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A UNIFORM ANALYSIS OF DEVELOPMENT PATTERNS

by

Hollis B. Chenery
Hazel Elkington
Christopher Sims

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June 1970

A UNIFORM ANALYSIS OF DEVELOPMENT PATTERNS*

Hollis Chenery
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There is currently great interest in economics and other social sciences in identifying and describing the uniform features of the processes of modernization and development. Characteristics of the social and economic system that vary systematically with the level of per capita income may be described as development patterns. The scientific value of analyzing such patterns is shown by the findings of Kuznets (1966) and Chenery and Taylor (1968) that historical patterns of industrial development have strong similarities to the present-day patterns that are measured by cross-country comparisons.

The present paper extends the methods of intercountry regression analysis to a wide variety of structural features in order to present a systematic picture of development patterns.

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Within the past decade the national statistics of the poorer countries have been greatly improved, making possible a much wider coverage of developing countries than was feasible in earlier studies. They also permit a combination of time series and cross-section analysis to be used to test a number of hypotheses about the basic processes of development.

The compilation by the World Bank[1] of a comprehensive set of economic and social statistics for the period 1950-1967 provides an opportunity to recalculate on a more uniform basis many of the intercountry development patterns that have been found and to test their stability. The IBRD data are better suited to this purpose than the United nations and AID sources that have previously been used because they provide a more complete coverage of countries, uniform values of per capita GNP in constant dollars, and some revisions of original country sources.[2]

Our main purpose is to provide a consistent description of development patterns that can be used as a basis for inductive theory. We have drawn largely on other studies of the

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1. IBRD, Department of Economics, Comparative Data Division. We are indebted to the Bank for making this material available to us prior to its publication. Hagen and Hawrylyshyn (1969) have also used this set of data as their primary source.

2. The U.N. abstains from making such revisions and from publishing per capita income figures currently; the AID estimates are more comparable to the IBRD but less complete in coverage.

Harvard Project for Quantitative Research in Economic Development for our theoretical framework and statistical formulation.[1]

I. CONCEPTUAL FRAMEWORK

Statistical analyses of structural change can be used in several ways to formulate and test theories of development. They show first how a given feature normally varies with the level of income and how uniform this relationship is among countries and over time. Analysis of the residual variation usually suggests additional explanatory variables and alternative forms of regression equations. This inductive process leads ultimately to specific tests of alternative hypotheses and the extension or rejection of a priori theory.

The present results cover the early phases of this sequence. We will describe the relation of various structural features to the level of development, test for shifts in the relationship over time, try to identify other significant influences (such as size, urbanization, capital inflow, or trade pattern) and present the country residuals as a source of additional hypotheses.

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1. Chenery and Taylor (1968) have studied production patterns, Landau (1969) savings relations, R. Weisskoff (1969), price and income elasticities of demand, S. Robinson (1969), sources of growth, and T. Weisskopf (1970) the effects of capital inflow.

Alternative approaches to the analysis of structural change are discussed by Kuznets (1966), Adelman and Morris (1967), and Chenery and Taylor (1968). Kuznets stresses that the value of cross-country analysis is limited unless there is a specific test of the relationship between the intercountry pattern and the comparable relationship in individual countries over time. One of our first objectives has therefore been to test for systematic changes over time and to measure those that appear to be significant.

Both theoretical and statistical analyses suggest that modern economic growth should be conceived of as a process of transition from a primitive to a modern social system rather than as a steady increase in all variables. Aspects of the economic and social structure such as the composition of employment, output, demand, etc., should be expected to have a non-linear relation to the level of income if we consider a wide enough range. For example, industrialization and urbanization increase rapidly at middle income levels, but taper off when industry reaches 35% of GNP and when two-thirds of the population lives in cities. Such processes can be represented by functions that reach a maximum or approach an asymptote. Most previous studies have not examined this phenomenon, since they are based on linear (or log-linear)

functions. We have followed the procedure of Chenery and Taylor (1968) by assuming a non-linear relation of each structural feature to the level of income and testing several alternative forms.

In this preliminary exploration, we make only minimal assumptions about the nature of causation. Adelman and Morris (1967) have shown by factor analysis that many economic and social phenomena are systematically related to income level, and hence per capita GNP serves as a general index of development. We will investigate the effects of some of the other principal variables that have been shown to affect development patterns -- size, natural resources, capital inflow -- but leave detailed analysis of individual relations to subsequent studies.

The basic hypothesis that underlies this set of statistical estimates is, then, that there is a set of development processes of sufficient uniformity across countries to produce a consistent pattern of change in resource allocation, factor use, and other structural features as national product rises. Our statistical analysis is designed to explore various aspects of this general hypotheses: (1) the extent of variation in each feature with the income level; (2) the income range over

which each process shows the most pronounced change;

(3) differences between time-series and intercountry relations;

(4) the major sources of differences in growth patterns and the nature of their effects.

(5) the relationships between the level of development and the rate of growth.

II. ECONOMETRICS

The first test of the present econometric approach to comparative structural analysis was made by Chenery and Taylor (1968). They analyzed changes in the sector composition of GDP within the framework described below. We therefore start from the simpler of their two non-linear equations for cross-country analysis (form B):

$$X_i = \alpha + \beta \ln y + \beta' (\ln y)^2 + \gamma \ln N$$

where: X_i = dependent variable

y = per capita GNP

N = population (millions)

This equation allows for one of the main characteristics of the transition from a primitive economy to a mature industrial society that has been observed in earlier studies; namely the declining effect of further increases in income as the levels of the advanced countries are approached. (An accurate representation of both the early and later stages of many processes

would require a more complex function, such as a logistic curve, which we have not yet tested.)

We apply equations of this form to study three types of development pattern: (A) Accumulation (investment, government revenue, education); (B) Resource Allocation (domestic demand, production, exports, imports); (C) Population and Labor Force (population growth, urbanization, labor allocation). Table 2 lists 27 measures of structural change that will be analyzed in this way. In most cases, the measure of the dependent variable used is the share of each aggregate supplied or used in a specified way. Since these relations can be plausibly described by either logged or unlogged forms of the dependent variable, we have computed the regressions in both forms.[1]

Why Regressions?

Since the aim of this paper is to describe development patterns as a basis for further analysis, we wish to make only minimal assumptions as to the causal structure underlying those patterns. Clearly Gross Domestic Product, population, and the various indexes on the left-hand side of our regressions are interrelated in a web of mutual causation. A regression treats dependent and independent variables asymmetrically, however, and

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1. There are some characteristic disadvantages to each form. Estimates based on the log of the share are systematically lower than the unlogged form because negative deviations have greater weight. The estimated shares thus total less than 100% while the unlogged shares total 100% when the same sample is used. However, for a number of variables, the curvature is exaggerated by the unlogged form and the extreme values are fitted less well. The choice between the two thus depends to some extent on the use that is to be made of the results. We have tended to prefer the unlogged form because of its easier interpretation. The logged form is shown as a dashed line in the graph.

the usual justification for the asymmetry is a postulated direction of causation running from independent to dependent variables. Our rationale for using regression is that, while for policy purposes the causal relation running, say, from share of manufacturing in GNP to the level of GNP per capita may be very important, statistically this causal link can be safely ignored in an international cross-section.

There are two variables which we treat as approximately exogenous: GNP per capita and population. International differences in population, while perhaps marginally influenced by levels of development, are largely determined by accidents of history and geography. The level of GNP per capita is the best available indicator of the level of development, and the full list of variables we treat as dependent might even plausibly be taken as determining the level of development in a causal sense. However, the causal links from GNP to any one of the dependent variables are probably much stronger than the causal links in the reverse direction. Hence, treating population and GNP per capita as approximately exogenous may be justified.

One could argue that, because directions of causation are hard to sort out with this kind of data, a perfectly symmetrical statistical technique like factor analysis might be more

appropriate. Adelman and Morris (1967) have chosen this technique for a somewhat similar descriptive analysis. A principal advantage of the regression technique we have chosen is that non-linearities, which are important here, are more easily handled in a regression than in a factor analysis.

At some points we utilize regression equations involving as "independent" variables quantities like net foreign balance or investment rates which cannot be regarded as even approximately exogenous. In these equations the coefficients and t-statistics on the non-exogenous independent variables are merely representative of the size and sign of partial correlations. In no case are regression results presented only for equations involving non-exogenous independent variables if the addition of the non-exogenous variables substantially altered coefficients on per capita GDP and population.

Effects of Time.

There are two natural hypotheses about possible differences between time series and cross-country results in estimating development patterns. One, tested by Chenery and Taylor (1968), supposes that income differences within one country over time will produce different patterns of response than appear across countries at one point in time. The other supposes that there

are homogeneous shifts in some dependent variables occuring over time in all countries independent of within-country income changes. These two hypotheses are, of course, neither identical nor exclusive, but in practice the data do not allow us to distinguish them. We tested the first alternative using forms like

$$* \quad X_{ti} = a\, y_{ti} + b(y_{ti} - \bar{y}_i),$$

where $\bar{y}_i$ is country i's mean income. If the within-country response to income differs from the between-country response, the estimate of b should be significantly different from zero. This formulation gave less sharp results than the forms (like quation BT in Table 1) which allowed for a homogeneous time trend. In a more detailed analysis over longer periods it might be desirable to use a form like (*) above with "b" replaced by "b_i" -- i.e., allowing each country a different within-country response to income.

Other Independent Variables.

The only other explanatory variables found to have a widespread effect on this set of structural relations are the country's population and the inflow of external capital. The importance of the size effect was stressed in Chenery (1960). The capital inflow effect has been studied theoretically in the context of two-gap models and empirically by Landau (1969) and Weisskopf (1970). On the basis of these studies, we can

expect the inflow of capital (with a given level of income) to be associated with lower savings, exports, and commodity production and higher investment, consumption, imports, and the production of non-traded commodities and services. The capital inflow variable (F) was tested for almost all relations; the results are reported below whenever its t ratio exceeded 1.0.

Other explanatory variables, such as the degree of industrialization, the extent of urbanization, and the composition of exports, have been found significant in specialized studies, but we do not attempt a systematic examination of them here.

The four regression equations listed in Table 1 were computed for all of the variables. Tables 3-5 list the results, including T and F for purposes of comparison even when they were not significant.[1] The predicted values at different income levels are given in Table 6.

Extension to the Analysis of Growth.

Although our main purpose in undertaking this analysis was to provide a consistent description of the structural changes that take place in the course of development, some of our results suggested that the rate of growth might show a systematic relationship to the level of income and the economic structure. In the final section of the paper, we have therefore extended

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1. In cases where the separate income coefficients are not significant, dropping one of them will produce a significant relation for the other, but the predicted values are very little affected.

TABLE 1.

Regression Equations for Measuring Development Patterns

X = dependent variable
Y = GNP per capita in 1964 U.S. dollars
N = population in millions
T = time: 1950 = 1, 1955 = 2, 1960 = 3, 1965 = 4
F = net imports of goods and services minus net exports of goods and services as % of total resources[2]
E_p = share of primary exports in GNP
E_m = share of manufactured exports in GNP

Code[1]	Equation
B	$X = \alpha + \beta \ln Y + \beta' (\ln Y)^2 + \gamma \ln N$
BT	$X = \alpha + \beta \ln Y + \beta' (\ln Y)^2 + \gamma \ln N + \delta T$
BF	$X = \alpha + \beta \ln Y + \beta' (\ln Y)^2 + \gamma \ln N + \varepsilon F$
BTF	$X = \alpha + \beta \ln Y + \beta' (\ln Y)^2 + \gamma \ln N + \delta T + \varepsilon F$

1. A prefix L (LB, LBT, etc.) indicates that the dependent variable is in log form.
2. This form was used instead of the share of GNP because the IBRD tables are computed on this basis. Total resources are defined as GNP plus net imports (see appendix).

the analysis to test several hypotheses of this sort. The regression equations used for this purpose will be developed after the analysis of structural change is presented.

III. CONSISTENT MEASUREMENTS OF STRUCTURAL CHANGE[1]

Although there have been numerous measurements of the structural changes that accompany rising income, they have utilized a variety of data and statistical procedures that make it difficult to combine the results into a consistent analysis. To avoid this problem, we have adopted the uniform set of regression equations listed in Table 1. While it would often be possible to discover a better explanation of a given relationship by including additional variables, the uniform procedure adopted here has the advantage of being able to compare the effects of given variables on each structural characteristic.

Of particular interest is the general picture that our study provides of development as a set of interrelated processes. Since the similarities in development patterns have been much discussed, we will try to bring out some of the main differences in timing, intertemporal stability, and the influence of other

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1. This approach owes much to the work of Simon Kuznets (1966). The main difference is our use of formal multivariate analysis.

variables that have emerged so far.

The statistical series used in this test cover the period 1950-1965 at five-year intervals. They were chosen as the best measures of the sources and uses of resources that are readily available for large numbers of countries. The characteristics analyzed and number of countries in each regression are listed in Table 2. The main sets of regression coefficients for each variable are given in Tables 3-5. Further information on both data and results is given in the appendix.

Comparison of Development Patterns

We start with a comparison of the separate patterns of change in the nine major structural features listed in Table 2. We define a development pattern by the variation of each structural index with the level of income as estimated by multiple regression analysis. For the principal national aggregates -- domestic demand, production, exports, imports, labor use -- we have used a sector breakdown similar to that of Kuznets. Modifications were introduced to make the division of production more compatible with the role of each sector in international trade.[1]

Although each structural feature shows substantial variation with the level of income, these development patterns vary in

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1. We follow Chenery and Taylor (1968) in combining mining with agriculture in the primary sector because trade in both is based mainly on resource endowments. For similar reasons we separate utilities from industry. The resulting definition of "primary" (ISIC 0,1) and "industry (ISIC 2-4) is followed as far as possible in the analysis of trade and labor use also.

TABLE 2

STRUCTURAL CHARACTERISTICS ANALYZED

Dependent Variable	Number of Countries		Number of Observations	
A. ACCUMULATION PATTERNS				
Investment				
A1 Gross National Savings as % of GNP	90	( )	221	( )
A2 Gross Domestic Investment as % of GDP	101	(89*)	246	(220*)
A3 Capital Inflow (Net Import of Goods & Services as % of GDP)	90	( )	231	( )
Government Revenue				
A4 Government Revenue as Percentage of GDP	95		231	
A5 Tax Revenue as Percentage of National Income Education	90		215	
Education				
A6 Education Expenditure by Government as % of GDP	101		236	
A7 Primary and Secondary School Enrollment Ratio	118		359	
A8 Adult Literacy Rate	64		99	
B. RESOURCE ALLOCATION PATTERNS				
Final Demand				
B1 Personal Consumption as Percentage of GDP	101		246	
B2 Government Consumption as Percentage of GDP	79		197	
B3 Food Consumption as Percentage of Total Consumption	45		115	
Structure of Production				
B4 Primary Output as Percentage of GDP	95		282	
B5 Industry Output as Percentage of GDP	93		277	
B6 Service Output as Percentage of GDP	88		254	
B7 Utilities Output as Percentage of GDP	77		236	
Trade				
B8 Exports as Percentage of GDP	95		220	
B9 Primary Exports as Percentage of GDP	95		220	
B10 Industry Exports as Percentage of GDP	95		220	
B11 Imports as Percentage of GDP	84		192	
B12 Primary Imports as Percentage of GDP	84		192	
B13 Industry Imports as Percentage of GDP	84		192	

(Continued on following page)

TABLE 2 (Continued)

Dependent Variable	Number of Countries		Number of Observations	
C. POPULATION AND LABOR FORCE				
Population Growth				
C1 Birth Rate	84		221	
C2 Death Rate	80		205	
Urbanization				
C3 Urban Population	96		157	
Labor Allocation				
C4 Share of Primary Labor	120	( )	221	( )
C5 Share of Industry Labor	79	(69*)	123	(102*)
C6 Share of Service Labor	75	( )	121	( )

*We computed an alternative sample for A1-A3 and C4-C6 in order to avoid discrepancies due to differences in sample size. This is referred to in the test as the compatible sample.

magnitude, timing, and the extent to which they are influenced by other variables. The variation in magnitude and timing is brought out most clearly in the separate graphs of the normal pattern for each attribute. We are particularly interested in identifying variations in the timing of processes, which may suggest causal sequences for further analysis.

Table 6 gives a summary picture of the structural transformation by showing the normal values of each index at selected levels of income.[1] These show the extent of the changes in each characteristic between the least developed ($50) level and the advanced ($2000) level and the proportion of this change that has been completed at levels of $200 and $400. We classify as "early" those processes in which 50% or more of the total transformation has been completed at a level of $300, since change is less pronounced thereafter. "Late" processes are those in which less than 50% of the total change as been completed at the $400 level and change continues to be significant up to high income levels.[2]

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1. Since the regression equations are most liable to error at the extremes of income, we have preferred this measure to the regression value.

2. In interpreting these results, it should be noted that a constant rate of structural change (or constant growth elasticity in the log form of the regression equation) will take longer to reach the halfway mark the greater the absolute amount of change involved and the lower the initial starting point. In the greatest changes, such as the growth of literacy or the rise of non-primary employment, a steady rate of increase would only reach the halfway point at between $500 and $600. An alternative method of describing the timing of structural change is to utilize the curvature of the logarithmic regression lines in the charts; the results are similar.

The "early" development patterns reflect processes of change that are important at relatively low income levels but whose impact on resource allocation and growth at higher levels has been largely exhausted. A typical example of an early process is the domestic processing of food and textiles, which causes most of the rise of industry below the $200 level but has little additional effect on industrialization thereafter. Another early change is the fall in the death rate due to improved public health measures, which also exhaust their impact at low income levels. At the other extreme, late development processes are typified by heavy industry, higher education, and birth control, which only become significant after a certain level of wealth, education, and technology has been acquired.

The general picture of leads, lags, and time trends in development processes indicated by our results can be summarized as follows.

(1) Most measures of increased accumulation -- gross investment, educational expenditures, primary school enrollment, adult literacy -- show early transformations that are more than half complete by the time a country reaches an income level of $250-300. Furthermore, most of these regressions show significant upward trends in the postwar period, as measured by the coefficients in Table 3. Taken together, these results show an increasing mobilization of resources for development in the

postwar period in addition to the effects of rising income.

(2) A fall in death rates and increase in urbanization also takes place at a relatively early stage, and the death rate regression also shows the expected downward time trend. The increase in urbanization is explainable by the shift to industry and services with rising income, however, since it shows no significant time trend. The hypothesis of rising urbanization unrelated to growth is not borne out in our results.

(3) The change in composition of output takes place in a fairly constant relation to rising income for all countries taken together. However, as Chenery and Taylor (1968) have shown, industrialization is an early process in large countries and a late process in primary exporters, reflecting the operation of comparative advantage.

(4) The reallocation of the labor force follows a somewhat different pattern from the transformation of production. The shift of labor into services is much more pronounced than the rise of service output and is one of the most significant structural changes at high levels of development.

(5) The transformation in trade patterns and the rise of government revenue and expenditure are late processes which are only half completed at the $500 level. The significant upward time trend in manufactured exports is favorable to

more rapid growth, but there is no similar time trend in revenue collection.

(6) While time trends are significant for 7 of the 27 variables shown in Tables 3-5, they only indicate substantial differences between time series and cross-section relations in two or three cases. There are significant upward trends in school enrollment, educational expenditures, government expenditures, and industrial imports. Downward trends are statistically significant in the share of primary output, private consumption, and death rates.

Differences in Development Patterns

Differences in development patterns can be studied either by dividing countries into groups (types) or by introducing additional variables into the regression equations. The desirability of combining these two approaches was shown by Chenery and Taylor (1968). Often the nature of a non-linear relationship is better demonstrated by splitting the sample of countries than by adding successive polynomial terms.[1] This is particularly true when it is desired to bring out differences in timing, such as the acceleration of industrialization in large countries. We will only pursue this approach to a limited extent in the present paper, however.

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1. The desirability of subdividing the sample is determined by an F test that compares the unexplained residuals from the separate regressions to the results for the combined sample.

We start with the effects of size, which have been studied in a similar framework by Chenery (1960), Chenery and Taylor (1968), and Keesing (1968). Country size affects directly the advantages of international trade through scale elasticities (γ in the log form) of about -.3 for both exports and imports. The existence of a larger domestic market size favors manufacturing much more than primary production, however. As a result the shares of industrial imports and of primary exports in GNP have scale elasticities of -.4 and -.5 respectively and fall markedly with increasing size.

These effects of comparative advantage are also reflected in the structure of production, where industrial output has a scale elasticity of +.11 while primary production has an elasticity of -.04. The same phenomenon carries over into the extent of urbanization. Somewhat surprisingly, school enrollment and literacy also rise with the size of country, which may be connected to urbanization.

The other explanatory variable that we have studied systematically -- the extent of capital inflow -- turns out to have wider ramifications than was originally anticipated.[1] Combining the separate results for the aggregate variables in the two-gap model of Chenery and Strout (1966), we have the

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1. In addition to the four effects noted, it affects the composition of trade and production. The latter only becomes clear in a less aggregated analysis, however.

following average picture of the effect of a change in the inflow of capital in the unlogged form:

Increase in investment	.11	Increase in imports	.41
Fall in savings	.49	Fall in exports	.19
	.60		.60

In both cases, the aggregate effects are underestimated, since they should total 1.0.[1] This result suggests that in general capital inflow does more to increase imports than investment, in accordance with the notion of a dominant trade gap. Any such inference from inter-country data must be highly qualified, however, particularly because of the problems of interpretation inherent in treating F as an independent variable.

While several variables -- size, trade patterns and the extent of capital inflow -- have been shown to have a significant influence on development patterns, none of these effects is so pronounced as to destroy the usefulness of the underlying notion of universal development processes. The systematic variation detected results mainly from the extent to which the economy is open or closed.[2] An examination of the residuals from some of our regressions given in the Appendix may suggest other sources of systematic variation to the reader.

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1. According to the accounting identities: $F = I - S = M - E$. This reduction in the total "effect" below its theoretical value reflects the fact that F is not properly treated as purely exogenous in these equations.

2. Ranis and Fei (1964) have suggested the importance of classifying less developed economies on the basis of the extent of surplus labor, but so far there are no acceptable measures of this phenomenon that can be tested in intercountry comparisons.

IV. VARIATION IN GROWTH WITH THE LEVEL OF DEVELOPMENT

There are many possible relations between a country's economic structure and the rate at which it can increase its national product. Many of the structural changes analyzed in the preceding section suggest that growth should become easier as a country becomes richer. Most notably, the level of skills, rate of capital accumulation, and taxing ability increase substantially as income rises. On the other hand, the growth potential of a poor country benefits from unused labor, from resource transfers from abroad, and from increased efficiency made possible by importing more advanced technology. Apart from such measurable elements, there are many less tangible factors, such as absorptive capacity and administrative competence, that vary with the income level and economic structure. The combined effect of all these elements is hard to predict on *a priori* grounds.

Previous statistical studies have brought out significant differences in the determinants of growth at different levels of development. In their factor analysis of the relation between social and political factors and growth rates, Adelman and Morris (1967) show that non-economic factors are important at low levels but decline at higher income levels. Hagen and Hawrylyshyn (1969) failed to find any net effect of the level of income on growth rates, however, after allowing for investment rates and

a number of the other specific factors mentioned above.

Our analysis of structural change suggests a somewhat different approach to this question. We have seen that the changes in structure that are likely to raise the rate of growth ultimately decline in importance as the level of income rises. We therefore hypothesize that a rise in income will increase the rate of growth at lower levels of development but that the effect of the level of development will decline at higher levels. We will break down the combined effect of the income level into separate effects of investment, labor force, capital inflow, exports and other elements for which a causal hypothesis can be specified. We will then determine whether the level of development explains a significant portion of the remaining variation in growth rates. The analysis will be repeated for high and low income countries separately to determine whether the level of development affects the estimates for other variables.

Econometrics

Our approach is essentially an extension of the methodology developed for the study of structural change. In addition to the four exogenous variables used above, we include three others--the rate of investment, the growth of the labor force, and the growth of exports--suggested by various theories of development. We take advantage of previous work by Hagen and

Hawrylyshyn (1969) and Robinson (1969) in our choice of specification. The independent variables are defined as follows:

(1) log y, where y is per capita GNP in 1964 U.S. dollars;

(2) $(\log y)^2$;

(3) log N, where N is population in millions;

(4) $\frac{I}{Y}$, the ratio of gross domestic investment to GDP;

(5) $\frac{J}{Y}$, the capital inflow (investment minus savings) as a ratio to GDP;[1]

(6) $\frac{\Delta E}{Y} = \frac{E}{Y} \cdot g_E$ = (export share of GDP) x (growth of exports).

(7) $\frac{\Delta L}{L}$ = growth rate of population (as proxy for growth of labor force).

The dependent variable throughout this analysis is the rate of growth of GNP. We have broken the period under study into two parts: 1950-59 and 1960-65. Our sample includes all countries for which the IBRD World Tables contain the relevant variables. It is subdivided by income level into two groups: developed countries (per capita income over $700 in 1960) and underdeveloped countries (per capita income under $700). The number of observations in each sample is shown in column A below, and the countries are listed in the appendix.

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1. There are slight conceptual differences (explained in the appendix) between this measure of the capital inflow and the balance of payments measure (F) used in Section III.

Period	Underdeveloped (U)		Developed (D)	Total (T)	
	A	B	A and B	A	B
1. 1950-59	34	31	19	53	50
2. 1960-65	48	31	19	67	50
3. Pool	82	62	38	120	100

Since the number of underdeveloped countries having the necessary data increases substantially from the first period to the second, we have selected a second sample (B) having a constant composition. When the four samples are pooled, the A sample contains 120 observations and the B sample 100.

The treatment of "independent" variables in the study of growth rates raises questions of interdependence similar to those discussed earlier. Country size, income level, and the growth of population are unaffected by the rate of growth in GNP over a period of 5-10 years, but the other three variables are likely to be partly determined by, as well as determinants of, the growth rate. As before, we recognize that regressions including such non-exogenous variables may support different causal interpretations. Where inclusion of such variables has noticeable effects on other coefficients, we have tried to display these effects.

Statistical Results

Our analysis of the causes of variation in the rate of growth among countries is summarized in tables 7-9 for the underdeveloped, developed, and all country samples.[1] Our principal finding is the very substantial effect of the level of development, even after other variables have been allowed for. By specifying a non-linear function of the level of income per capita, we also arrive at somewhat different conclusions from other investigators as to the importance of other explanatory variables.

In discussing the results, we take up first the partial effect of each explanatory variable. We note the magnitude and significance of the regression coefficients, their stability over time, interaction with other variables, and the extent of the difference between the underdeveloped and developed country samples. A more general assessment of the significance of these findings is given in the concluding section.

Investment. In a Harrod-Domar model, the rate of growth depends on the investment rate ($\frac{I}{Y}$) and the incremental ratio of output to capital ($\frac{\Delta Y}{\Delta K}$). The regression coefficient of the investment

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1. We computed some 800 regressions in arriving at these results. Among the alternative specifications tested were logged values of all variables, the growth of exports relative to GNP, the share of primary production in total output, the share of primary labor in total labor force, and a capital inflow variable in which outflows were set equal to zero. Only the last showed any improvement over the results given here.

ratio is therefore an estimate of the average value of ($\frac{\Delta Y}{\Delta K}$). Alternatively, we can take the investment rate as a proxy for the growth of the capital stock and interpret the regressions including growth of the labor force, in terms of a neoclassical production function.[1]

When all the explanatory variables are included in the pooled regression (A3), the coefficient for investment is .22. With population growth omitted -- as in the Harrod-Domar formulation -- the regression coefficient is increased to .24, corresponding to a capital-output ratio of about 4. Differences in investment rates alone explain less than 10% of the variance in the growth rates, however.

When the sample is divided by income level, we find an investment coefficient for advanced countries of .16 and for underdeveloped countries of .27, which confirms the greater importance of capital accumulation for growth in poor countries.[2]

Population Growth. The growth of population is used here as a proxy for the increase in labor inputs, since a direct measure of the latter is not available in many countries. For the pooled samples, we find regression coefficients of .40 for underdeveloped countries, .78 for advanced countries, and .66

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1. The assumptions underlying this interpretation are developed in Hagen and Hawrylyshyn (1969).

2. This difference is largely offset by the lower average rates of investment in poor countries, however.

for the total sample. This variable alone gives a value of R^2 of .50 in advanced countries, but it adds very little to the explanation of growth in underdeveloped countries. This result gives strong support to the surplus labor hypothesis for underdeveloped countries.

The inclusion of population growth has little effect on the regression coefficients of the underdeveloped countries, but it reduces the estimates for investment and capital inflow in the developed countries quite substantially.

Capital Inflow. In a neoclassical context, the capital inflow should add nothing to the effect of the rate of investment. However, if growth is limited by a shortage of imports in a sufficient number of countries, we would expect that the import-augmenting effect of external capital would add something to the pure investment effect. The two-gap hypothesis is therefore tested by the inclusion of $\frac{F}{Y}$ as well as $\frac{I}{Y}$ in the regression equation.

The regression coefficient for $\frac{J}{Y}$ is .12 and highly significant for all countries in regression (A3) and varies only slightly between underdeveloped and developed countries. The coefficients vary between periods but are unaffected by the exclusion of the export variable. They rise slightly when $\frac{I}{Y}$ is excluded.

For the underdeveloped countries, these results lend some support to the hypothesis that growth is often limited by a shortage of foreign exchange. An alternative interpretation might be that investment financed by foreign capital is more productive, but this seems less plausible.

Size of Country. The population of the country has a small but significantly positive effect on the rate of growth in almost all regressions. The typical coefficient value (.005) implies that an increase in growth rate of 1% corresponds to a size difference of 7 times. This size effect only shows up when we allow for investment and capital inflow; otherwise the population coefficient is not significant.

Exports. Since exports are part of GNP, we would expect the regression coefficient of ($\frac{\Delta E}{Y}$) to be 1.0 if the effect of exports on growth is no different from that of any other component. This is approximately the case for the underdeveloped countries, for which the export coefficients are not significantly different from 1.0. In the advanced countries, they are significantly less than 1.0 in almost all cases. These results lend no support to the hypothesis that growth of GNP is generally favored by high export growth.

Stability of Estimates. We have carried out F-tests to check the stability of all parameters across time and across development levels. The simplest form we estimated (regression "B") relates growth rate to population and income alone. F-tests of the hypothesis that coefficients in that relation were the same in 1950-59 as in 1960-65 would not allow rejection of the null hypothesis of a stable relation at any reasonable level of significance.[1] However, the hypothesis that coefficients were the same across income groups was rejected very strongly for both 1950-59 and the pooled sample. This indicates that our simple log-quadratic form does not capture all of the nonlinearity in the gross effects of income.

The picture changes when we move to the most elaborate regression we present, the "BIJEL" form. The temporal stability persists, but in this relation the null hypothesis of constant coefficients across income groups cannot be rejected. A narrowly classical approach to the statistics might suggest that discussion of differences by income group in the coefficients is unjustified. The actual coefficients in the relations do in some cases differ by economically significant amounts, as we have pointed out. The reader should simply bear in mind that, while we have good evidence that most of the variables discussed

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1. F-statistics were all below two with sample size of 50 for each period.

have important explanatory power, the differences among coefficients by income groups are only suggestive. The data do not provide positive evidence that the estimated BIJEL relation does not hold across all income groups.

Effects of the Level of Development. From the preceding analysis we can distinguish three types of effect of the level of development on the rate of growth: (i) the effect of systematic variations in growth-producing factors -- investment, population growth, capital inflow -- with income level; (ii) changes in the productivity of these factors with the income level; (iii) systematic variations in omitted elements, such as entrepreneurship and technological change. We will analyze the total variation in growth rates in these terms.

Of the six explanatory variables used here, three -- investment rates, population growth, and capital inflow -- have been shown earlier to vary systematically with the level of income.[1] The total effect of the level of development can therefore be measured by the "B" regressions in Tables 7-9 which have $\ln Y$, $(\ln Y)^2$, and $\ln N$ as exogenous variables. Graphs of the three pooled regressions against the level of income are shown in Figure DE for a country of 10 million population.

A study of the regression equations and their residuals shows that the simple two-parameter function employed here represents the underlying variation better when it is fitted separately to the poor and rich countries instead of the whole

1. See Table 6 above. The population size is unrelated to the level of income and can therefore be allowed for separately.

sample. The U3 curve in Figure D1 fits the underlying data well in the range of incomes from $50 to $300 and shows a peak in the growth rates of about 5.5% in the vicinity of $200.[1] At high income levels, the curvature should be reversed (as shown in the D3 curve) with growth rates falling at a declining rate.

Our previous discussion showed that about half of the total variation in growth rates is explained by the three factors which vary systematically with the level of income: investment, labor force growth, and capital inflow. When these factors (plus size and export growth) are held constant at their mean values, we can discover the residual effect of the level of development. Figure D2 is constructed on this basis and shows the variations of growth rates with income level for the two groups of countries and the whole sample.[2] It shows that a rise in the level of development tends to reduce the rate of growth once we have allowed for the three growth-producing factors thereafter.

In summary, we have the following general picture of the factors affecting the rate of growth at different levels of income:

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1. Figure D1 is based on the B regressions, which are significantly different for the developed and underdeveloped groups.

2. Figure D2 is based on the BIJEL regressions, which are not significantly different for the two groups (as indicated above).

(1) At the lowest income levels investment rates are low and population growth contributes little or nothing to the growth of GNP. The observed rise in growth rates up to $200 is due partly to rising investment and capital inflow and partly to unspecified factors associated with the level of development.[1]

(2) At middle income levels the growth of the labor force remains high and contributes increasingly to income growth. The productivity of investment falls slightly but is offset by rising levels of investment.

(3) Among the developed countries there is a net decline in aggregate growth rates as income levels rise. This is due to the falling rate of population growth, the shift from capital importing to capital exporting, and perhaps some increase in the capital-output ratio. The unspecified "level effects" are negative at higher incomes.

Several important differences in growth mechanisms are brought out by a comparison of the regression results for underdeveloped and developed countries.[2] While the growth of the labor force is a major determinant of growth in developed countries, it is only marginally significant in the underdeveloped

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1. The nature of these factors is suggested in Adelman and Morris (1967).
2. Robinson (1969) gives a comparison to time series analysis that is generally in accord with these conclusions.

group. The higher savings rate in advanced countries are largely offset by the lower productivity of investment and the outflow of capital. Finally, a rise in the level of development is growth producing in poor countries but growth reducing in rich ones.

Given the complexity of the interaction among these elements and the averaging effects of cross-country analysis, we cannot hope to derive very accurate estimates of individual factors from this type of study. On the whole, our results for the decade 1950-59 are considerably more satisfactory from both a statistical and economic standpoint than the analysis for the shorter period 1960-65, in which the results for the underdeveloped countries differ considerably from the earlier period.[1]

V. CONCLUSIONS

Our main purpose in this study has been to provide a comprehensive test of a quantitative method of comparative analysis that derives from earlier studies by Colin Clark and Simon Kuznets. The results of section III demonstrate the value of econometric analysis of intercountry relations and

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1. For the other three sub-samples, the value of R^2 is over .75 but it falls to less than .40 in the U2 regressions. The differences in the estimates for the two periods are not statistically significant, however.

confirm their general stability over time. While time trends are observable in a few of the development patterns, they are not large enough to distort an analysis based on cross-country relations very seriously.

In Section IV we have used the analysis of structural change as part of an explanation of sources of growth and showed that growth processes differ considerably between underdeveloped and developed economies.

In general we have focussed on testing the validity of these analytical techniques rather than on a detailed interpretation of the results, which is undertaken elsewhere.[1] It is our hope that the present summary may provide a starting point for more detailed studies of some relations that are only given passing attention here.

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1. H.B. Chenery, "Targets for Development" (1970) and "Development Processes and Patterns" (in preparation).

REFERENCES

I. Adelman and C. Morris, Society, Politics, and Economic Development, Baltimore, 1967.

H. Chenery, "Patterns of Industrial Growth," American Economic Review, September 1960.

H. Chenery, "Targets for Development," Harvard University, Economic Development Report No. 153, March 1970.

H. Chenery, "Development Processes and Patterns," (in preparation).

H. Chenery and A.M. Strout, "Foreign Assistance and Economic Development," American Economic Review, September 1966.

H. Chenery and L. Taylor, "Development Patterns: Among Countries and Over Time," Rev. Econ. Stat., November 1968.

J.C.H. Fei and G. Ranis, Development of the Labor Surplus Economy, New Haven, 1964.

E.E. Hagen and O. Hawrylyshyn, "Analysis of World Income and Growth, 1955-65," Economic Development and Cultural Change, Part II, October 1969.

I.B.R.D., World Tables, mimeo, December 1968.

D. Keesing, "Population and World Trade," American Economic Review, June 1968.

S. Kuznets, Modern Economic Growth, New Haven, 1966.

L. Landau, "Determinants of Savings in Latin America," to be published in H. Chenery, ed., Studies in Development Planning, 1970.

S. Robinson, "Aggregate Production Functions and Growth Models in Economic Development: a Cross-Section Study," unpublished dissertation, Harvard University, Cambridge, Mass., June 1969.

R. Weisskoff, "Demand Elasticities for a Developing Economy: An International Comparison of Consumption Patterns," Harvard University, Economic Development Report No. 125, 1969.

T. Weisskopf, "The Impact of Foreign Capital Inflow on Savings in Underdeveloped Countries," to be presented at the Second World Congress of the Econometric Society, Cambridge, England, September 1970.

TABLE 3A
ACCUMULATION PATTERNS (UNLOGGED FORM)

	Constant	ln y	$(\ln y)^2$	ln N	T	F	R^2	SEE
INVESTMENT								
A1) Gross National Saving as % of GNP.	-0.0598 (0.618)	0.0297 (0.919)	0.0010 (0.345)	0.0055 (2.172)	0.0031 (0.847)	-0.4894 (12.25)	.6448	.0436
A2) Gross Domestic Investment as % of GDP.	-0.1638 (1.504)	0.0832 (2.232)	-0.0040 (1.271)	0.0004 (0.126)	0.0053 (1.240)	0.1108 (2.169)	.3327	.0533
A3) Capital Inflow (Net Imports of Goods & Services as % of GDP).	0.2229 (2.080)	-0.0531 (1.467)	0.0037 (1.210)	-0.0159 (5.786)	0.0069 (1.685)		.1685	.0498
GOVERNMENT REVENUE								
A4) Government Revenue as % of GDP.	0.1563 (1.314)	-0.0444 (1.096)	0.0086 (2.483)	0.0005 (0.163)	0.0019 (0.377)		.5140	.0588
A5) Tax Revenues as % of National Income.	0.3064 (2.137)	-0.1248 (2.533)	0.0178 (4.194)	0.0079 (2.117)	-0.0019 (0.317)		.6237	.0675
EDUCATION								
A6) Education Expenditure by Gov't. as % of GDP	-0.0146 (0.626)	0.0046 (0.581)	-0.0001 (0.178)	0.0008 (1.340)	0.0052 (5.347)		.1776	.0118
A7) Primary and Secondary School Enrollment Ratio	-1.420 (5.778)	0.4662 (5.445)	-0.0231 (3.093)	0.0191 (2.958)	0.0269 (3.623)		.6644	.1537
A8) Adult Literacy Rate	-1.528 (1.869)	0.5200 (1.811)	-0.0252 (0.990)	0.0233 (1.401)	-0.0071 (0.335)		.4684	.2024

TABLE 3B

ACCUMULATION PATTERNS (LOGGED FORM)

		Constant	ln y	$(\ln y)^2$	ln N	T	F	R^2	SEE
	INVESTMENT								
A1)	Gross National Saving as % of GNP	-3.307 (3.104)	0.2555 (0.714)	-0.0010 (0.033)	0.0324 (1.171)	-0.0249 (0.615)	-2.392 (5.437)	.3173	.4801
A2)	Gross Domestic Investment as % of GDP	-3.635 (6.424)	0.4551 (2.374)	-0.0223 (1.362)	-0.0003 (0.017)	0.0204 (0.919)	0.6149 (2.316)	.3555	.2768
A3)	Capital Inflow (Net Imports of Goods & Services as % of GDP)								
	GOVERNMENT REVENUE								
A4)	Government Revenue as % of GDP	-2.397 (3.538)	-0.0282 (0.122)	0.0266 (1.346)	-0.0125 (0.688)	-0.0041 (0.145)		.4477	.3348
A5)	Tax Revenue as % of Nationnal Income	-2.621 (3.122)	0.0713 (0.247)	0.0402 (1.615)	0.0178 (0.820)	-0.0310 (0.899)		.5310	.3951
	EDUCATION								
A6)	Education Expenditures by Gov't. as % of GDP	-6.392 (5.70)	0.5595 (1.453)	-0.0385 (1.160)	0.0049 (0.161)	0.2163 (4.648)		.1221	.5707
A7)	Primary and Secondary School Enrollment Ratio	-8.022 (11.180)	2.0437 (8.178)	-0.1383 (6.349)	0.0681 (3.607)	0.0578 (2.662)		.5676	.4486
A8)	Adult Literacy Rate	-9.274 (3.852)	2.5483 (3.013)	-0.1783 (2.382)	0.0807 (1.650)	-0.0548 (0.881)		.3672	.5962

TABLE 4A

RESOURCE ALLOCATION PATTERNS (UNLOGGED FORM)

FINAL DEMAND	Constant	ℓn Y	(ℓn Y)^2	ℓn N	T	F	R^2	SEE
B1) Personal Consumption as % of GDP	0.8697 (6.874)	-0.0003 (0.008)	-0.0038 (1.037)	-0.0029 (0.866)	-0.0108 (2.180)	0.7052 (11.88)	.5551	.0619
B2) Government Consumption as % of GDP	0.3106 (3.547)	-0.0767 (2.592)	0.0068 (2.693)	-0.0013 (0.594)	0.0088 (2.720)	0.0760 (2.088)	.1135	.0361
B3) Food Consumption as % of Total Consumption	0.8200 (3.144)	-0.0408 (0.482)	-0.0050 (0.735)	0.0107 (2.277)	-0.0021 (0.303)	0.2272 (2.414)	.7427	.0581
STRUCTURE OF PRODUCTION								
B4) Primary Output as % of GDP	1.515 (7.971)	-0.2744 (4.249)	0.0125 (2.249)	-0.0120 (2.654)	-0.0082 (1.590)	0.0020 (0.095)	.6868	.0921
B5) Industry Output as % of GDP	-0.3546 (3.216)	0.1050 (2.803)	-0.0016 (0.507)	0.0213 (7.930)	-0.0030 (0.977)	0.0059 (0.479)	.7517	.0535
B6) Service Output as % of GDP	-0.2376 (1.354)	0.1904 (3.197)	-0.0145 (2.838)	-0.0060 (1.354)	0.0101 (1.966)	0.3448 (4.622)	.1879	.0820
B7) Utilities Output as % of GDP	-0.0134 (0.233)	0.0121 (0.618)	0.0006 (0.367)	-0.0025 (1.780)	0.0022 (1.346)	0.0937 (3.769)	.3953	.0262
TRADE								
B8) Exports as % of GDP	0.2836 (1.319)	-0.0280 (0.391)	0.0044 (0.734)	-0.0498 (9.155)	0.0145 (1.851)	-0.3692 (3.383)	.3283	.0916
B9) Primary Exports as % of GDP	0.3995 (2.403)	-0.0337 (0.609)	0.0008 (0.174)	-0.0442 (10.516)	0.0028 (0.458)	-0.3315 (3.927)	.4155	.0708
B10) Industry Exports as % of GDP	-0.1159 (0.572)	0.0057 (0.085)	0.0036 (0.635)	-0.0056 (1.084)	0.0117 (1.588)	-0.0378 (0.367)	.2506	.0863
B11) Imports as % of GDP	0.0311 (0.133)	0.0654 (0.848)	-0.0362 (0.556)	-0.0498 (8.608)	0.0158 (1.853)	0.2942 (2.222)	.3911	.0930
B12) Primary Imports as % of GDP	-0.2006 (1.708)	0.0742 (1.910)	-0.0050 (1.541)	-0.0040 (1.382)	0.0032 (0.756)	0.2002 (3.003)	.1578	.0468
B13) Industry Imports as % of GDP	0.2317 (1.475)	-0.0088 (0.169)	0.0014 (0.327)	-0.0457 (11.746)	0.0125 (2.186)	0.0940 (1.475)	.4859	.0626

TABLE 4B

RESOURCE ALLOCATION PATTERNS (LOGGED FORM)

FINAL DEMAND	Constant	ℓn Y	(ℓn Y)^2	ℓn N	T	F	R^2	SEE
B1) Personal Consumption as % of GDP	-0.1733 (0.948)	0.0156 (0.252)	-0.0067 (1.270)	-0.0033 (0.677)	-0.0155 (2.163)	1.043 (12.15)	.5539	.0894
B2) Government Consumption as % of GDP	-0.7387 (0.944)	-0.5895 (2.231)	0.0542 (2.404)	-0.0158 (0.782)	0.0629 (2.171)	0.3946 (1.214)	.0856	.3227
B3) Food Consumption as % of Total Consumption	-1.232 (1.930)	0.3545 (1.712)	-0.0507 (3.027)	0.0304 (2.648)	-0.0106 (0.631)	0.5879 (2.552)	.7745	.1422
STRUCTURE OF PRODUCTION								
B4) Primary Output as % of GDP	0.4215 (0.583)	-0.0110 (0.045)	-0.0423 (2.006)	-0.0427 (2.474)	-0.0519 (2.632)	-0.0693 (0.858)	.6863	.3504
B5) Industry Output as % of GDP	-6.228 (10.753)	1.1820 (6.010)	-0.0681 (4.040)	0.1079 (7.636)	-0.0209 (1.302)	-0.0279 (0.430)	.7068	.2810
B6) Service Output as % of GDP	-2.838 (6.379)	0.5632 (3.731)	-0.0426 (3.298)	-0.0085 (0.762)	(0.0257) (1.972)	(1.0755) (5.686)	.2367	.2080
B7) Utilities Output as % of GDP	-4.569 (7.451)	0.4287 (2.023)	-0.0153 (0.846)	-0.0166 (1.073)	0.0426 (2.356)	1.0566 (3.912)	.4775	.2850
TRADE								
B8) Exports as % of GDP	-1.012 (0.834)	-0.1873 (0.464)	0.0264 (0.772)	-0.3159 (10.293)	0.0550 (1.243)	-2.1059 (3.416)	.3636	.5171
B9) Primary Exports as % of GDP	0.4080 (0.248)	-0.2210 (0.404)	-0.0087 (0.188)	-0.4926 (11.839)	-0.0026 (0.043)	-2.0385 (2.439)	.4939	.7009
B10) Industry Exports as % of GDP	-15.75 (5.183)	2.7839 (2.753)	-0.1438 (1.682)	0.0322 (0.419)	0.2061 (1.859)	4.0375 (2.616)	.4301	1.295
B11) Imports as % of GDP	2.754 (2.794)	0.1598 (0.490)	-0.0065 (0.235)	-0.2911 (11.919)	0.0595 (1.652)	0.5055 (0.904)	.5001	.3930
B12) Primary Imports as % of GDP	-7.506 (4.416)	1.2500 (2.223)	-0.0814 (1.716)	-0.0838 (1.990)	0.0367 (0.592)	3.0420 (3.152)	.2332	.6778
B13) Industry Imports as % of GDP	-0.3114 (0.310)	-0.3540 (1.066)	0.0308 (1.101)	-0.3941 (15.835)	0.0782 (2.130)	-0.1087 (0.191)	.6081	.4004

TABLE 5A

POPULATION AND LABOR FORCE PATTERNS (UNLOGGED FORM)

	Constant	ℓn Y	$(\ell n\ Y)^2$	ℓn N	T	R^2	SEE
POPULATION GROWTH							
C1) Birth Rate	0.7127	-0.0418	-0.0033	-0.0152	0.0007	.4965	.085
	(3.765)	(0.650)	(0.613)	(3.376)	(0.102)		
C2) Death Rate	0.8378	-0.2211	0.0169	-0.0018	-0.0079	.3663	.0342
	(9.106)	(7.184)	(6.584)	(0.953)	(2.423)		
URBANIZATION							
C3) Urban Population	-1.250	0.4070	-0.0210	0.0121	-0.0024	.6784	.1153
	(3.929)	(3.701)	(2.200)	(1.694)	(0.271)		
LABOR ALLOCATION							
C4) Share of Primary Labor	1.708	-0.2123	-0.0004	-0.0006	0.0054	.7723	.1214
	(6.707)	(2.452)	(0.054)	(0.099)	(0.634)		
C5) Share of Industry Labor	-0.1476	0.0301	0.0060	-0.0055	-0.0006	.5758	.0793
	(0.532)	(0.323)	(0.765)	(0.898)	(0.078)		
C6) Share of Service Labor	0.7322	-0.2270	0.0265	-0.0147	0.0090	.4662	.0922
	(1.831)	(1.713)	(2.412)	(2.052)	(1.022)		

TABLE 5B

POPULATION AND LABOR FORCE PATTERNS (LOGGED FORM)

POPULATION GROWTH	Constant	ℓn Y	(ℓn Y)^2	ℓn N	T	R^2	SEE
C1)							
C2)							
URBANIZATION							
C3) Urban Population	-11.25 (10.260)	3.0456 (8.035)	-0.2164 (6.577)	0.0496 (2.011)	-0.0479 (1.583)	.7062	.3973
LABOR ALLOCATION							
C4) Share of Primary Labor	-1.805 (2.441)	0.8930 (3.552)	-0.1206 (5.818)	0.0140 (0.744)	0.0149 (0.569)	.7425	.3524
C5) Share of Industry Labor	-5.538 (3.847)	0.8593 (1.775)	-0.0298 (0.732)	-0.0127 (0.402)	-0.0251 (0.636)	.5511	.4114
C6) Share of Service Labor	-1.567 (1.085)	-0.1687 (0.352)	0.0383 (0.965)	-0.0398 (1.533)	0.0327 (1.024)	.3952	.3330

TABLE 6

NORMAL VARIATION IN ECONOMIC STRUCTURE WITH LEVEL OF DEVELOPMENT

		Per Capita GNP						#Proportion Completed at	
	INVESTMENT	$50	$100	$200	$400	$800	$2000	$200	$400
A1)	Gross National Saving as % of GNP	7.8	11.0	14.1	17.1	19.9	23.4	40	78
A2)	Gross Domestic Investment as % of GDP	12.7	14.8	17.1	19.4	21.8	25.2	35	73
A3	Capital Inflow (Net Import of Goods & Services as % of GDP equals A2-A1)	4.9	3.8	3.0	2.4	2.0	1.8	61	93
	GOVERNMENT REVENUE								
A4)	Government Revenue as Percentage of GDP	12.2	14.2	17.0	20.6	25.1	32.4	24	42
A5)	Tax Revenue as Percentage of National Income Education	9.8	12.7	16.7	21.8	28.0	38.0	25	43
	EDUCATION								
A6)	Education Expenditure by Government as % of GDP	1.93	2.19	2.44	2.68	2.91	3.20	40	59
A7)	Primary and Secondary School Enrollment Ratio	17.5	36.2	52.6	66.9	78.9	91.4	48	67
A8)	Adult Literacy Rate	15.3	36.5	55.2	71.5	85.4	100.1	47	66
	FINAL DEMAND								
B1)	Personal Consumption as Percentage of GDP	77.1	74.9	72.2	69.2	65.9	60.9	30	49
B2)	Government Consumption as Percentage of GDP	13.9	12.6	12.0	11.9	12.6	14.5		
B3)	Food Consumption as Percentage of Total Consumption	61.9	56.1	49.9	43.0	35.9	25.6	33	52
	STRUCTURE OF PRODUCTION								
B4)	Primary Output as Percentage of GDP	58.1	46.4	36.0	26.7	18.6	9.8	46	65
B5)	Industry Output as Percentage of GDP	7.3	13.5	19.6	25.5	31.4	38.9	39	58
B6)	Service Output as Percentage of GDP	29.9	34.6	37.9	39.9	40.5	39.3	85	100
B7)	Utilities Output as Percentage of GDP	4.63	5.74	6.95	8.27	9.69	11.74	33	51

TABLE 6 (Continued)

	Per Capita GNP						#Proportion Completed at	
	$50	$100	$200	$400	$800	$2000	$200	$400
TRADE								
B8) Exports as Percentage of GDP	16.5	17.1	18.2	19.7	21.6	24.8	21	39
B9) Primary Exports as Percentage of GDP	16.5*	16.3	14.5	12.8	11.2	9.1	41	59
B10) Industry Exports as Percentage of GDP	0. *	0.8	3.7	6.9	10.5	15.7	24	44
B11) Imports as Percentage of GDP	17.1	19.5	21.5	23.2	24.6	25.9	50	69
B12) Primary Imports as Percentage of GDP	1.8	3.8	5.4	6.6	7.2	7.4	73	89
B13) Industry Imports as Percentage of GDP	15.3	15.6	15.9	16.4	17.0	18.0	22	41
POPULATION GROWTH								
C1) Birth Rate	46.6	41.8	36.6	31.1	25.3	17.1	34	53
C2) Death Rate	20.5	15.2	11.4	9.3	8.9	10.7	93	114
URBANIZATION								
C3) Urban Population	6.9	20.0	33.8	45.5	55.3	65.1	49	68
LABOR ALLOCATION								
C4) Share of Primary Labor	84.2*	74.0*	57.4	43.9	29.0	5.1	35	52
C5) Share of Industry Labor	6.5*	9.9*	16.3	23.4	31.1	40.5	26	50
C6) Share of Service Labor	19.5*	21.8*	26.3	32.7	40.0	52.4	24	40

Footnote: a) Estimates based on the unlogged form of the regressions in Tables 3-5 (with N=10 million) except those indicated by an asterisk, where the logged form provides a better fit. Estimates for A1-A3 and C4-C6 were computed from a compatible sample in order for values to add to 100%.

#) The last two columns measure the proportion of the change from $50 to $2000 that is completed at the levels of $200 and $400.

TABLE 7

GROWTH RATE REGRESSIONS

Under $700 GNP Per Capita

	Reg. #	Form	# Obs.	Constant	ℓn Y	(ℓn Y)^2	ℓn N	I/Y	J/Y	ΔE/Y	ΔL/L	$\bar{R}^2$	SEE
U1 1950/59	653	BIJE	34	-0.2789	0.1263	-0.0135	0.0053	0.1475	0.1914	0.6080		.7129	.0120
				(2.895)	(3.380)	(3.726)	(2.734)	(2.254)	(3.560)	(2.028)			
	517	BIJE	31	-0.3253	0.1449	-0.0153	0.0045	0.1639	0.1824	0.4871		.7254	.0122
				(2.538)	(2.984)	(3.341)	(1.992)	(2.340)	(3.214)	(1.492)			
	512	BIJ	31	-0.3529	0.1560	-0.0165	0.0029	0.2269	0.1770			.6999	.0125
				(2.718)	(3.174)	(3.562)	(1.437)	(3.965)	(3.051)				
	508	IJ	31	0.022				0.1538	0.1609			.2227	.0190
				(1.688)				(1.912)	(1.841)				
	511	B	31	-0.4037	0.1824	-0.0183	0.0040					.3637	.0175
				(2.225)	(2.663)	(2.834)	(1.420)						
	703	BIJEL	31	-0.2214	0.0935	-0.0100	0.0064	0.1400	0.2125	0.7499	0.5913	.7719	.0114
				(1.722)	(1.832)	(2.039)	(2.817)	(2.117)	(3.889)	(2.291)	(2.165)		
	708	BL	31	-0.3982	0.1797	-0.0180	0.0041				0.0382	.3639	.0178
				(2.064)	(2.385)	(2.499)	(1.376)				(0.099)		
U2 1960/65	655	BIJE	48	-0.0042	0.0175	-0.0031	-0.0001	0.2689	-0.0535	0.9710		.3179	.0284
				(0.150)	(1.256)	(1.747)	(0.032)	(2.345)	(0.475)	(2.306)			
	532	BIJE	31	-0.2579	0.1064	-0.0111	0.0021	0.3255	-0.0170	0.1567		.3811	.0229
				(0.920)	(1.022)	(1.146)	(0.472)	(3.005)	(0.104)	(0.313)			
	527	BIJ	31	-0.2766	0.1138	-0.0118	0.0015	0.3397	-0.0130			.3786	.0225
				(1.029)	(1.143)	(1.273)	(0.383)	(3.522)	(0.081)				
	523	IJ	31	0.0071				0.2583	-0.0178			.2562	.0233
				(0.446)				(3.106)	(0.112)				
	526	B	31	-0.1986	0.0880	-0.0080	0.0055					.0672	.0266
				(0.629)	(0.752)	(0.741)	(1.295)						
	721	BIJEL	31	-0.1757	0.0675	-0.0072	0.0029	0.3292	0.0147	0.2239	0.3633	.3883	.0233
				(0.539)	(0.521)	(0.586)	(0.609)	(2.986)	(0.083)	(0.426)	(0.518)		
	726	BL	31	-0.2410	0.1078	-0.0100	0.0053				0.1946	.0698	.0270
				(0.674)	(0.771)	(0.755)	(1.187)				(0.270)		
U3 1950/65	562	BIJE	62	-0.2763	0.1185	-0.0125	0.0032	0.2677	0.1090	0.2111		.4610	.0181
				(1.933)	(2.213)	(2.493)	(1.350)	(4.128)	(1.555)	(0.722)			
	745	BIJEL	62	-0.1990	0.0812	-0.0087	0.0041	0.2646	0.1316	0.3004	0.3960	.4756	.0181
				(1.278)	(1.323)	(1.491)	(1.667)	(4.095)	(1.824)	(1.001)	(1.226)		
	750	BL	62	-0.2908	0.1312	-0.0127	0.0049				-0.0440	.1327	.0226
				(1.551)	(1.796)	(1.832)	(1.853)				(0.117)		

TABLE 8

GROWTH RATE REGRESSIONS

Over $700 GNP Per Capita

	Reg. #	Form	# Obs.	Constant	ℓn Y	(ℓn Y)^2	ℓn N	I/Y	J/Y	ΔE/Y	ΔL/L	R^2	SEE
D1 1950/59	647	BIJE	19	0.5224	-0.1386	0.0084	0.0062	0.2974	0.1332	0.0317		.6579	.0164
				(0.440)	(0.143)	(0.350)	(1.409)	(2.659)	(1.420)	(0.099)			
	487	BIJE	19	0.5224	-0.1386	0.0083	0.0062	0.2974	0.1331	0.0317		.6579	.0163
				(0.440)	(0.413)	(0.350)	(1.409)	(2.659)	(1.420)	(0.099)			
	482	BIJ	19	0.5211	-0.1374	0.0082	0.0061	0.2965	0.1321			.6576	.0157
				(0.457)	(0.426)	(0.360)	(1.478)	(2.767)	(1.475)				
	488	IJ	19	-0.0097				0.2392	0.1630			.4806	.0174
				(0.403)				(2.244)	(2.288)				
	481	B	19	1.668	-0.4312	0.0285	-0.0014					.3897	.0195
				(1.437)	(1.299)	(1.201)	(0.355)						
	709	BIJEL	19	0.3396	-0.0749	0.0035	0.0062	0.0794	0.0450	0.3692	1.0974	.8388	.0117
				(0.398)	(0.310)	(0.206)	(1.958)	(0.783)	(0.626)	(1.482)	(3.513)		
	714	BL	19	0.5687	-0.1227	0.0063	0.0035				1.1380	.7866	.0120
				(0.766)	(0.579)	(0.418)	(1.313)				(5.102)		
D2 1960/65	649	BIJE	19	-0.0170	0.0193	-0.0020	0.0024	0.1078	0.1780	-0.0302		.7533	.0083
				(0.021)	(0.083)	(0.121)	(1.057)	(1.564)	(3.650)	(0.140)			
	502	BIJE	19	-0.0170	0.019	-0.0020	0.0024	0.1078	0.1778	-0.0302		.7533	.0083
				(0.021)	(0.083)	(0.121)	(1.057)	(1.564)	(3.654)	(0.140)			
	497	BIJ	19	0.0134	0.0106	-0.0013	0.0023	0.1056	0.1751			.7529	.0080
				(0.018)	(0.099)	(0.089)	(1.090)	(1.658)	(4.121)				
	493	IJ	19	0.0330				0.0768	0.1730			.7025	.0081
				(2.623)				(1.482)	(5.024)				
	496	B	19	0.9213	-0.2274	0.0150	-0.0038					.3006	.0126
				(0.867)	(0.764)	(0.719)	(1.441)						
	727	BIJEL	19	-0.5493	0.1620	-0.0118	0.0038	0.0952	0.1497	0.2028	0.5535	.8262	.0073
				(0.718)	(0.756)	(0.785)	(1.842)	(1.568)	(3.352)	(0.931)	(2.148)		
	732	BL	19	0.2252	-0.0362	0.0017	-0.0024				0.4643	.3693	.0124
				(0.190)	(0.109)	(0.073)	(0.829)				(1.234)		
D3 1950/65	547	BIJE	38	0.4577	-0.1208	0.0075	0.0048	0.2456	0.1544	-0.0101		.6391	.0125
				(0.6832)	(0.636)	(0.558)	(2.106)	(4.017)	(3.212)	(0.0550)			
	751	BIJEL	38	0.0378	-0.0048	-0.0005	0.0061	0.1644	0.1104	0.3317	0.7823	.7633	.0103
				(0.067)	(0.030)	(0.047)	(3.176)	(3.027)	(2.687)	(1.908)	(3.968)		
	756	BL	38	0.4522	-0.0978	0.0055	0.0004				0.9049	.5200	.0139
				(0.663)	(0.506)	(0.401)	(0.193)				(4.158)		

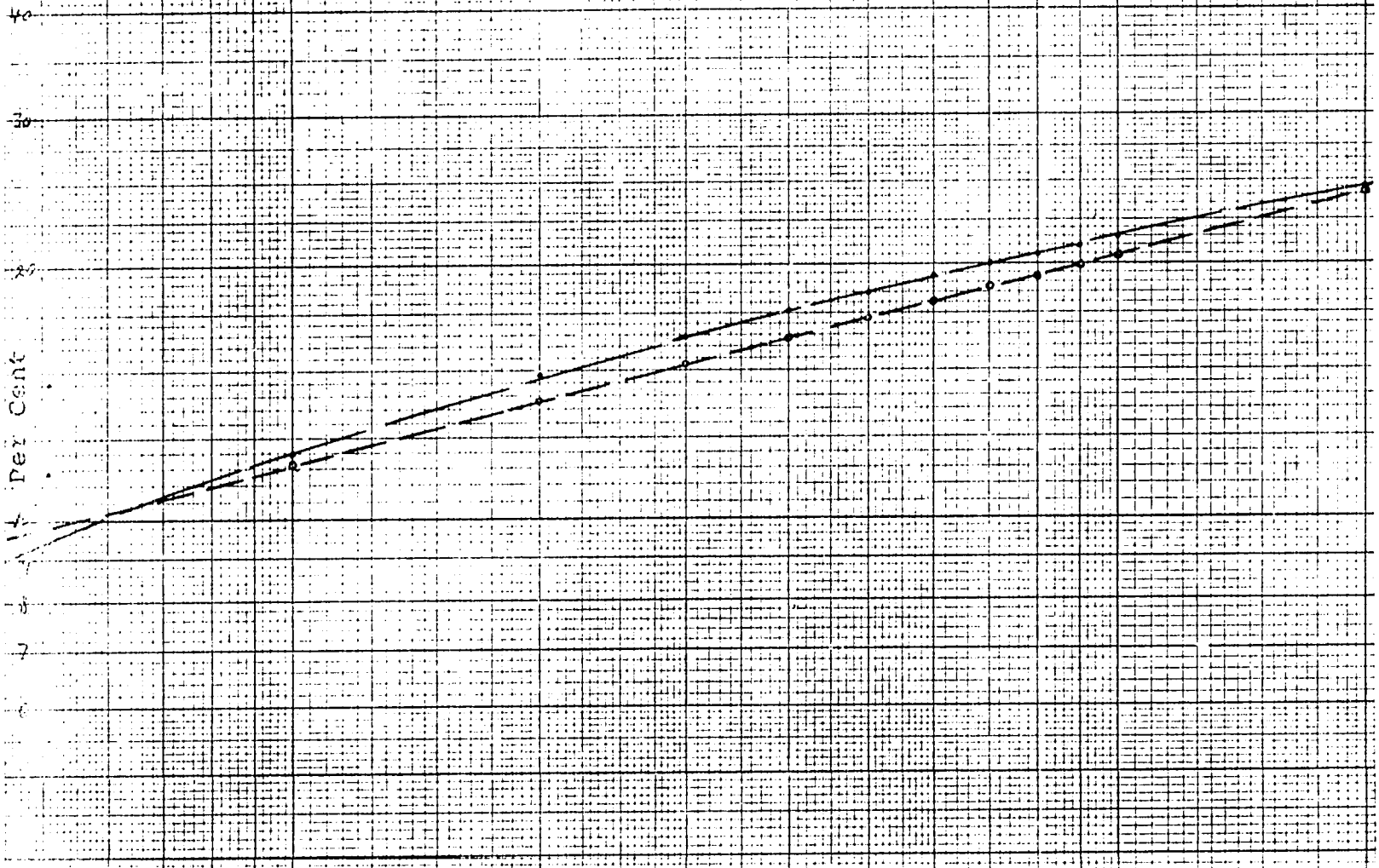
TABLE 9

GROWTH RATE REGRESSIONS

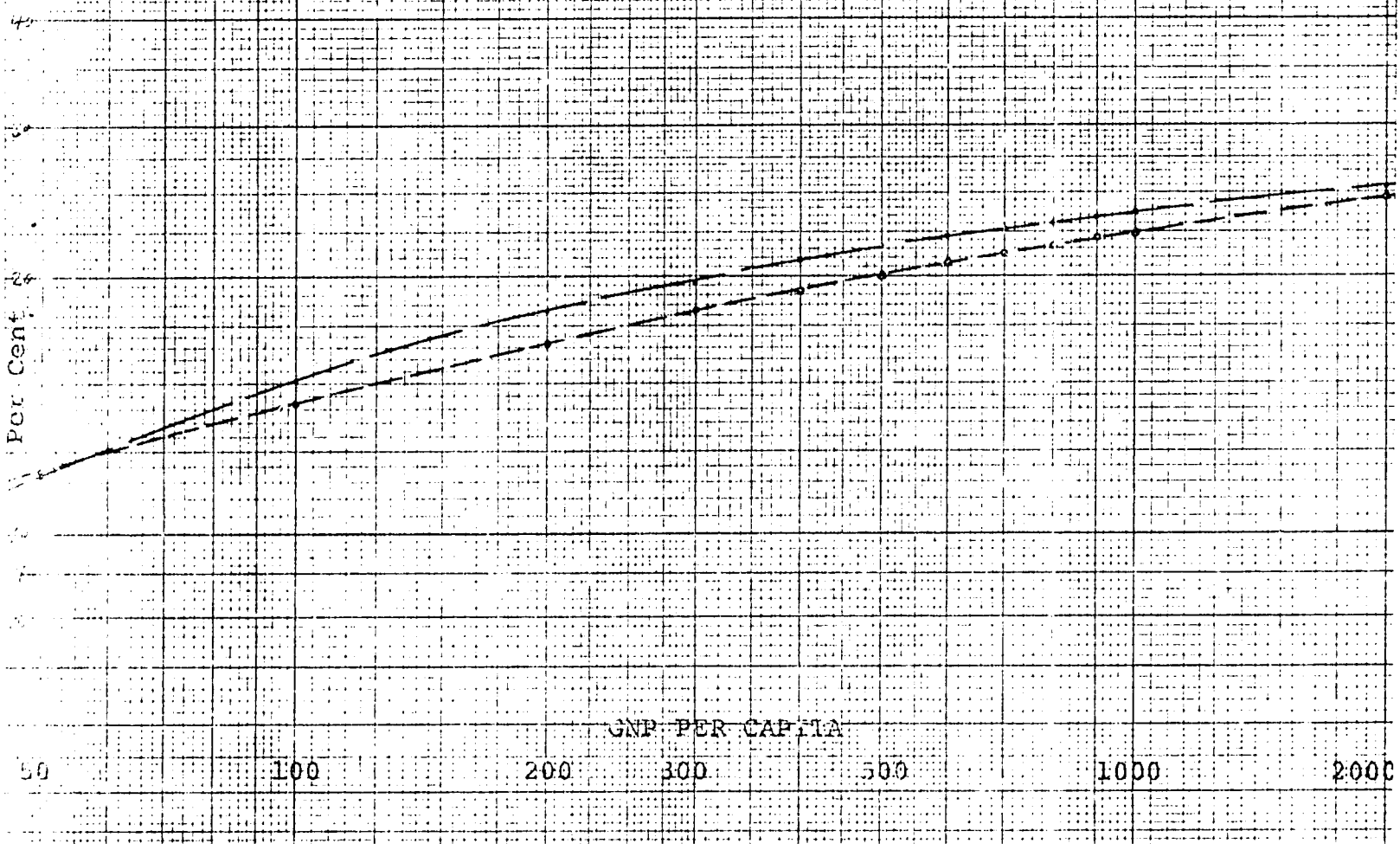
All Incomes

	Reg. #	Form	# Obs.	Constant	ℓn Y	(ℓn Y)^2	ℓn N	I/Y	J/Y	ΔE/Y	ΔL/L	R^2	SEE
A1 1950/59	659	BIJE	53	-0.0311	0.0210	-0.0029	0.0057	0.2183	0.1560	0.3191		.5734	.0146
				(0.484)	(0.959)	(1.565)	(3.135)	(4.044)	(3.418)	(1.641)			
	577	BIJE	50	0.0234	0.0036	-0.0015	0.0048	0.2264	0.1621	0.2765		.5841	.0147
				(0.282)	(0.129)	(0.650)	(2.488)	(4.114)	(3.430)	(1.384)			
	572	BIJ	50	0.0150	0.0059	-0.0017	0.0042	0.2579	0.1593			.5656	.0149
				(0.179)	(0.208)	(0.708)	(2.204)	(5.097)	(3.340)				
	568	IJ	50	0.0271				0.0982	0.1844			.2622	.0188
				(2.831)				(1.946)	(3.289)				
	715	BIJEL	50	-0.0312	0.0121	-0.0018	0.0074	0.1560	0.1540	0.6235	0.8312	.7289	.0120
				(0.454)	(0.528)	(0.952)	(4.418)	(3.294)	(3.984)	(3.485)	(4.735)		
	720	BL	50	-0.0945	0.0430	-0.0038	0.0039				0.7851	.2675	.0191
				(0.872)	(1.197)	(1.258)	(1.588)				(3.312)		
A2 1960/65	661	BIJE	67	-0.0014	0.0131	-0.0020	0.0017	0.1873	0.0083	0.7520		.2802	.0250
				(0.056)	(1.385)	(2.261)	(0.573)	(2.319)	(0.110)	(2.499)			
	592	BIJE	50	-0.0046	0.0075	-0.0014	0.0036	0.2471	0.0989	0.1555		.3629	.0188
				(0.040)	(0.201)	(0.442)	(1.380)	(3.673)	(1.317)	(0.527)			
	587	BIJ	50	-0.0124	0.0102	-0.0016	0.0033	0.2599	0.1076			.3588	.0187
				(0.111)	(0.277)	(0.516)	(1.295)	(4.180)	(1.481)				
	583	IJ	50	0.0177				0.1629	0.1165			.2381	.0197
				(1.684)				(3.258)	(1.700)				
	733	BIJEL	50	-0.0338	0.0075	-0.0011	0.0050	0.2598	0.0901	0.2879	0.6092	.4121	.0183
				(0.305)	(0.206)	(0.376)	(1.883)	(3.952)	(1.232)	(0.975)	(1.874)		
	738	BL	50	-0.0591	0.0335	-0.0026	0.0021				0.2253	.0217	.0228
				(0.430)	(0.749)	(0.721)	(0.715)				(0.585)		
A3 1950/65	607	BIJE	100	0.0194	0.0019	-0.0011	0.0041	0.2429	0.1344	0.1837		.4521	.0166
				(0.286)	(0.084)	(0.600)	(2.615)	(5.729)	(3.271)	(1.097)			
	739	BIJEL	100	-0.0173	0.0049	-0.0011	0.0059	0.2218	0.1242	0.3906	0.6634	.5309	.0155
				(0.272)	(0.233)	(0.619)	(3.838)	(5.574)	(3.241)	(2.375)	(3.932)		
	744	BL	100	-0.0658	0.0332	-0.0027	0.0030				0.5733	.0992	.0211
				(0.760)	(1.167)	(1.158)	(1.563)				(2.632)		

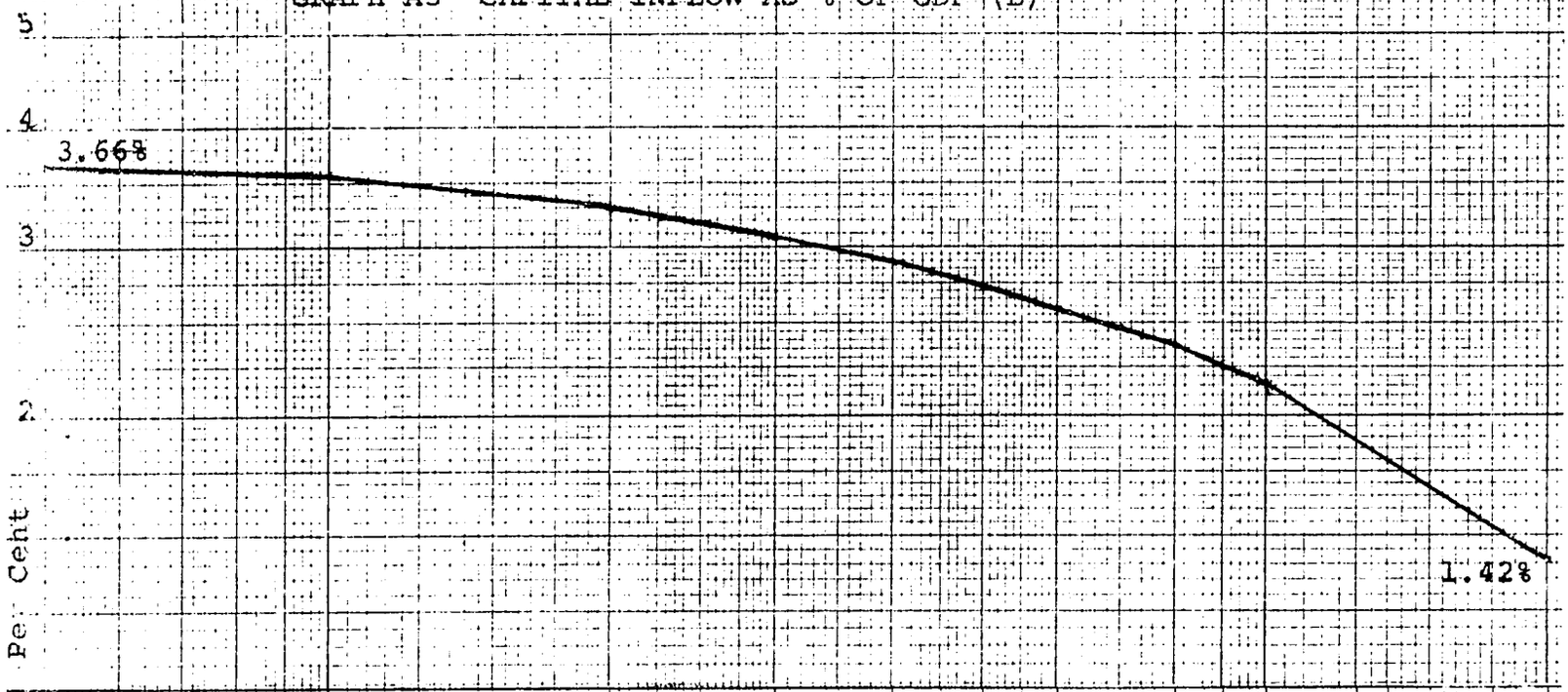
GRAPH A1 GROSS NATIONAL SAVINGS (BTF)



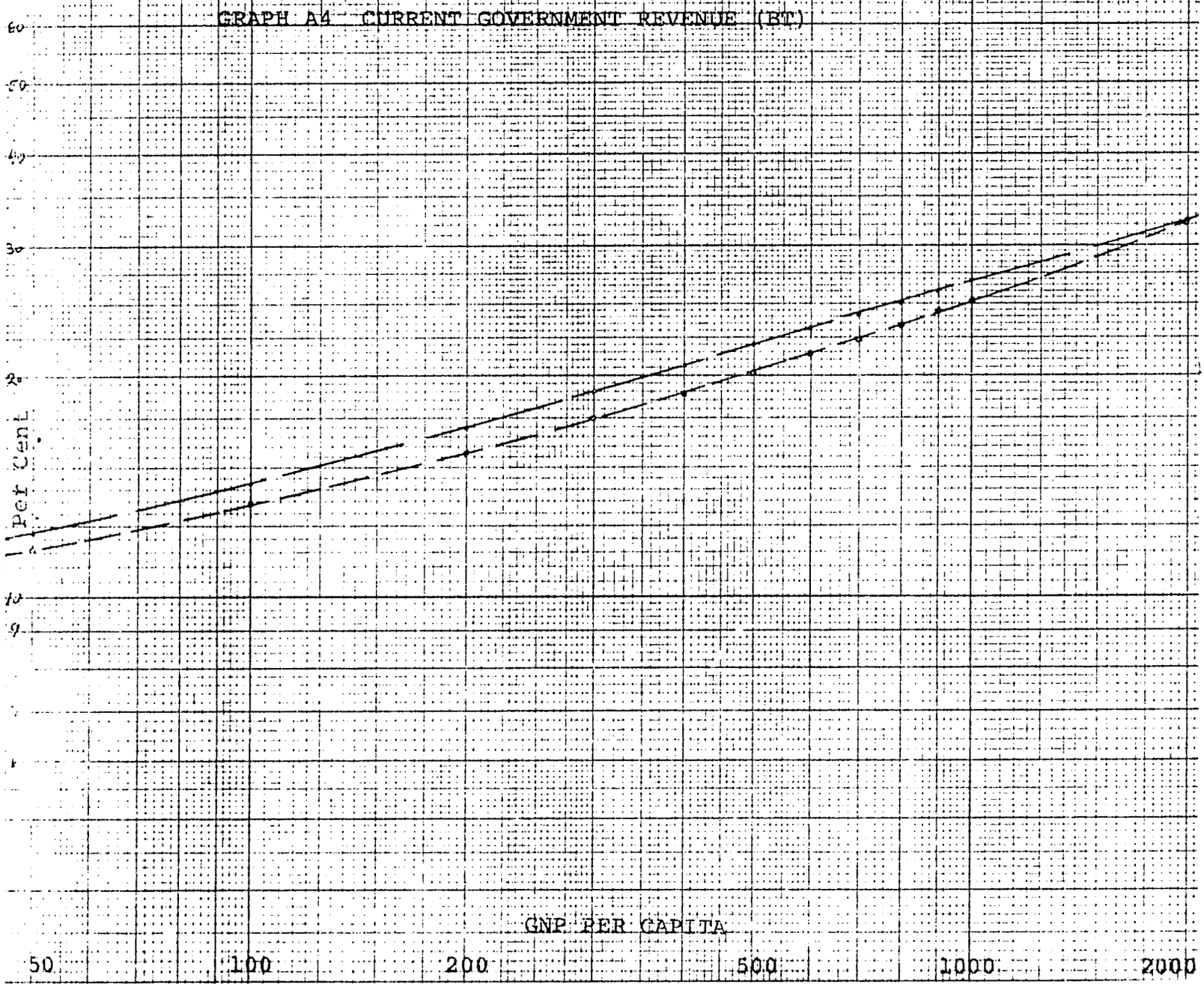
GRAPH A2 GROSS DOMESTIC INVESTMENT (BTF)



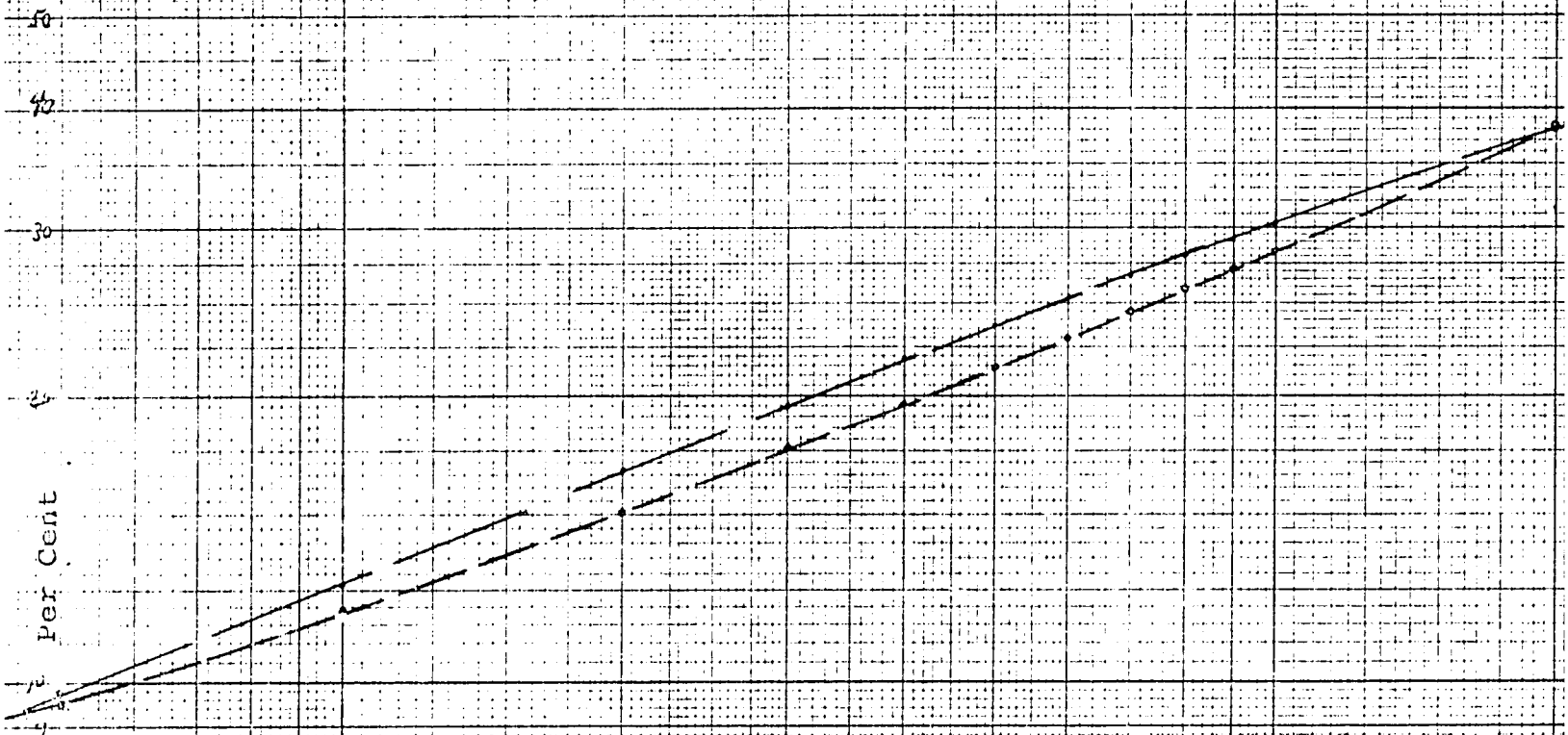
GRAPH A3 CAPITAL INFLOW AS % OF GDP (B)



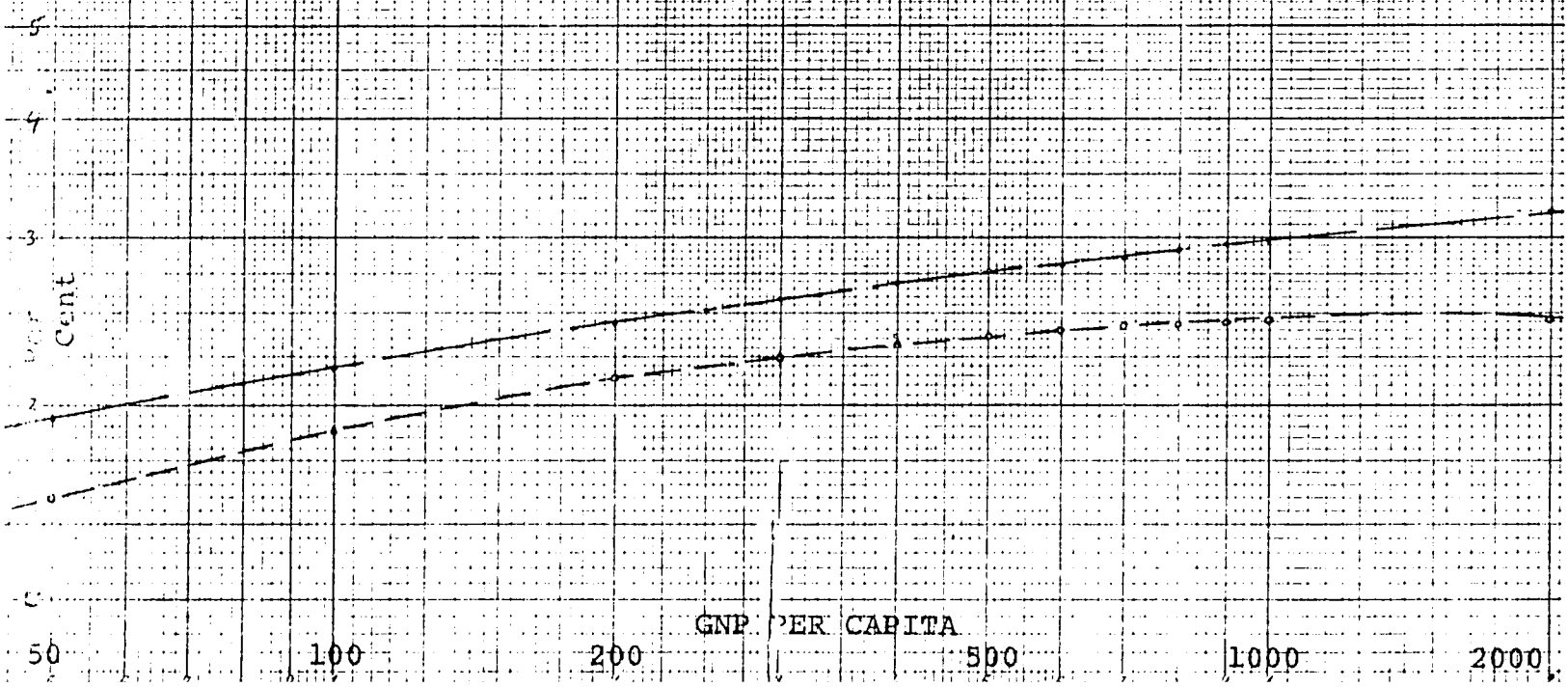
GRAPH A4 CURRENT GOVERNMENT REVENUE (BT)



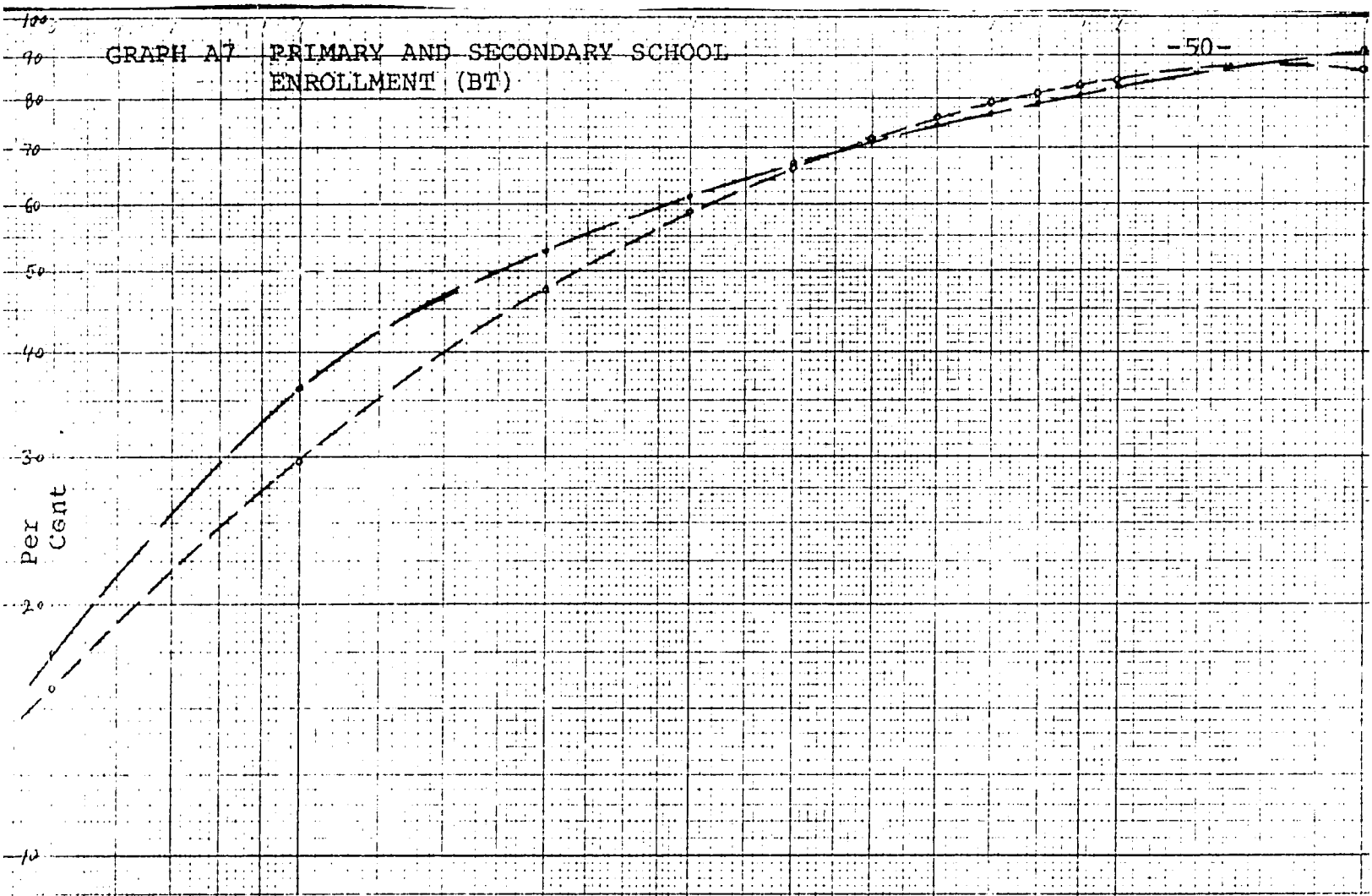
GRAPH A5 TAX REVENUE (BT)



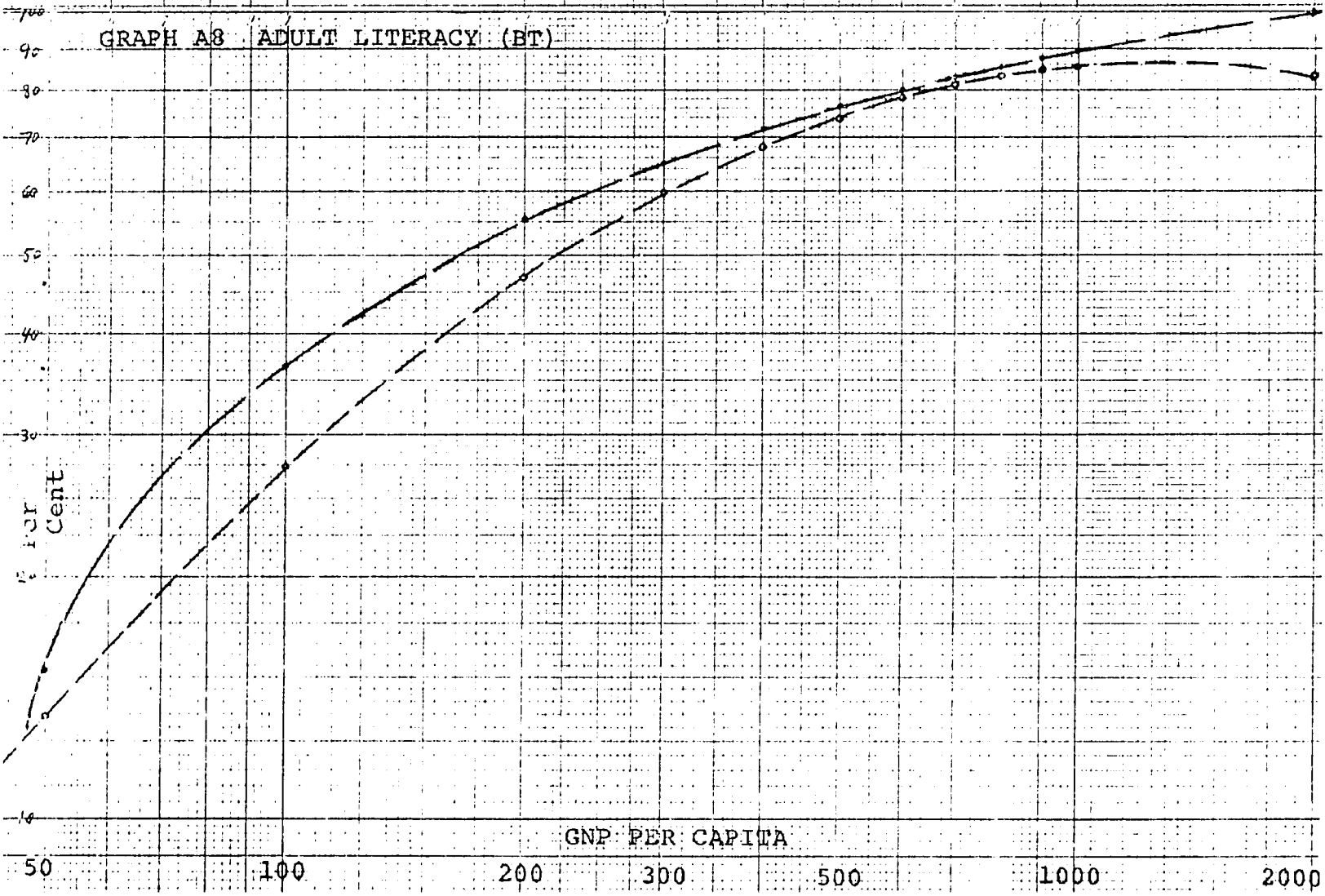
GRAPH A6 EDUCATION EXPENDITURES (BT)



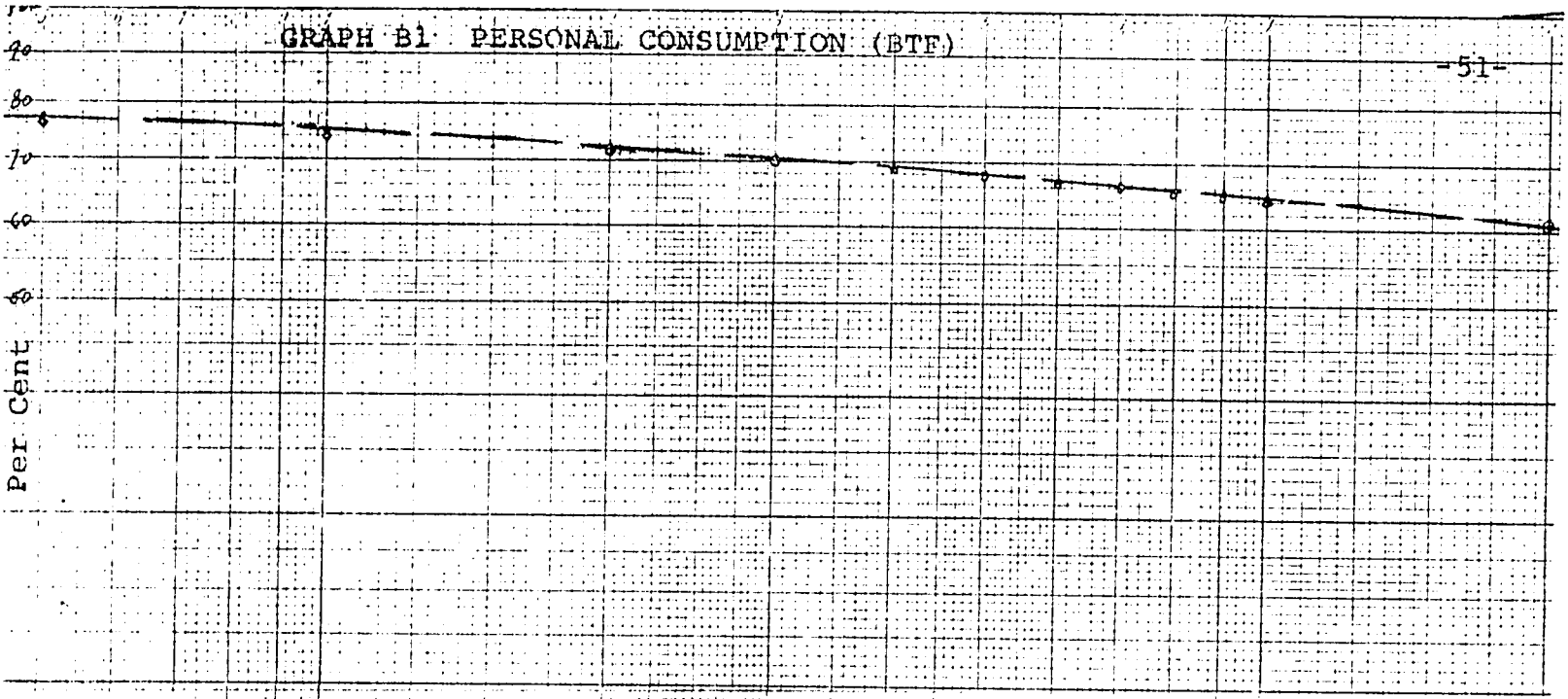
GRAPH A7 PRIMARY AND SECONDARY SCHOOL ENROLLMENT (BT)



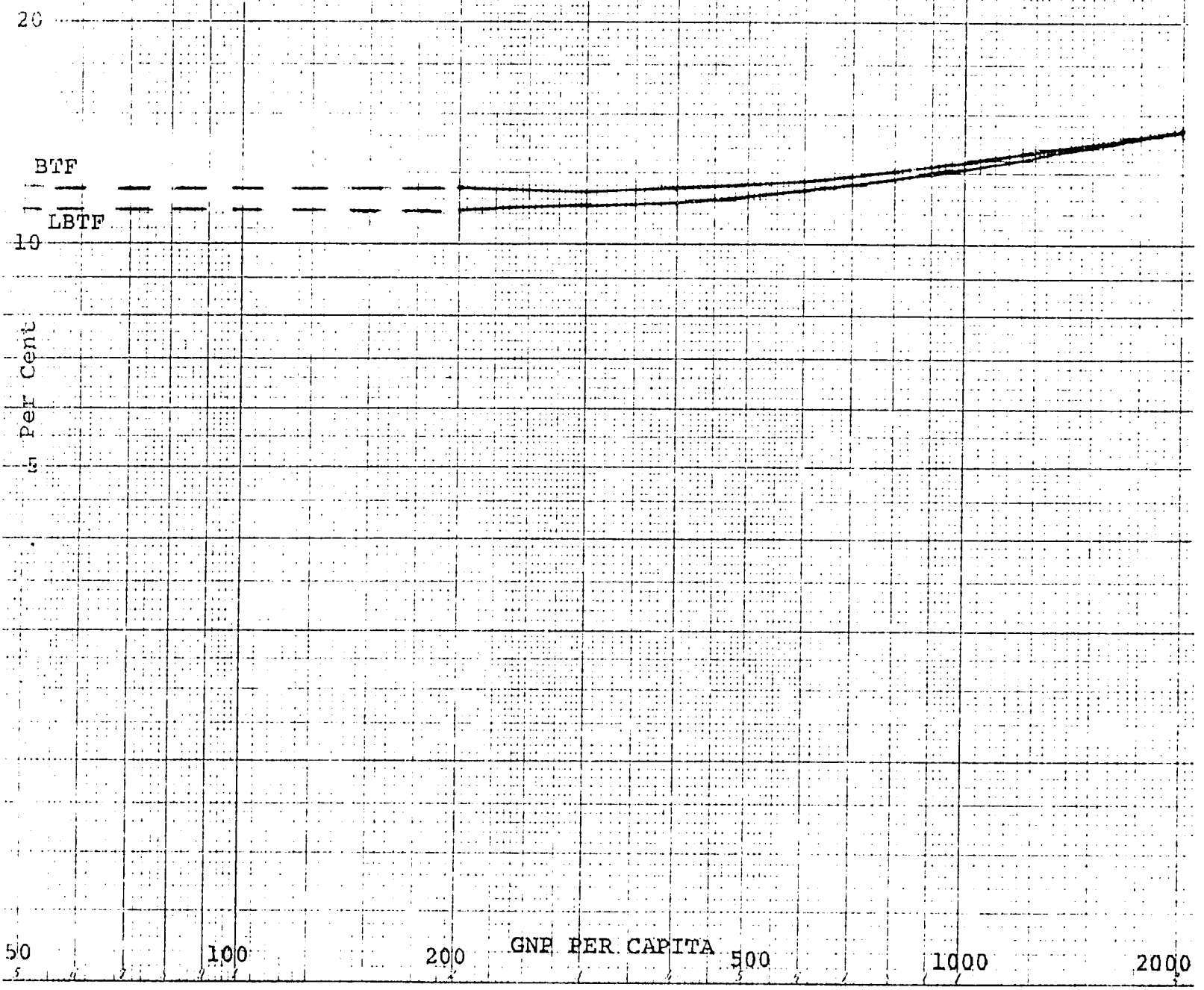
GRAPH A8 ADULT LITERACY (BT)



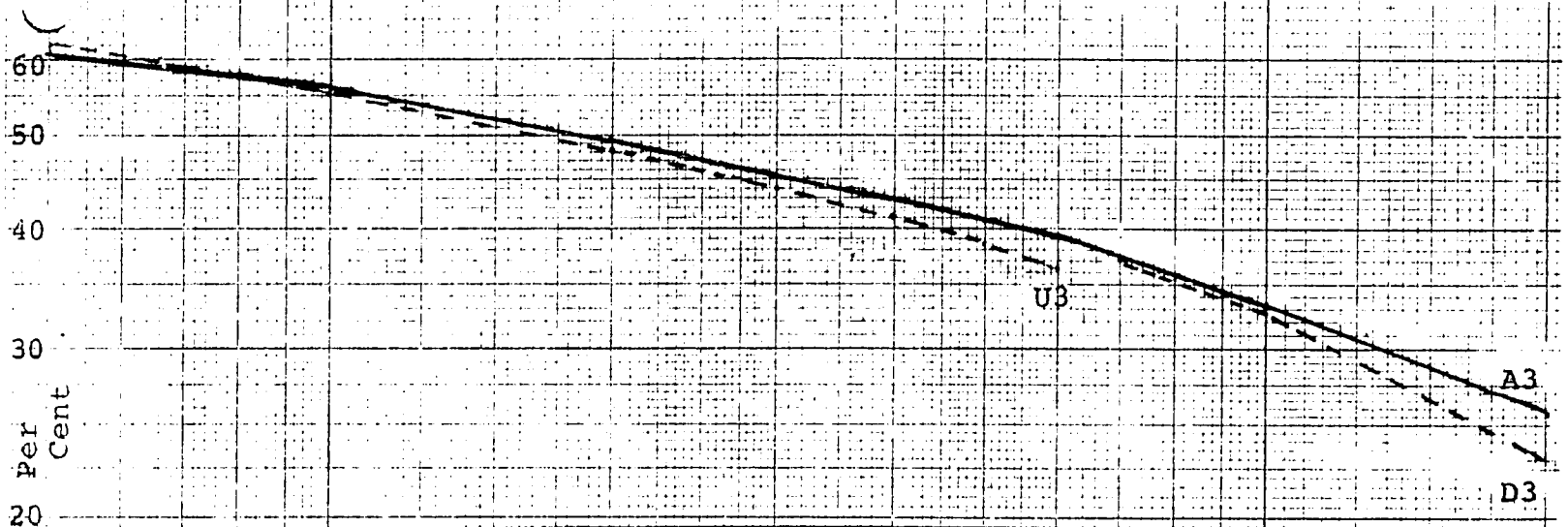
GRAPH B1 PERSONAL CONSUMPTION (BTF)



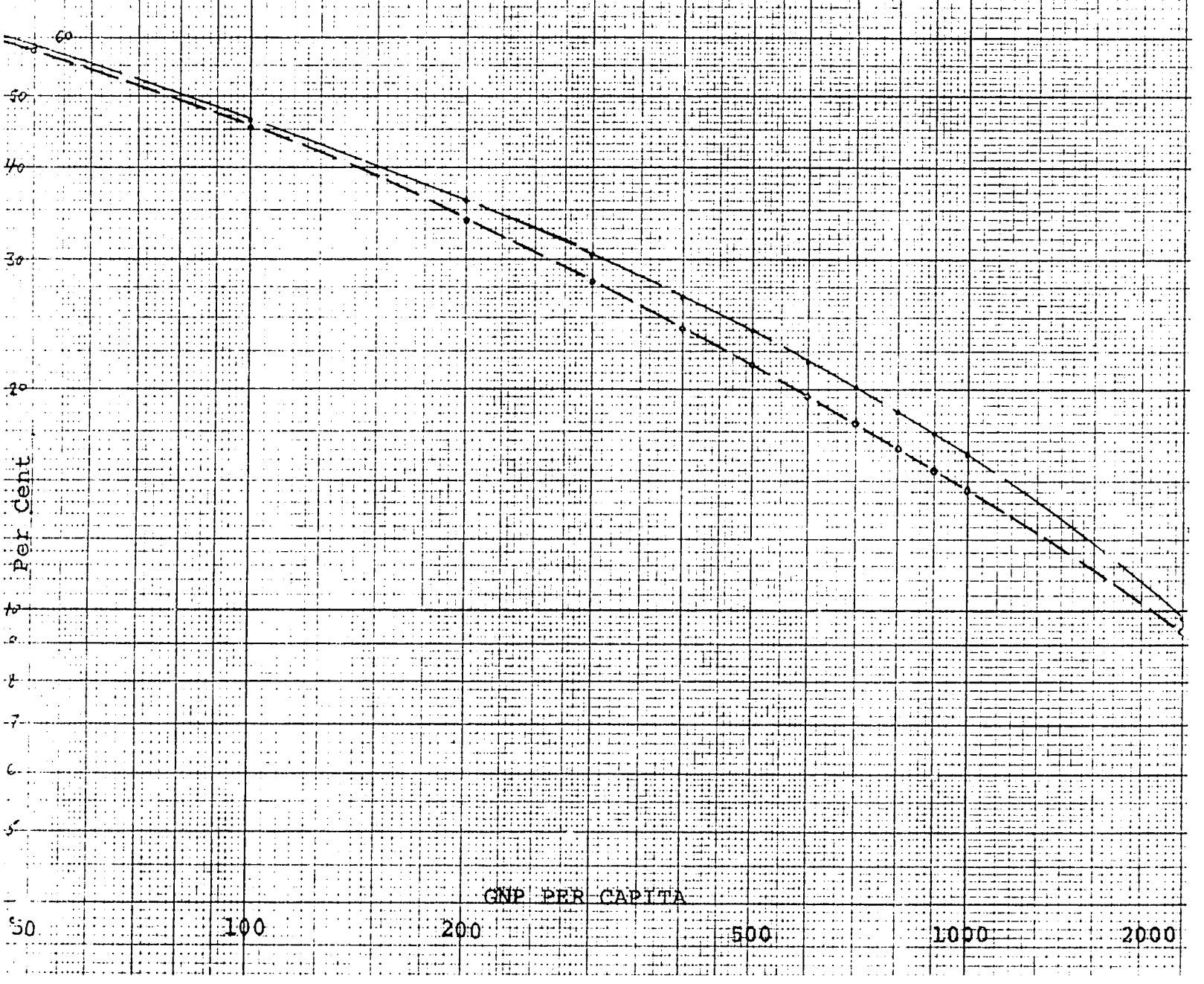
GRAPH B2 GOVERNMENT CONSUMPTION AS PERCENTAGE OF GNP (BTF) (LBTF)



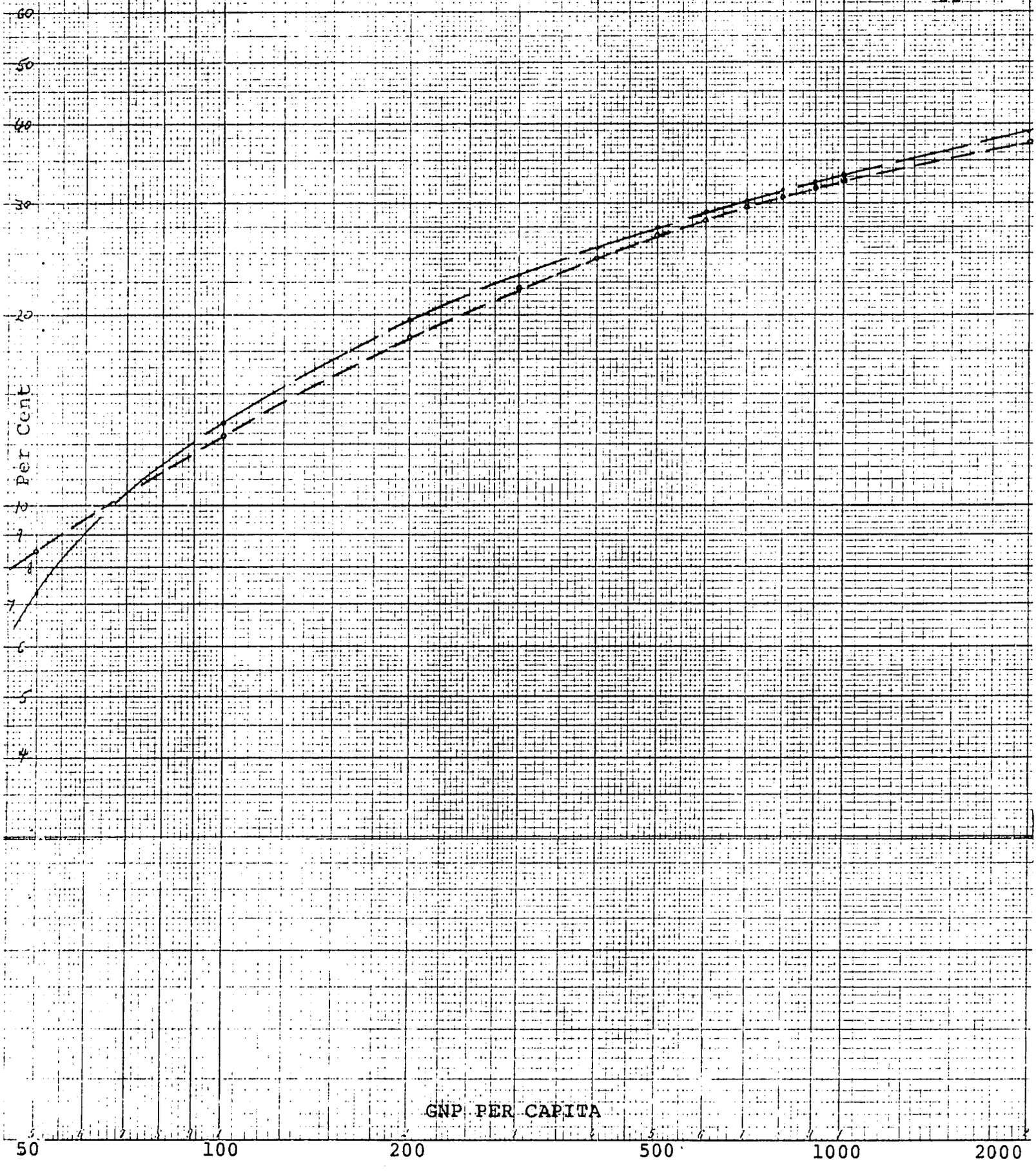
GRAPH B3 FOOD CONSUMPTION SHARE (BTF)



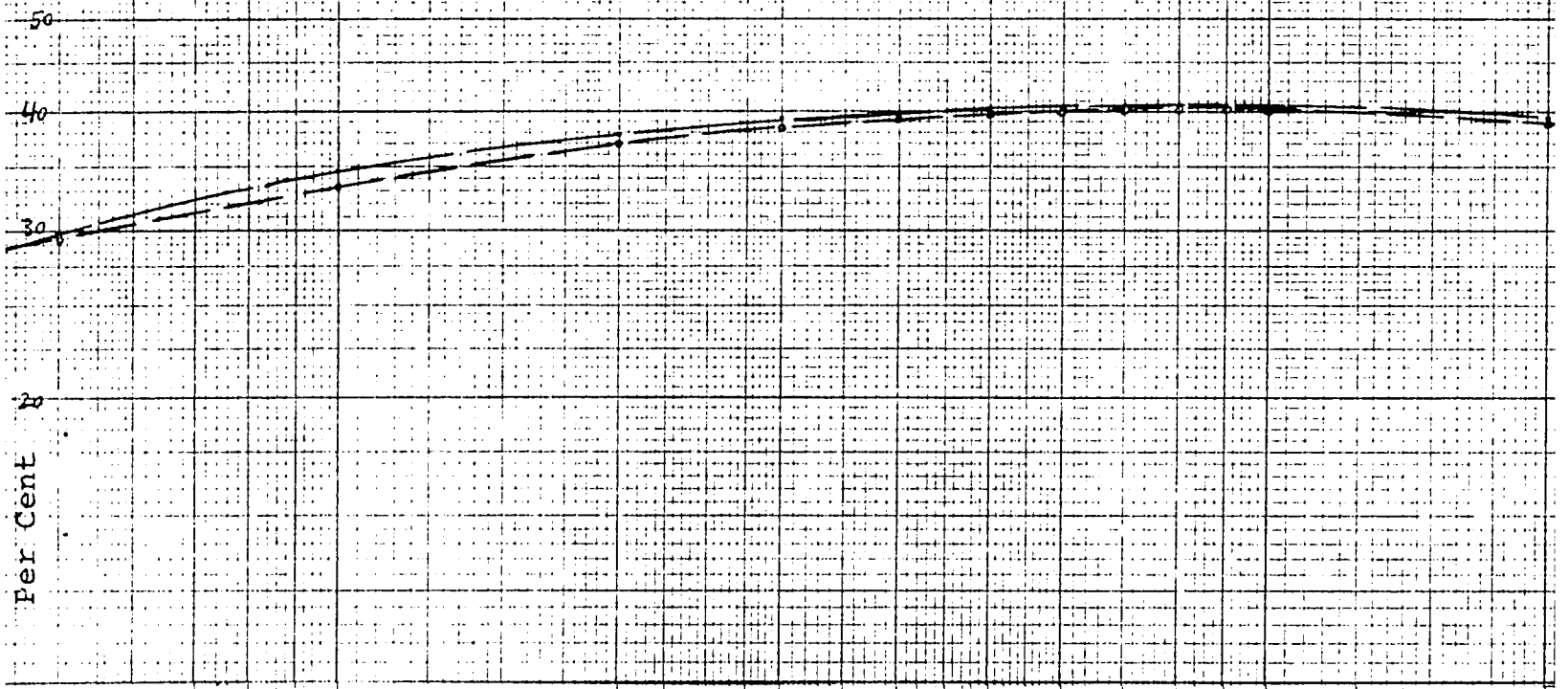
GRAPH B4 PRIMARY SHARE OF GDP (BT)



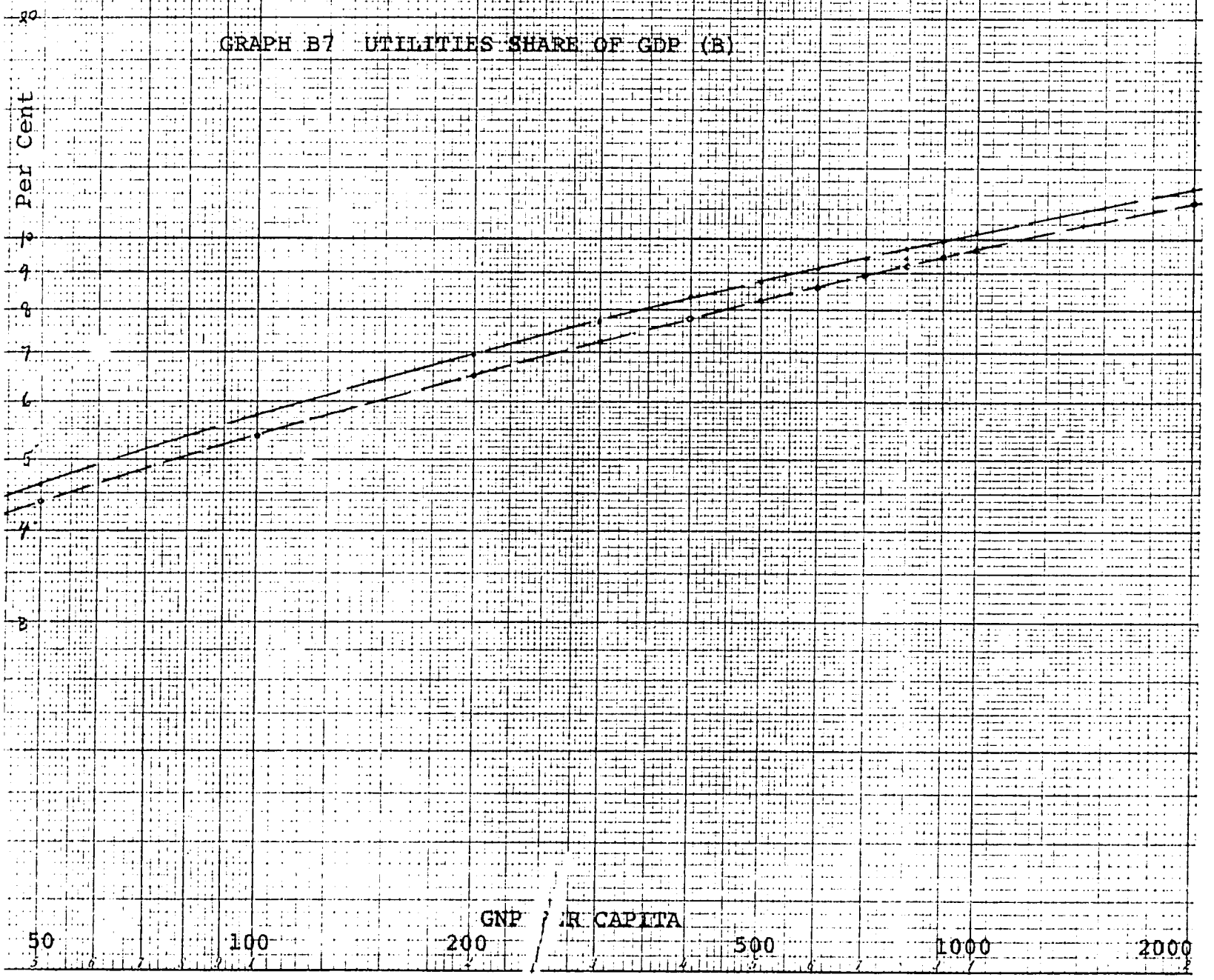
GRAPH B5 INDUSTRY SHARE OF GDP (BI)



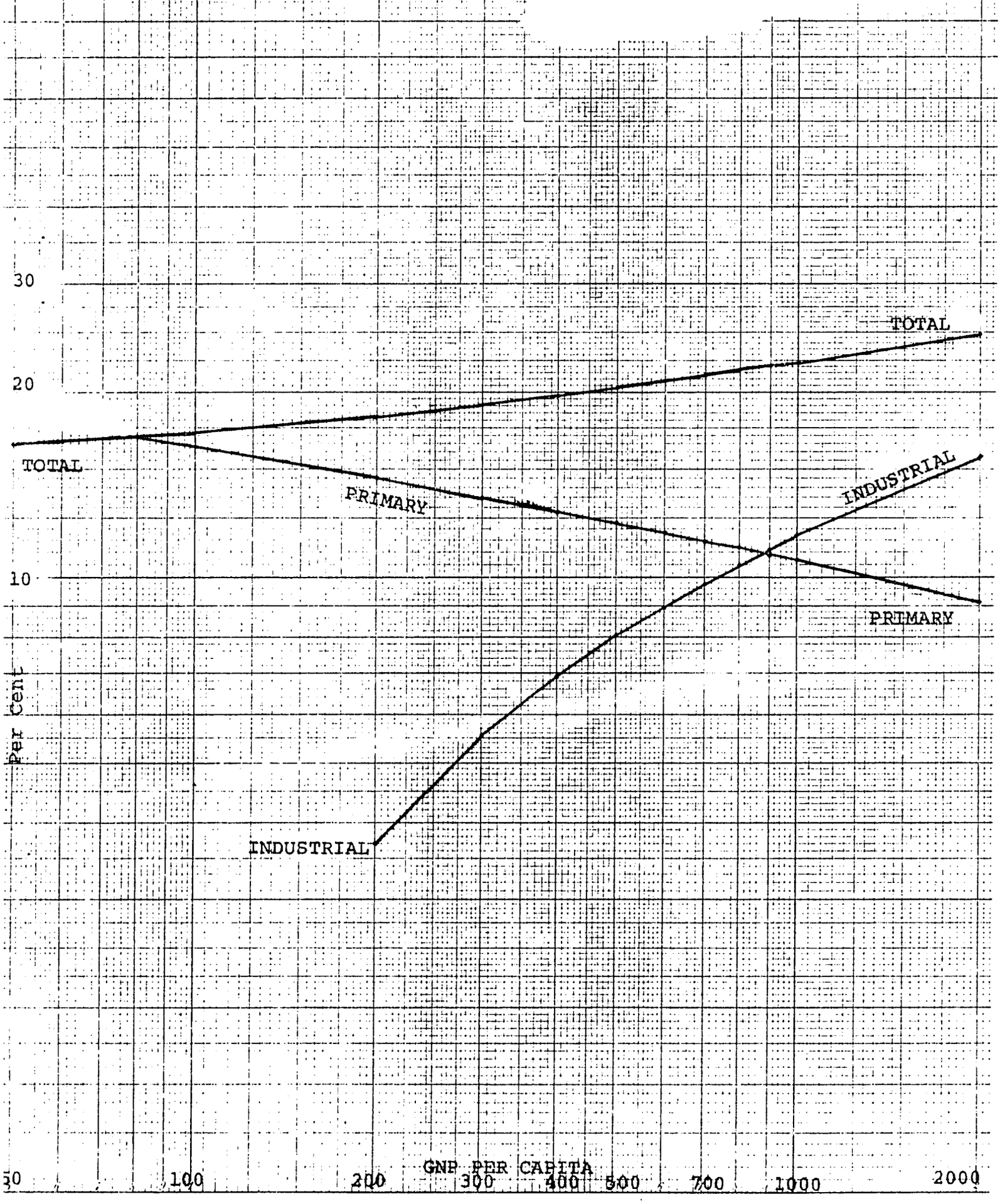
GRAPH B6 SERVICES SHARE OF GDP (B)



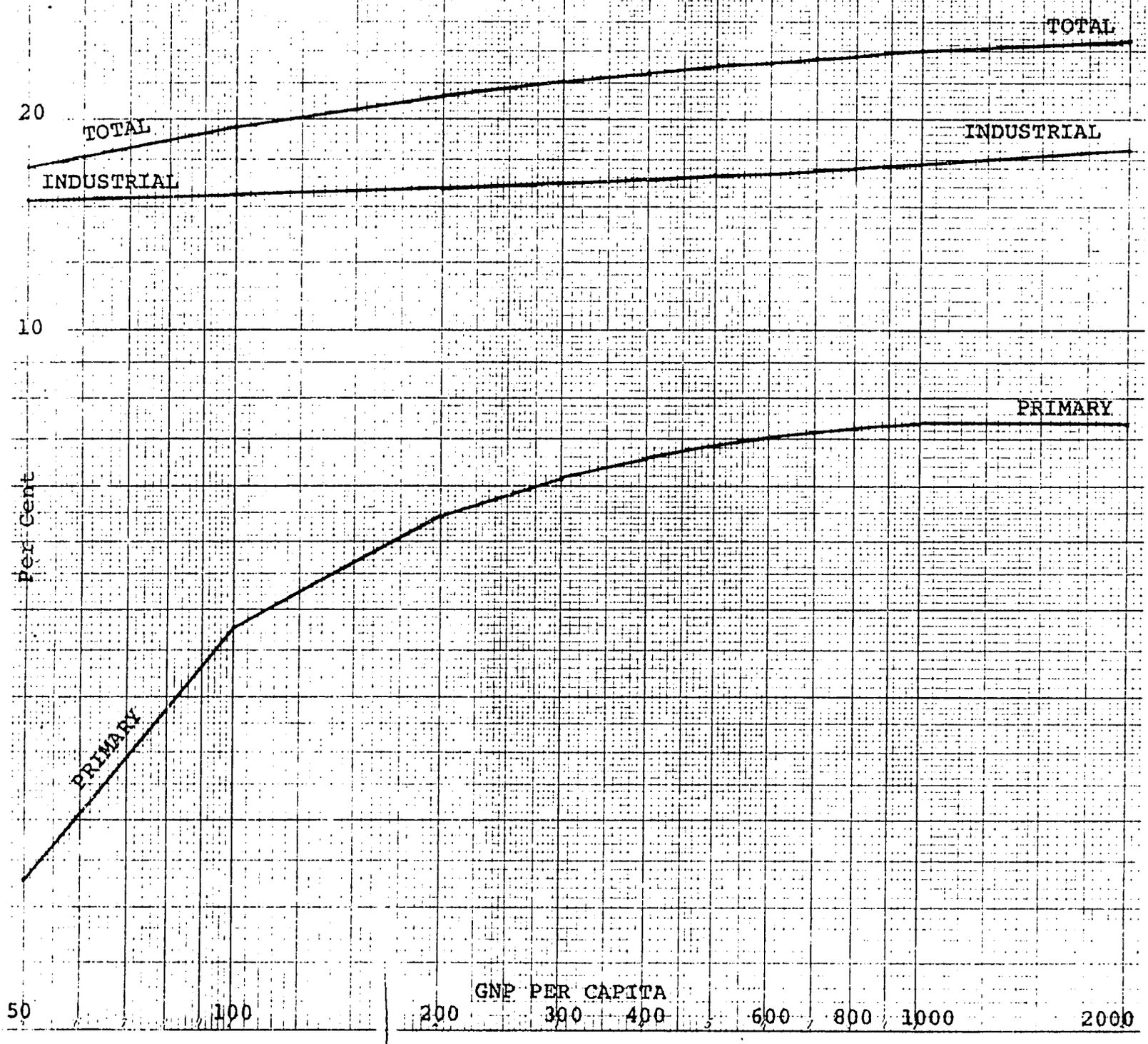
GRAPH B7 UTILITIES SHARE OF GDP (B)

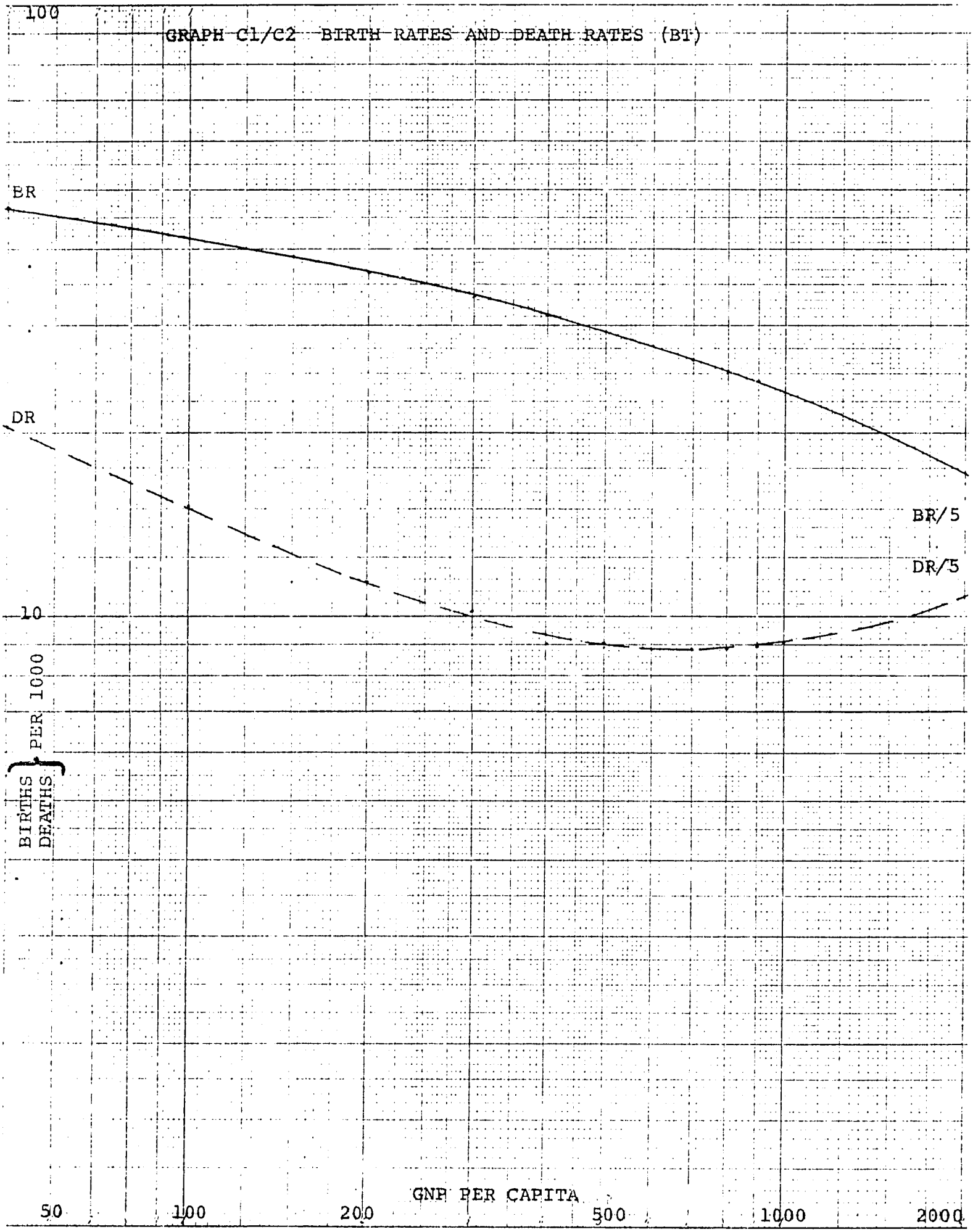


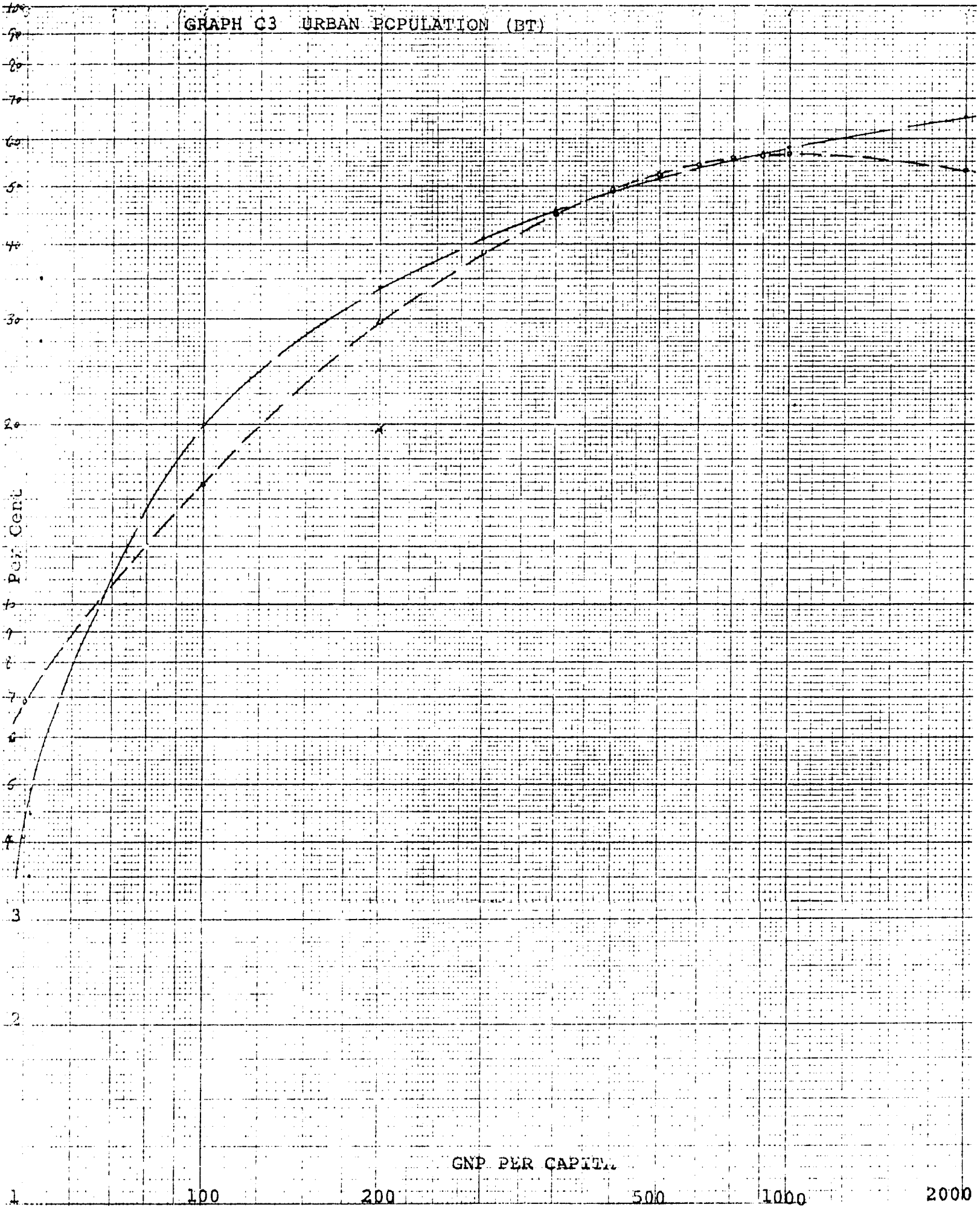
GRAPH B8/B9/B10 EXPORTS (BTF)

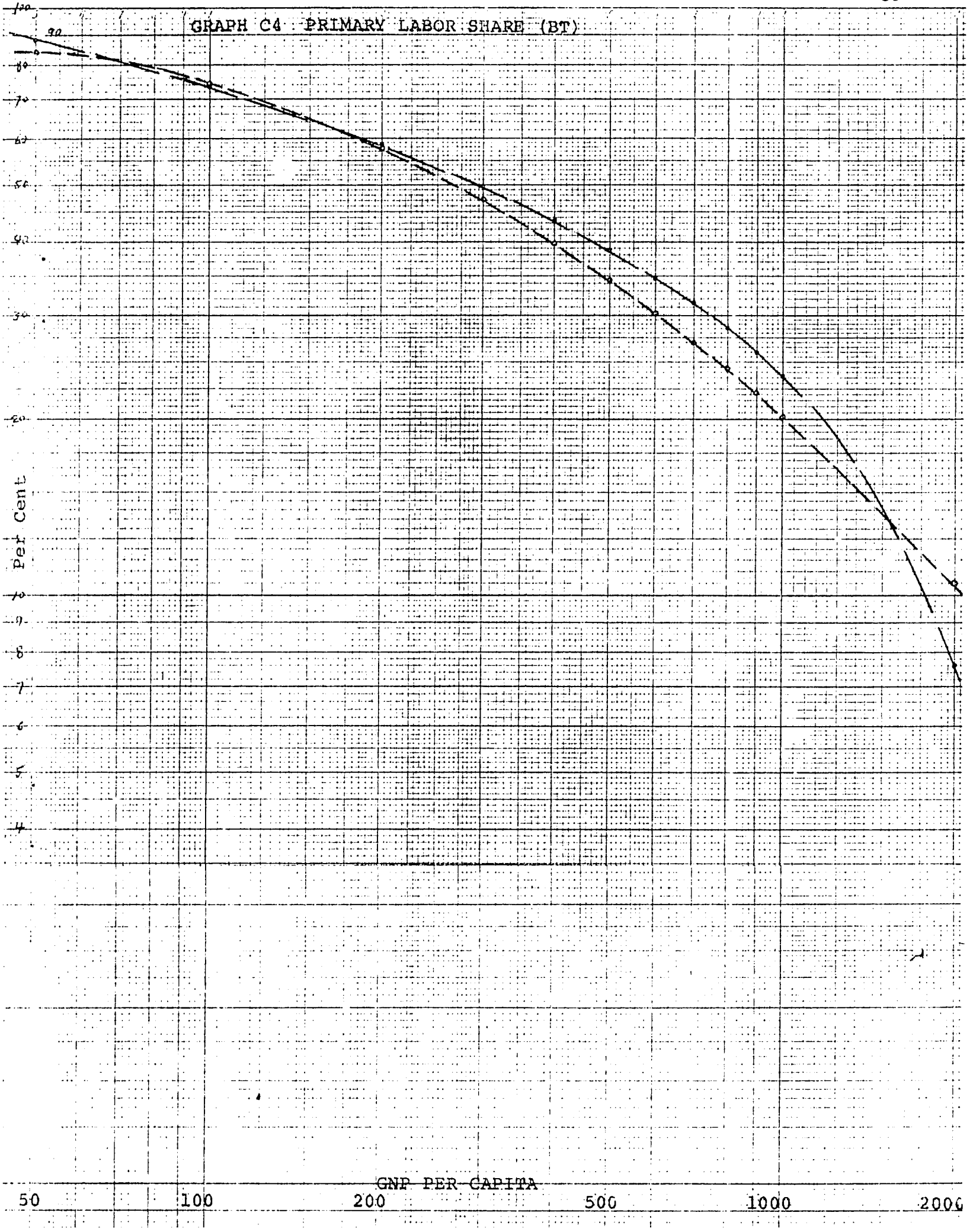


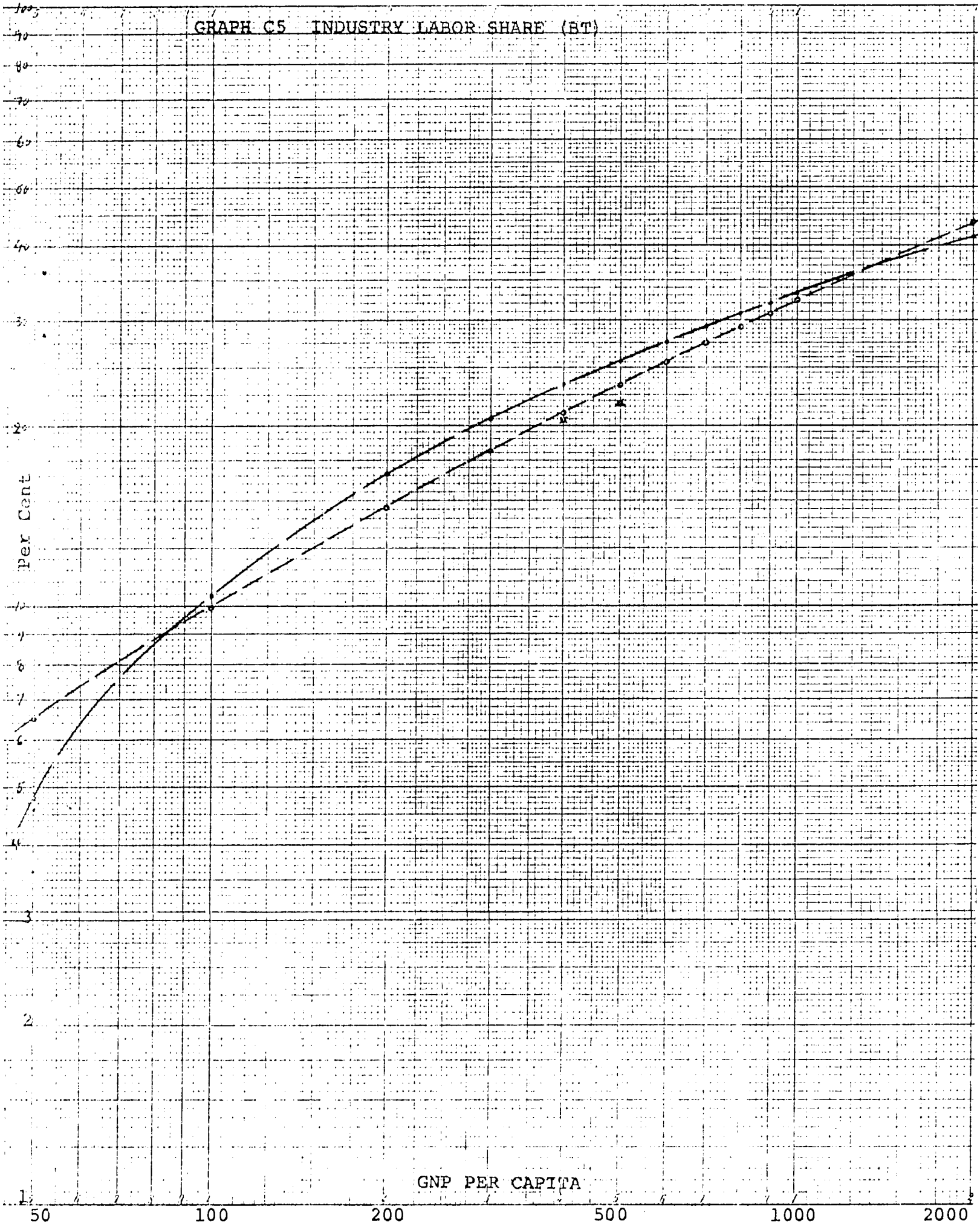
GRAPH B11/B12/B13 IMPORTS (BTF)



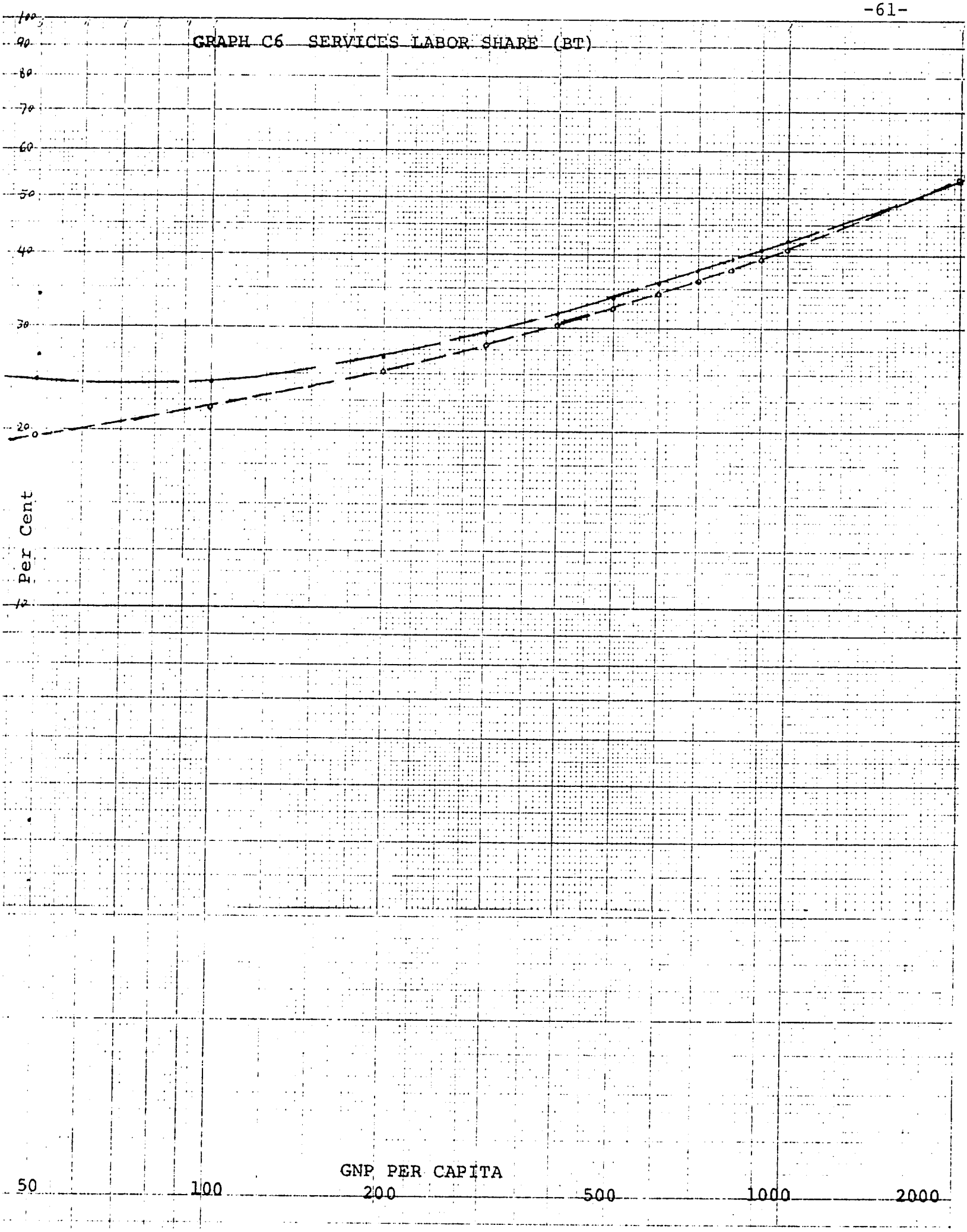

GRAPH C1/C2 BIRTH RATES AND DEATH RATES (BT)
100
BR
DR
BR/5
DR/5
10
BIRTHS
DEATHS
PER 1000
GNP PER CAPITA
50
100
200
500
1000
2000

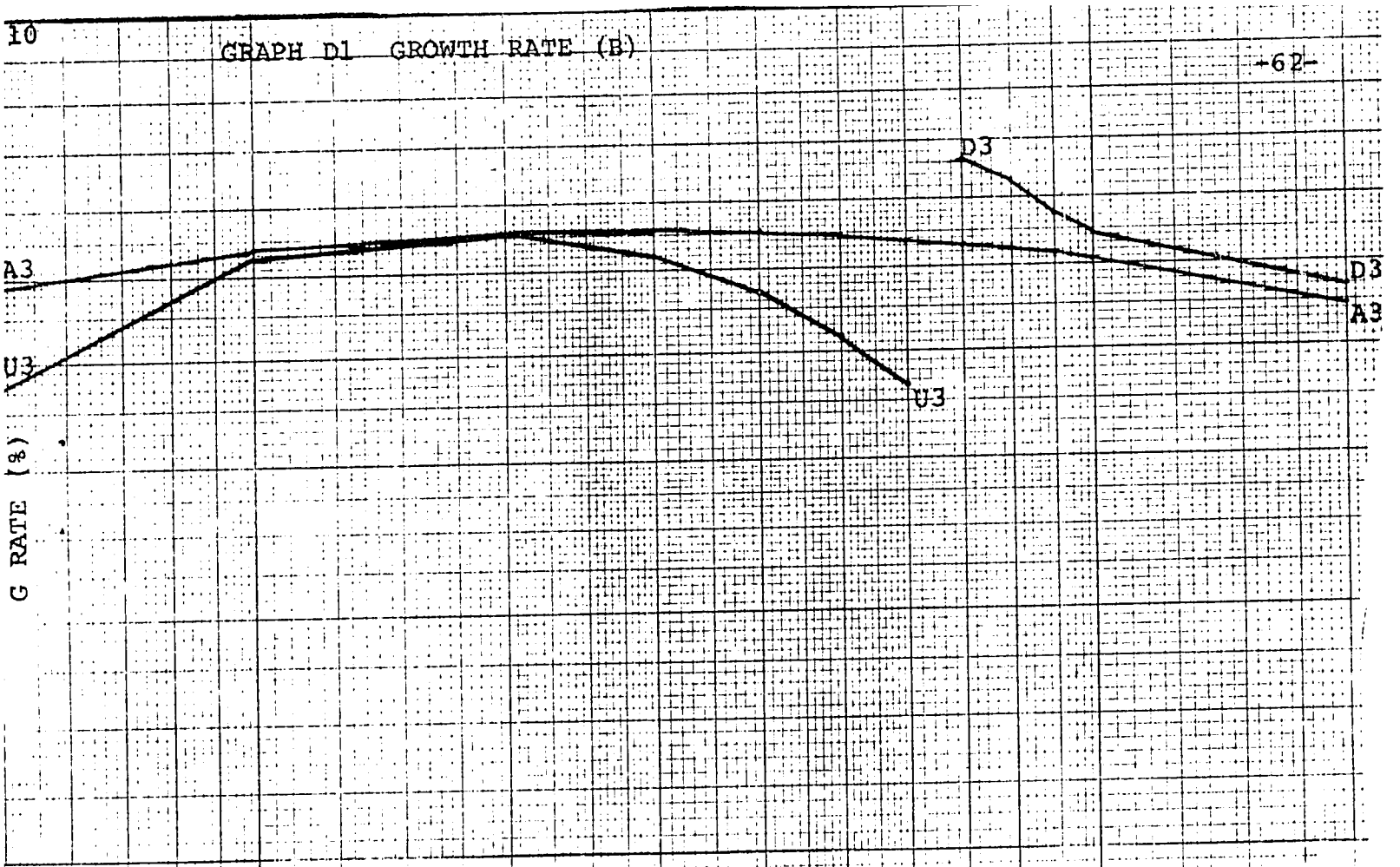

GRAPH C3 URBAN POPULATION (BT)
Per Cent
GNP PER CAPITA
100
200
500
1000
2000

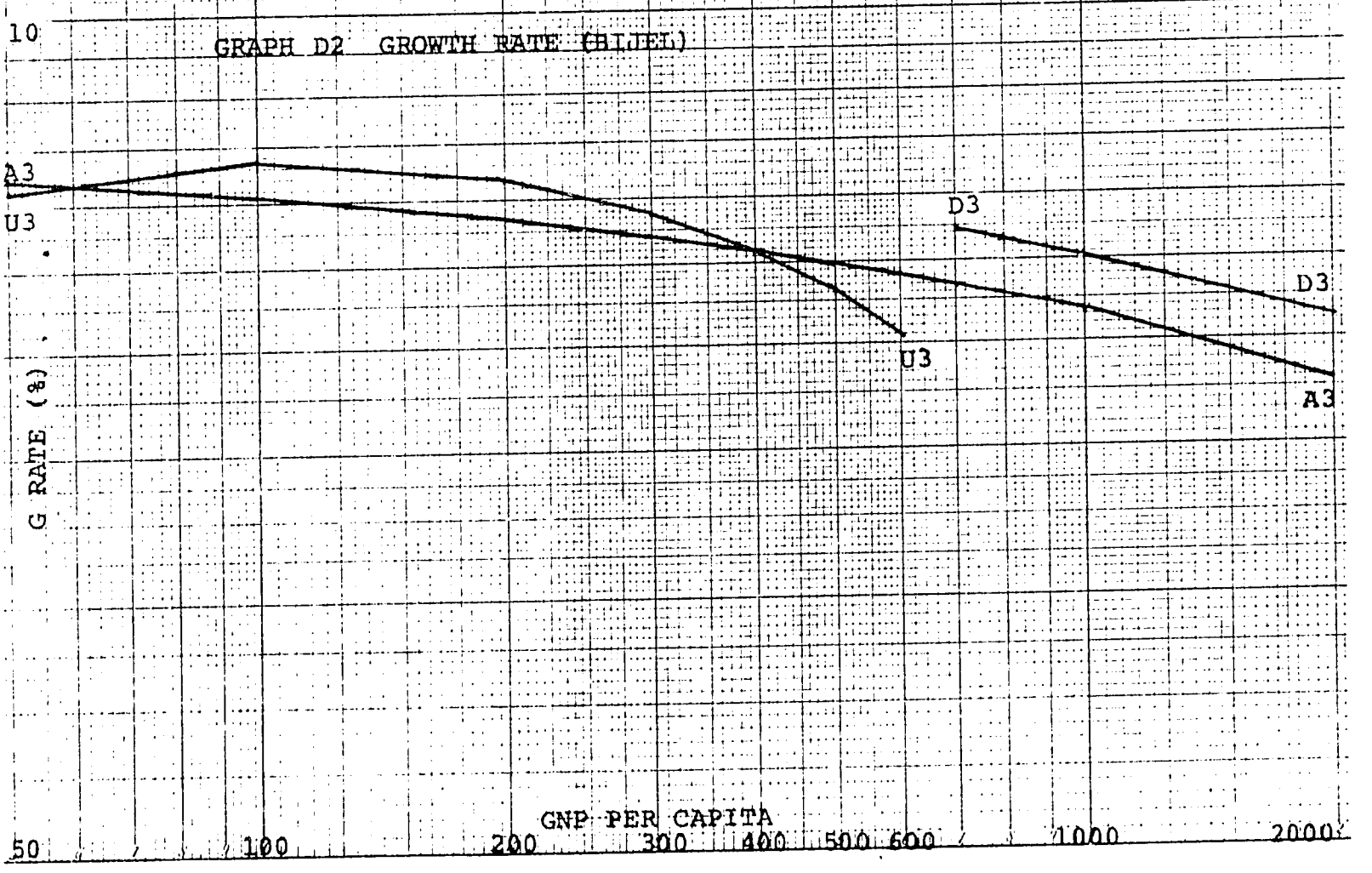

GRAPH C4 PRIMARY LABOR SHARE (BT)
Per Cent
100
90
80
70
60
50
40
30
20
10
9
8
7
6
5
4
GNP PER CAPITA
50
100
200
500
1000
2000


GRAPH C5 INDUSTRY LABOR SHARE (BT)
Per Cent
GNP PER CAPITA
50
100
200
500
1000
2000

GRAPH C6 SERVICES LABOR SHARE (BT)




10
GRAPH D1 GROWTH RATE (B)
D3
A3
D3
A3
U3
U3
G RATE (%)


10
GRAPH D2 GROWTH RATE (BIJEL)
A3
U3
D3
D3
U3
A3
G RATE (%)
GNP PER CAPITA
50
100
200
300
400
500
600
1000
2000