that can be precisely defined, since these factors sometimes involve indicators that correspond to quite heterogeneous aspects.

The education indicators appear in three quite separate factors representing different educational levels. The consumption aspects, for their part, constitute two perfectly clear-cut factors: consumption of energy and basic products and consumption relating to communications media.

Finally, the nutrition indicators are associated with the general health indicator.

At this point in the analysis, it would be interesting to find out whether the factors that have emerged so far remain valid when the influence of certain indicators diminishes and whether factors with clearer-cut meaning could be obtained by omitting some of the variables. The method was thus applied once again, but omitting the indicators for public expenditure on education and dwellings with main drainage facilities. The results are shown in table 24.

Only two of the previous factors remain: 2 and 5, which now become 2 and 4 respectively. The per capita income also appears with similar weighting for several different factors.

The main feature of the new factors is the emergence of a general factor, factor 1, which accounts for some 20 per cent of the total variation as covers housing, consumption of basic products and some aspects of communications media. Factor 3 consists of two indicators, one for secondary education and the other for the level of ownership of radio

Table 24

FACTOR MATRIX: 21 LEVEL-OF-LIVING INDICATORS[a]

(Variation accounted for: 86 per cent)

	F_1	F_2	F_3	F_4	F_5	F_6
1 Per capita income	0.55530	0.10067	−0.27863	−0.34846	−0.53139	−0.17806
13 Dwellings with running water	0.72909	0.17124	−0.17262	−0.17725	−0.34579	−0.13782
15 Dwellings with electric light	0.63732	0.24224	−0.13614	−0.36704	−0.41419	−0.02182
16 Apparent consumption of energy	0.88067	0.01275	−0.18710	−0.00384	0.06010	−0.04817
17 Apparent consumption of cement	0.81721	0.11865	−0.31342	−0.25219	−0.15507	−0.15665
19 Consumption of newsprint	0.59975	0.01784	−0.47040	0.07037	−0.55517	−0.02835
22 Television sets per 1,000 inhabitants	0.59792	0.00465	−0.47873	0.17426	−0.49258	−0.09851
23 Consumption of rolled products	0.80881	0.02329	0.09561	−0.25562	−0.26030	−0.11020
3 Hospital beds per inhabitant	0.10321	0.92465	−0.10034	−0.11292	−0.21138	−0.19361
12 Average number of persons per room	0.08550	0.96224	−0.02907	−0.01212	−0.07103	−0.16427
9 Enrolment in secondary education	0.23965	0.12226	−0.85165	−0.06221	−0.15478	−0.25234
20 Radio sets per 1,000 inhabitants	0.14048	0.03317	−0.83675	−0.24594	−0.25946	−0.14010
7 Average level of education	0.08684	0.12057	−0.35833	−0.82706	−0.15043	−0.16540
10 Enrolment in universities	0.34053	0.00727	0.04373	−0.77195	−0.20455	−0.23543
4 Calorie consumption	0.16859	0.25274	−0.05602	−0.19739	−0.69944	−0.45225
5 Protein consumption	0.08583	0.15811	−0.19417	−0.11821	−0.85341	−0.19755
18 Motor vehicles per 1,000 inhabitants	0.41696	0.08093	−0.28055	−0.32282	−0.71008	−0.03867
21 Telephones per 1,000 inhabitants	0.35171	0.08250	−0.53752	−0.28968	−0.61392	0.06350
2 Life expectancy at birth	0.40322	0.15355	−0.20127	−0.10440	−0.50894	−0.59925
6 Literacy rate	0.41628	0.32899	−0.16586	−0.37163	−0.32493	−0.55066
8 Enrolment in primary education	0.01958	0.28195	−0.23632	−0.22961	−0.09876	−0.82213

[a] Indicators 11 and 14 are omitted.

sets. Previously, these were combined with those relating to communication media, which are now incorporated in a more heterogeneous factor.

Factors 5 and 6 are also somewhat different from before: the primary education factor now comes out more clearly, but is linked with the health level indicator. Factor 6 still comprises the nutrition group, but with the addition of some other consumption indicators.

In short, the second application of the method sheds more light on the educational aspects but has not managed to clarify other factors relating to the remaining aspects.

The omission of the per capita income indicator produced similar results to those obtained previously, with the advantage, however, of enabling the primary education factor to be isolated while maintaining two factors of a general nature—factors 1 and 5 (see table 25). Whereas 1 is identical to the previous factor 1, factor 5 now includes the life expectancy indicator.

What still remains effective is the separation of the educational aspect into three mutually independent groups corresponding to the three levels of education.

As for the concentration that occurs in turn in the other factors when indicators for health and nutrition, consumption and housing are consolidated, the process was repeated omitting in turn the indicators for health and nutrition and those for education and housing. The results appear in tables 26, 27 and 28.

If health and nutrition are omitted (table 26), the consumption indicators fall basically into two groups representing consumption of energy and basic products on the one hand and communications media and availability of motor vehicles on the other. The division of the three levels of education remains, while the housing groups form a separate factor, with the exception of the density-of-occupation index (average number of persons per room) which appears under the primary-education factor.

When the education indicators are omitted (table 28), it becomes possible to identify the two factors corresponding to the consumption indicators: consumption of energy and basic products and use of communications media. The indicators for health and nutrition and for housing appear together and present the following characteristics: the nutrition indicators are separate from the health indicators and a factor comprising density of occupation and medical attention appear once again, as it did originally. Life expectancy remains linked with the housing indicators, and availability of motor vehicles remains linked with the nutrition indicators.

Omitting the housing indicators does not greatly alter the results of the previous analyses as far as the division of the consumption indicators into two groups and the separation of the nutrition and health indicators and those for the three different levels of education are concerned.

A number of conclusions can be drawn from the results obtained as regards the various factors that accompany independently the different aspects of the level of living:

(*a*) The desirability of breaking down the education sector into three separate levels—primary, secondary and university;

(*b*) The separation of the nutrition indicators from the health indicators—although no clear way of grouping them has been found;

(*c*) The separation of the housing quality indicators from the density-of-occupation indicators;

(*d*) The separation of the indicators for consumption of energy and basic products from the other consumption indicators.

Obviously, these conclusions only reflect a few regularly occurring features observed in the results achieved by the application of factor analysis. It cannot be said that this method was rigorously applied, or that the results obtained permit the determination of precise independent factors capable of socio-economic interpretation.

No further tests were made to obtain more acceptable results by the gradual variation of the quantity of indicators used, since the criterion for grading the acceptability could have made the results depend on their adaptation to *a priori* schemes. The present method avoids this situation, and this fact is considered one of its advantages. These general conclusions were therefore maintained, subject to possible future modification in the light of new results. It may happen that the results obtained may depend to some extent on the quality of the indicators used, especially in the case of education, where there is no strict uniformity as

Table 25

FACTOR MATRIX: 20 LEVEL-OF-LIVING INDICATORS[a]

(Variation accounted for: 86 per cent)

	F_1	F_2	F_3	F_4	F_5	F_6
13 Dwellings with running water	0.72671	0.17447	−0.17732	−0.19023	−0.35096	−0.12595
15 Dwellings with electric light	0.63798	0.23965	−0.13632	−0.38831	−0.42853	−0.00678
16 Apparent consumption of energy	0.88137	0.01227	−0.19130	0.00101	0.06191	−0.05127
17 Apparent consumption of cement	0.81557	0.11909	−0.31688	0.26301	−0.15726	−0.14962
19 Consumption of newsprint	0.59938	0.01650	−0.47747	0.06728	−0.55128	−0.03382
22 Television sets per 1,000 inhabitants	0.59524	0.00693	−0.48739	0.14696	−0.48422	−0.10157
23 Consumption of rolled products	0.80563	0.02450	0.08449	−0.24581	−0.24444	−0.12614
3 Hospital beds per inhabitant	0.09959	0.92552	−0.10268	−0.11219	−0.20716	−0.19414
12 Average number of persons per room	0.08342	0.96304	−0.02996	−0.01235	−0.06946	−0.16350
9 Enrolment in secondary education	0.23798	0.12217	−0.85242	−0.07096	−0.15543	−0.24512
20 Radio sets per 1,000 inhabitants	0.13058	0.03793	−0.84424	−0.23499	−0.23851	−0.14597
7 Average level of education	0.08112	0.11913	−0.35933	−0.83030	−0.14677	−0.16177
10 Enrolment in universities	0.33810	0.00428	0.03783	−0.76820	−0.19574	−0.24574
4 Calorie consumption	0.16814	0.25098	−0.06360	−0.19755	−0.69349	−0.46125
5 Protein consumption	0.08725	0.15350	−0.19860	−0.12568	−0.85629	−0.20131
18 Motor vehicles per 1,000 inhabitants	0.41440	0.07879	−0.28722	−0.32666	−0.70657	−0.04246
21 Telephones per 1,000 inhabitants	0.34836	0.08089	−0.54146	−0.29749	−0.61386	0.06677
2 Life expectancy at birth	0.40028	0.15903	−0.20989	−0.10986	−0.50287	−0.59476
6 Literacy rate	0.41370	0.33205	−0.17043	−0.38278	−0.32555	−0.54047
8 Enrolment in primary education	0.01909	0.28378	−0.23992	−0.23262	−0.09423	−0.82093

[a] Indicators 1, 11 and 14 are omitted.

Table 26

FACTOR MATRIX: 16 LEVEL-OF-LIVING INDICATORS[a]

(Variation accounted for: 89 per cent)

	F_1	F_2	F_3	F_4	F_5	F_6
16 Apparent consumption of energy	0.92835	−0.12051	0.16181	0.00241	−0.17162	0.03356
17 Apparent consumption of cement	0.71315	−0.45675	0.31293	0.12442	−0.26900	0.20417
23 Consumption of rolled products	0.69396	−0.11093	−0.12160	0.08843	−0.43058	0.41769
13 Dwellings with running water	0.44291	−0.59590	0.10370	0.21204	−0.46698	0.14098
15 Dwellings with electric light	0.35090	−0.70404	0.08896	0.18360	−0.42447	0.26529
9 Enrolment in secondary education	0.20794	−0.08530	0.83080	0.20886	−0.31844	0.02378
20 Radio sets per 1,000 inhabitants	0.07511	−0.11337	0.83633	0.04582	−0.33699	0.17044
6 Literacy rate	0.24992	−0.46856	0.25913	0.52773	−0.21866	0.41069
8 Enrolment in primary education	0.05513	0.12128	0.38703	0.70404	−0.03837	0.43431
12 Average number of persons per room	0.02234	−0.18711	−0.01281	0.88126	−0.06969	−0.05134
18 Motor vehicles per 1,000 inhabitants	0.12022	−0.31009	0.20336	0.11697	−0.76612	0.39896
19 Consumption of newsprint	0.41277	−0.09634	0.34407	0.06749	−0.78835	0.04794
21 Telephones per 1,000 inhabitants	0.07899	−0.44626	0.45874	0.01398	−0.65645	0.21314
22 Television sets per 1,000 inhabitants	0.38236	−0.13553	0.35022	0.08667	−0.76244	−0.04202
7 Average level of education	0.00931	−0.44007	0.98640	0.06612	0.04101	0.67453
10 Enrolment in universities	0.21518	−0.12119	0.02702	0.10268	−0.21125	0.88787

[a] Indicators 1, 2, 3, 4, 5, 11 and 14 are omitted.

Table 27

FACTOR MATRIX: 15 LEVEL-OF-LIVING INDICATORS[a]

(Variation accounted for: 87 per cent)

	F_1	F_2	F_3	F_4	F_5
2 Life expectancy at birth	0.50625	0.23710	−0.49461	0.31738	0.20125
13 Dwellings with running water	0.76273	0.15531	−0.14362	0.28048	0.41710
15 Dwellings with electric light	0.81167	0.16858	−0.26685	0.18296	0.34749
3 Hospital beds per inhabitant	0.14756	0.93647	−0.24542	0.10965	0.05950
12 Average number of persons per room	0.09331	0.97333	−0.09953	0.02387	0.05086
4 Calorie consumption	0.16924	0.29629	−0.85619	0.15805	0.18781
5 Protein consumption	0.19821	0.12764	−0.85657	0.32679	0.05548
18 Motor vehicles per 1,000 inhabitants	0.53021	0.04221	−0.53601	0.45911	0.22423
19 Consumption of newsprint	0.25442	0.01571	−0.36916	0.64530	0.50644
20 Radio sets per 1,000 inhabitants	0.11115	0.11450	−0.15883	0.87437	0.07709
21 Telephones per 1,000 inhabitants	0.51040	0.04004	−0.37367	0.67027	0.13373
22 Television sets per 1,000 inhabitants	0.30426	0.03319	−0.25328	0.67234	0.44132
16 Apparent consumption of energy	0.13909	0.03970	0.00972	0.20499	0.92610
17 Apparent consumption of cement	0.51540	0.13600	−0.13579	0.31743	0.68662
23 Consumption of rolled products	0.34598	0.04672	−0.29178	0.04254	0.77238

[a] Indicators 1, 6, 7, 8, 9, 10, 11 and 14 are omitted.

Table 28

FACTOR MATRIX: 17 LEVEL-OF-LIVING INDICATORS[a]

(Variation accounted for: 88 per cent)

	F_1	F_2	F_3	F_4	F_5	F_6
4 Calorie consumption	0.68023	−0.43899	0.13361	−0.04175	0.20924	−0.34138
5 Protein consumption	0.84679	−0.19521	0.03206	−0.18381	0.13061	−0.25228
18 Motor vehicles per 1,000 inhabitants	0.73724	−0.15200	0.32898	−0.29030	0.32923	−0.00667
19 Consumption of newsprint	0.61587	−0.08554	0.56140	−0.16122	−0.04090	0.02466
21 Telephones per 1,000 inhabitants	0.63793	−0.04630	0.26289	−0.55664	0.27476	−0.03797
22 Television sets per 1,000 inhabitants	0.54279	−0.18605	0.53085	−0.47816	−0.12984	0.09122
2 Life expectancy at birth	0.49275	−0.71143	0.29078	−0.21600	0.08688	−0.04279
6 Literacy rate	0.30794	−0.66556	0.31584	0.19353	0.34074	−0.25856
8 Enrolment in primary education	0.05779	−0.83280	−0.01465	0.22306	0.21800	−0.22715
16 Apparent consumption of energy	0.01454	−0.01971	0.92346	−0.19056	0.03260	−0.08783
17 Apparent consumption of cement	0.20201	−0.21471	0.77187	−0.34329	0.25309	−0.12940
23 Consumption of rolled products	0.31384	−0.14865	0.79973	0.08977	0.29576	−0.00433
9 Enrolment in secondary education	0.16926	−0.27506	0.21142	−0.84832	0.04449	−0.11913
20 Radio sets per 1,000 inhabitants	0.25719	−0.15250	0.10267	−0.83669	0.23066	−0.05081
7 Average level of education	0.13336	−0.17776	0.03762	−0.38371	0.81391	−0.18497
10 Enrolment in universities	0.21955	−0.26891	0.30986	0.03722	0.80533	0.03535
3 Hospital beds per inhabitant	0.20849	−0.29775	0.09800	−0.09464	0.07768	−0.87152

[a] Indicators 1, 11, 12, 13, 14 and 15 are omitted.

regards the type of teaching at the different levels, nor as regards school ages, so that the nature of the indicators varies from country to country. Thus, these conclusions should be understood in relation to the volume and quality of the indicators up to the present, the same being true of the description of the various factors.

To sum up, according to the results obtained, the separate aspects that have to be taken into account to reflect the level of living adequately are as follows:

Factor 1: Reflects the state of health of the population and the efforts made to tackle the different health problems and thereby improve health standards.

The available indicators making up this factor are:

(*a*) Expectation of life at birth.

(*b*) Number of hospital beds per 1,000 population.

Factor 2: Describes the average level of nutrition.

The available indicators are:

(*a*) Per capita calorie intake.

(*b*) Per capita intake of proteins.

Factor 3: Provides information on the most elementary level of education and the effectiveness of education policy.

The available indicators are:

(*a*) Primary school attendance in relation to the total population of school age.

(*b*) Percentage of literate persons in relation to the population aged over 15.

Factor 4: Covers aspects relating to secondary education. The corresponding indicator is:

(*a*) Secondary and vocational enrolment in relation to the population aged 15-19.

Factor 5: Describes the efficiency of the educational system at the university level, and the secondary educational level of the population, which is the source of university entrants.

The indicators for this factor are:

(*a*) Population having completed secondary education in relation to total population.

(*b*) Number of university graduates per 100,000 inhabitants.

Factor 6: Describes the quality of housing. This factor is made up of the following indicators:

(*a*) Percentage of dwellings with piped water.

(*b*) Percentage of dwellings with electricity.

Factor 7: Provides information on the consumption of energy and basic products.

The indicators for this factor are:

(*a*) Apparent per capita consumption of energy.

(*b*) Apparent per capita consumption of cement.

(*c*) Apparent per capita consumption of rolled products.

Factor 8: Covers the availability and use of various consumer articles, largely consumer durables.

The component indicators are:

(*a*) Apparent per capita consumption of newsprint.

(*b*) Radio receivers per 1,000 population.

(*c*) Television sets per 1,000 population.

(*d*) Motor vehicles per 1,000 population.

(*e*) Telephones per 1,000 population.

It is not considered necessary to dwell on the link that exists between the development process and each of the component indicators of each factor. The establishment of a single indicator for each factor would undoubtedly facilitate the analysis, provided that the homogeneity of the indicator were beyond doubt. One way of achieving this would be to combine all the indicators for a given factor, weighting them according to the average weight of each in the different tests. According to the method used, this index or combination of indicators would make possible comparative measurements for countries over a given period, but not for an indefinite length of time, since the weightings of the indicators and the factors themselves are determined only for a specific period. In other words, the independence of the factors is conditional upon the simultaneous consideration of various economic and social aspects in all the Latin American countries together, but it is not possible to infer from this type of analysis that the factors retain their independence in the event of the evolution of a given country. Only if additional tests were carried out for other periods to check the continued validity of the indices and the weightings given to them could these

factors be accepted for the purpose of long-term measurement (supposing that they are to be used for all the Latin American countries). Such a procedure would take no account of the particular features that may characterize development in a given country; indeed, as already stated, it would amount to admitting the existence of a common process defined on the basis of the different experiences of the various Latin American countries.

There are a number of objections to this latter interpretation: (*a*) the different levels of endowment with natural resources in the different countries; (*b*) differences in the size of the markets in each country, with the consequent repercussions on the scale and economy of production; (*c*) differences in the historical conditions under which development takes place and in the efforts made to speed up the growth rate, with consequent variations in the priorities allotted to the economic and social objectives connected with development; (*d*) cultural differences, etc.

For this reason, only limited use can be made of these factors to measure the development of countries in time, and beyond a certain point it is impossible to be sure that they are sufficiently representative to describe the level of living in specific countries. On the other hand, it is interesting to observe how far the factors so determined can make possible a more synthetic description of the levels of living and consequently, what results they are likely to give when applied to the classification of countries.

To this end, the information contained in the original indicators was brought down to the level of the factors determined in the factor analysis.

Each factor was estimated by using as weighting coefficients the average weights of each indicator in the respective factor, in accordance with the results obtained in the application of the factor analysis. Only in the case of factor 1, which comprises indicators of expectation of life at birth and the number of hospital beds per 1,000 population, was a simple average of both indicators used, the reason for this being that these two indicators did not appear together in any of the other factors enumerated.

The first step in the calculation of the factors was to transform the indicators by centring them and dividing them by standard deviation.

The weightings used were as follows:

Factor 1	
Expectation of life at birth	0.50
Number of hospital beds	0.50
	1.00
Factor 2	
Calorie intake	0.73
Intake of proteins	0.80
	1.53
Factor 3	
Primary school attendance	0.56
Literacy rate	0.78
	1.34
Factor 4	
Secondary school enrolment	1.0
	1.0
Factor 5	
Population having completed secondary education	0.50
Number of university graduates	0.50
	1.00
Factor 6	
Dwellings with piped water	0.50
Dwellings with electricity	0.50
	1.00
Factor 7	
Per capita consumption of energy	0.91
Per capita consumption of cement	0.75
Per capita consumption of rolled products	0.75
	2.41
Factor 8	
Apparent per capita consumption of newsprint	0.67
Radio receivers	0.43
Television sets	0.64
Motor vehicles per 1,000 population	0.38
Telephones per 1,000 population	0.65
	2.77

The results obtained are given in table 29.

Table 29

VALUES OF INDEPENDENT FACTORS CORRESPONDING TO LEVEL-OF-LIVING INDICATORS (FIRST STAGE) FOR THE CLASSIFICATION OF THE LATIN AMERICAN COUNTRIES

	Health	*Nutrition*	*Primary education*	*Secondary education*	*University education*	*Housing*	*Consumption of basic products*	*Consumption of other products*
Argentina	95.9	73.2	94.1	63.2	83.0	95.0	67.9	99.9
Bolivia	17.0	18.7	41.2	38.6	14.4	11.9	5.7	3.1
Brazil	50.4	51.5	73.9	41.4	16.7	39.0	26.9	29.2
Colombia	43.0	27.9	68.4	39.0	34.3	75.4	28.8	32.6
Costa Rica	70.2	51.8	92.8	26.4	45.1	81.2	28.0	37.2
Chile	61.6	62.2	98.3	34.3	100.0	17.5	58.5	37.6
Ecuador	38.4	25.4	70.6	40.0	21.0	37.8	12.7	16.0
El Salvador	33.4	15.3	48.9	26.4	9.8	32.9	9.4	22.2
Guatemala	28.4	31.6	41.6	7.9	2.5	19.6	10.9	12.6
Haiti	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Honduras	21.4	26.6	42.7	9.8	6.4	21.9	7.2	6.5
Mexico	45.3	47.1	67.1	33.8	14.5	46.2	45.3	41.6
Nicaragua	25.7	36.8	41.1	18.7	13.2	30.4	14.1	13.2
Panama	58.2	45.0	85.6	87.0	59.3	59.3	38.7	64.0
Paraguay	42.3	46.1	74.6	20.3	16.0	9.2	3.5	9.1
Peru	41.1	33.0	86.3	65.4	45.0	29.6	26.8	30.6
Dominican Republic	32.0	31.6	50.5	27.4	22.8	26.7	10.5	12.2
Uruguay	100.0	100.0	100.0	100.0	53.1	92.7	44.8	100.0
Venezuela	59.1	46.6	81.9	72.4	34.9	100.0	100.0	66.7

Once the independent factors had been estimated, classification was effected according to the method described previously, using the two types of heterogeneity ratios.

For heterogeneity ratio 1, the results are given in table 30 (see also dendrogram 8).

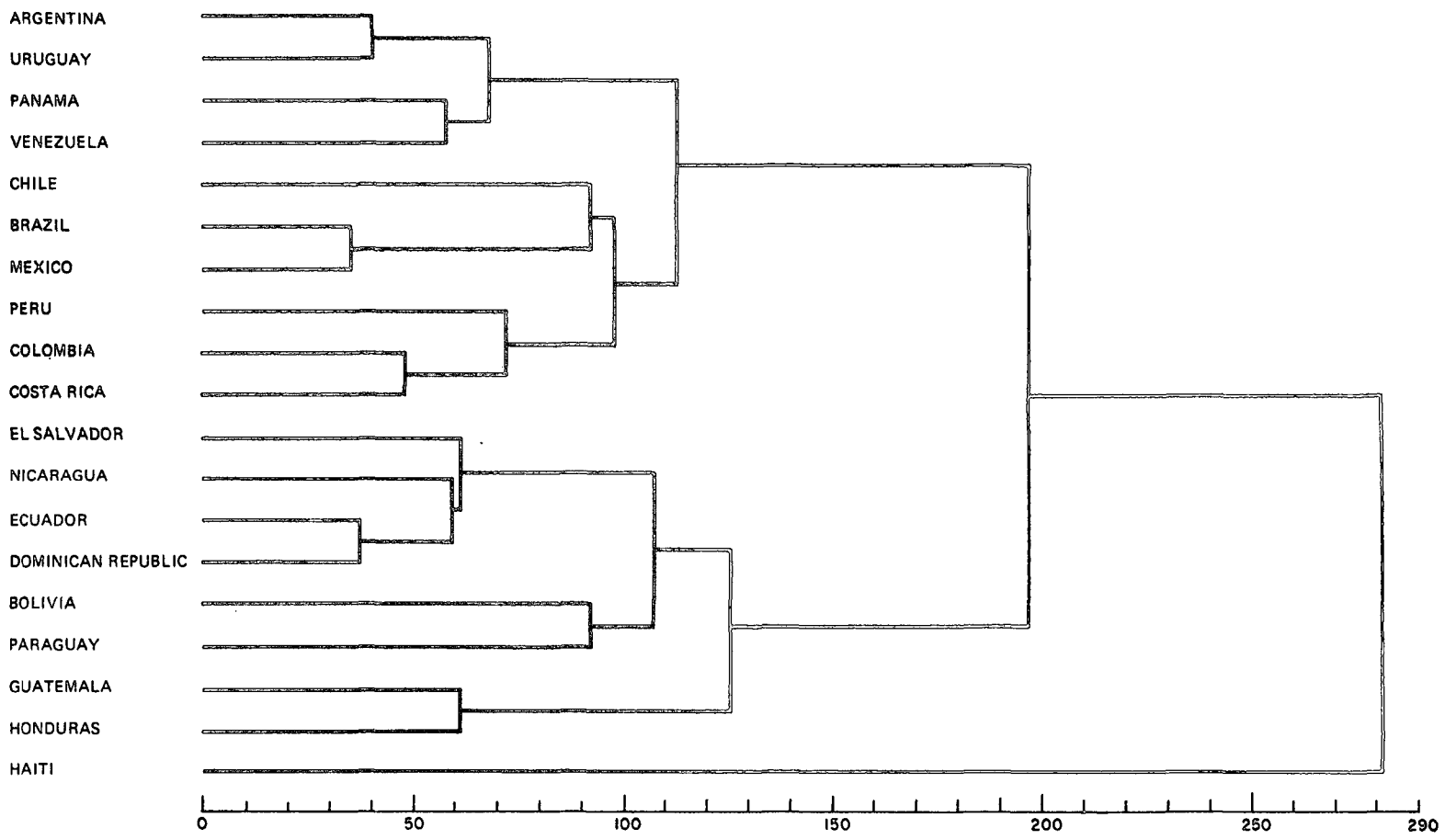
Table 30

LATIN AMERICA: CLASSIFICATION OF COUNTRIES ON THE BASIS OF INDEPENDENT LEVEL-OF-LIVING FACTORS, USING HETEROGENEITY RATIO 1[a]

I.	(*a*)	Argentina
		Uruguay
	(*b*)	Panama
		Venezuela
II.	(*a*)	Chile
		Brazil
		Mexico
	(*b*)	Peru
		Colombia
		Costa Rica
III.	(*a*)	El Salvador
		Nicaragua
		Ecuador
		Dominican Republic
	(*b*)	Bolivia
		Paraguay
IV.	(*a*)	Guatemala
		Honduras
V.		Haiti

[a] Formula 1, chapter III.

DENDROGRAM 8 LATIN AMERICA : CLASSIFICATION OF COUNTRIES ON THE BASIS OF INDEPENDENT LEVEL-OF-LIVING FACTORS, USING HETEROGENEITY RATIO I



If this result is compared with the one obtained before, using the same distance ratio, but this time in respect of all the indicators without prior factor formation, some special features stand off: (i) the appearance of an intermediate group made up especially of large countries (Brazil, Mexico, Peru, Colombia); (ii) the inclusion in this group of Chile and Costa Rica, which in the previous classification appeared in the group of higher-income countries. This change is due to discrepancies in some factors, especially "secondary education" and "consumption of other articles", which are most responsible for the dissimilarity between these countries and Panama and Venezuela, and consequently for their inclusion in a different group.

At all events, the construction of the factors appears to alter the original relationships between the countries and thus influence the resultant classification. It may be noted, however, that groups I and II coincide with the groups calculated using the Ivanović distance for the complete set of level of living indicators. This is interesting in view of the fact that the Ivanović correction is designed to reduce the effect of the highly correlated indicators in favour of the more independent indicators; in other words, the determination of factors through factor analysis has led to quite similar results.

The results of applying heterogeneity ratio 2, which are shown in table 31 and dendrogram 9, are similar to those resulting from the application of heterogeneity ratio 1. There are discrepancies only in the manner in which the countries are assembled in groups III and IV. The corrections introduced in the factors by the Ivanović coefficients do not appear to lead to important changes, owing to the independence of the factors.

Moreover, if these results are compared with those obtained through the application of the same heterogeneity ratio to the total set of indicators for the level of living (table 5 and dendrogram 3), discrepancies are likewise observed only in the grouping of the countries included in groups III and IV. In this case, the reduction of the information contained in the indicators to the smaller number of factors maintains a considerable degree of similarity between the two sets of results. This could be due to the fact that the application of the Ivanović correction to the total number of indicators increases the incidence of the independent indicators, a situation achieved in the factor analysis by the formation of combined factors, which are also independent of each other.

The use of the Ivanović coefficients would therefore be more suitable where groups of indicators are employed without taking any account of the degree of correlation between them; it would not be advisable when the groups of indicators have undergone prior processing for the formation of independent factors. The estimation of factors permits a greater degree of synthesis of the elements describing the level of living in each country, without unduly affecting the resultant classification, i.e., the resultant relation between countries. These conclusions need, however, to be verified by a greater number of observations.

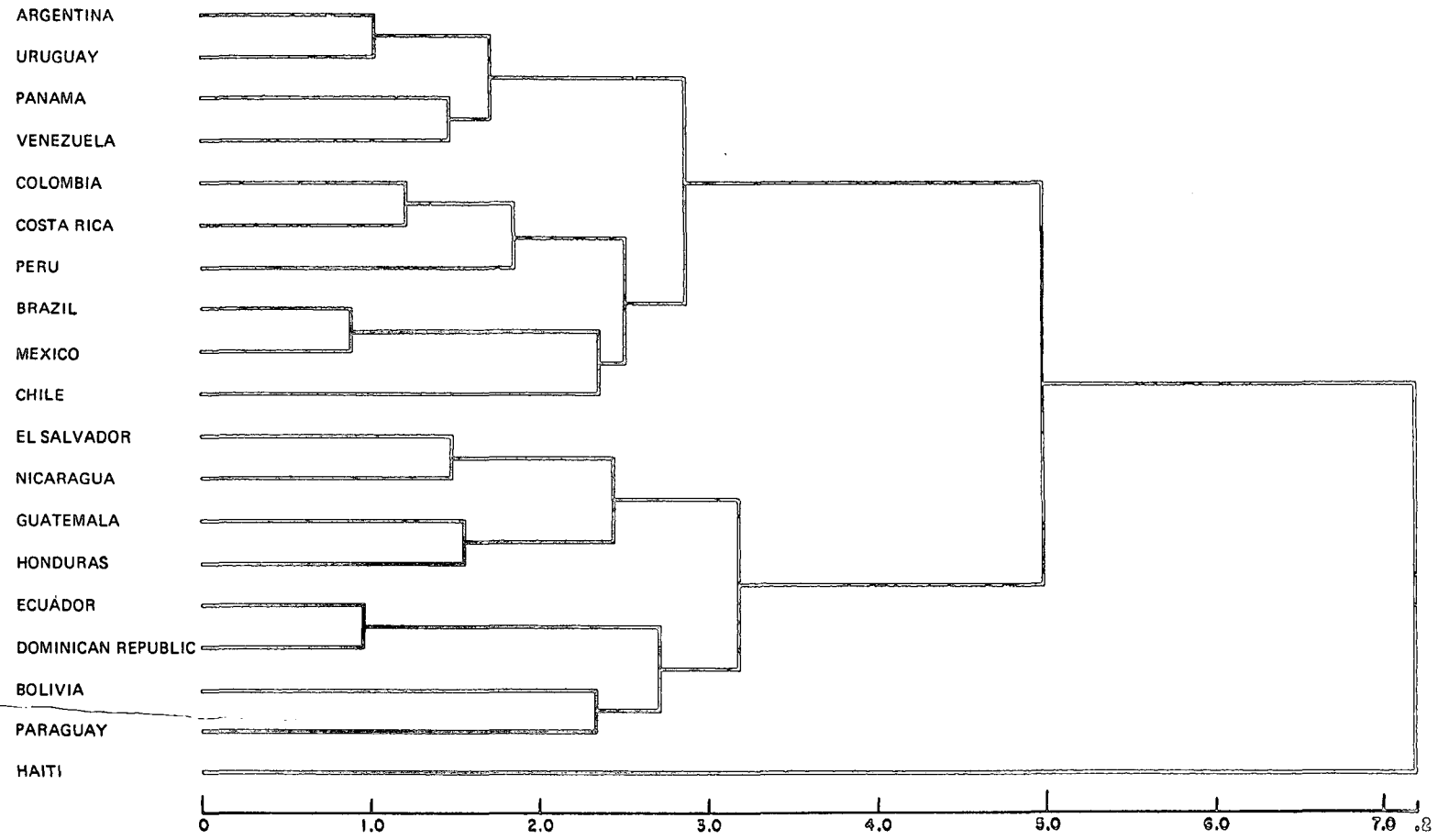
Table 31

LATIN AMERICA: CLASSIFICATION OF COUNTRIES ON THE BASIS OF INDEPENDENT LEVEL-OF-LIVING FACTORS, USING HETEROGENEITY RATIO 2[a]

I.	(*a*)	Argentina
		Uruguay
	(*b*)	Panama
		Venezuela
II.	(*a*)	Chile
		Brazil
		Mexico
	(*b*)	Colombia
		Costa Rica
		Peru
III.	(*a*)	El Salvador
		Nicaragua
	(b)	Guatemala
		Honduras
IV.	(*a*)	Ecuador
		Dominican Republic
	(*b*)	Bolivia
		Paraguay
V.		Haiti

[a] Formula 6, chapter III.

DENDROGRAM 9 LATIN AMERICA : CLASSIFICATION OF COUNTRIES ON THE BASIS OF INDEPENDENT LEVEL-OF-LIVING FACTORS, USING HETEROGENEITY RATIO 2



III. METHODOLOGY OF THE CLASSIFICATION

1. *Measurement of heterogeneity or dissimilarity between countries*

Once the characters to be used as a basis for the classification have been established, an operational definition has to be made of the heterogeneity or dissimilarity between pairs of countries. The formula chosen to express this relationship can have a great influence on the resultant classification.

The Euclidean or Pythagorean distances could be taken as a measurement of the dissimilarity or heterogeneity between each point of countries, i and j:

$$d_{i,j} = \sqrt{\sum_{k=1}^{m} (x_{ik} - x_{jk})^2}$$

or alternatively other expressions of distance could be used, but for reasons specified below it was preferred to use the following formula:

$$(1) \qquad d_{i,j} = \sqrt{\sum_{k=1}^{m} \frac{1}{p_k} \sum_{h=1}^{p_k} \left(\frac{x_{ihk} - x_{jhk}}{x_{ihk} + x_{jhk}} \right)^2} \qquad [20]$$

where:

m = the number of groups of indicators (in the case of levels of living five groups were taken: income, health and nutrition, education, housing and consumption);

p_k = the number of indicators in group k (thus, in the case cited, we have $p_1 = 1$ in the first group; $p_2 = 4$ in the second; $p_3 = 6$ in the third; $p_4 = 4$ in the fourth; $p_5 = 8$ in the fifth). In this case $\sum_{k=1}^{5}$ $p_k = p = 23$. x_{ihk}, x_{jhk} represent the value of the indicator h of group k in country i and country j.

This expression is not affected by changes of scale and inversions, but it is affected by changes of origin or complementation.

If the number of groups were to coincide with the number of indicators or—what amounts to the same thing—if there were only one indicator in each group, or if there were no weighting, it would be seen that $p_1 = \ldots = p_m = 1$, $p = m$,

$$(2) \qquad d_{ij} \sqrt{\sum_{h=1}^{m} \left(\frac{x_{ihk} - x_{jhk}}{x_{ihk} + x_{jhk}} \right)^2}$$

The measurement of dissimilarity between countries varies between 0 and 1 for each positive indicator. It will be equal to 0 when the indicator is the same for both countries, and it will be 1 when the indicator of one of the countries is 0. For the whole set of positive indicators, d_{ij} varies between 0 and $\sqrt{\sum \frac{1}{p_k}}$.

With this formula, the absolute difference between the magnitudes of an indicator is expressed in relation to the sum of those magnitudes. In other words, the same absolute difference will give a higher or lower measurement of dissimilarity, according to whether the sum of the magnitudes between which it occurs is small or large.

Expressions (1) and (2) have the following advantages:

(a) *Standardization*

Generally speaking, standardization of the characters or indicators is necessary if the measurements are to be comparable, since the characters may be expressed in absolute values with units that may be very different, or in

[20] The expression

$$\sum_{h=1}^{p} \left(\frac{x_{ih} - x_{jh}}{x_{ih} + x_{jh}} \right)^2$$

is a special case of the following expression:

$$\sum_{h=1}^{p} \left(\frac{x_{ih} - x_{jh}}{x_{ih} + x_{jh}} \right)^r$$

where r = 2, as is the so-called "Camberra's metric":

$$\sum_{h=1}^{p} \left(\frac{x_{ih} - x_{jh}}{x_{ih} + x_{jh}} \right)$$

where r = 1 (see R. M. Cormack (1971)).

percentages, etc. For the purpose of standardization, it is usual to take the deviations from an average for each indicator extended to all the countries, and to divide by another average, the standard deviation, or another characteristic.

Formulas (1) and (2) provide the basis for standardization approach and are unaffected, as stated above, not only by changes of scale, but also by inversions. Thus, for example, the same result is obtained by taking the number of doctors per 1,000 population or the number of inhabitants per doctor.

(b) *Weighting*

The influence of the magnitude of the indicators is compensated, since in each case the difference is divided by the sum (the same result would be obtained by dividing by the average).

Moreover, in (1) an attempt is made to compensate for the variation in the number of indicators of each group by dividing by this number, p_k, the square of the difference divided by the sum of the values of the corresponding indicator for both countries.

2. *Other measurements of dissimilarity*

Without at this point going into the question of the different measurements of dissimilarity and their drawbacks and advantages, it may be pointed out that formulas can be used which incorporate a correction for the possible correlations between characters.

Thus, for example, there is the *Mahalanobis distance.*[21] This distance is based on the prior standardization of the variables or characters, whose numerical value is divided by the standard deviation of each character. For n countries, the deviations of p characters (designating the numerical value of the h^{th} character in the i^{th} country as X_{ih}), are as follows:

$$s_1 = \sqrt{\frac{\sum_{i=1}^{n} (x_{i1} - \bar{x}_1)^2}{n}}, \ldots, \quad s_p = \sqrt{\frac{\sum_{i=1}^{n} (x_{ip} - \bar{x}_p)^2}{n}}$$

$$\text{for} \quad \bar{x}_1 = \frac{\sum_{i=1}^{n} x_{i1}}{n}, \ldots, \quad \bar{x}_p = \frac{\sum_{i=1}^{n} x_{ip}}{n}$$

The definition of the Mahalanobis distance between countries i and j is:

$$(3) \quad d_{ij} = (/x_{i1} - x_{j1}/, \ldots, /x_{ip} - x_{jp}/)R^{-1} (/x_{i1} - x_{j1}/ \ldots /x_{ip} - x_{jp}/)^1$$

where R is the inverse of the matrix $p \times p$ of correlations between characters.

If the characters were not correlated, it would be verified that $R = I_{pp}$, the unitary matrix $p \times p$, and therefore:

$$(4) \quad d_{ij} = \sum_{h=1}^{n} \frac{(x_{ih} - x_{jh})^2}{s_h}$$

which is the Euclidean distance between countries, based on standardized measurements.

Another expression that takes account of the correlation between characters is:[22]

$$(5) \quad \sum_{h=1}^{p} \frac{/d_h/}{s_h} \sum_{k=1}^{p-1} (1 - r_{hk}), \quad d_h = x_{ih} - x_{jh}$$

$$\text{or} \quad \sum_{h=1}^{p} \frac{/d_h/}{s_h} \sum_{k=1}^{p-1} (1 - r_{kh}, 12 \ldots k - 1)$$

where s_h represents the standard deviation of the character or indicator h, and r_{hk} the correlation between the characters h and k. In the same way, the square root can be used with $(d_h/s_h)^2$. When $r_{hk} = 0$, this brings us down to expression (4).

In the present work, the Ivanović correction is applied to expression (2), giving the following result:

[21] See, for instance, P. C. Mahalanobis (1936), C. R. Rao (1965), etc.

[22] B. Ivanović (1965) (the spelling Ivanovitsch is also used).

$$(6) \qquad d_{ij} = \sqrt{\sum_{h=1}^{p} \left(\frac{x_{ih} - x_{jh}}{x_{ih} + x_{jh}}\right)^2 \sum_{k=1}^{p-1} (1 - r_{hk})}. \quad [23]$$

3. *The classification procedure used*

Once the measure of dissimilarity has been established, the classification procedures may be divided into two groups, namely:

(*a*) Procedures that first establish the number of classes and then try to minimize the heterogeneity as measured, for instance, from the variation within the over-all classification;

(*b*) Procedures establishing the threshold of precision or homogeneity (for instance, through the similarity of the elements in each class) and attempting to minimize the number of classes in cases where there are multiple solutions.

The minimum similarity requirement may refer to similarity between:

(i) Each element and any other element of its class, thus establishing a concatenation or *simple link* between elements (Sneath, 1957).

(ii) Each element and the average similarity with the other elements in the class, or *average link* (Sokal, Michener, 1957).

(iii) Each pair of elements in the class, or *strong link* (Sorensen, 1948).

The latter procedure was used, and was applied in the following manner:

(*a*) Once the level of dissimilarity between the countries had been determined, the countries were divided into groups, starting with the smallest values which indicate less distance. For this purpose, a scale of progressive limits was established for the dissimilarity values, ranging from the minimum to the maximum observed in the calculation of these values (each of these successive values will be called a "norm").

For instance, in the table of dissimilarity values for Latin America (table 32), the lowest value is 28,352, which corresponds to the distance between El Salvador and Ecuador. The second lowest value is 30,634, between Guatemala and Nicaragua, the third lowest is 31,406, between Argentina and Uruguay, the fourth lowest, 38,009 is that between El Salvador and Guatemala, and so on successively.

(*b*) Starting with the smallest norm, countries whose dissimilarity ratios were less than or equal to the norm were grouped together. The inclusion of a country in a previously formed group also had to satisfy the same requirements in relation to each and every country in the group.

Continuing with the above example, the first group is that formed by El Salvador and Ecuador. When we proceed to the next norm, 30,634, a second group made up of Guatemala and Nicaragua, is formed. Likewise, norm 31,406 gives group containing Argentina and Uruguay.

When the next norm (38,009) is reached, it is observed that the heterogeneity value between Guatemala and Ecuador is 45,453, so that Guatemala cannot be included in the group previously formed. The following norm is 38,107, between Nicaragua and Ecuador, but here again Nicaragua is excluded because of its higher heterogeneity value with respect to El Salvador. In the last two cases, since Nicaragua and Guatemala formed part of a previously formed group, it would also have been necessary to verify the relationship between them and the other country belonging to the group in which it was intended to include them.

The next norm, 40,927, gives rise to the formation of another group comprising Bolivia and Honduras, and so on.

(*c*) Once the groups corresponding to a specific norm have been established, we pass on to the next group in order of magnitude. In this way a class hierarchy is obtained, starting from the highest norm, which classifies all the countries in a single group, since all satisfy the requirement of having a dissimilarity value be-

[23] In the work by Ivanović (UNCTAD RM41/5/11/70) the application of the Ivanović correction presupposes the existence of a dominant indicator, on the basis of which new indicators are aggregated, weighted in inverse proportion to their correlation with the preceding indicators. In the adaptation of the Ivanović formula for this work, the correction introduced adds a relatively lower weighting to the indices which are more highly correlated, without establishing any predominance of one over the others. For this reason, the Ivanović corrections were introduced on the basis of the sum instead of the product. Thus, in the case of highly correlated indicators, their weighting is diminished, but not eliminated as would in practice be the result in the Ivanović formula when one of the factors of the product is close to zero.

tween themselves that is equal to or lower than the norm, to the minimum norm, where each country constitutes a separate group.

(*d*) In the event that a country (or countries) can be included in two or more previously formed groups, it is placed in that group to which it is closest in terms of its average distance from the other members of the group.

(*e*) The groups are determined in accordance with the norm that is selected as the maximum limit of heterogeneity, in other words, only those countries that do not exceed the limit can be incorporated in each group.

Continuing with the above example, if it is decided to terminate the process by taking the norm of 31,406 as the maximum for forming a group, the classification will include only three groups: (1) Ecuador; (2) Nicaragua and Guatemala, and (3) Argentina and Uruguay, the rest of the countries standing separately.

If it is not decided to terminate the process in this way, the next norm established in accordance with the above rule is taken.

In order to secure a more objective criterion for the selection of the norm which will determine the composition of the groups, a method based on the preparation of an index of heterogeneity has been adopted.

Obviously, as the number of groups that it is wished to establish is reduced, the heterogeneity of the countries included in the groups thus formed increases. The total heterogeneity may be measured by the sum of the averages of the intragroup heterogeneity values corresponding to each group, each of these averages being weighted by the ratio of the number of countries belonging to the group to the total number of countries in the classification. By this means, a heterogeneity index can be established, starting from 0, when the number of g groups coincides with the number of countries, and increasing as g diminishes. When g is 1, the index coincides with the average of the intragroup dissimilarity values corresponding to the single group.

The classification procedure is aimed at finding a solution with the minimum possible heterogeneity values and the smallest possible number of groups, bearing in mind that the "gain" derived from the reduction in the number of groups must be offset by the "loss" caused by the increase in heterogeneity. In this dual approach, the decline in heterogeneity can conveniently be represented as a consequence of the increase in the number of groups (see table 33 and figure III).

Obviously, it becomes necessary to stop the process of increasing the number of groups at the point where it ceases to bring about a significant decrease in the heterogeneity. This increase can be read off from the column which records the absolute value of the ratio of the increase in the heterogeneity index to this index. The greater this quotient, the greater the loss of heterogeneity in the classification as the number of groups composing it goes up. In the example considered, the number of groups to be formed is determined at the level of the norm 37,194, since the increase from three to four groups would involve a drop in heterogeneity (0.145) only one half the value of the drop recorded at the previous step (0.291). Similarly, in the case of the sub-groups, the decrease in heterogeneity achieved by an increase from six to seven sub-groups is less than that recorded at the previous step.

As an additional element of judgement, the "elasticity" values of the total heterogeneity were calculated in respect of the number of groups by multiplying the said number by the previous ratio (bearing in mind that $\Delta g - 1$). These elasticity values would be used in a manner similar to the quotient referred to above.

Tabl

CLASSIFICATION OF THE LATIN AMERICAN COUNTRIES: HETEROGENEITY RATIO

Country	Argentina	Bolivia	Brazil	Colombia	Costa Rica	Chile	Ecuador
Argentina		122,028	84,311	77,587	60,603	49,728	101,961
Bolivia			69,009	77,368	94,464	104,235	52,126
Brazil				42,607	50,416	67,622	51,218
Colombia					46,561	55,721	47,078
Costa Rica						49,270	68,090
Chile							78,509
Ecuador							
El Salvador							
Guatemala							
Haiti							
Honduras							
Mexico							
Nicaragua							
Panama							
Paraguay							
Peru							
Dominican Republic							
Uruguay							
Venezuela							

Tab

HETEROGENEITY AN

(Indicator: P

Norm	Number of groups	/Bt/ Heterogene index
80,775	1	27,914
57,274	2	15,859
37,194	3	11,237
28,546	4	9,609
18,756	5	6,780
13,128	6	5,094
11,474	7	4,066
10,977	8	2,858
5,378	9	1,946
4,195	10	1,492
4,189	11	0.963
2,325	12	0.522
1,422	13	0.277
0.786	14	0.15(
0.412	15	0.08(
0.184	16	0.04:
0.121	17	0.02-
0.104	18	0.01
0	19	0

2

FORMULA 1) BETWEEN COUNTRIES (ON THE BASIS OF LEVEL-OF-LIVING INDICATORS)

El Salvador	*Guatemala*	*Haiti*	*Honduras*	*Mexico*	*Nicaragua*	*Panama*	*Paraguay*	*Peru*	*Dominican Republic*	*Uruguay*	*Venezuela*
100,377	115,955	175,814	121,833	67,890	105,228	50,113	121,977	78,554	112,718	31,406	40,974
51,105	45,257	110,866	40,927	93,153	52,832	101,743	41,692	74,284	57,584	114,289	109,126
49,041	62,478	147,417	71,187	49,843	49,170	63,616	76,326	43,139	64,830	75,778	68,915
47,183	71,111	152,452	74,976	49,434	57,269	52,003	83,691	43,618	67,072	68,344	60,296
64,112	82,154	161,699	90,293	53,294	66,778	48,661	90,245	48,667	75,001	58,932	48,490
77,047	95,495	164,958	100,302	58,534	81,983	48,838	105,530	58,209	93,681	54,156	50,731
28,352	45,453	138,461	45,318	65,085	38,107	76,266	58,039	51,323	49,340	93,296	87,435
	38,009	135,659	43,706	63,022	35,297	76,320	59,041	49,713	47,434	93,688	83,569
		125,615	39,734	76,759	30,634	92,914	50,675	67,981	51,036	110,597	103,666
			116,841	157,552	134,388	167,635	112,836	151,996	131,530	174,304	168,693
				85,730	46,935	100,669	45,755	76,000	52,302	116,722	108,400
					67,690	43,550	92,420	46,485	83,062	62,983	53,193
						82,993	52,559	57,499	45,384	98,587	90,508
							102,978	46,473	90,686	42,254	43,420
								79,589	53,637	118,685	108,711
									65,563	74,451	64,687
										109,537	98,340
											44,495

3

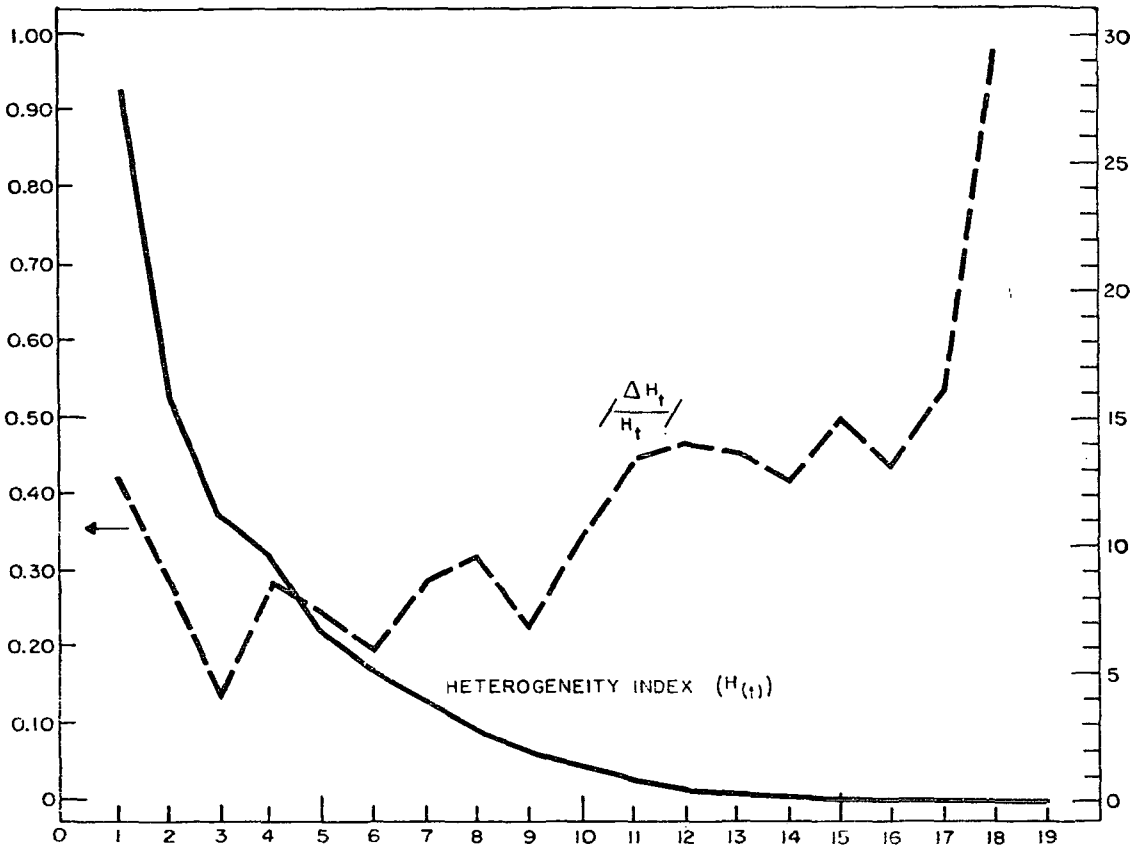
OTAL ELASTICITY INDEX

pita income level)

$/\frac{\Delta H_t}{H_t}/$	$E = /\frac{\Delta H_t}{H_t}/ g$
0.432	0.432
0.291	0.145
0.145	0.048
0.294	0.073
0.249	0.050
0.202	0.034
0.297	0.042
0.319	0.040
0.233	0.026
0.355	0.036
0.458	0.042
0.469	0.039
0.458	0.035
0.427	0.030
0.500	0.033
0.442	0.020
0.542	0.032
1	0.056
—	—

Figure III

HETEROGENEITY AND ELASTICITY INDEX



Annex I

SOURCE AND METHODOLOGY OF THE INDICATORS

Various sources were used to obtain and estimate the indicators, the aim being to select the most recent and most complete information, i.e., information covering the greatest possible number of countries. Generally speaking, the use of two or more sources for the same indicator was avoided, so as to maintain a uniform estimation criterion.

In many cases it was not possible to obtain information for a specific year, so that the indicators refer to various years, provided there was no significant variation. In cases where there were significant annual variations, it was preferred to adopt averages.

(a) *Indicators of the level of living*

Gross national income. Gross national income was calculated from the average for the period 1965-1969, using ECLA data. For the computation of the gross domestic product in dollars at 1960 prices, the series of figures expressed in national currency at 1960 prices were transformed using the corresponding exchange rates calculated by ECLA. Adjustments to take account of the "terms-of-trade effect" and "external factor payments" were calculated using ECLA data expressed in dollars at 1960 prices. The population series used were also those of ECLA, prepared from information supplied by CELADE.

Expectation of life at birth (1965-1970). The source used was CELADE, *Boletín Demográfico* (July 1969).

Number of inhabitants per hospital bed. The data were taken from the Pan American Sanitary Bureau's four-yearly projections.

Per capita daily calorie intake. The data were taken from the Pan American Sanitary Bureau's four-yearly projections. For Argentina, Brazil, Mexico and Nicaragua these data are provisional.

Per capita protein consumption (grammes per day). Here again the source was the Pan American Bureau's four-yearly projections.

Literates as percentage of the total population aged 15 and over. Source: Pan American Sanitary Bureau, four-yearly projections.

Population with secondary education in relation to the total population. This indicator was prepared by ECLA on the basis of census data.

Primary school enrolment in relation to the total population of school age. The data on primary enrolment were taken from Pan American Union, *América en cifras: 1967, Situación cultural,* Washington, 1969. The total population of school age was estimated on the basis of information on ages of school entrance and years of study at the primary level taken from the previous source and population data by age taken from CELADE, *Boletín Demográfico,* July 1969.

This indicator was calculated for the year 1965.

Secondary and vocational school enrolment as a percentage of the population aged 15-19. The data were taken from the Pan American Sanitary Bureau's four-yearly projections. They are provisional for Argentina, Brazil, El Salvador, Mexico and Nicaragua.

Number of university graduates per 100,000 inhabitants per annum. This indicator was prepared on the basis of data taken from *América en cifras: 1967,* table 501-79. Owing to the lack of data, the information does not refer to a single year, but fluctuates between 1961 and 1967. Population data for the corresponding years were prepared by ECLA, on the basis of data supplied by CELADE.

Public expenditure on education as a percentage of national income. The general source used was the United Nations *Compendium of Social Statistics, 1967.* Estimates were made by ECLA in respect of Brazil, El Salvador, Haiti, Honduras, Paraguay and Uruguay, on the basis of data from the same source on total expenditure on education in these countries. Data on national income at market prices for the corresponding years were prepared by ECLA, except in respect of Uruguay, data for which were taken from the United Nations *Yearbook of National Accounts Statistics, 1968.* Since more up-to-date information was subsequently found, these estimates are considered as provisional. The indicator corresponds in each case to one year, but the actual year varies from 1961 to 1964 for the different countries.

Average number of persons per room in occupied dwellings. In many cases these figures correspond to estimates made by the United Nations on the basis of the most frequent occupation figures for different types of rooms in different types of dwellings. Generally speaking, these estimates are considered to be somewhat unreliable owing to the limitations of the hypotheses. They correspond to various years between 1960 and 1964. The source used was the United Nations *Statistical Yearbook, 1968.*

Percentage of the total population living in dwellings with piped water supply. The source used was the Pan American Sanitary Bureau's four-yearly projections. Four provisional indicators for Argentina, Bolivia, Mexico, and Nicaragua are included.

Percentage of urban population living in dwellings with main drainage facilities. The source was *América en cifras: 1967,* on the basis of data taken from the Third Report on the World Health Situation.

Percentage of dwellings with electric light. The source was the United Nations *Statistical Yearbook, 1968.* The data relate to various years between 1960 and 1964. As the information for Haiti relates to the urban sector only, it was modified with data taken from *América en cifras, 1967.*

Apparent per capita consumption of energy (kg coal equivalent). This indicator was prepared on the basis of data on the apparent consumption of energy taken from *América en cifras, 1967* and population data supplied by CELADE. The indicators correspond to average consumption for the period 1960-1966, so as to avoid circumstantial changes that might affect the results if a specific year were considered.

Apparent per capita consumption of cement. As in the case of the foregoing indicator, the data used are averages, but here they correspond to variable periods, according to the data existing for individual countries, from 1961 onwards:

Argentina, Brazil, Paraguay, Dominican Republic, Venezuela	1961-1967
Bolivia	1961-1966
Colombia, Ecuador	1961-1964
Costa Rica	1964-1965
Chile, El Salvador, Honduras, Mexico, Nicaragua, Uruguay	1961-1965
Guatemala	1961-1965 (except 1962)
Haiti	1962-1964
Panama	1961-1965 (except 1964)

Apparent consumption of newsprint (tons per 1,000 population). The sources used were the same as for the previous indicators. The data correspond to averages for the period 1961-1966, except in respect of the following countries, for which some data were not available:

Guatemala	(except 1964)
Haiti	(except 1965 and 1966)
Honduras	(except 1964 and 1966)
Paraguay and Dominican Republic	(except 1965)

Apparent consumption of rolled steel products (in terms of tons of rolled products per 1,000 population). The data on total consumption for all

the countries except the Central American countries, Panama and Haiti were taken from the Latin American Iron and Steel Institute's *Anuario Estadístico, 1968*. Information on Central America was taken from the ECLA/IDB document *Prospects for the steel industry in the relatively less developed countries* (E/CN.12/843/Add.1), while information on Panama was provided by ECLA, on the basis of data contained in foreign trade yearbooks. There are no data for Haiti. The average for recent years was calculated according to the information obtained, as follows:

Period 1961-1966: Argentina, Bolivia, Brazil, Colombia, Chile, Ecuador, Mexico, Paraguay, Peru, Uruguay, Venezuela.

Period 1960-1965: Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua.

Period 1960-1966: Panama, Dominican Republic.

Motor vehicles, per 1,000 population. Data on passenger motor vehicles on the road and estimated midyear population were taken from the United Nations *Statistical Yearbook, 1968*. They correspond to the year 1967, except in the case of Nicaragua, where they correspond to 1966.

Radio receivers in use per 1,000 population. The data were taken from *América in cifras, 1967*. They do not all correspond to the same year:

1966: Argentina, Colombia, Ecuador, Haiti, Mexico, Nicaragua, Dominican Republic, Uruguay, Venezuela.

1965: Bolivia, Costa Rica, El Salvador, Honduras, Panama.

1964: Brazil, Peru.

1962: Chile, Paraguay.

Number of telephones in use per 1,000 population. This information was taken from the United Nations *Statistical Yearbook, 1968*. The data correspond to the year 1967.

Television sets per 1,000 population. The source used was *América en cifras, 1967*. The data correspond to the year 1966, except in the case of El Salvador, Uruguay and Venezuela, where they correspond to the year 1965.

(b) *Indicators of structure and dynamic aspects*

Total population (according to census results for the 1960s). The data used were prepared by ECLA, on the basis of information from national censuses. The following data were estimated: Peru (30 June 1950), Uruguay (30 June 1950), Bolivia (30 June 1950), Haiti (30 June 1960). Data on Guatemala for the 1960s (census date 18 April 1964) are provisional.

Structure of the gross domestic product (1950-1959 and 1960-1969). These data are ECLA estimates.

Demographic aspects. Economically active population (indicators *a, b, c, d,* and *e*): United Nations, *Demographic Yearbook,* 1956 and 1966 and national census publications. The estimated percentages were based on uncorrected census figures, and do not include post-censal adjustments.

Urban-rural distribution of the population: ECLA estimate, on the basis of census data.

Growth rate of the population: the intercensal rate was estimated on the basis of data from censuses. The rate for the period 1965-1970 was estimated by CELADE.

Foreign trade and the balance of payments. Indicators (*a*) and (*b*) were calculated by ECLA on the basis of information taken from national publications, while indicators (*c*) and (*d*) were arranged and calculated by ECLA on the basis of data taken from the International Monetary Fund's *Balance of Payments Yearbook.*

Dynamic aspects. ECLA estimates.

Values representing the economic structure that were used as a basis of economic coefficient projections. Both the indicators (*a*) and (*b*) were obtained from estimates made by ECLA in connexion with the projections for each country. These estimates were made using linear adjustment. In cases where no coefficients of this type were available (Haiti and Uruguay), no indicator was determined.

Annex II

BIBLIOGRAPHY OF LITERATURE ON METHODS OF CLASSIFICATION, MULTIVARIATE ANALYSIS AND BASIC INDICATORS

The bibliography which follows includes reports and other works consulted in the preparation of this paper (marked with an asterisk), as well as a list of publications on taxonomic questions known to the author at the time of completing this study. These latter publications have been included in the bibliography with a view to making it as complete as possible.

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