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THE ROLE OF THE INDUSTRIAL SECTOR IN ECONOMIC DEVELOPMENT

Presented by the Executive Director
of the United Nations Industrial Development Organisation

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Contents

ANNEX

Introduction

1. During the period 1938-1961, industrial production of the world tripled and the share of the industrial sector in the world gross domestic product rose from 30 per cent to 38 per cent during that period.[1] Furthermore:

> The importance of the industrial sector in total production increased at the expense of the role of agriculture. The growth between 1938 and 1961 in the agricultural output of the market-economy countries of the world approximated a third of that in the domestic product, and a fourth of that in industrial output. The proportion of the domestic product contributed by agriculture during 1961 was, therefore, less than two-thirds of that during 1938.[2]

2. The process of industrialization and the role of manufacturing industries as the strategic factor in the economic growth of modern nations has been much discussed recently. Present concern with such wide subject matter as the role of industry in economic development seems justified in view of economic policy considerations of importance to countries on their way to industrialization. Only recently, the role to be played by the industrial sector in economic development had to be stressed and defended vis-a-vis agriculture at the third session of the Governing Council of the United Nations Development Programme.[3] Several reasons such as the apparent prospects of food shortages and explosive rates of population growth, have led at the international level to an emphasis on agriculture and education. Declared policies of the major donor countries are rather clear in this respect.

3. Changes in the relative importance of agriculture and industry are the core of the process of growth. The purpose in this study is to present factual evidence on the structural changes within economic development designed to be used for economic planning and projection in countries undergoing industrialization.

1/ United Nations, The Growth of World Industry, 1938-1961, (document ST/STAT/SER.P/3) p. 1. (Mining and public utilities are included with manufacturing in the industrial sector in this publication.

2/ Ibid., p. 2.

3/ Document DP/L. 36, para. 14-15.

4. This paper presents a report of research carried out and attempts to show quantitatively the pattern of change in the composition of output with economic growth.[4/] Such a problem could be tackled with time-series or cross-section analysis. The main problem in using time-series for developing countries is, of course, the absence of data. Furthermore, the problem is aggravated because of the drastic changes that are characteristic of economies starting development from a low income base. The main justification then for the use of cross-section methods is based on the potential usefulness of such an approach, when, considering projection and planning purposes, developing countries have no other way but to try either to extrapolate past trends or to copy the existing structure and parametres of more advanced economies that have already passed through the initial stages of development.

5. The study was undertaken in two steps. First, an exploratory analysis was conducted, then a set of regression equations were fit to sectoral data.

I. AN EXPLORATORY STATISTICAL ANALYSIS

Introduction

6. A preliminary statistical analysis of the data available for forty-one countries for 1958 was conducted to uncover changes in the composition of the gross national product that can be considered a characteristic feature of the complex growth process normally termed "industrialization".

7. As the per capita income is commonly accepted as a yardstick of economic development, it is logical to study the structure (in the sense of the industrial composition) in relation to the levels of per capita income.[5/]

4/ The complete study summarized in this paper will be available in mimeographed form later in 1967.

5/ The structure was related to the level of per capita income rather than to the rate of change of per capita income. The rate of change may be the relevant variable in the context of a dynamic process. However, in this cross-section analysis, the level of per capita income was used.

8. The gross domestic product (GDP) at factor cost was first disaggregated into eleven sectors according to their industrial origin:

1. Agriculture-forestry-hunting-fishing;
2. Mining-quarrying;
3. Manufacturing;
4. Construction;
5. Electricity-gas-water;
6. Transportation-storage-communication;
7. Wholesale trade-retail trade;
8. Banking-insurance-real estate;
9. Ownership of dwellings;
10. Public administration-defense;
11. Services.

9. The proportion of GDP originating from each sector was considered for 1958. All countries included in the sample do not have the same uniform degree of disaggregation so the sample size differs from sector to sector. For instance, the agriculture sector has data for forty-one countries, while banking-insurance-real estate has been separately classified for only thirty-one countries. The analytical procedure consisted of forming for each sector a frequency distribution based on the per capita income, the data for which was obtained from the United Nations Yearbook of National Accounts Statistics, 1962. The next step was to compute the mean value of the percentages in each group of per capita income.

10. The results are presented in table 1 (see Annex). Table 2 of the Annex presents the frequency distributions and their standard deviations and the coefficients of variation.

Rationale behind the statistical procedure

11. The objective of this analysis was limited to the empirical aspect of one of the facets of changes in the economic structure with economic growth. The type of structural change that the study seeks to discover is a concomitant of economic growth and it seems to be inherent in the growth process itself. It is, therefore, logical to attempt to relate the structure to some measure of economic growth.

The difficulties involved in "quantifying" economic growth need not be enumerated here. It is sufficient to say that national income per capita is perhaps the best available indicator of economic growth. In defining the structure in terms of the break-down of national income by sectors of industrial origin, the problem is to relate this structure systematically to the national income per capita; this then is the fundamental relationship.

12. The structure of the countries falling within a per capita income group naturally would not exhibit strict uniformity. At a given level of per capita income, a host of factors - economic and non-economic - are responsible for dissimilarities in structure. Among the economic factors are: size of country and national resource endowment; among the non-economic factors are: differences in the institutional set-up, culture, and political organization. (These dissimilarities may not be negligible.) As a first approximation, a study could be made of the structural differences between per capita incomes alone, discounting structural variations within a per capita income group.

Some broad conclusions

13. The analysis of cross-section data shows that there exists a significant relationship between changes in the structure of output and the level of per capita income. The most significant structural change accompanying the increase in the level of per capita income is characterized by a decline in the share of agriculture and a rise in the share of manufacturing.

14. The share of mining and quarrying does not show a consistent pattern; the share increases as per capita income rises from low levels (under $US 100), reaching a peak in the range of $US 250-$US 500, and declines thereafter until a high level of per capita income of about $US 1,000 is reached, at which point it begins to rise again although not to the level of the previous peak. The share of construction shows an upward trend.

15. The proportion of transport-storage-communication in the total GDP probably shows an increase in the early stages of growth of per capita income and levels off at higher levels of income. The contribution of electricity-gas-water shows a marked upward trend as the level of per capita income increases.

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16. The rise in the share of banking-insurance-real estate with per capita income is significant; it is faster at lower levels of income. The share probably tends to be stable at high income levels. Wholesale trade-retail trade shows a remarkable constancy of proportion.

17. Ownership of dwellings probably shows a perceptible increase as per capita income begins to increase from a low level. The proportion appears to reach a stable level at an early stage of growth of per capita income.

18. There is no significant trend in the share of public administration-defense. The services sector probably shows an upward trend with rising levels of per capita income.

Relative importance of sectors in structural change

19. The analysis of cross-section data on GDP has brought out the major structural characteristics relating to different levels of per capita income. The most significant difference in the structure was confined to the relative shares of agriculture and manufacturing. Significant trends in other sectors have also been noted.

20. The change in structure is the result of the differences in the relative rates of growth of sectors. There is a second dimension to this aspect of structural change, namely, the relative importance or weight that each sector holds in the aggregate product. The relative contribution of a sector to structural change is thus dependent not only on its rate of growth but also on its share in the economy.

21. Using the cross-section data, the average or "typical" structure of the GDP corresponding to each of the five groups of per capita income was arrived at earlier. These structures show a persistent pattern. There exists a significant difference between the structures at any two levels of per capita income. Some sectors, of course, contribute more than others to this structural difference. The predominance of the agriculture and the manufacturing sectors in structural change is expected. The pattern that emerges seems to be stable enough to offer some scope for generalization. In interpreting the results, however, it is necessary

to proceed with caution. Observations based on the empirical findings can be regarded at best as a hypothesis concerning the sequence of sectors in the process of growth.

22. There are certain shifts occurring in the relative contribution of sectors as the per capita income rises. In the early stages of growth when the per capita income is at a low level, the most significant shift is found in the manufacturing sector. Once this shift has taken place, the second stage seems to indicate a significant response of the agriculture sector to structural change as well as a spurt in the activity of the wholesale trade-retail trade sector. In the final stage it is the services sector that bears the brunt of structural change.6/

23. In a recent meeting, the following opinion was voiced in this connexion:

> Faith in the viewpoint that agriculture and industry should develop hand in hand had been severely shaken by some research carried out in the United States in the last two or three years. These studies had pointed out that historically, in all countries from which evidence could be obtained, the agricultural take-off had invariably followed the industrial take-off and by a considerable period of time. It has not been argued, however, that all that was needed was to industrialize and agricultural development would inevitably follow, but there were indications that it was the accumulated scientific knowledge, accumulated industrial capital and materials, industrial processing of agricultural output, etc., which had provided the incentive to agricultural take-off.7/

6/ One might like to call the sectors shifting their relative contribution to structural change the "leading sectors" with reference to the appropriate stage of growth. Permitting this view, it becomes clear that there is a definite sequence in the expansion of sectors as the economy passes from one stage to the next.

7/ See M. Clawson, in The Strategy of Industrial Development in Developing Countries, Summary of Papers and Discussions of an Interdisciplinary Conference held in Geneva, June 1965, edited by E.E. Papanicolau and D. Peart, p. 13; Society for International Development, Washington, D. C.

II. THE MAIN HYPOTHESIS

Introduction

24. The starting hypothesis was that economic growth as measured in terms of income per capita, gives rise to changes in the structure of GDP, (i.e. the composition of output by industrial origin), the pattern of these changes is such that a study of countries along the income per capita variable would tell much the same story as a time series analysis of individual country experience. The discrepancies from this general pattern would be due to differences in additional explanatory variables such as size and natural resources.

25. Although it can be claimed that each country or national unit is a special case, uniqueness in economic growth can be expressed generally in one or more of the following factors: size, availability of natural resources, level of income per capita, and cultural, social and institutional aspects having a bearing on behaviour related to economic activity.

Income

26. The process of economic growth is seen here as both effect and result of the accumulation of capital and skills to satisfy similar human wants through the application of similar techniques and the access to world markets. As income per capita grows, changes in the composition of demand are reflected in concomitant changes in the composition of domestic product and trade.

27. The similarity of human needs and wants and the relative satiation of the more basic needs (food, shelter) at low levels of income leads to an increased proportion of manufacturing in the composition of the domestic product with economic growth. As Kuznets puts it:

> The substance of modern economic development lies in the adoption of the industrial system, a term denoting widespread application of empirical science to the problems of economic production. One corollary that follows is the shift in the distribution of the labour force away from agriculture, first toward manufacturing and public utilities, and subsequently toward trade and service pursuits. This commonly observed shift is due, at bottom, to the structure of human wants, their easy

long-term satiability by products of agriculture - so that increasing productivity of labour in the latter releases an increasing proportion of labour to other pursuits. 8/

28. The process of relative satiation with food as described by Engel's Law finds its parallel correspondent in the relative saturation with manufactures taking place at higher levels of income per capita and leading to the allocation of an increased share of output to the production of services. Two additional factors help to accentuate this trend. First, the fact that technological change has been rather slow in the services sector. Second, the possibility of replacing the product of domestic factors with imports is seriously constrained in services as a result of the nature of the product. Thus, low productivity and limited trade possibility contribute to reinforce this effect. This could be formulated as follows: At high levels of income per capita, additions to income are spent in increasing proportion on the consumption of services, while the share spent on the consumption of goods declines. While the transition between being poor and middle income, at the country level, lies in the decline of the relative importance of food in the national "budget", the shift between middle income and rich lies in the starting decline of manufactures and the rise in the share allotted to services. 9/

Size

29. Gross domestic product and population have been taken as indicators of market size. Since the two dimensions defining the size of a market are population and income per capita, population would be an adequate variable to capture the influence of market size in determining the composition of GDP by industrial origin if population size were perfectly correlated with national income size. This is not the case. Countries such as India or Indonesia, although they have a large population, command a smaller GDP than other much less populated countries. We

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8/ See S. Kuznets, "Under-developed Countries and the Pre-Industrial Phase in the Advanced Countries - An Attempt at Comparison". Proceedings of the World Population Conference, 1954, Papers: volume V (reprinted in The Economics of Under-development by A.N. Agarwala and S.P. Singh, Oxford University Press, 1958, p. 141-142.)

9/ The introduction of a second degree term in income in the equations tries to capture these two stages of saturation or satiation of human demand.

experimented with both variables, population and GDP, and the latter gave better results. The size effect is generally described as being due to the presence of economies of scale. Countries with a large market will have a larger share of manufacturing industry because of the added incentive of reaping scale economies while increasing output, and also because lines of production which could not otherwise be efficiently developed in small countries would be undertaken in the case of larger markets.

30. The extent to which present national boundaries encompass small economic units, a phenomenon of increasing proportions in recent years as a result of the decolonization process following the end of the Second World War is clearly shown in Chart I of the Annex. Thirty-four countries come within the box at the lower left corner of the chart which includes countries with less than five million population and less than $US 5 billion in gross domestic product. There is also a cluster of countries with larger populations but also below $US 5 billion in GDP. There are sixteen countries with populations between five and fifteen million and eight countries with populations larger than fifteen million. These countries add up to a total of 58 out of the 73 countries indicated on the chart.

Natural resources and international trade

31. Although we expect the level of income per capita (as an indicator of the stage of economic growth achieved by a country, together with its size as a market for goods and services) to "explain" most of the variation in the composition of GDP by industrial origin, we still must account for the variations due to unevenness in the distribution of natural resources.

32. A certain degree of association between the availability of natural resources and country size measured by area is to be expected. Ceteris paribus, a large country is more likely to be endowed with all the resources necessary for autarchic development than smaller countries which have per force to rely on international trade sources of supply because of the non-availability of certain raw materials. The uneven distribution of natural resources and considerations of comparative advantage have led some countries to be heavily dependent on international trade. Because of this phenomenon, some significant deviations from the "standard" pattern in the industrial composition of output "prescribed" by the level of economic

well-being, as measured by income per carita, and market size, as measured by GNP should be expected. These deviations will be, for example for Great Britain a larger share of manufacturing and a smaller share of agriculture due to the need to export manufacturers to pay for imports of food which cannot be produced economically; a higher share of mining for the oil producing countries such as Iran, Kuwait and Venezuela, and so forth.

33. As a variable to account in general, for natural resources or trade dependence, the proportion of commodity trade to GNP was first tried. A certain degree of collinearity is to be expected between the size variable, GDP, and the natural resources or trade orientation variable T. It is well established that the bigger and more developed a country is, the smaller would be T, the proportion of trade in GDP.[10/]

34. More explanatory value is achieved by splitting the T variable into two variables, one measuring the proportion of agricultural exports to total trade, the other the proportion of mining exports to total trade. In this way it becomes possible to deal with concentration in both agricultural and mineral raw materials, and to "explain" countries with a high degree of concentration of exports in particular commodities such as: Peru (fishmeal), Brazil (coffee), Argintina (meat and cereals), Ghana (cocoa); Iran, Venezuela, Kuwait (oil), Bolivia (tin), Chile and the Congo (copper), etc.

III. CROSS-SECTION ANALYSIS - METHODOLOGICAL ASPECTS

Level of aggregation

35. Pioneering quantitative work in this field, notably that of Colin Clark and Simon Kuznets was based on a high degree of aggregation because of the difficulties of procuring statistical data. The old classification according to primary, secondary and tertiary sectors is adhered to sometimes, even today, although it is realized that further disaggregation is fruitful. The situation with regard to statistical material, especially on a cross-country basis, has been improving , thanks to the co-operation

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10/ T is defined as $\frac{X+M}{GNP}$; where X = value of commodity exports and M = value of commodity imports.

and international bodies. The gap between the type and quality of data that are desirable for meaningful analysis and those that are available now, however, remains wide.

36. As mentioned before, we started with eleven sectors ranging from agriculture-forestry-hunting-fishing, to services. At an early stage of the analysis it became clear that the minimum levels of aggregation necessary for a meaningful analysis of structural changes are as follows[11/]

I. Agriculture, forestry and fishing;

II. Mining;

III. Manufacturing;

IV. Infra-structure: construction, Electricity, water and gas, transport and communication;

V. Banking, insurance and real estate;

VI. Public administration, defence, services, ownership of dwellings, wholesale trade and retail trade.

37. Some points must be made with regard to the above sectoral classification for structural analysis.

(a) In an international economic comparison, the mining sector needs special treatment and as such it cannot be combined with proximate sectors such as agriculture or manufacturing, as has often been done for similar purposes. The behaviour of this sector happens to be quite unlike the behaviour of agriculture or manufacturing. Therefore, treating mining, say, as part of a "primary" sector together with agriculture, will seriously limit the usefulness of the model.

(b) Construction is treated as a sub-group of infra-structure in the model. Sometimes analysts have included construction in manufacturing. Ideally, one would get more information by treating construction as a sector by itself, as in fact we have attempted. It appears from this analysis that manufacturing is best treated as a sector that does not include construction. When a higher level of aggregation becomes necessary, it appears to be appropriate to include construction as part

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11/ As stated above, the sectoral break-down was considered as the necessary minimum for analysing structural changes in broad terms. For detailed work relating to planning and programming of industrial development, it goes without saying that disaggregation must be carried to the most practicable level. Further disaggregation is desirable in III (Manufacturing) and VI, which appears here as a "catch-all".

of infra-structure but not of manufacturing. The loss of information is minimal in this procedure.

(c) The catch-all sector VI, which includes trade, ownership of dwellings, public administration, defence, and services, is perhaps the trickiest sector to handle. The heterogeneity arising from aggregation is obvious. The definitions are conceptually weak, not to mention the statistical material. There is much yet to learn about the growth behaviour of the various components of this sector. After carrying out a preliminary analysis of available information, it was decided to treat it as a "residual" after "explaining" the variations in all the other sectors.

Per capital gross domestic product as a measure of the level of economic development

38. Since the structural characteristics of an economy are intimately tied up with the level of economic development, analysis of the structure rests on the selection of a quantitative indicator of the level. Despite its many shortcomings, per capita GDP comes closest to the concept of the level of development that is appropriate to the analysis of economic structures. Statistical comparisons based on the conventional measure often tend to exaggerate the contrast between the developed and the developing countries. While it is important to note this point, it does not appear to be necessary, as some have attempted, to exaggerate the magnitude of this problem. Nor is it necessary to discard this measure. Analytical precision can be enhanced, if desired, by improving the existing measure but not by discarding it altogether.

39. It is in the light of the above observations that the choice of per capita GDP as the measure of the level of development is justified. To cope with the question of precision, two sets of currency conversion rates for each country have been used. They are explained below

Monetary unit for international comparisons

40. In the analysis, the structure of output is viewed in terms of its composition by industrial origin. Measured in their respective national currency units, the output structure thus defined would boil down to proportions for each country,

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making them apparently independent of the units of measurement. Although this is a matter of considerable practical convenience, the problems of relative valuation of sectoral outputs between different economies appear to remain latent in them. These problems tend to grow harder as the gulf between the levels of any two economies being compared becomes bigger, and perhaps most perplexing in the case of the services sector.

41. One reason which would seem to indicate the need to use different sectoral parity rates is the well-known divergence existing in prices and factor remunerations in many developing countries, where agricultural prices tend to be lower and manufacturing prices higher than warranted by relative factor scarcities. This affects not only the comparison of shares in GDP, but also the value of income per capita.

42. Despite the limitations of this procedure, the exchange rates fixed officially under the present international monetary system have often been used for international comparisons for the simple reason that more realistic conversion rates were not obtainable for the majority of countries. More recently, estimates of parity rates for selected years have been made available.[12/]

43. In general, parity rates were estimated by adjusting official or free market exchange rates in 1938 by the relative change in the level of prices from 1938 to the year in question between the United States and the country concerned. In some cases, where analysis of the official or free rates for 1938 in the light of other available rates of conversion and prevailing economic and political conditions indicated that they were too unrealistic to be utilized, the starting point for calculating the parity rates was either the official rate of exchange in 1929 or the purchasing power equivalent for 1950 derived from the Gilbert-Kravis study.[13/]

12/ See Yearbook of National Accounts Statistics, 1965, table 9B, United Nations, New York, 1966.

13/ See An International Comparison of National Products and the Purchasing Power of Currencies, by Milton Gilbert and Irving B. Kravis, Organisation for Economic Co-operation and Development, Paris, 1954.

44. In view of the importance of finding a satisfactory set of conversion rates for all countries included in the analysis, it was considered necessary to experiment with both sets that were available. In most cases, the performance of the new parity rates was found to be superior to that of official exchange rates.

45. The search for a satisfactory conversion rate is, of course, far from finished. The possibility of utilizing an index of real consumption per head has recently been discussed and further work in this direction will no doubt be encouraged.[14/]

Cross-section vs. time series

46. There is a tendency among the growth specialists to regard the growth experience of a given country over a long span of years as the appropriate basis for analysing the structural relations underlying the process of economic growth. Ideally, one would not hesitate to subscribe to this view. Even a superficial survey seems to be enough to confirm the heterogeneity in the structural characteristics of a cross-section sample. Every country regarded as an economic unit is unique in a sense. Every country has a history of its own, a culture of its own. While it is true that international dissimilarities are striking to the casual observer, a closer examination of the international plane is bound to reveal the real strength of the currents cutting across the arbitrary boundaries of a nation in various forms, such as the basic structure of human wants, scientific knowledge, and the entire spectrum of technological advances.

47. The strength of these and other factors manifests itself in the observable characteristics of a nation's economic structure, despite the countervailing influence of many (arbitrarily created) barriers impeding international flows. This important point does not seem to have received adequate attention thus far by experts interested in enhancing analytical knowledge of economic growth. It is a lack of appreciation of this point that has led to the view that meaningful analysis of structural changes associated with economic growth can be done only by taking at a specific time a nation's past experience.[15/]

14/ See Wilfred Beckerman, International Comparisons of Real Incomes, OECD, Paris, 1966.

15/ See, for example: S. Kuznets, Modern Economic Growth. Rate, Structure and Spread, Yale University Press, New Haven, 1966, p. 431-437.

48. This historical approach need not be discarded. But its value appears to be such that it cannot by itself provide a valid basis for understanding the nature of structural changes associated with economic growth and much less for policy purposes. Quantitative analysis based on international comparisons despite severe limitations, must play a vital role in filling the gap.

49. International comparisons, despite some of their inherent weaknesses, may prove more useful for obtaining analytical understanding of modern economic growth than similar analysis based on historical data of a given country. One of the problems in which the superiority of the cross-section over the time-series approach is very likely to be evident is that of analysing the relationship between (economic) "size" (say, as measured by GDP) and level of economic development (say, as approximated by the concept of income per capita). The time-series approach often poses the problem of positive association between the size and the level, for the nation's economy is likely to have grown over long periods of time pari passu with per capita income. Further, the size itself grows rather gradually; so does the income per capita. On the other hand, the variety of information available at the cross-section level, and the fact that with this variety the seriousness of the problem of multicollinearity is likely to be reduced, makes the use of cross-section information more desirable from the analytical point of view.

IV. PRESENTATION AND ANALYSIS OF THE RESULTS

The Model

50. Sectoral proportions

$P_a = P_1$		Agriculture
$P_{mi} = P_2$		Mining
$P_{mf} = P_3$		Manufacturing
$P_{infra} = P_{4,5,6}$		Infrastructure
$P_{bank} = P_8$		Banking, insurance, real estate
$P_{serv.} = P_{7,9-11}$		Trade, ownership of dwellings, public administration and services

Explanatory variables

y : per capita income

Y : gross domestic product

X_a : Proportion of agricultural exports in total trade

X_m : Proportion of mining exports in total trade

The equations

$$P_a = \alpha_1 + \beta_1 y^2 + \beta_2 y^2 + \beta_3 Y + \beta_4 X_a + \epsilon_1$$

$$P_{mi} = \alpha_2 + \tau X_m + \epsilon_2$$

$$P_{mf} = \alpha_3 + \delta_1 y + \delta_2 y^2 + \delta_3 Y + \delta_4 X_m + \epsilon_3$$

$$P_{infra} = \alpha_4 + w_1 y + w_2 y^2 + w_3 Y + \epsilon_4$$

$$P_{bank} = \alpha_5 + \mu_1 y + \mu_2 Y + \epsilon_5$$

$$P_{serv} = 1 - \hat{P}_a - \hat{P}_{mi} - \hat{P}_{mf} - \hat{P}_{infra} - \hat{P}_{bank}$$

51. The regression equations for agriculture, mining, manufacturing, infrastructure, and banking, insurance and real estate are shown in table 3. Discussion of the results appears below at two levels of analysis: by sectors, and by variables.

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Results by sectors

Agriculture

52. Table 3 shows the regression equations for 1958, 1964 and the result of pooling together 1958 and 1964 data. The regression equations show a significant negative association of the share of agriculture with per capita income. This association is weakened as per capita income increases, as indicated by the positive term in y^2 of the regression equations. This result is in agreement with the hypothesis of a declining share of agriculture with economic growth as measured by per capita income, and also of the slowing down of this shift at higher levels of income.[16/]

53. The equations also show a negative association of the share of agriculture with size as measured by gross domestic product. This could reflect economies of scale in agriculture or may be just an indication of that part of the total "income effect" which is included in Y. Both hypotheses are plausible, and further elaboration on this point is left for later when we analyse the regression results for manufacturing, and the symmetric nature of the results.

54. The last variable included X_a, is positively associated with the share of agriculture, accounting for the proportion of agricultural output directed to exports as well as being an indication of the influence of natural resources.

Mining

55. The regression equation for mining indicates a linear relationship of the share of mining in GDP, p_{mi} with the proportion of mining exports in total trade X_m. Although more than 80 per cent of the variance in the share of mining in GDP is "explained" by the proportion of mining exports in total trade, a scatter diagram would show two clusters of points, one at low levels of p_{mi} and the other at high levels of p_{mi}. The latter mainly composed of the oil exporting countries. The equation indicates that with nil mining exports, the share of mining in GDP would be 0.6 per cent (the value of the constant term), and that the sensitivity of the

16/ Close correspondence has been observed between these results of cross-section analysis and time series data for 1953, 1958 and 1964 showing the association between the proportion of agriculture in GDP and per capita income.

share of mining in GDP to X_m is such that any increase in X_m would originate as a response an increase a little less than a half its size in p_{mi}.

56. For mining it would probably be worthwhile to try to relate mining output to the level of output in manufacturing especially since after a certain level of industrialization the mining sector would supply manufacturing with the necessary mineral raw materials inputs.

Manufacturing

57. The regression equations for manufacturing show a positive and significant association between the share of manufacturing in GDP, p_{mf} and income, per capita, y, as well as a negative association with y^2, indicating non-linearity in the association.

58. There is also a positive association between p_{mf} and size of GDP, Y, and a negative association with the share of mining exports in total trade X_m. The regression equation for manufacturing depicts a relationship which is like a mirror image of the equations for agriculture. Comparing the 1958, 1964 equations for both the share of agriculture and that of manufacturing, which are reproduced below,

$$p_a = 29.6 - 3.6\,y + 0.13\,y^2 - 0.5\,Y + 0.32\,X_a \qquad (1)$$

$$p_{mf} = 8.1 + 3.5\,y - 0.13\,y^2 + 0.5\,Y - 0.14\,X_m \qquad (2)$$

we see that for the explanatory variables in common, y, y^2 and Y, the coefficients have similar or the same value, although the opposite sign. While the share of agriculture declines with rising income per capita, the share of manufacturing rises, and the decline in the share of agriculture is almost exactly matched by an equivalent increase in the share of manufacturing. The non-linear term in income per capita shows a positive effect with respect to the share of agriculture corresponding to a saturation of the trend towards an increasing share of manufacturing with the growth of income per capita. Furthermore, the coefficients are the same and have, of course, opposite signs. This is also the case with respect to size of GDP, Y.

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Infra-structure

59. Under infra-structure, we have included: construction, electricity, gas and water and transport, storage and communication. Although the equation for infra-structure is better than most of the equations for individual component sub-sectors, the explained variance is rather low, indicating an over-all correlation coefficient a little below 0.7. The equation in logarithms gave a better fit, so we can read off directly the elasticities.

60. The equation shows a positive and significant association between the share of infra-structure in GDP and income per capita, as well as a negative association with the size of GDP.

$$\log p_{inf} = 2.3 + 0.29 \log y - 0.06 \log Y$$ [17/]

61. The elasticity of the share of infra-structure with respect to income per capita is 0.29, and with respect to GDP, - 0.06. In this case, the negative association of the share with size, could perhaps be best explained simply in terms of scale economies in infra-structure.

62. It would probably improve the results to establish a relationship of complementarity between the share of infra-structure and that of manufacturing in GDP.[18/] Also, the very validity of the concept of a pre-requisite "infra-structure" could, in this way, perhaps be quantitatively asserted; but this is beyond the scope of the present study.

Banking, insurance and real estate

63. The regression equation has been estimated only for 1958 data. It indicates a positive and significant association between the share of banking, insurance and real estate p_{bk}, and income per capita as well as between p_{bk} and the size of GDP.

Results by variables

64. In order to pinpoint the relative importance of the different variables, we present below their effects when taken one by one, while the ceteris paribus

17/ In exponential form, the equation is $p_{inf} = 9.97\ y^{0.29}\ Y^{-0.06}$

18/ Preliminary results of analysis of the relationship between employment in manufacturing and in infra-structure shows a positive and significant association. The equation is $N_{inf} = 0.725 N_{mf}^{0.898}$; $R^2 = 0.96$

assumption is supposed to hold.

Income effects

65. Let us take two economies with different per capita income level; I: $US 200 and II: $US 500 with the same size of GDP (5 billion dollars) and the same proportion of agricultural and mining exports in total trade (30 per cent and 3 per cent). The predicted shares in GDP are shown below.

	P_a	P_{mi}	P_{mf}	P_{inf}	P_{bank}	Total	Residual
I	37.0%	2.1%	14.4%	11.07%	1.8%	66.37	33.63
II	24.2%	2.1%	22.2%	14.5 %	2.1%	65.1	34.9

66. The main differences are between the shares of agriculture and manufacturing. The rise in income per capita from 200 to 500 dollars, is accompanied by a 50 per cent increase in the share of manufacturing and a 50 per cent decrease in the share of agriculture.

Size effects

67. Consider two economies with same income per capita: $US 500, and with different size of GDP; 5 billion, and 40 billion, and the same proportion of agricultural and mining exports in total trade (30 per cent and 3 per cent).

	P_a	P_{mi}	P_{mf}	P_{inf}	P_{bank}	Total	Residual
I	24.2%	2.1%	22.2%	14.5%	2.1%	65.1	34.9
II	22.4%	2.1%	23.9%	12.8%	2.5%	63.7	36.3

68. The effect of a change in size from a 5 billion dollars GDP economy to one with a 40 billion dollars GDP is depicted in the accompanying table. There are no drastic changes; there is a slight increase in the share of manufacturing. The proportion of infra-structure declines and that of banking, insurance and real estate rises.

Natural resources effects - agriculture

69. Assume two economies with same income per capita: $US 500, and the same size of GDP, 5 billion, and the same proportion of mining exports in total trade: 3 per cent, but different proportions of agricultural exports in total trade: 30 per cent

/...

and 10 per cent.

	P_a	P_{mi}	P_{mf}	P_{inf}	P_{bank}	Total	Residual
I	24.2%	2.1%	22.2%	14.5%	2.1%	65.1	34.9
II	17.8%	2.1%	22.2%	14.5%	2.1%	58.7	41.3

70. The main difference in this case corresponds to a decline in the share of agriculture due to the decline in the proportion of agricultural exports in total trade. This could be assumed to be the result of export diversification or a shift in comparative advantage.

Natural resources effects - mining

71. Consider two economies with same income per capita: US$ 500, and the same size of GDP, 5 billion, same proportion of agricultural exports in total trade: 10 per cent, but different proportions of mining exports in total trade: 30 per cent and 3 per cent.

	P_a	P_{mi}	P_{mf}	P_{inf}	P_{bank}	Total	Residual
I	17.8%	15.9%	18.4%	14.5%	2.1%	68.7	31.3
II	17.8%	2.1%	22.2%	14.5%	2.1%	58.7	41.3

72. The main effect of a decline in the proportion of mining exports in total trade is ceteris paribus, a drastic drop in the proportion of mining in GDP, from 15.9 percent to 2.1 per cent and a 20 per cent increase in the share of manufacturing.

V. USE OF THE RESULTS AND CONCLUSIONS

73. Acceptance that the general pattern of sectoral relationships with the explanatory economic variables - income, size, and natural resources - describes fairly well the changes in the composition of domestic product with economic growth, does not imply, of course, that the individual circumstances of each economy are well taken into account and "explained". On the contrary, it is precisely the need for more specific work in projecting and planning that justifies the preparation of special or "case" studies. On the other hand, for analysing long-term development prospects, projections using sectoral regression equations like those presented in this paper could help, for example, in analysing alternative policies and targets of development planning.

74. The results obtained should be useful for long-term projections where estimates of sectoral proportions in total output (gross domestic product) are required. Although in many cases estimates are still used only at a more aggregate level, i.e. only distinguishing primary, secondary and tertiary sectors, it is generally desirable to make use of a finer sub-division of sectors.[19/]

75. Results could be used directly in the case, for example, where it is desired to project the structure of GDP or the level of a given sector at a certain future date and either the level of income per capita and the population or the rates of growth of income and population are given; also estimates of future level or projected rates of growth of agricultural and mining exports are necessary.

76. Alternatively, the equations can be used to check on projected rates of growth or on the consistency of a set of separate sectoral projections by assuming or imputing between two points in time, given changes in the composition of GDP and computing the implicit rates of growth of income and other variables.

77. The set of equations are no substitute, of course, for more detailed inter-industry models like input-output tables or linear programming models; but the

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19/ For example, in Japanese planning, the set of equations used for the central plan includes two types of supply equations: output by sectors and capital stock equations by sectors. See Reply of the Government of Japan to questionnaire on Industrial Planning and Development (United Nations document E/C.5/24/Add. 31).

applicability of these last methods is generally restricted to economies that have achieved a certain level of industrial development and already have a substantial volume of inter-industry transactions.20/

78. Further disaggregation of the model is necessary and, as previously mentioned, it is planned to do so in two different ways. First, a breakdown of manufacturing in twenty sectors at the two digit ISIC level is planned, and further disaggregation is foreseen for the services sector. In addition, it is expected that the introduction of an additional trade variable, proportion of exports of manufactures in total trade, will probably enhance the explanatory value of the regression equations.

79. A breakdown of the countries in two groups of developed and developing countries is also intended. While the results of applying separately the same type of equations to these two sub-groups were not good, this was probably due to the fact that the underlying functional relationship may be different, and also to the problem of the continuity along the income per capita variable, namely, where is the cut-off point between developing and developed countries to be made?

80. A similar analysis of the structural changes in the composition of employment is under way, and this will permit the deriving also of a set of estimates of average sectoral productivities or output per head, and their changes with economic growth.

81. The main features of this study may be summarized as follows:

(a) An attempt was made in the regression analysis to account for observed non-linearity by introducing a second degree term in income per capita;

(b) Two different trade variables were used to account for the structural differences arising from concentration of exports in mining products (especially oil), and in agricultural products;

20/ See "Use of Models in Programming" in Industrialization and Productivity Bulletin No. 4, United Nations, New York, 1961, p. 12, where it was suggested that as a rule of thumb, this is the case in countries having a per capita income of $US 150 or more or at least 15 per cent of their gross national product originating in industry.

(c) Gross domestic product instead of population, was used as a size indicator;

(d) New data relating to 1958 and 1964, where available, have been used as well as two types of foreign exchange rates, official and parity rates. The latter generally gave much better results.

92. While cross-section regression analysis like the one in this study has many limitations, it may perhaps become a helpful tool for new countries that lack historic data and are forced to resort to the experience of older and more developed countries in devising their own long-term strategy for industrialisation.

Table 1

The percentage composition of GDP at factor cost by per capita income group - 1958 based on cross-section data for 41 countries

Income per capita in U.S. dollars	Agri-culture	Mining & quar-rying	Manu-factur-ing	Con-struc-tion	Elec, gas & water	Transp. storage comm.	Whole-s. le & ret. trde.	Bank-ing, ins. real est.	Own-ership of dwell.	Publ. adm. & defense	Services
Under $US 100	52.0	1.1	7.8	3.7	0.5	4.2	16.7	1.1	3.5	6.1	5.2
$US 101-250	35.7	2.1	12.6	4.2	1.1	5.9	14.8	1.9	6.0	7.3	9.0
$US 251-500	21.6	3.8	20.8	5.8	1.3	7.2	15.7	2.7	6.2	7.0	8.5
$US 501-1000	13.8	2.1	26.7	7.4	2.3	6.9	12.7	2.6	5.4	6.1	6.7
$US 1001 & over	9.6	3.1	30.8	7.4	2.1	7.2	12.7	3.0	5.1	6.4	11.5
ALL COUNTRIES	30.3	2.4	16.8	5.3	1.3	6.5	14.7	2.1	5.4	6.8	8.4

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Table 2

Standard deviation and coefficient of variation of the percentage distribution of GDP by levels of per capita income: 1958

Per capita income in U.S. dollars	No. of countries (n)	Percentage of Agriculture	(n)	Percentage of Min'g & quarrying	(n)	Percentage of Manufacturing	(n)	Percentage of Construction	(n)	Percentage of Electricity gas & water
Under US$100	8	52.0	8	1.1	7	7.8	7	3.7	7	0.5
US$101-250	15	35.7	14	2.1	14	12.6	13	4.2	12	1.1
US$251-500	8	21.6	8	3.8	8	20.8	8	5.8	8	1.3
US$501-1000	5	13.8	3	2.1	2	26.7	5	7.4	4	2.3
US$1001-over	5	9.6	5	3.1	5	30.8	5	7.4	5	2.1
	41	-	38	-	36		38	-	36	-
Mean percentage		30.3		2.37		16.8		5.3		1.3
Standard deviation		14.24		0.934		7.67		1.45		0.56
Coefficient of variation		47%		39%		46%		27%		45%
Significance 1/		***		**		***		**		***

1/ Interpretation of significance:

*** "highly significant" — Coefficient of variation 45% and over
** "significant" — " " " 25% - 44%
* "probably significant" — " " " 10% - 24%
n.s. "not significant" — " " " less than 10%

Table 2 (contd.)

n	Percentage of transport storage & communication	n	Percentage of whole-sale & ret. trade	n	Percentage of banking, ins., real estate	n	Percentage of owner-ship of dwelling	n	Public adm. & defense	n	Percentage of services
6	4.2	4	16.7	7	1.1	7	3.5	7	6.1	5	5.8
13	5.9	13	14.8	11	1.9	14	6.0	14	7.3	12	9.0
8	7.2	8	15.7	5	2.7	6	6.2	8	7.0	7	8.5
5	6.9	5	12.7	4	2.6	4	5.4	5	6.1	4	6.7
4	7.2	4	12.7	4	3.0	4	5.1	4	6.4	4	11.5
36	-	34	-	31	-	35	-	38	-	32	
	6.5		14.7		2.1		5.4		6.8		8.4
	1.09		1.33		0.659		0.993		0.5216		1.66
	17%		9%		31%		18%		8%		20%
	*		n.s		**		*		n.s		*

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Table 3

Results of cross-section analysis

Sector	Year	Regression equations	R^2	Sample size
Agriculture	1958	$p_a = 30.9 - 4.3y + 0.18y^2 - 0.065Y + 0.34\ Xa$ (4.3) (1.02) (0.068) (0.049) (0.087)	0.70	56
	1964	$p_a = 30.4 - 3.7y + 0.13y^2 - 0.06Y + 0.29\ Xa$ (3.1) (0.64) (0.034) (0.028) (0.065)	0.72	67
	1958, 1964	$p_a = 29.6 - 3.6y + 0.13y^2 - 0.05Y + 0.32\ Xa$ (2.4) (0.49) (0.027) (0.023) (0.051)	0.72	123
Mining	1958	$p_{mi} = 0.43 + 0.52\ Xm$ (0.59) (0.036)	0.82	44
	1964	$p_{mi} = 0.7 + 0.51\ Xm$ (0.4) (0.027)	0.85	63
	1958, 1964	$p_{mi} = 0.6 + 0.51\ Xm$ (0.3) (0.022)	0.84	107
Manufacturing	1958	$p_{mf} = 8.6 + 4.6y - 0.22y^2 + 0.09Y - 0.20\ Xm$ (3.1) (0.63) (0.041) (0.029) (0.055)	0.79	44
	1964	$p_{mf} = 7.8 + 3.5y - 0.13y^2 + 0.06Y - 0.12\ Xm$ (1.3) (0.38) (0.019) (0.015) (0.047)	0.74	63
	1958, 1964	$p_{mf} = 8.1 + 3.5y - 0.13y^2 + 0.05Y - 0.14\ Xm$ (0.9) (0.28) (0.015) (0.012) (0.035)	0.74	107
Infra-structure	1958	$\log_{infra} = 2.3 + 0.29 \log y - 0.06 \log Y$ (0.06) (0.05) (0.03)	0.53	32
	1958, 1964	$\log_{infra} = 2.3 + 0.29 \log y - 0.06 \log Y$ (0.045) (0.036) (0.021)	0.46	88
Banking, insurance & real estate	1958	$p_{bank} = 1.6 + 0.10y + 0.0096Y$ (0.22) (0.035) (0.0028)	0.65	32

Numbers in parenthesis are the standard errors of estimate of the coefficients.

Chart I

Distribution of countries by gross domestic product and population size

(GDP in billions - U.S. dollars - 1964)

Population (millions)	<5	5-9	10-19	20-39	40-99	100-299	>300
>300				*			
150-300							*
75-149.9		*	*		*		
30-74.9	*	*	* *		***	*	
15-29.9	**** ***	* *	* *		*		
5-14.9	***** ***** ***** *	* *	****	*			
<5	***** ***** ***** ***** ***** ***** ****	***					

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