DEVELOPMENT PATTERNS:

AMONG COUNTRIES AND OVER TIME

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Generalizations about economic development have two main sources: historical studies of advanced countries and comparisons among countries at different income levels. The third possibility -- time series for underdeveloped countries -- has proved less promising because of limited data and the past stagnation of many countries. Since each source presents serious econometric difficulties, they will provide a better basis for testing development theories if they can be used in combination.

This paper brings together evidence from all three sources to test the hypothesis that there are uniform patterns of change in the structure of production as income levels rise. Simon Kuznets, the pioneer in this field, was originally impressed with the similarities between historical and cross-country patterns, but recently he has become much

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more sceptical.[1] We will therefore apply more formal econometric methods to determine the relative importance of the factors leading to uniformity and those leading to diversity among countries.

Our study consists of three parts: (i) reestimation of multiple regressions describing intercountry growth patterns for major sectors and country groups, which provide a more satisfactory treatment of the effects of differences in income level, scale and trade patterns; (II) comparison of postwar changes in each group of countries to the intercountry regressions and to the historical patterns of the advanced countries; (III) analysis of twelve industry sectors designed to provide a disaggregated view of production patterns.

I. VARIATION AMONG COUNTRIES

A. Hypotheses

A development pattern may be defined for a given country by the time paths of variables describing production, domestic use, international trade, and resource allocation in each sector.

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[1] In 1957 /10, p. 17/ Kuznets concluded that "the direct evidence on long-term trends in the industrial structure of national product is thus remarkably consistent with that provided by the association of international differences in industrial structure and in level of income." His assessment in 1966 is much more cautious: "The value of such [cross-section] analysis for generating some preliminary hunches cannot be denied. But unless innovational changes can somehow be taken into account in the use of the cross-section data proper, use of its results may lead to erroneous inferences concerning past changes in structure in the process of growth. And the same applies, pari passu, to application of cross-section analysis to projections into the future." / 12 , p. 436/

A comparable cross-section pattern may be defined by the variation in the same set of variables among countries at a given moment in time. The two patterns can be compared by expressing both as functions of per capita income and other variables.[1]

A complete model for the study of the relations among these variables was set out in Chenery, Shishido and Watanabe / 4/ and elaborated by Taylor /17/ for the analysis of inter-country variations. The latter derives intercountry patterns from a set of simulations of the effects of variations in domestic demand and trade patterns with income level and population, which provide a starting point for the present study. While our statistical analysis covers only the variation in trade patterns and value added by sector, our interpretation of the results relies on the more complete model.

The intercountry pattern of any year is generated by the intertemporal development patterns of all countries in prior years. If each country's pattern is dominated by a set of universal factors common to all, the cross-section relations will reveal some of the characteristics of these

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[1] A close analogy is found in the study of consumer demand, in which cross-section relations to income, family size, and other variables are determined from budget studies and compared to time series estimates of the same relations. Our approach to the problem follows that of Houthakker /8 / and Kuh /10/.

underlying factors. If, however, individual peculiarities of each country and changes in the universal relationships predominate, the cross-section relations may be of little use in analysing country growth patterns.

The universal factors suggested in earlier studies /2,11/ to explain the intercountry uniformities include:

(i) similarities in production relations -- common production functions, substitution of capital for labor with rising income, etc.

(ii) similarities in domestic demand -- both in private consumption and public expenditures.

(iii) similarities in opportunities for trade and international capital movements.

In a world in which growth took place mainly through capital accumulation, without much change in tastes, technology or economic organization, we might observe common features of each country's development that would carry over directly to the cross-country pattern. The introduction of changing technology and organization makes the relation between the two patterns less predictable. While the introduction of new products may cause shifts in demand functions that modify or even reverse the existing inter-country pattern,[1] technological change (e.g. labor-saving innovations) may also be systematically related to rising income.

[1] Kuznets /12, pp. 434-5/ gives examples of this type.

For purposes of empirical analysis, we will regard the time pattern for each country as composed of three elements: (i) the average effects of universal factors, which can be measured by the inter-country variation in output shares; (ii) systematic effects of changes in technology and other universal factors, which can be measured by changes in the cross-country patterns over time; (iii) individual differences in development patterns due to varying resources, trading opportunities, social organization or other elements.

There are many suggestions in the development literature to the effect that differences in development patterns will be associated with abundant or scarce natural resources, open or closed economies, rapid or slow growth, etc. It is not clear whether these factors can be adequately reflected by adding variables in a multiple regression analysis or will require different functional forms for the equations. We therefore investigate both alternatives.

In summary, our statistical procedure is designed to test for several types of uniformity in development patterns: similarities between the production relations estimated from time series and cross-section data, systematic shifts in these relations over time, and improvements in the estimates that may come from grouping countries in accordance with a priori criteria. The remaining variation in production is attributed to forces specific to each country.

B. Econometric Procedure

Data. Our first test of this approach utilizes U.N. national accounts data for major branches of production, which provide a sample of fifty-four countries over the period 1950-1963. The sample is distributed fairly evenly over the range from least to most developed, with the advanced countries comprising only a quarter of the total.[1] The second stage of the analysis, reported in section III, deals with census data for selected industrial sectors in a similar group of countries.

The dependent variables in the regression equations are the shares of the three major components in GNP:

(i) x_p = share of primary production (mining and agriculture)

(ii) x_m = share of industry (manufacturing and construction)

(iii) x_s = share of services (all other sectors)

Our breakdown follows Kuznets except that we have combined mining with agriculture because of its similar role in trade.

Explanatory variables.[2] The explanatory variables are chosen to represent the degree of openness of the economy, its trade pattern, and its rate of growth. The United Nations /19, p. 36/ tested eight proxy variables for these factors

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[1] Previous studies of development patterns have been dominated by the experience of the advanced countries.

[2] Complete definitions and average values of the variables for all countries are given in table A-1 of the appendix.

in estimating growth patterns for individual sectors of industry. From these and other experiments, we have chosen the following set of explanatory variables:

y = per capita GNP (in 1960 dollars)

N = population in millions

k = share of gross fixed capital formation in GNP $(\frac{I}{Y})$

e_p = share of primary exports in GNP $(\frac{E_p}{Y})$

e_m = share of manufactured exports in GNP $(\frac{E_m}{Y})$

Two procedures have been suggested for quantitative comparisons of economic structure. The earlier approach of Kuznets and others is to use the values of some of the variables as a basis for subdividing the sample into groups of countries that are expected to have more homogeneous growth patterns. The alternative used by Chenery /2/ and the United Nations /19/ is to utilize all the explanatory variables in a single multiple regression equation. This method assumes that the effect of each variable is additive in logarithms and independent of the values taken by the others. The former approach is preferable when there is a complex interaction among the explanatory variables that may require different functional forms for each group, but it has the disadvantage of reducing the size of the sample.

In summary, the procedure we have adopted is the result of tests of two methods of analysis: use of continuous variables and grouping by one or more indices. Further justification for the combination selected will be provided in discussing the results.

Regression equations.

We will estimate three logarithmic equations from cross-country data:

Regression A

$$\ln x_i = \alpha + \beta_1 \ln y + \beta_2 (\ln y)^2 + \gamma \ln N + \delta \ln k + \epsilon_1 \ln e_p + \epsilon_2 \ln e_m$$

Regression B

$$\ln x_i = \ln \alpha + \beta_1 \ln y + \beta_2 (\ln y)^2 + \gamma \ln N$$

Regression C

$$\ln x_i = \ln \alpha + \beta \ln y + \gamma \ln N$$

A sample of 703 observations on 54 countries between 1950-1963 is available for regressions B and C as compared to 606 observations on 48 countries for equation A.[1]

A preliminary test was run using regression B to determine whether the cross-section relations had varied appreciably over the period of observation. Since the annual variation is not significant, we discuss first the cross-section patterns derived from the pooled sample for 1950-1963.[2] These are given for the whole group of countries in table 1.

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[1] The logarithmic forms have several properties that make them preferable to linear relations, as pointed out in /8/ and /2 /. Regression C was used in previous studies by Chenery /2 / and the United Nations /19/. Equation B is used by Taylor /17/ to estimate several elements of his simulation model.

[2] The annual variation is discussed in section II.

TABLE 1 - ESTIMATES OF PRODUCTION PATTERNS: ALL COUNTRIES

Sector and Equation		Intercept α	$\ln y$ (β_1)	$(\ln y)^2$ (β_2)	$\ln N$ (γ)	$\ln k$ (δ)	$\ln ep$ (ε_1)	$\ln \epsilon_m$ (ε_2)	R^2	Standard Error
INDUSTRY										
(x_m)	A	-5.8453	1.2594	-.0838	.0264	.1024	-.1087	.0573	.794	.211
		(.33)	(.11)	(.01)	(.01)	(.02)	(.01)	(.01)		
	B	-7.0315	1.5024	-.0970	.0768				.727	.240
		(.33)	(.11)	(.01)	(.01)					
	C	-3.7562	.3713		.0440				.688	.257
		(.06)	(.01)		(.01)					
PRIMARY	A	-1.5470	.4983	-.0750	.0657	.0019	.1880	-.0584	.866	.211
(x_p)		(.33)	(.01)	(.01)	(.01)	(.02)	(.01)	(.01)		
	B	-.0981	.0204	-.0433	-.0287				.788	.258
		(.35)	(.12)	(.01)	(.01)					
	C	1.5611	-.4848		-.0433				.782	.261
		(.06)	(.01)		(.01)					
SERVICES	A	-1.1874	.0393	.0038	-.0513	-.0144	-.0452	-.0026	.359	.147
(x_s)		(.23)	(.08)	(.01)	(.01)	(.01)	(.01)	(.01)		
	B	-1.4783	.1638	-.0060	-.0279				.321	.149
		(.20)	(.07)	(.01)	(.01)					
	C	-1.2751	.0936		-.0300				.321	.149
		(.03)	(.01)		(.01)					

Regression A provides a substantially better explanation of the variation in the shares of industry and primary production than the equation that had been used previously (regression C). The non-linear income term $(\ln y)^2$ allows for the decline in elasticities with rising income that has been noted in most industrial sectors /19, p.14 /. This formulation avoids the necessity of subdividing the sample by income level. It will be shown to be particularly important for large countries.

<u>Subdividing the Sample</u>. Before proceeding to interpret these results, we will explore the merits of alternative formulations in which the same regression equations are fitted for subgroups of the total sample. These tests are designed to determine whether the effects of income level, scale and trade patterns can be considered as independent of each other. Where there are substantial departures from this assumption, we will estimate separate patterns that are representative of more homogeneous sub-groups of countries.[1]

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[1] Subdivision of the 54 countries in the sample cannot proceed beyond 3 or 4 groups without having the subgroups become too small, so we have tested a number of alternatives. For brevity, we present only the final results.

We expect large countries to industrialize earlier than small ones because economies of scale shift their comparative advantage toward industry. However, the importance of this effect declines as incomes rise, and it may ultimately be outweighed by greater exports of manufactured goods from small countries.

To determine whether large countries have different growth patterns from small ones, we divided the sample into groups having populations above and below 15 million.[1] The significance of this subdivision is strongly confirmed by the regression results. The large country regressions (given in Table 2a and Figure 1)[2] show that industrial share rises at a rapid rate during the early phases of growth, but then reaches a peak at a per capita income of $1200. By contrast, the negative coefficient on ln y and the positive coefficient on $(\ln y)^2$ in the regressions for small countries taken as a group (Table 2b) indicate that the rate of increase in the share of industry increases as per capita income rises. Since these differences cannot be captured in the pooled regression we maintain the size distinction in further analysis.

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[1]The dividing line is largely arbitrary and might be moved up to 25 million with essentially the same results. Kuznets /14, Ch.II/ suggests 10 million as a convenient definition of a small country, but there are a number of countries just above this level. We have taken advantage of the fact that there are only 3 countries -- Canada, Burma, and Argentina -- in the interval 14-22 million in 1958, and have set the dividing line to include them as large countries after an examination of their economic structure. The countries in each group are given in table A-1.

[2]In Figure 1 and subsequent figures, the pool regression lines are plotted from regression A, using predicted values of ep and em from cross-section regressions. The slopes of the regression lines are thus total elasticities with respect to y, close in value to the elasticities from regressions B and C.

TABLE 2a - ESTIMATES OF PRODUCTION PATTERNS: LARGE COUNTRIES (L)

Sector		Intercept (α)	Regression Coefficients with Respect to: ln y (β_1)	$(\ln y)^2$ (β_2)	ln N (γ)	ln k (δ)	ln ep (ε_1)	ln em (ε_2)	R^2	Standard Error
INDUSTRY (x_m)	A	-7.2881	1.8813	-.1342	.0553	.2177	.0005	.0400	.910	.157
		(.35)	(.11)	(.01)	(.02)	(.03)	(.02)	(.01)		
	B	-8.5416	2.0328	-.1422	.0839				.874	.186
		(.33)	(.11)	(.01)	(.02)					
	C	-3.6270	.3683		.0159				.753	.259
		(.11)	(.01)		(.02)					
PRIMARY (x_p)	A	-1.2787	.2918	-.0616	.0634	-.1163	.0844	-.0311	.920	.188
		(.42)	(.13)	(.01)	(.02)	(.04)	(.02)	(.01)		
	B	.2715	-.0368	-.0402	-.0238				.905	.204
		(.36)	(.12)	(.01)	(.02)					
	C	1.6594	-.5064		-.0430				.899	.210
		(.09)	(.01)		(.02)					
SERVICES (x_s)	A	-.8245	.0203	.0067	-.0541	.1088	-.0001	-.0116	.484	.142
		(.31)	(.10)	(.01)	(.02)	(.03)	(.02)	(.01)		
	B	-.8887	-.0059	.0090	-.0590				.452	.145
		(.26)	(.08)	(.01)	(.01)					
	C	-1.2013	.1000		-.0547				.449	.145
		(.06)	(.01)		(.01)					

TABLE 2b - ESTIMATES OF PRODUCTION PATTERNS: SMALL COUNTRIES (S)

Sector	Intercept (α)	ln y (β_1)	$(\ln y)^2$ (β_2)	ln N (γ)	ln k (δ)	ln ep (ε_1)	ln em (ε_2)	R^2	Standard Error
INDUSTRY									
(x_m) A	-3.26	.32 (.02)	-.004 (.018)	-.017 (.018)	.08 (.02)	-.19 (.02)	.07 (.01)	.75	.21
B	-4.17 (.59)	.50 (.20)	-.01 (.02)	.06 (.02)				.62	.26
C	-4.17 (.59)	.37 (.01)		.05 (.02)				.62	.26
PRIMARY									
(x_p) A	-.59	.12 (.02)	-.04 (.02)	.13 (.02)	.01 (.02)	-.10 (.01)	.24 (.01)	.86	.19
B	-.10 (.64)	.04 (.22)	-.04 (.02)	.03 (.02)				.68	.28
C	1.34 (.09)	-.46 (.02)		.02 (.02)				.67	.28
SERVICES									
(x_s) A	-2.38	.47 (.14)	-.03 (.01)	-.08 (.01)	-.05 (.02)	-.06 (.01)	.02 (.01)	.37	.15
B	-1.87 (.29)	.30 (.01)	-.02 (.01)	-.04 (.01)				.27	.15
C	-1.26 (.04)	.09 (.01)		-.04 (.01)				.26	.15

We next take up the effects of natural resources and trade patterns in the small country group.[1] Rich natural resources have an opposite effect from size on the timing of industrialization. On balance they shift comparative advantage away from industry because the resource cost of earning foreign exchange through primary exports is lower. The interaction between resources and income levels is less predictable but will be subject to empirical test.

There is no single criterion for classifying countries according to resource endowments that is both statistically feasible and theoretically satisfactory. We have therefore divided the small countries into two equal groups on the basis of an index of trade orientation -- toward primary or manufactured exports -- modified in marginal cases by consideration of agricultural resources (arable land per capita) and the existing industrial structure.[2] Thirty of the thirty-five small countries can be classified with little difficulty as resource rich (primary trade oriented) or resource poor (manufactured trade oriented)[3]; the assignment

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[1]Since total trade is a small share of GNP in large countries, trade effects are relatively insignificant and we have not subdivided the L group further.

[2]The index of trade orientation is defined as:

$$T = .07\ (e_m - \hat{e}_m) - .19\ (e_p - \hat{e}_p)$$

where e_p and e_m are the actual and $\hat{e}_p$ and $\hat{e}_m$ the predicted values of primary and manufactured exports for the country's income and size. The weights are the small country regression coefficients for the industrial sector. The regression coefficients of the export equations for small countries are given in the footnote on p. 31.

[3]Bolivia, Greece, Chile, Jamaica and Finland are intermediate cases that show elements of both patterns.

of the remaining five is more arbitrary but has little effect on the statistical results. The two country groups are identified in table A-1 below.

Tables 3 and 4 and figures 2 and 3 show the regression results for the small, primary-oriented (SP), and small industry-oriented (SM) groups. The hypothesis that the regression coefficients are the same is strongly rejected by an analysis of covariance,[1] so we will retain this subdivision of the small countries.

The three development patterns that emerge from this series of experiments provide a substantially different view of the interaction of the main explanatory variables from the pooled regression. The separate regressions have substantially lower standard errors and hence are statistically more satisfactory. More important, they reveal the interaction of the three main factors affecting the growth patterns -- income level, size, and resources -- in a way that is not feasible in a single regression equation.[2]

C. Three Development Patterns

Large Countries. The large country (L) pattern of figure 1 shows industry rising rapidly from 16% of GNP at an income of \$100 to 32% at \$400. Thereafter the increase is much slower and a peak share of 37% is reached at \$1200. Primary production falls steadily and crosses the industry curve at

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[1]The one per cent rejection level for the null hypothesis using equation A is 2.7. The F ratios were: industry (43.5), primary (23.5), services (14.4).

[2]We tried introducing cross-product terms in the regression as an alternative, but they are unsatisfactory because the nature of the interaction is more complex.

TABLE 3 - ESTIMATES OF PRODUCTION PATTERNS: SMALL INDUSTRY ORIENTED COUNTRIES (SM)

Regression Coefficients with Respect to:

Sector and Equation		Intercept (α)	ln y (β_1)	$(\ln y)^2$ (β_2)	ln N (γ)	ln k (δ)	ln ep (ε_1)	ln em (ε_2)	R^2	Standard Error
INDUSTRY (x_m)	A	-7.1628 (.59)	1.7950 (.20)	-.1315 (.02)	.0352 (.02)	-.0599 (.02)	-.0299 (.02)	.1087 (.02)	.844	.15
	B	-5.8017 (.64)	1.1431 (.22)	-.0688 (.02)	.1009 (.02)				.733	.18
	C	-3.5110 (.09)	.3420 (.01)		.0967 (.02)				.718	.19
PRIMARY (x_p)	A	1.1097 (.69)	-.6098 (.23)	.0252 (.02)	.1580 (.03)	.0402 (.02)	.1379 (.03)	-.1406 (.02)	.874	.18
	B	1.0549 (.74)	-.3850 (.26)	-.0097 (.02)	.0377 (.02)				.798	.21
	C	1.3789 (.10)	-.4983 (.02)		.0371 (.02)				.798	.21
SERVICES (x_s)	A	2.4261 (1.14)	-1.1066 (.39)	.0699 (.03)	.2443 (.04)	.0722 (.04)	-.0406 (.05)	-.0421 (.03)	.496	.15
	B	-2.7260 (.51)	.6509 (.18)	-.0497 (.02)	-.0671 (.01)				.237	.15
	C	-1.0692 (.07)	.0715 (.01)		-.0701 (.01)				.201	.15

TABLE 4 - ESTIMATES OF PRODUCTION PATTERNS: SMALL PRIMARY ORIENTED COUNTRIES (SP)

Sector and Equation		Intercept (α)	ln y (β_1)	$(\ln y)^2$ (β_2)	ln N (γ)	ln k (δ)	ln ep (ε_1)	ln em (ε_2)	$\bar{R}^2$	Standard Error
			Regression Coefficients with Respect to:							
INDUSTRY (x_m)	A	1.6875	-1.4666	.1474	-.0305	.1619	-.2406	.0058	.798	.16
		(.84)	(.29)	(.02)	(.02)	(.04)	(.03)	(.01)		
	B	-1.4256	-.4748	.0705	.0259				.716	.20
		(.62)	(.21)	(.02)	(.02)					
	C	-3.7951	.3439		.0569				.697	.20
		(.09)	(.02)		(.02)					
PRIMARY (x_p)	A	-4.6389	1.8371	-.1850	.0238	.2539	.2732	-.0268	.900	.13
		(.68)	(.24)	(.02)	(.02)	(.03)	(.02)	(.01)		
	B	-1.8486	.6374	-.0863	.0066				.684	.22
		(.71)	(.24)	(.02)	(.02)					
	C	1.0528	-.3652		-.0312				.659	.23
		(.11)	(.02)		(.02)					
SERVICES (x_s)	A	1.1088	-.6811	.0469	-.0072	-.2608	.1571	-.0097	.552	.15
		(.80)	(.28)	(.02)	(.02)	(.04)	(.02)	(.01)		
	B	-2.1639	.3910	-.0257	-.0210				.271	.14
		(.45)	(.16)	(.01)	(.02)					
	C	-1.2997	.0924		-.0323				.259	.14
		(.07)	(.01)		(.01)					

a level of $280, where the share of each is 27%.[1] For both sectors the fit is extremely good; less than 10% of the variance in the shares remains unexplained by regression A.[2]

Apart from income and size, only the share of investment (k) is significant for large countries in regression A. Effects of positive and negative deviations in k of one standard deviation are shown in figure 1. The trade variables have negligible effects.

Figure 1 shows that among large countries there are few significant deviants from the average pattern. Nigeria and Korea are appreciably lower than their predicted industrial values and Burma and India significantly higher. In primary production, Burma and the UK are low and Nigeria, Turkey and Canada significantly high. As will be noted below, the time series parallel the cross-section patterns for the large countries to a high degree.

Small, Industry Oriented Countries. As shown in figure 2, the variation of production shares with income in the small, industry oriented (SM) countries is very similar to the large country pattern. Industry equals primary production at about the same income level ($270). The significance of the other variables is quite different, however. Figure 2 shows the effects of variation of one standard deviation in the two export variables, which causes a 20% change in the primary share.[3] The share of investment (k) on the other hand, has a lesser effect in small countries since capital goods are largely imported.

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[1] Mexico and Spain have both passed this point in the predicted income range in the postwar period.

[2] The predicted values are shown for each country in figure 1 as well as the actual variation over the period.

[3] The T+ curve is derived by increasing the value of ep by one standard deviation and decreasing the value of em by one standard deviation. The T- curve has the opposite combination.

The overall fit of the regression equations is almost as good for the SM countries as for the L group. Significant positive deviations from the SM industrial pattern are shown by Portugal and Austria; Finland has the only significant (positive) deviation from the primary pattern.

Small, Primary Oriented Countries. The countries oriented toward primary exports have a development pattern that is notably different from the first two types. Primary production declines much more slowly and exceeds industry up to an income level of nearly $800. The effects of rich natural resources on the productive structure are illustrated in most extreme form by Venezuela, Malaya, and Iraq -- the countries having the highest indices of primary orientation. Variation in the trade patterns has a greater effect on the share of industry in the SP than in the SM group, as is shown by a comparison of the regression coefficients.

Since there are only four countries in this group having incomes above $400 per capita, the shape of the regressions above that level cannot be determined with any confidence. The examples of Australia, Denmark and Sweden (figure 4) suggest that above levels of $1000 primary resources have much less effect on the share of industry and the three patterns converge.[1]

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[1] Canada, which is on the borderline between large and small, also fits the SP regression quite well.

II. VARIATION OVER TIME

This section takes up three questions: (i) the extent to which changes in the productive structure over time are similar to the cross-country pattern; (ii) whether the three groups of countries just identified exhibit significantly different growth patterns; (iii) whether there is any relation between the rate of growth of GNP and the pattern of structural change. We examine first the historical evidence on question one and then analyse all three on the basis of post-war experience.

A. Historical Evidence

The historical studies of Kuznets and others have produced fairly comparable estimates of the productive structure of nine presently advanced countries stretching back to the nineteenth century, when they were in the middle of the present-day income range. The time series for primary production and industry are plotted in figure 4 for comparison to our large-country cross-section patterns.[1]

Temin /18/ has carried out a regression analysis to test the similarity of the time series relations in this group of countries to the cross-section results of Chenery /2/. To avoid having to compare income levels over long periods, he treats the change in share over each twenty-year interval as a separate observation. On this basis he computes an average income elasticity for the share of industry of .32, with no indication of significant period effects up to 1950.[2]

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[1] Our data are taken from Temin /18/with mining shifted to the primary sector and an approximate conversion of income levels to 1960 dollars.

[2] His sample consists of 30 such observations on the 9 countries shown in figure 4. For agriculture, the period by period variation is such that Temin's estimates of the average relation to income change is not statistically significant. A regression for the whole period in each country would give better results.

while his regression only explains 25% of the period by period variation, it does support the hypothesis that the aggregate effects of industrialization over the past century have been comparable to the present-day cross-country variation.

Figure 4 shows considerable similarity in the overall pattern of structural change that has taken place in the advanced countries. The rise of industry has been quite consistent with the cross-country patterns that we have derived for the postwar period. The fall of the primary share has been even more pronounced than the postwar pattern; on the average, movement along the cross-section regression(L) would explain about 80% of the observed decline in these nine countries.[1] This downward shift has persisted into the postwar period, as will be shown below.

B. Intertemporal v. Intercountry Variation in the Postwar Period

We will test the similarity of intertemporal and inter-country patterns for the postwar period in three ways: by the stability of successive annual cross sections over the period 1950-1963, by comparison of time series estimates of income elasticities to the corresponding cross-section estimates, and by the accuracy of forecasts of change based on the cross-section pattern.

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[1] The proportion of the historical decline explainable by the present-day regression in each country is: U.S. (80%), U.K. (66%), France (80%), Germany (74%), Italy (86%), Sweden (86%), Norway (80%), Canada (67%), Japan (86%).

Stability of Annual Cross-Section Patterns. Table 5 gives the coefficients from cross-section regressions at four-year intervals during the period 1950-63. Inspection of the standard errors of the coefficients indicates that the yearly regressions can be pooled in a statistical sense. However, the tendency for the primary production share to decline more rapidly than the cross-section would indicate shows up in the decreases in income elasticities and increases in intercepts of the primary production equations for both large and small countries. This tendency for the cross-section regression to "rotate" clockwise would no doubt prove to be statistically significant, given a longer period of observations.

By contrast, the cross-section regressions for the industrial share show marked stability. The small country elasticity changes by only .01 in the three years shown (and varies but little more in the full 14-year sample). The curvilinear large country equations show non-trending variations of the coefficients well within the ranges of the standard errors. These postwar results for both primary output and industry are consistent with our impressionistic analysis of the historical series.

The Distribution of Time-Series Elasticities. The time series elasticity has been computed for each country by fitting a linear logarithmic regression to the data for 1950-1963.[1]

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[1]The variables in regression A other than income do not have the same meaning for short-run changes that they do for intercountry comparisons. Over a longer period, changes in the trade variables should have some importance, but they are omitted here because they did not prove to be significant for most countries in this short period. The equation used was therefore regression C without the population term.

Table 5

CROSS-SECTION REGRESSIONS FOR SELECTED YEARS

Sample	Year	α	β_1	β_2	γ	R^2	Number of Observations
Small Countries Industry	1952	-3.74	.367		.051	.61	31
		(.33)	(.06)		(.07)		
	1956	-3.71	.365		.047	.61	35
		(.32)	(.05)		(.07)		
	1960	-3.78	.374		.044	.64	33
		(.32)	(.05)		(.07)		
Small Countries Primary	1952	1.11	-.415		.012	.61	31
		(.37)	(.06)		(.08)		
	1956	1.33	-.463		.033	.68	35
		(.34)	(.06)		(.07)		
	1960	1.41	-.486		.058	.72	33
		(.35)	(.06)		(.08)		
Large Countries Industry	1952	-9.51	2.335	-.167	.0965	.88	17
		(1.50)	(.51)	(.04)	(.07)		
	1956	-8.03	1.872	-.129	.072	.88	19
		(1.28)	(.42)	(.04)	(.06)		
	1960	-8.38	2.001	-.140	.079	.90	19
		(1.19)	(.39)	(.03)	(.05)		
Large Countries Primary	1952	1.44	-.475		-.025	.88	17
		(.38)	(.05)		(.07)		
	1956	1.63	-.502		-.042	.90	19
		(.34)	(.04)		(.06)		
	1960	1.76	-.523		-.048	.91	19
		(.36)	(.04)		(.06)		

The resulting regression equation is plotted for each country in figures 1-3 over the actual range of variation of its per capita income. The quartile values of the frequency distribution for each country group are given in table 6.

Although the interquartile range of the time series elasticities is substantial, the median values are quite close to the (linear) cross-section elasticities for all three groups. Consistent with the previous results, there is some tendency for primary production to decline more rapidly than the cross-section would suggest.

We have also investigated the effect of a country's initial position on its postwar growth pattern with essentially negative results. In a few countries such as Israel, South Korea and Pakistan, the subsequent growth pattern was obviously affected by the initial disequilibrium in the productive structure. The result was a tendency for industry and primary production to converge toward the average cross-sectional pattern. Although a number of other examples of this type can be identified in the country charts, this tendency is not born out for the sample as a whole. The majority of countries tend to move parallel to the cross-country pattern, suggesting that long-term differences in comparative advantages and other factors rather than short-term disequilibrium are typically responsible for the initial departures from the predicted values.

<u>Projections from Cross-Section Regressions</u>. A more accurate comparison of cross-section and time-series regressions can be attained by using the former as a basis for dummy projections.

TABLE 6. DISTRIBUTION OF TIME SERIES ELASTICITIES

AND COMPARISON TO CROSS - SECTION*

SAMPLE	LOW ESTIMATE	TWENTY-FIVE PERCENT	MEDIAN	LOG-LINEAR CROSS-SECTION ELASTICITY	SEVENTY-FIVE PERCENT	HIGH ESTIMATE	INTER QUARTILE RANGE
Large Countries							
Industry	-.25	.18	.32	.37	1.10	3.89	1.16
Primary	-2.85	-.77	-.60	-.51	-.44	-.18	.54
Small Industry Oriented Countries							
Industry	-.23	.07	.32	.34	.43	.57	.36
Primary	-1.56	-.83	-.40	-.50	-.11	.48	.74
Small Primary Oriented Countries							
Industry	.12	.26	.34	.34	.83	1.99	.57
Primary	-2.31	-.79	-.55	-.37	-.38	.02	.41

* SOURCES: TIME-SERIES ELASTICITIES ARE COMPUTED FOR THE PERIOD 1950-1963 AS DESCRIBED ABOVE AND ARE SHOWN GRAPHICALLY IN FIGURES 1 - 3. THE CROSS-SECTION ELASTICITIES ARE FROM REGRESSIONS C, TABLES 2-4.

We have made predictions for each sector and country group based on regression B and the observed change in per capita GNP from 1950/52 to 1961/63.[1] The results are given in table 7.

The mean errors for primary production show that the regression predictions underestimate the actual decline in primary output by about 5% on the average, while they underestimate the rise of industry by about the same amount.[2] The second section of the table compares the hypothetical projections to the naive prediction that the share of each sector in GNP will stay the same. The predictions from the pool regression equations show an improvement of 25% in industry and 40% in primary production.

---

[1] The formula for the prediction is:

$$\hat{x}_i^2 = x_i^1 \, (y^2/y^1)^{(\beta_1 + 2\beta_2 \ln \bar{y})}$$

where $\hat{x}_i^2$ is the predicted share of sector i in GNP at the end of the period;

y^j = per capita GNP (three year average) at the beginning ($j = 1$) and end ($j = 2$) of the period;

$\bar{y}$ = mean per capita GNP during the period;

x_i^1 = share of sector i (three year average) at the beginning of the period;

the β_1 and β_2 coefficients are from Regression B.

[2] Since we have not adjusted the regression results to assure additivity, the weighted sum of the errors is not zero.

TABLE 7. ANALYSIS OF PREDICTED AND ACTUAL CHANGES IN SECTOR SHARES*

	MEAN ERRORS			ROOT MEAN SQUARE ERRORS		
SAMPLE	INDUSTRY	PRIMARY	SERVICES	INDUSTRY	PRIMARY	SERVICES
Pool	.0517	-.0474	.0416	.74	.61	.98
Large Countries	.1101	-.0360	.0076	.70	.38	1.07
Small Industry Oriented Countries	-.0352	-.0194	.0292	.73	.70	1.03
Small Primary Oriented Countries	.0785	-.0897	.0928	.87	.74	.91

*SOURCE: REGRESSION EQUATIONS "B" IN TABLES 2-4.

MEAN AND ROOT MEAN SQUARE PREDICTION ERRORS ARE CALCULATED ACROSS THE VARIOUS SUBSAMPLES FROM THE EQUATIONS MEAN ERROR = $\sum_i (R_i - P_i)/S$ AND

RMS ERROR = $\sqrt{\sum_i/(R_i - P_i)^2/\ \sum_i R_i^2}$ WHERE P_i = PREDICTED PERCENTAGE CHANGE IN SECTOR SHARE, R_i = ACTUAL PERCENTAGE CHANGE, i = INDEX COUNTRIES, AND S = SAMPLE SIZE.

C. Growth Rates and Development Patterns

It is often suggested that "balance" between industry and primary production is conducive to rapid growth in less developed countries. While we have been unable to find any reflection of this phenomenon in our study, the analysis of this relationship is of some interest in itself.

Table 8 classifies the 42 countries that may be considered as "less developed"[1] according to their development patterns and the deviation of the proportions of increase in primary production and industry from the "normal" determined by the appropriate regression equation. The rate of growth in GNP for the period 1950-1963 is shown for each country and medians for each category. Over this period, the large countries have grown somewhat faster than the small ones (5.3% vs. 4.6%). Whether the relative rates of growth of primary production and industry are above or below the normal has no apparent effect on the average growth rate.

The nine sub-groups in this classification suggest possibilities for more detailed comparisons. Examples of growth rates of 5.5% or better -- the upper third of the group -- are found in seven of the nine. The largest concentration is in large countries having balanced growth, but there are also eight examples of rapid growth with significant deviations above or below the normal proportion. In sum, balance in this sense is neither necessary nor sufficient for rapid growth over the medium term.

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[1] Countries with an income of less than $600 per capita or an industry share less than 30% in table A-1. Israel is marginal on both criteria.

TABLE 8

Growth Rates and Development Patterns

Deviation from Normal Relative Changes of Primary Output and Industry[1]

Development Patterns	Low Primary		Normal Proportions		High Primary		Total	Median
Large Countries (L)	Philippines	5.4%	Japan	9.1%	Turkey	5.1%		
	Burma	5.4%	Mexico	5.8%	Spain	4.4%		
	Korea	4.6%	Italy	5.8%	India	3.6%	14	(5.3%)
	Pakistan	3.1%	Thailand	5.7%				
	Argentina	2.7%	Brazil	5.5%				
			Nigeria	3.3%				
Small Industry Oriented (SM)	Algeria	7.1%	Taiwan	7.6%	Israel	9.6%		
	Puerto Rico	5.6%	Portugal	4.7%	Jamaica	6.8%		
			Tunisia	3.4%	Greece	6.1%	13	(4.8%)
			Paraguay	3.1%	Peru	4.8%		
					Haiti	1.8%		
					Bolivia	0.6%		
					Uruguay	-0.1%		
Small Primary Oriented (SP)	Costa Rica	5.9%	Iraq	5.9%	Venezuela	6.9%		
	Malaya	4.7%	El Salvador	4.6%				
	Cambodia	6.2%	Ecuador	4.4%				
	Rhodesia	5.2%	Guatemala	4.0%			15	(4.5%)
	Colombia	4.4%	Kenya	2.9%				
	Congo	3.8%						
	Honduras	3.7%						
	Chile	3.4%						
	Ceylon	3.4%						
Total	16		15		11		42	
Median		4.6%		4.6%		4.8%		

[1]The relative change of the ratio of primary to industry value added per capita is given by the ratio

$$\frac{\partial \ln (P/N)/ \partial \ln y}{\partial \ln (M/N)/ \partial \ln y}$$ which indicates a country's

direction of movement in the ln (X_p/N) vs. ln (X_m/N) plane as per capita income increases.

Deviations from the normal relative change are measured by differences of the ratio calculated from time series regressions and the cross-section normal for the same mean per capita income. "High primary" countries are those with a deviation greater than +.15; "normal proportions" are within .15 of the norm; "low primary" have a proportion more than .15 below the norm. Growth rates for each country were calculated by regression on time for the years covered in the sample.

III. CHANGES IN INDUSTRY STRUCTURE

Our explanations of development patterns can be materially improved by disaggregating the industrial sector into its component industries. Since detailed analysis of disaggregated growth patterns will require a separate paper, we merely summarize here results that lend support to the hypotheses presented above.

The differences among the three development patterns are sharpened when individual industries are examined. Although the small primary (SP) pattern shows only 60% as much industry as the large country (L) pattern over the middle income range, the difference is concentrated in sectors that are particularly affected by international trade and comparative advantage. We investigate these differences by computing separate regressions for each of twelve industry groups and each type of country. The aggregate cross-country pattern will thus be broken down into component parts which help to identify the underlying causes of variation.

A. Econometrics

Our econometric procedure is based on the results of the aggregate analysis and follows it in most respects. The main difference is that the dependent variable in the regressions is sectoral value added *per capita*[1] rather than the share in GNP. This substitution has the effect of increasing the proportion of variance explained (relative to the share) and also adds unity to the income elasticities, but it has no effect on significance tests.

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[1] This is the form in which the data are compiled by the U.N. and it permits easier comparison among countries.

The basic data consist of value added by sector of industry for some 50 countries for the period 1950-1963.[1] We have computed regressions A and B and a number of variants for the pooled data and regression B for each year.[2] As with the aggregate data, the year to year variation is not significant; we will discuss only the pooled regressions for the whole period.

Dividing the analysis according to the three country types results in rather small samples for the SM and SP groups. After some experimentation, we omitted the terms in $(\ln y)^2$ and $\ln N$ from regression A in the regressions on which the breakdown of the industry pattern is based.[3] Estimates of regression A for large and small countries and of the modified form for SM and SP are given in table 9.

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[1]The data were taken from unpublished worksheets used for the UN Growth of World Industry, 1953-1965. They include corrections for the difference in coverage of industrial censuses, as described in /19/. The figures after 1958 are derived by applying production indexes to the 1958 base year values. A total of 59 countries had data for at least some industries listed in the U.N. worksheets, but the sample was reduced by the limitation of our trade and income data. Table 9 gives the number of countries included in each subsample.

[2]Variants of the regression results are given in an unpublished annex to the present paper by Armin Claus and Hazel Elkington that is available on request to the Project for Quantitative Research in Economic Development, Center for International Affairs, Harvard University.

[3]The different forms of the regression equation have little effect on the predicted values in the income range $300-900 but diverge at the extremes. The SM sample is lacking in low-income observations, which produces erratic estimates of the sectoral elasticities.

The relation between value added in each sector and the level of per capita income is shown in figure 5 for each country group. Since the trade pattern varies with income level, the predicted values of E_p and E_m have been used in computing the curves.[1] Aside from extreme curvature sometimes induced by the quadratic regression in the small sample SP and SM groups, predicted values from other regression specifications are similar to those shown in figure 5.

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[1]The export regression coefficients by country group are as follows:

Group and Equation	Intercept	ln y	$(\ln y)^2$	ln N
Large				
e_p	8.4950	-2.5946	.1823	-.7741
e_m	-17.8493	3.2452	-.2037	.6342
Small				
e_p	2.7040	-1.3565	.0960	-.0730
e_m	-1.0172	-1.7893	.2084	.5368
SM				
e_p	-.5430	-.2873	.0114	-.3037
e_m	-5.6325	-.1247	.0894	.2823
SP				
e_p	.8591	-3.4032	.2697	-.0461
e_m	1.6297	-2.6360	.2442	.8097

B. Large Country Patterns

The development pattern of large countries is primarily determined by the growth of domestic demand since trade and resource differences are relatively unimportant. This pattern is therefore the simplest to analyse, and it provides a convenient starting point for the subsequent discussion of the effects of scale and resources on the industrialization of small countries.

Since our main objective is to determine the contribution of each industry to the overall growth pattern, we classify sectors according to the stage at which they make their main contribution to the rise of industry. The shape of the L curves in figure 5 permits us to describe industries as "early", "middle" or "late". The components of each group are identified in figure 5.

Early Industries. The early industries are those which (i) supply essential demands of the poorest countries, (ii) can be carried on with simple technology, and (iii) increase their share of GNP relatively little above income levels of $200 or so. They consist of food, leather goods, and textiles, whose growth patterns are shown in figures 5a-5c. These industries have income elasticities of domestic demand of 1.0 or less[1] and exhaust their potentials for import substitution and export growth at fairly low income levels. The group as a whole maintains a fairly constant share of GNP; it declines from 56% to 23% of manufacturing as per capita income rises from $100 to $1000.

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[1]Income elasticities of demand estimated from both inter-country data and budget studies are summarized in Maizels /13/ and Chenery /5/.

Maizels shows a similar decline for this group in Western Europe from 1901 to 1959 from 47% to 20% of manufacturing.[1] In both food and textiles the decline is a little more pronounced than that implied by the present cross-country relations, since the earlier levels are somewhat above the cross-section prediction.

Middle Industries. We define the middle industries as those which double their share of GNP in the lower income levels but show relatively little rise above income levels of $400-$500. These characteristics are shown in figures 5d-5g by non-metallic minerals, rubber products, wood products, and chemicals and petroleum refining. This group of industries accounts for 40% of the increase in the industrial share in large countries from $100 to $400 but contributes considerably less thereafter.

The finished goods produced by these industries (roughly half their output) typically have income elasticities of 1.2-1.5. The early rise of this group is due to a considerable extent to import substitution, which is exhausted at fairly low income levels.

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[1] Maizels' calculations /13, p. 46/ of the share of manufacturing in Western European countries (including the U.K.) are:

	1901	1929	1959
Food, etc. (20-22)	27%	16%	13%
Textiles (23)	20	13	7
	47	29	20

The inclusion of leather products (29) would add 1-2% to these totals.

The share of the middle group in total manufacturing does not vary much above the level of $200 per capita. This relative constancy is also shown in Western Europe since 1900 apart from the chemical industry, which increased its share quite substantially.[1]

<u>Late Industries</u>. The late industries are those that continue to grow faster than GNP up to the highest income levels; they typically double their share of GNP in the later stages of industrialization (above $300). This group includes clothing, printing, basic metals, paper, and metal products. Taking an income of $300 as the half-way mark in the process of industrialization, the late industries account for 80% of the subsequent increase in the share of industry in large countries.[2]

This group includes consumer goods with high income elasticities -- durables, clothing, printing -- as well as investment goods and the principal intermediate products used to produce them.[3] The twentieth century increase in metal products in the advanced countries has been even more rapid than the cross-section pattern would suggest, reflecting the effects of technological advance.[4]

---

[1] Maizels estimates a time-series elasticity of 2.44 in Western Europe for chemicals over this period in comparison to our 1.45 for the cross-section pool. As a result of the rise of chemicals, the middle group increased its share of manufacturing from 17% to 27% between 1901-1959; the cross-section would predict a fairly constant 27%.

[2] The twelve sectors covered here increase from 20% to 30% of GNP between $300 and $1000; the late industries rise from 8% to 16% over the same interval.

[3] A disaggregation of the chemical industries would put a large portion of its products in this group as well.

[4] Maizels' time-series income elasticity is 1.96 compared to our cross-section pool value of 1.75.

<u>The Overall Pattern</u>. The combined effect of the variation in these three groups of industries is shown in figure 6a. Their total is quite consistent with the pattern for industry as a whole, which includes construction. The decline in the share of all industry at income levels above $1200 also shows up in many individual sectors, although the small number of countries above this level makes extrapolation hazardous.[1]

Although the overall development pattern for large countries is influenced to some extent by the change in the composition of trade,[2] the predominant elements underlying the large country pattern are the changing composition of domestic final demand and its repercussions on other industries. Technological change has been an important factor in the rise of chemicals and metal products; its overall effect on change over time has been to accentuate the cross-section patterns.

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[1] Since our analysis is conducted in current prices, the decline of industry reflects in part the rise in the price of services compared to manufactured goods, which may not be so pronounced in other countries as it has been in the United States. See Balassa /1/.

[2] Primary exports decline from 9% to 3% of GNP in large countries as income levels increase from $100 to $1000, while manufactured exports increase from 1% to 6%. These changes are incorporated in figure 5.

C. Effects of Scale and Resources

We can determine the effects of scale and resources on growth patterns by comparing the regression results for the two groups of small countries to those just described for large countries. It was previously noted that the groups of large countries and small primary oriented countries constitute two extremes with the small industry-oriented group resembling the large countries more closely in the aggregate. A similar comparison will be made for each sector, with the difference between SP and SM being attributed to resources alone and the difference between SM and L to scale effects.

Scale Effects. The size of the market affects the choice between domestic production and imports in industries having significant economies of scale. A given level of demand will be reached at a higher level of per capita income in a small country than in a large one, which postpones the time at which the cost of domestic production falls to the cost of imports. Smaller market size should therefore have the effect of shifting the regression curves to the right in figure 5.

Direct evidence on scale economies suggests that they should be important in basic metals, chemicals and petroleum, paper, and some types of metal fabricating (e.g. automobiles).[1] Aggregation to the two-digit level combines subsectors with varying degrees of scale economies, however, and only in "basic metals" can it be said that scale economies are important in all its major branches.

We measure "pure" scale effects by comparing the SM curve in each sector to the L curve.[2] The difference between the two

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[1] See Haldi and Whitcomb /7/.

[2] We have chosen this procedure in order to make scale and resource effects additive, but the full effect of scale is more properly shown by comparison to regressions for all small countries.

curves can be described by the delay of the SM country in reaching a given point on the L curve or by the vertical displacement of the SM curve. This difference constitutes a generalized size effect for the whole economy, since it includes repercussions on supplying industries of economies of scale in the sectors using their products.

The most pronounced scale effects are shown by basic metals, printing, rubber products, chemicals, textiles, and non-metallic minerals. The difference usually amounts to a delay of more than $300 or a reduction in value of 25% or more in the middle income range.[1] If we calculate the full scale effect from the regressions for all small countries, it amounts to a reduction from the L curves of 50% or more in all these sectors.[2]

Resource Effects. The availability of natural resources to support relatively high primary exports increases the supply of foreign exchange for imports. There is a movement up the scale of comparative advantage in each sector of industry and a corresponding reduction in the proportion of supply that it is economical to produce domestically. Since the primary-oriented countries are those which have relatively more primary exports and less industrial exports for their level of income, a comparison of the SP to the SM curves should bring out the relative importance of natural resource endowments to each sector.

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[1]The slope of the SM curve varies somewhat according to the variables included in the regression equation, but the average level in the middle income range is not affected.

[2]An alternative measure used in previous studies / 2,19/ is the scale coefficient in the pool regressions of table 9. While this indicator shows scale economies in the same sectors, it is less accurate because it does not take into account the greater curvature of the large country curves.

We find that over most of the income range, the SP curve is below the SM curve in almost all sectors. The resource effect is most pronounced in basic metals, paper, rubber, chemicals, textiles, wood products, and metal products, where the SP value in the middle income levels ranges from 30% - 50% of the SM value.[1] Only in food processing is the difference insignificant.

The total effects of resource differences are brought out by the differences between the aggregate curves for the SP and SM countries in figure 6. For the early and middle industries, the differences decrease as income rises, but there is no evidence of this tendency in the late industry group. Since so few high-income countries - Venezuela, Denmark, Australia, and Canada - qualify as primary-oriented, it is a matter of speculation whether the effects of primary exports will ultimately diminish in the late industries as well.

Combined Effects. Taken separately (small vs. large, SP vs. SM), the effects of scale and resources are comparable in magnitude and tend to affect the same sectors. In the SM countries, scale and resources work in opposite directions. The effects of small scale tend to predominate at low income levels, but at high incomes the shift to manufactured exports causes the SM curve to rise above the L curve in many industries.

In the SP countries scale and resource effects work together to lower the share of industry. The convergence of the SP curves toward the other two is slow and the pattern above $1,000 is uncertain. While industrialization ultimately takes place in most sectors, in some industries it may be postponed indefinitely as classical trade theory predicts.

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[1] The regression coefficients in the pooled regression are less useful as measures of resource effects because of the collinearity between size and exports.

TABLE 9. REGRESSIONS FOR SECTORAL LEVELS OF VALUE ADDED PER CAPITA[1/]

Country Group and Sector	Regression Coefficients with Respect to: Intercept (α)	ln y (β_1)	$(\ln y)^2$ (β_2)	ln N (γ)	ln ep (ε_1)	ln em (ε_2)	R^2	SE	No. of Observations	No. of Countries
Large Countries										
20-22	-1.876	0.616	0.036	-0.165	-0.033	-0.026	.8508	.4901	213	18
	(-1.55)	(1.71)	(1.25)	(-2.60)	(-0.59)	(-0.76)				
23	-7.824	2.250	-0.122	-0.215	-0.695	0.099	.8239	.6748	209	17
	(-4.65)	(4.47)	(-3.62)	(-2.44)	(-8.81)	(2.05)				
24	-10.679	2.787	-0.124	-0.514	-0.764	0.089	.7236	1.010	172	14
	(-2.49)	(2.24)	(-1.28)	(-3.40)	(-6.13)	(1.01)				
25-26	2.276	-1.056	0.159	-0.348	-1.082	0.255	.7242	1.076	178	14
	(0.77)	(-1.22)	(2.33)	(-4.01)	(-7.67)	(2.62)				
27	-13.038	3.196	-0.133	-0.001	-0.066	0.177	.8887	.6504	186	15
	(-5.71)	(4.78)	(-2.51)	(-0.01)	(-0.75)	(3.76)				
28	-17.214	4.524	-0.254	-0.155	-0.430	0.003	.8514	.6472	132	11
	(-5.91)	(5.28)	(-3.78)	(-1.45)	(-4.28)	(0.05)				
29	-4.493	0.578	0.017	-0.158	-0.363	0.082	.4478	1.2166	156	13
	(-1.00)	(0.44)	(0.17)	(-0.99)	(-2.82)	(0.78)				
30	-18.825	4.943	-0.298	-0.261	-0.400	-0.150	.8827	.6318	170	14
	(-11.05)	(9.87)	(-7.44)	(-2.83)	(-4.40)	(-2.71)				
31-32	-10.334	3.021	-0.144	-0.016	0.160	0.194	.9478	.4169	76	15
	(-9.38)	(9.31)	(-5.54)	(-0.28)	(-2.59)	(5.32)				
33	-18.432	5.203	-0.397	0.152	-0.184	0.091	.9930	.4454	196	16
	(-16.57)	(15.71)	(-6.42)	(2.46)	(-3.08)	(2.87)				
34	-24.901	6.463	-0.397	0.565	-0.155	0.009	.8806	.6960	170	14
	(-9.22)	(8.19)	(-6.42)	(5.24)	(-1.71)	(0.17)				
35-38	-15.924	4.135	-0.203	0.532	0.068	0.167	.8731	.6741	173	14
	(-5.57)	(4.97)	(-3.12)	(5.28)	(0.82)	(2.80)				

1/ t-ratios for regression coefficients are given in parentheses

TABLE 9 (continued)

Country Group and Sector	Intercept (α)	ln y (β_1)	$(\ln y)^2$ (β_2)	ln N (γ)	ln ep (ε_1)	ln em (ε_2)	R^2	SE	No. of Observations	No. of Countries
Small Countries										
20-22	-0.572	0.385	0.048	-0.208	-0.043	0.106	.8614	.3468	248	21
	(-0.30)	(0.59)	(0.90)	(-4.91)	(-1.11)	(5.75)				
23	-5.841	1.412	-0.038	0.265	0.365	0.166	.7377	.6021	240	20
	(-1.68)	(1.19)	(-0.40)	(3.88)	(-4.73)	(4.82)				
24	-17.496	5.532	-0.358	-0.237	-0.039	0.139	.7206	.6678	230	19
	(-4.23)	(3.95)	(-3.12)	(-2.59)	(-0.46)	(3.58)				
25-26	-20.926	6.960	-0.474	-0.302	0.156	0.354	.6440	.7523	191	16
	(-3.27)	(3.23)	(-2.69)	(-2.39)	(1.79)	(6.29)				
27	-16.826	4.548	-0.221	-0.325	-0.161	0.614	.8869	.6871	202	17
	(-3.71)	(2.97)	(-1.77)	(-3.21)	(-1.76)	(14.49)				
28	6.826	-2.740	0.345	-0.271	0.265	0.323	.9417	.3408	144	13
	(2.69)	(-3.16)	(4.83)	(-0.33)	(4.08)	(13.60)				
29	-15.718	4.521	-0.292	-0.665	-0.407	0.209	.7395	.6404	219	19
	(-3.85)	(3.28)	(-2.60)	(-8.26)	(-4.72)	(5.10)				
30	-27.718	8.585	-0.593	-0.039	0.431	0.400	.7216	.7679	192	17
	(-5.33)	(5.00)	(-4.25)	(-0.33)	(4.63)	(8.15)				
31-32	4.561	-2.426	0.317	0.225	-0.197	0.218	.8285	.6550	235	20
	(1.19)	(-1.89)	(3.02)	(2.69)	(-2.62)	(5.83)				
33	1.230	-1.259	0.211	-0.058	-0.262	0.161	.8661	.4825	246	21
	(0.45)	(-1.38)	(2.82)	(-0.97)	(-4.87)	(6.23)				
34	28.083	-10.199	0.911	0.271	-0.979	0.517	.7433	.7380	165	14
	(4.70)	(-5.25)	(5.85)	(1.99)	(-9.77)	(8.30)				
35-38	13.039	-4.760	0.516	-0.449	-0.439	0.314	.8598	.3815	184	16
	(3.20)	(-3.48)	(4.64)	(-4.66)	(-5.58)	(8.42)				

TABLE 9 (continued)

Country Group and Sector	Regression Coefficients with Respect to: Intercept (α)	ln y (β_1)	$(\ln y)^2$ (β_2)	ln N (γ)	ln ep (ε_1)	ln em (ε_2)	R^2	SE	No. of Observations	No. of Countries
SM Countries 2/										
20-22	-.643	.689			-.096	.281	.8488	.2487	120	10
	(-2.13)	(16.71)			(-2.24)	(9.66)				
23	-1.45	.549			-.602	.348	.8296	.3642	120	10
	(-3.29)	(9.12)			(-9.59)	(8.17)				
24	-3.516	.898			-.131	.020	.5363	.5929	110	9
	(-4.28)	(8.17)			(-1.26)	((.28)				
25-26	-2.092	.757			-.098	.246	.4572	.7581	105	9
	(-2.00)	(5.39)			(-.74)	(2.76)				
27	-7.576	1.703			.203	.447	.8606	.6072	110	9
	(-9.00)	(15.11)			(1.92)	(6.12)				
28	-5.822	1.461			.370	.388	.9694	.2355	64	6
	(-13.56)	(26.13)			(5.32)	(9.03)				
29	-2.577	.398			-.439	.246	.3826	.7238	115	10
	(-2.83)	(3.23)			(-3.48)	(2.90)				
30	-10.520	1.516			-.033	-.766	.7563	.4640	92	8
	(-12.40)	(14.92)			(-.39)	(-5.71)				
31-32	-4.463	1.110			-.247	.191	.9327	.2685	107	9
	(-9.41)	(19.22)			(-5.27)	(2.88)				
33	-6.296	1.177			-.575	.240	.9039	.3725	121	10
	(-13.91)	(19.14)			(-8.97)	(5.51)				
34	-2.477	.817			-.593	.942	.9170	.4238	98	8
	(-3.41)	(8.70)			(-7.60)	(17.92)				
35-38	-8.237	1.78			-.367	.259	.9115	.4188	105	9
	(-13.06)	(21.28)			(-5.00)	(5.10)				

2/ Only Sectors 28 and 35-38 pool.

TABLE 9 (continued)

Country Group and Sector	Regression Coefficients with Respect to: Intercept (α)	ln y (β_1)	$(\ln y)^2$ (β_2)	ln N (γ)	ln ep (ε_1)	ln em (ε_2)	R^2	SE	No. of Observations	No. of Countries
SP Countries [2/]										
20-22	-3.284	1.034			-.049	.039	.8220	.4080	128	11
	(-9.99)	(22.86)			(-.74)	(1.46)				
23	-4.41	1.08			.12	.08	.6958	.6352	120	10
	(-7.57)	(15.10)			(1.04)	(1.81)				
24	-6.028	1.333			.06	.08	.7524	.6719	120	10
	(-9.78)	(17.56)			(.44)	(1.61)				
25-26	-6.275	1.600			.636	.299	.9311	.3560	86	7
	(-16.05)	(28.12)			(9.99)	(10.31)				
27	-10.686	1.941			-.145	.454	.9204	.5490	92	8
	(-19.14)	(28.37)			(-1.23)	(10.40)				
28	-5.812	1.440			.454	.312	.9005	.4423	80	7
	(-11.82)	(23.86)			(4.64)	(18.12)				
29	-9.272	1.282			-.584	.011	.7776	.6137	104	9
	(-11.20)	(14.35)			(-4.46)	(.167)				
30	-5.500	1.395			.836	.440	.7408	.8259	100	9
	(-7.70)	(13.88)			(5.64)	(7.47)				
31-32	-7.214	1.630			.292	.159	.7824	.7452	128	11
	(-12.01)	(19.71)			(2.42)	(3.29)				
33	-5.907	1.322			.149	.156	.8484	.4900	125	11
	(-14.93)	(24.17)			(1.88)	(4.84)				
34	-8.528	1.474			-1.935	1.034	.6953	1.0380	67	6
	(-8.44)	(8.83)			(-8.19)	(6.50)				
35-38	-6.338	1.630			-.091	.407	.7693	.8369	79	7
	(-6.56)	(14.32)			(-.43)	(5.66)				

2/ Only Sectors 28 and 35-38 pool.

TABLE 9 (continued)

Country Group and Sector	Regression Coefficients with Respect to: Intercept (α)	ln y (β_1)	$(\ln y)^2$ (β_2)	ln N (γ)	ln ep (ε_1)	ln em (ε_2)	R^2	SE	No. of Observations	No. of Countries
Small Countries Pool										
20-22	-2.609 (-11.01)	.954 (29.80)			-.039 (-1.02)	.087 (4.66)	.8391	.3617	248	
23	-3.877 (-8.90)	.936 (16.87)			-.373 (-5.27)	.186 (5.55)	.7197	.6185	240	
24	-5.470 (-10.96)	1.188 (18.67)			-.177 (-2.30)	.081 (2.18)	.7016	.6759	230	
25-26	-5.373 (-8.70)	1.305 (15.33)			.065 (.76)	.265 (5.63)	.6493	.7821	191	
27	-9.457 (-17.60)	1.835 (26.89)			-.208 (-2.48)	.559 (13.89)	.8798	.6933	202	
28	-5.883 (-17.35)	1.467 (35.71)			.424 (6.83)	.346 (14.21)	.9317	.3666	144	
29	-5.803 (-9.13)	.855 (11.15)			-.487 (-5.47)	.171 (3.67)	.6365	.7316	219	
30	-26.673 (-4.78)	7.328 (4.00)			-.484 (-3.26)	.239 (2.02)	.6124	.8731	192	
31-32	-6.231 (-13.95)	1.427 (23.99)			-.117 (-1.58)	.251	.8076	.6724	235	
33	-6.373 (-20.35)	1.301 (30.76)			-.213 (-4.25)	.166 (6.69)	.8618	.4776	246	
34	-5.963 (-8.36)	1.208 (12.01)			-.846 (-7.54)	.705 (10.23)	.7058	.8978	165	
35-38	-7.178 (-13.48)	1.669 (24.93)			-.318 (-4.00)	.353 (9.14)	.8453	.6323	184	

IV. CONCLUSIONS

This paper tests the "patterns approach" to development analysis by comparing postwar changes in the composition of national product to the inter-country patterns. We have also tried to determine the effects of specialization and international trade on output levels.

Our principal results are as follows:

1. Three distinct development patterns have been identified from intercountry analysis: large countries, small primary-oriented countries, small industry-oriented countries. The variation of production levels with income and trade patterns is best described by separate regression equations for each group because scale and resource endowments interact differently in each.

2. Time series analyses of growth paths support the underlying hypothesis that universal factors affecting all countries are reflected in the intercountry patterns.[1] Although individual country differences cause substantial variation, the central tendencies of the time series estimates are close to the corresponding cross-section estimates in all cases.

3. The preceding conclusions are supported by the regression results from individual industries. The effects of scale and resources show up strongly in the cross-section patterns for the sectors where they can be expected to be significant.

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[1] Steuer and Voivodas /15/ made a comparison of time-series to cross-section estimates of import substitution that did not support this interpretation. The probable causes of the difference between our conclusions and theirs are the fact that they analyzed the change in the ratio of imports to total supply rather than production levels alone and considered a very short time period (5-7 years) in which cyclical factors are likely to outweigh long-term trends.

4. The combination of time-series and cross-section analysis provides a useful basis for determining the significance of technological change and other sources of variation over time. Our preliminary findings indicate several sectors -- primary production, chemicals, metal products -- in which technological change reinforces the cross-section pattern and produces a more pronounced rise (or fall) in the share of the sector over time.

5. The integration of time series and cross-section analysis should improve the empirical basis of development theory as it has in fields such as savings, consumption, and investment.

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Table A-1

BASIC DATA FOR AGGREGATE ANALYSIS[1]

Country	Country Classifications	Number of Observations		Per Capita GNP (1)	Population (Millions)(1)	Percentage Share of GNP				
						Industry(2)	Investment(3)	Primary Production (2)	Manufacturers' Exports(4)	Primary Exports(4)
		A	B	(y)	(N)	(M)	(I)	(P)	(E_m)	(E_p)
1. Nigeria	L	13	13	57.5	48.9	7.3	9.9	66.3	0.7	14.1
2. Burma	L	14	14	59.1	20.3	14.1	14.7	36.6	0.5	16.5
3. Pakistan (7)	L	14	13	67.5	94.0	10.6	18.4	54.7	1.5	8.3
4. Haiti	SM	11	11	70.7	3.7	13.1	7.0	49.9	1.0	12.9
5. India	L	13	13	73.5	397.3	17.5	14.3	50.6	3.0	2.6
6. Kenya	SP	14		74.8	7.4	12.8		44.4		
7. Cambodia	SM	13		86.3	5.1	10.6		50.6		
8. Thailand	L	13	13	87.6	24.3	15.6	15.4	41.0	0.4	19.7

Table A-1 Continued

		A	B	(y)	(N)	(M)	(I)	(P)	(E_m)	(E_p)
9. Congo	SP	10	10	92.4	12.5	13.1	26.3	51.4	0.8	32.9
10. Bolivia	SM	14	12	120.2	3.3	14.4		45.3	2.0	15.3
11. Taiwan	SM	13		125.8	9.6	22.8		34.3		
12. South Korea	L	11	11	128.0	23.5	13.5	11.5	39.4	0.8	2.9
13. Ceylon	SP	14	14	131.4	9.1	11.2	15.4	50.7	0.8	33.8
14. Rhodesia	SM	10	10	138.0	9.3	16.9	26.3	42.8	3.0	14.8
15. Brazil	L	11	11	155.8	60.4	21.3		30.7	0.9	7.5
16. Paraguay	SM	14	10	156.6	1.6	19.5	15.5	37.9	3.5	12.0
17. Ecuador	SP	14	14	164.8	3.9	18.9	15.3	39.9	0.6	16.0
18. Tunisia	SM	14	13	177.2	4.0	17.9	15.3	25.6	0.6	11.4
19. Peru	SM	14	12	182.2	9.4	21.6	23.1	29.7	0.7	13.0
20. Turkey	L	14	14	187.5	25.3	19.6	13.2	45.5	0.3	6.5
21. Philippines	L	14	14	190.7	24.9	18.6	8.0	39.5	1.0	14.9
22. El Salvador	SP	13	13	191.2	12.3	13.1	11.2	37.6	0.9	19.7
23. Iraq	SP	11	11	201.5	6.4	12.9	18.9	55.6	0.6	45.0
24. Honduras	SP	13	11	202.0	1.6	16.4	14.4	47.0	1.0	18.4
25. Algeria	SM	11		244.4	9.7	18.0		29.5		
26. Portugal	SM	14	14	239.8	8.7	35.6	15.3	29.2	11.4	8.3

Table A-1 Continued

			A	B	(Y)	(N)	(M)	(I)	(P)	(E_m)	(E_p)
27.	Guatemala	SM	14	14	257.3	3.4	15.4	11.3	31.0	1.2	10.4
28.	Colombia	SP	14	14	258.7	13.1	19.7	19.9	39.8	2.7	12.7
29.	Malaya	SP	8	8	267.8	6.6	11.7	13.2	44.6	1.4	39.2
30.	Mexico (6)	L	14	14	316.9	31.7	25.3	14.5	25.8	3.8	7.4
31	Costa Rica	SP	13	11	326.9	1.0	15.6	17.4	38.3	0.7	18.9
32.	Jamaica	SP	14	14	329.2	1.5	25.4	20.8	20.5	3.6	26.6
33.	Japan (8)	L	14	13	344.0	89.9	31.8	26.4	21.7	10.6	1.4
34.	Greece	SM	14	14	344.4	8.1	21.9	16.7	32.7	1.0	7.8
35.	Spain (9)	L	10	10	349.4	29.9	28.8	19.5	27.6	3.3	5.2
36.	Uruguay	SM	9		442.5	2.8	25.6		20.9		
37.	Argentina	L	14	14	547.1	19.4	35.4	19.7	19.0	0.8	10.3
38.	Italy	L	14	13	550.9	48.6	35.7	20.4	21.5	10.2	2.7
39.	Chile	SM	14	14	557.0	7.1	20.9	10.5	17.9	5.7	6.1
40.	Israel	SM	12	12	602.9	2.0	30.7	27.8	12.0	7.9	5.5
41.	Puerto Rico	SM	14		677.6	2.3	26.2		15.8		
42.	Austria	SM	14	12	732.6	7.0	46.4	21.1	14.9	14.8	4.8
43.	Netherlands	SM	12	11	846.5	10.8	36.9	22.3	14.0	26.5	15.6
44.	Venezuela (6)	SP	14	14	847.7	6.5	18.1	27.4	36.9	3.5	32.2
45.	Finland (5)	SM	14	10	891.3	4.3	39.3	27.0	22.5	12.3	12.3

	A	B	(Y)	(N)	(M)	(I)	(P)	(E_m)	(E_p)
[illegible]. West Germany	L 14	14	1057.2	53.5	45.4	21.9	13.4	15.8	7.4
47. Denmark	SP 14	13	1168.3	4.5	36.1	17.3	15.7	9.9	20.1
48. Belgium	SM 14	14	1175.1	9.0	34.7	17.7	10.5	25.3	3.4
49. France	L 14	14	1179.3	44.3	43.3	17.8	12.0	11.4	2.6
50. Norway	SM 14	14	1184.2	3.5	33.8	30.3	13.4	21.7	15.2
51. United Kingdom	L 14	14	1259.9	51.8	41.2	14.2	7.6	18.5	1.4
52. Australia(5)	SP 14	12	1458.8	9.5	35.7	24.7	18.6	0.9	12.6
53. Canada	L 14	14	2046.3	16.4	32.7	23.2	11.7	9.2	10.0
54. United States	L 14	14	2710.1	170.4	33.5	16.8	7.8	3.2	1.2

FOOTNOTES:

(1) Population and per capita income in $U.S.1960 from U.N.Stat.Office, Gross Domestic Expenditures (mimeo.), Table 1.

(2) Share of major sectors in GDP from U.N.Stat.Office, Gross Domestic Product by Industrial Origin (mimeo.), Table 2, unless otherwise specified.

(3) Investment data from U.N.Stat.Office, Gross Domestic Expenditures (mimeo.), Table 1. Gross Fixed Capital Formation in $U.S.1960 except for Algeria, Brazil, India, Tunisia, where Gross Capital Formation was used.

(4) Export data from U.N.Yearbook of International Trade Statistics, various years. Primary exports defined as food (0), unmanufactured tobacco leaf (121), inedible (2), synthetic fabrics (266), crude oil or partly refined (331), natural gas (341.1), oils and fats (4), wild animals (941).

(5) Sectoral data from country sources through U.N.

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(9) Sector shares in GDP in $U.S.1960 from U.N.Yearbook of National Accounts Statistics, 1965.

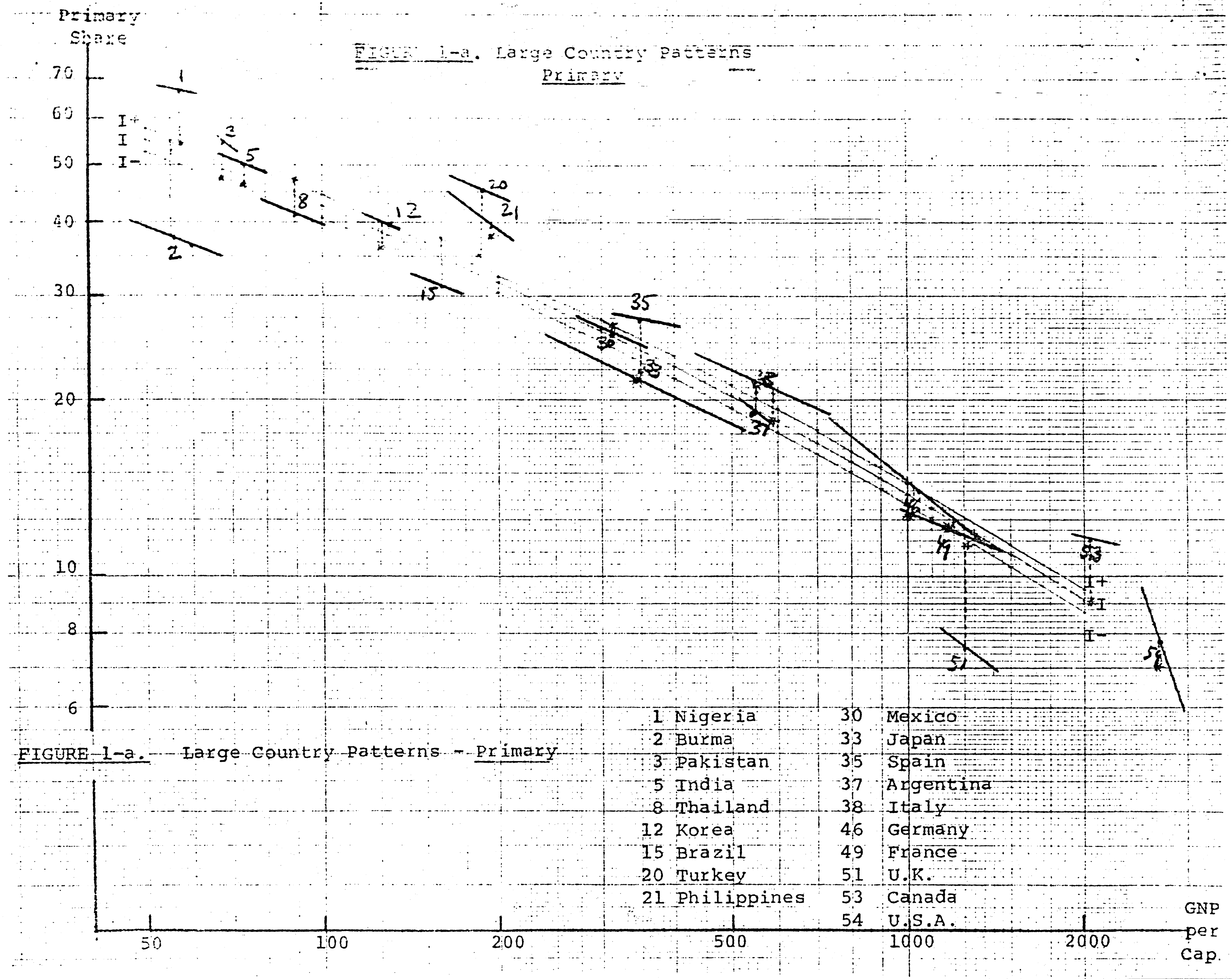


FIGURE 1-a. Large Country Patterns - Primary

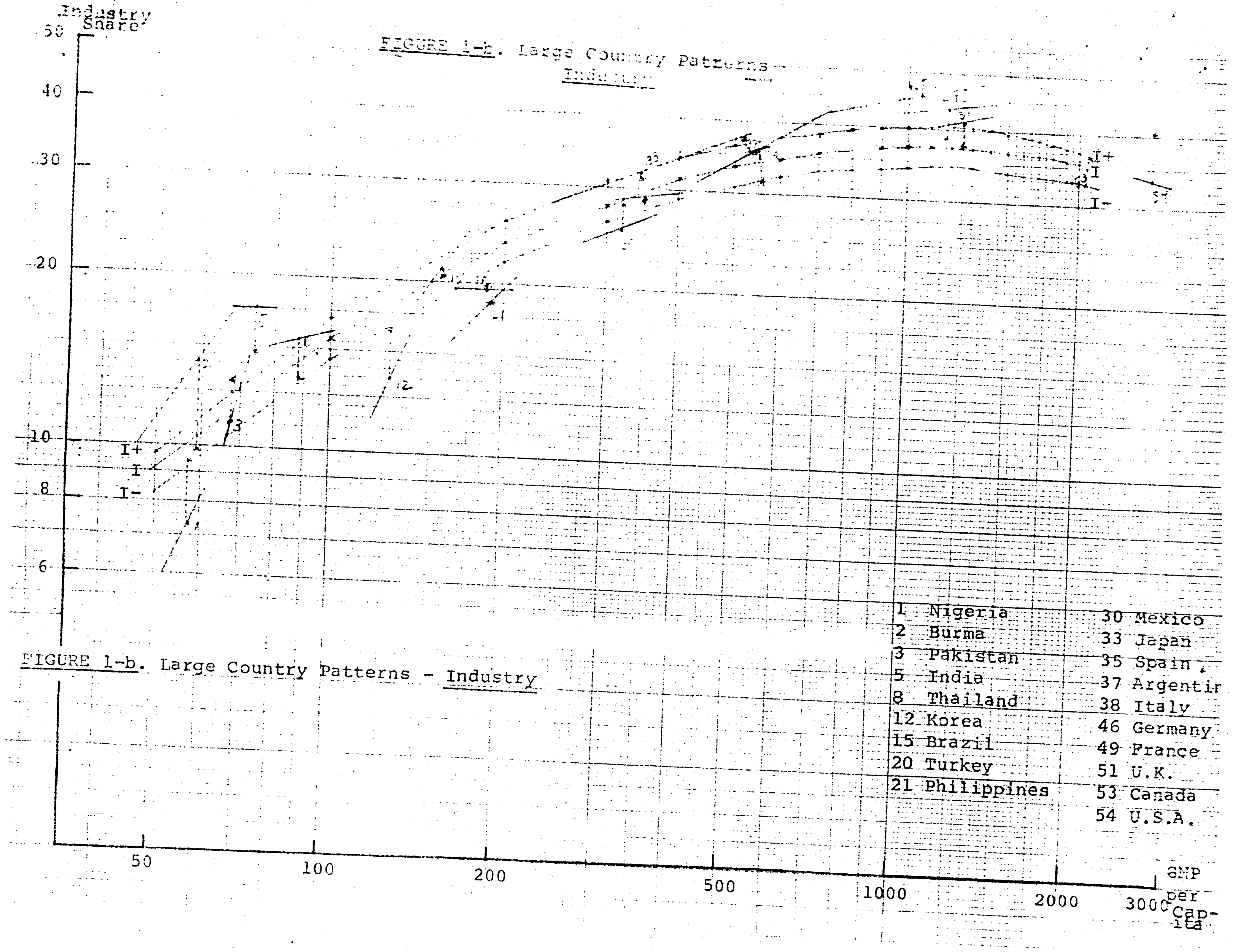


FIGURE 1-b. Large Country Patterns - Industry

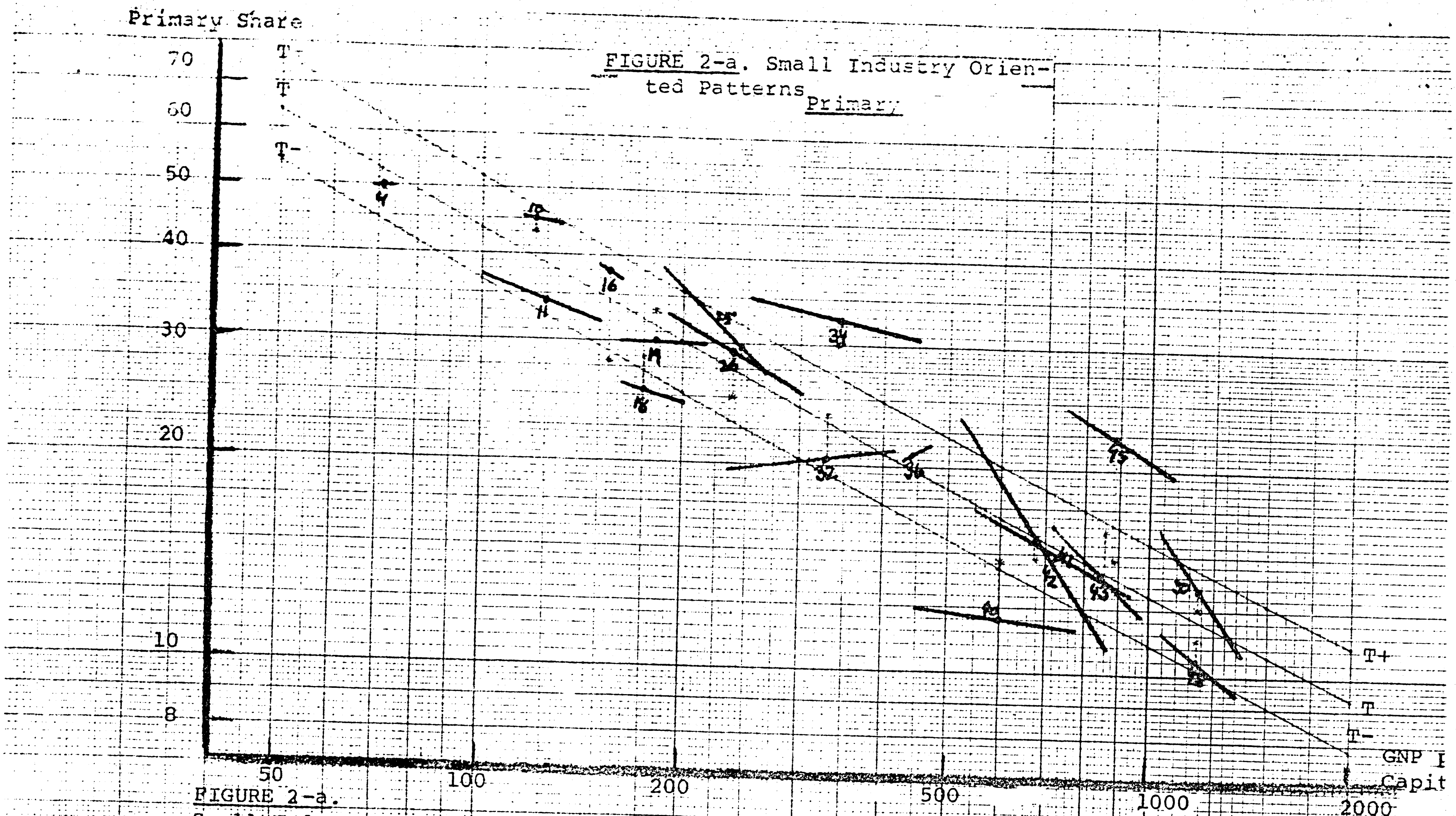


FIGURE 2-a.
Small Industry Oriented Patterns - Primary

4 Haiti	25 Algeria	41 Puerto Rico
10 Bolivia	26 Portugal	42 Austria
11 Taiwan	32 Jamaica	43 Netherlands
16 Paraguay	34 Greece	45 Finland
18 Tunisia	36 Uruguay	48 Belgium
19 Peru	40 Israel	50 Norway

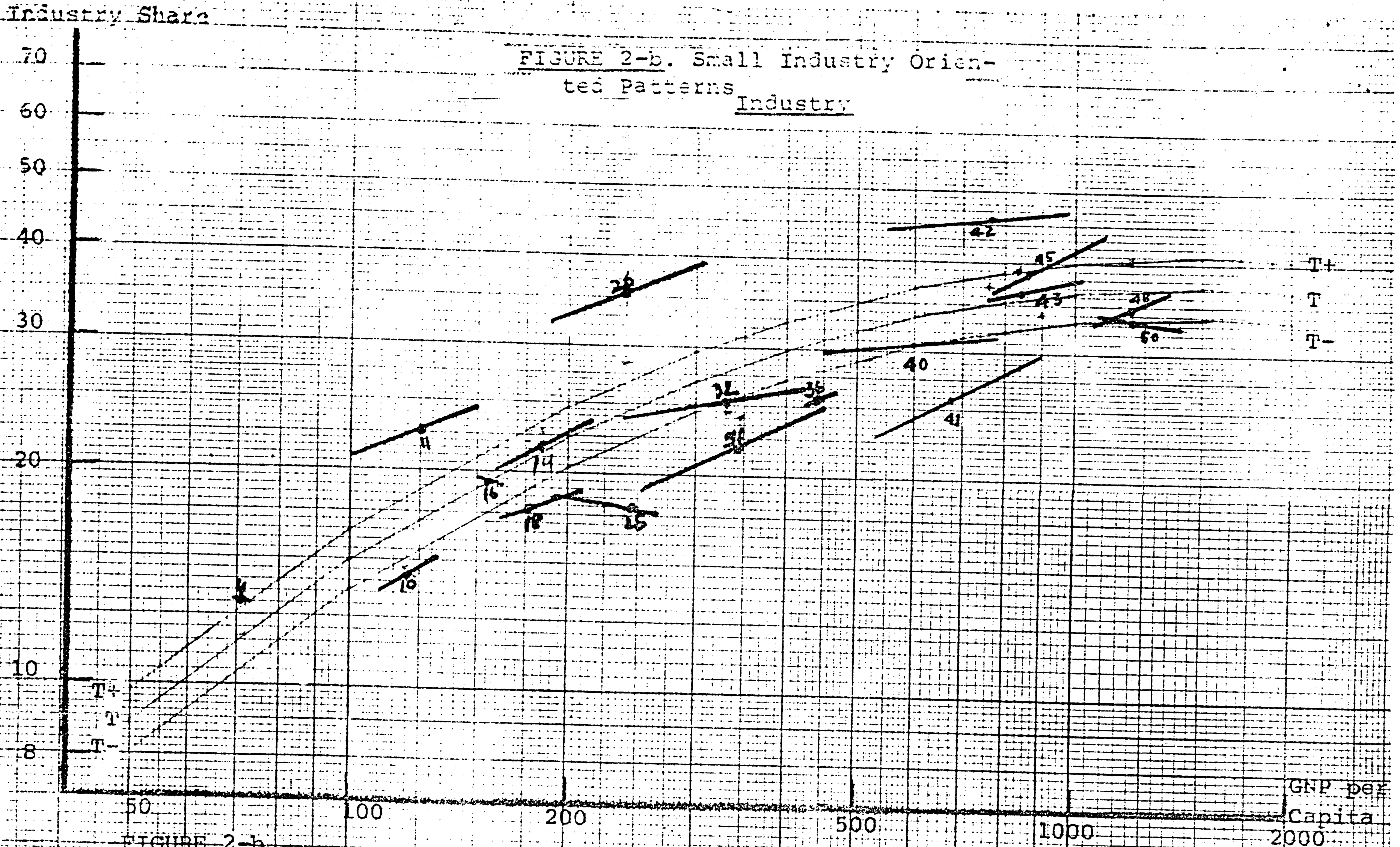


FIGURE 2-b

Small Industry Oriented Patterns - Industry

4 Haiti	25 Algeria	41 Puerto Rico
10 Bolivia	26 Portugal	42 Austria
11 Taiwan	32 Jamaica	43 Netherlands
16 Paraguay	34 Greece	45 Finland
18 Tunisia	36 Uruguay	48 Belgium
19 Peru	40 Israel	50 Norway

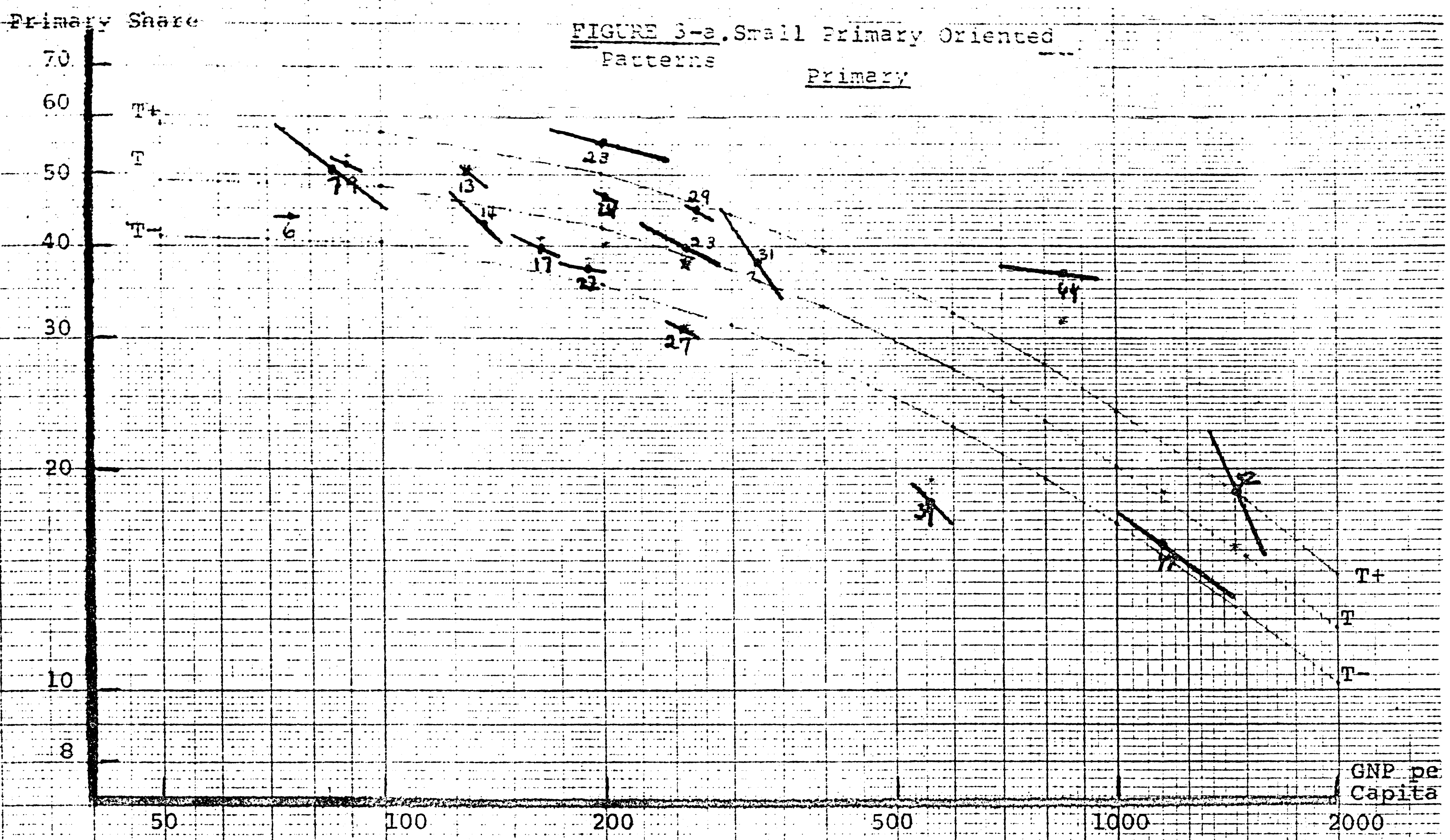


FIGURE 3-a
Small Primary Oriented Patterns - Primary

6 Kenya
7 Cambodia
9 Congo
13 Ceylon
17 Ecuador
22 El Salvador
23 Iraq
14 Rhodesia
24 Honduras
27 Guatemala
28 Colombia
29 Malaya
31 Costa Rica
39 Chile
44 Venezuela
47 Denmark
52 Australia

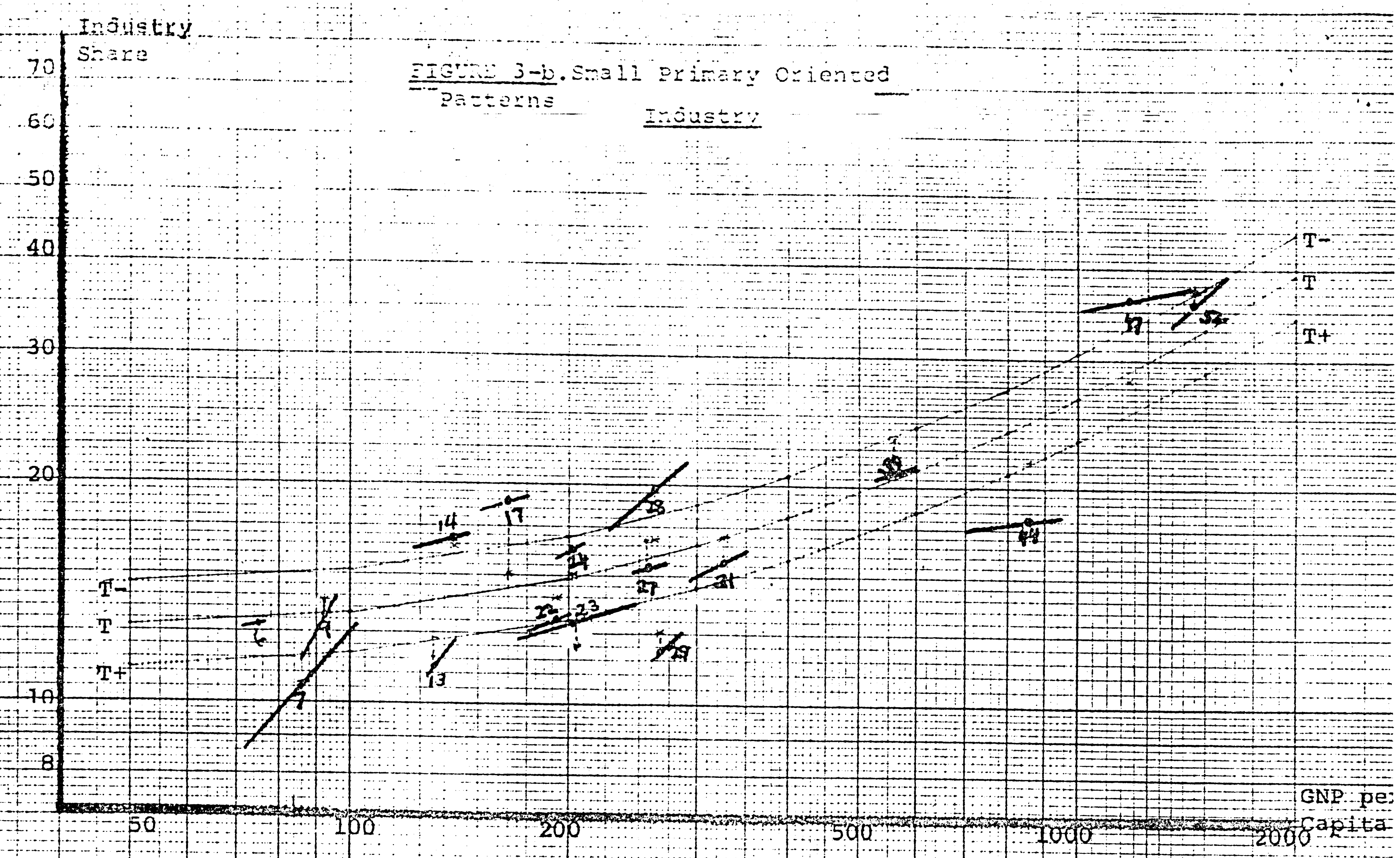


FIGURE 3-b

Small Primary Oriented Patterns - Industry

6 Kenya	24 Honduras
7 Cambodia	27 Guatemala
9 Congo	28 Colombia
13 Ceylon	29 Malaya
14 Rhodesia	31 Costa Rica
17 Ecuador	39 Chile
22 El Salvador	44 Venezuela
23 Iraq	47 Denmark
	52 Australia

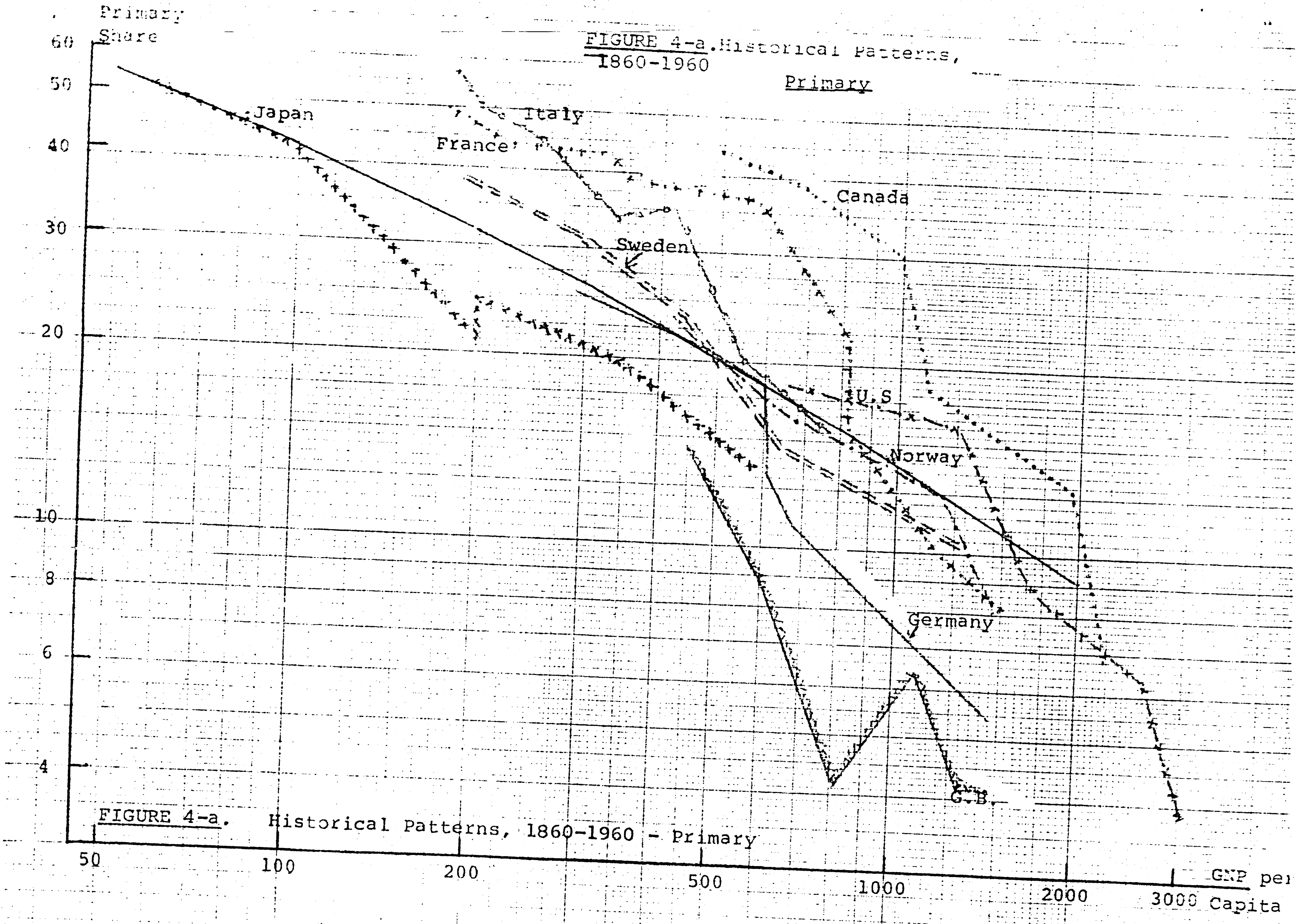


FIGURE 4-a. Historical Patterns, 1860-1960 - Primary

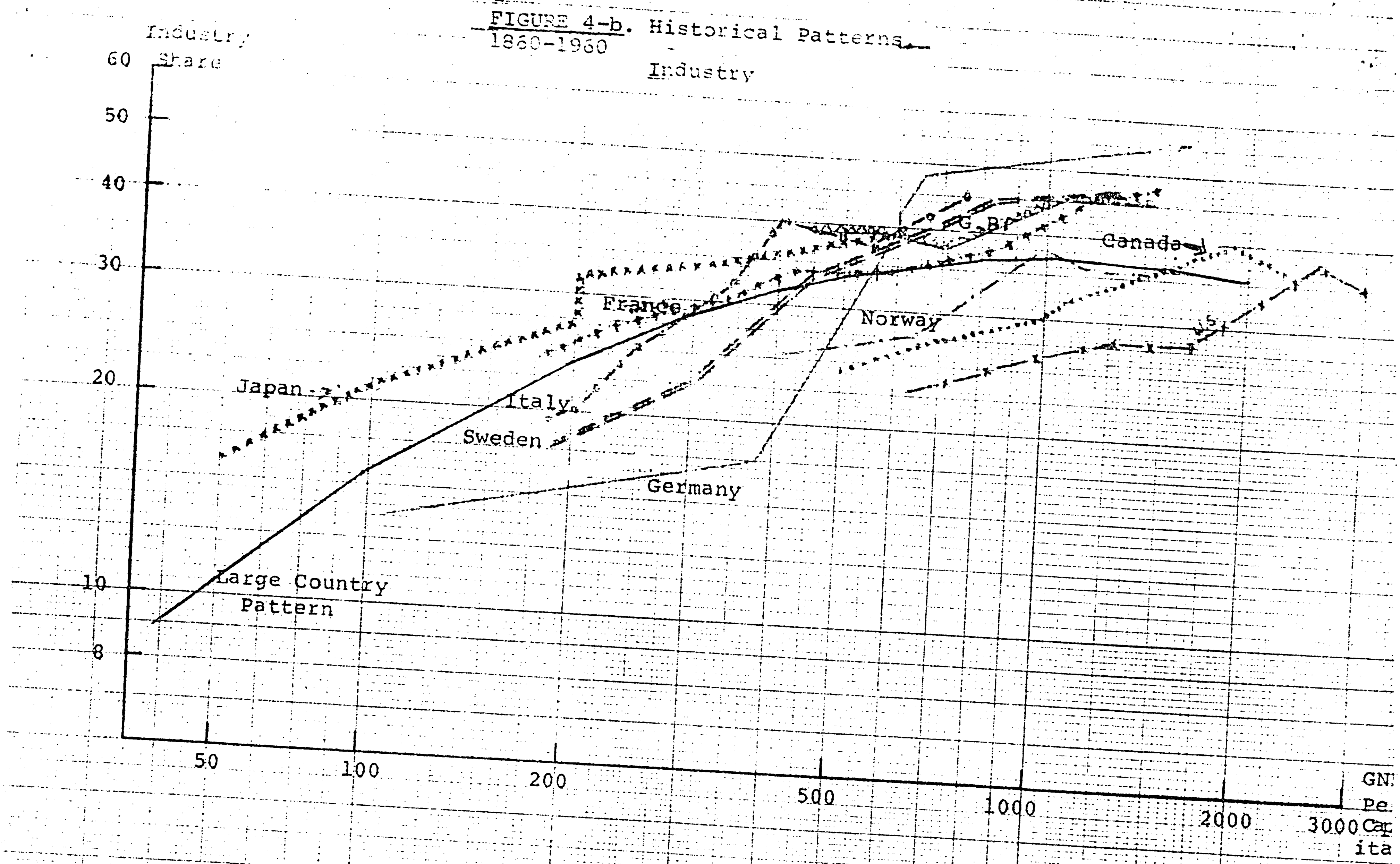


FIGURE 4-b. Historical Patterns, 1860-1960 - Industry

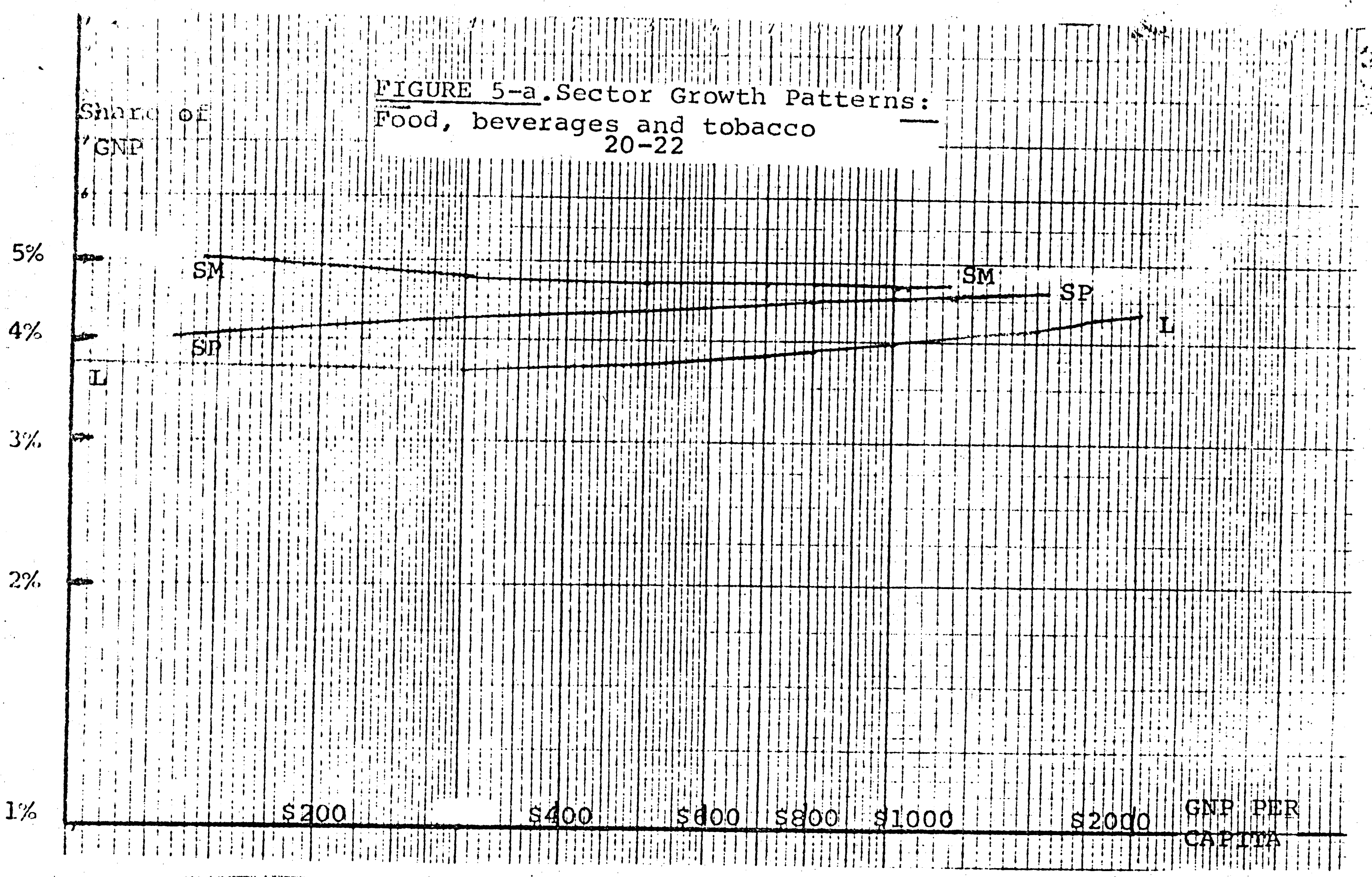


FIGURE 5-a. Sector Growth Patterns:
Food, beverages and tobacco
20-22
Share of GNP
5%
4%
3%
2%
1%
SM
SP
L
$200
$400
$600
$800
$1000
$2000
GNP PER CAPITA

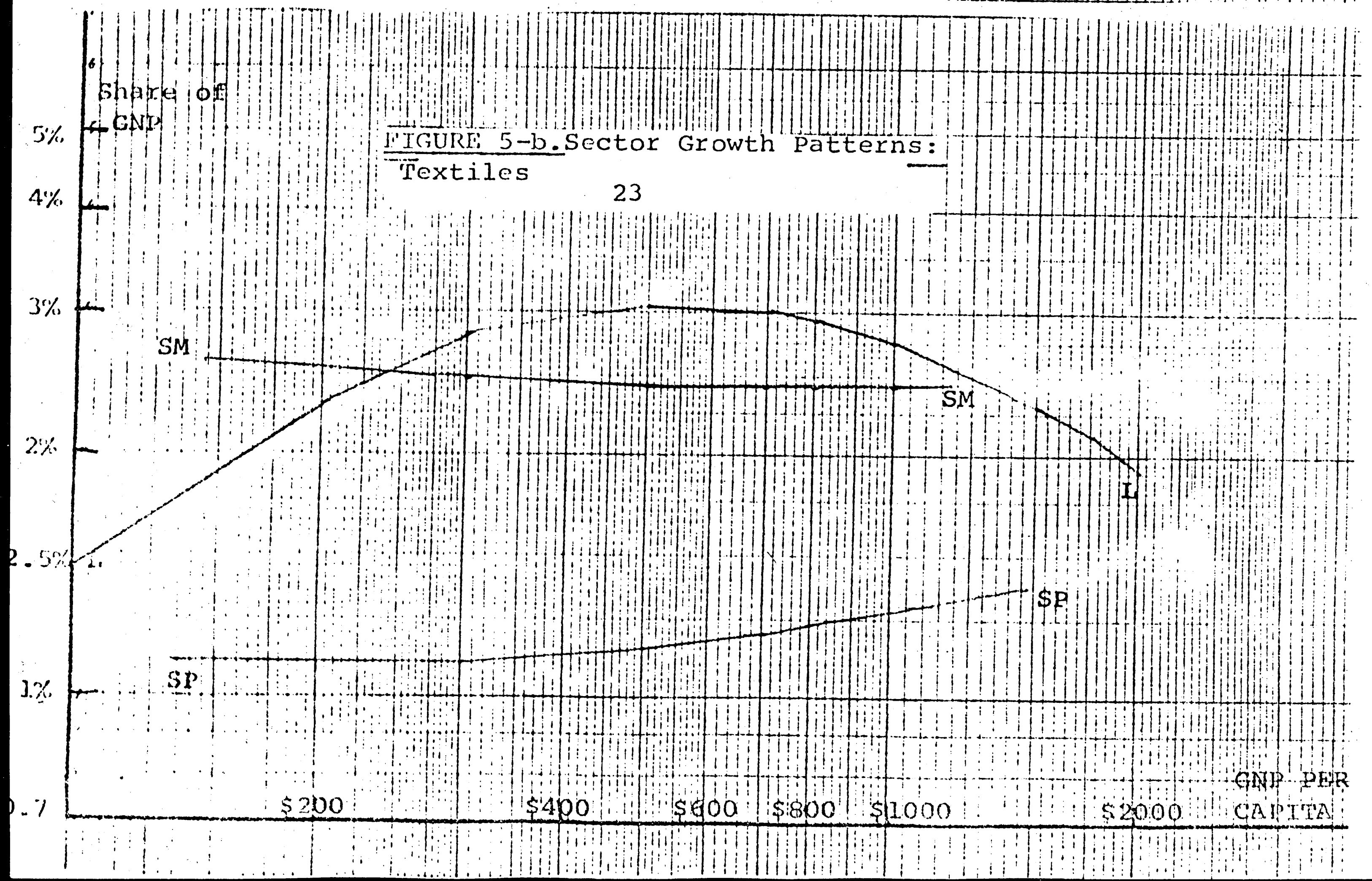
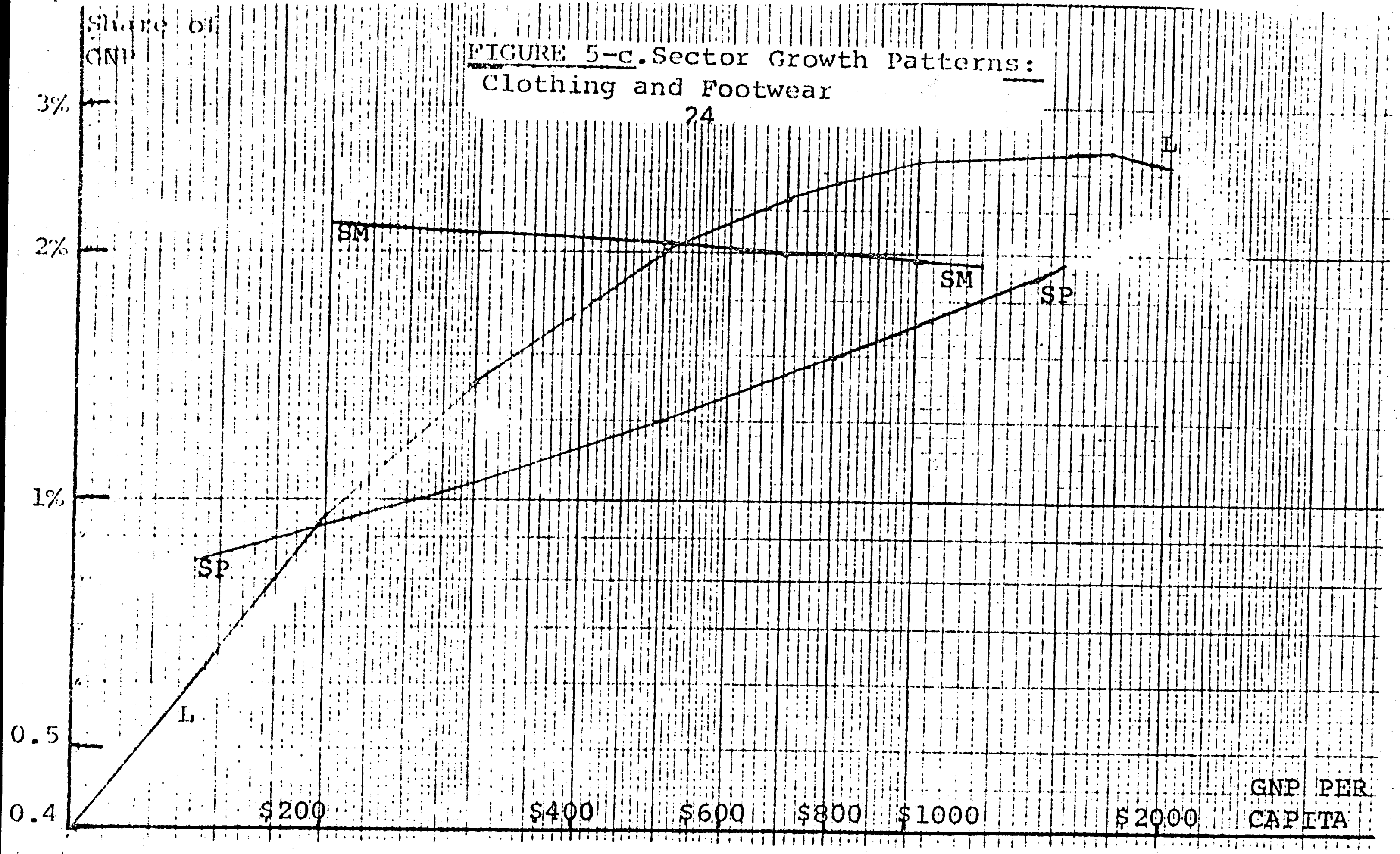
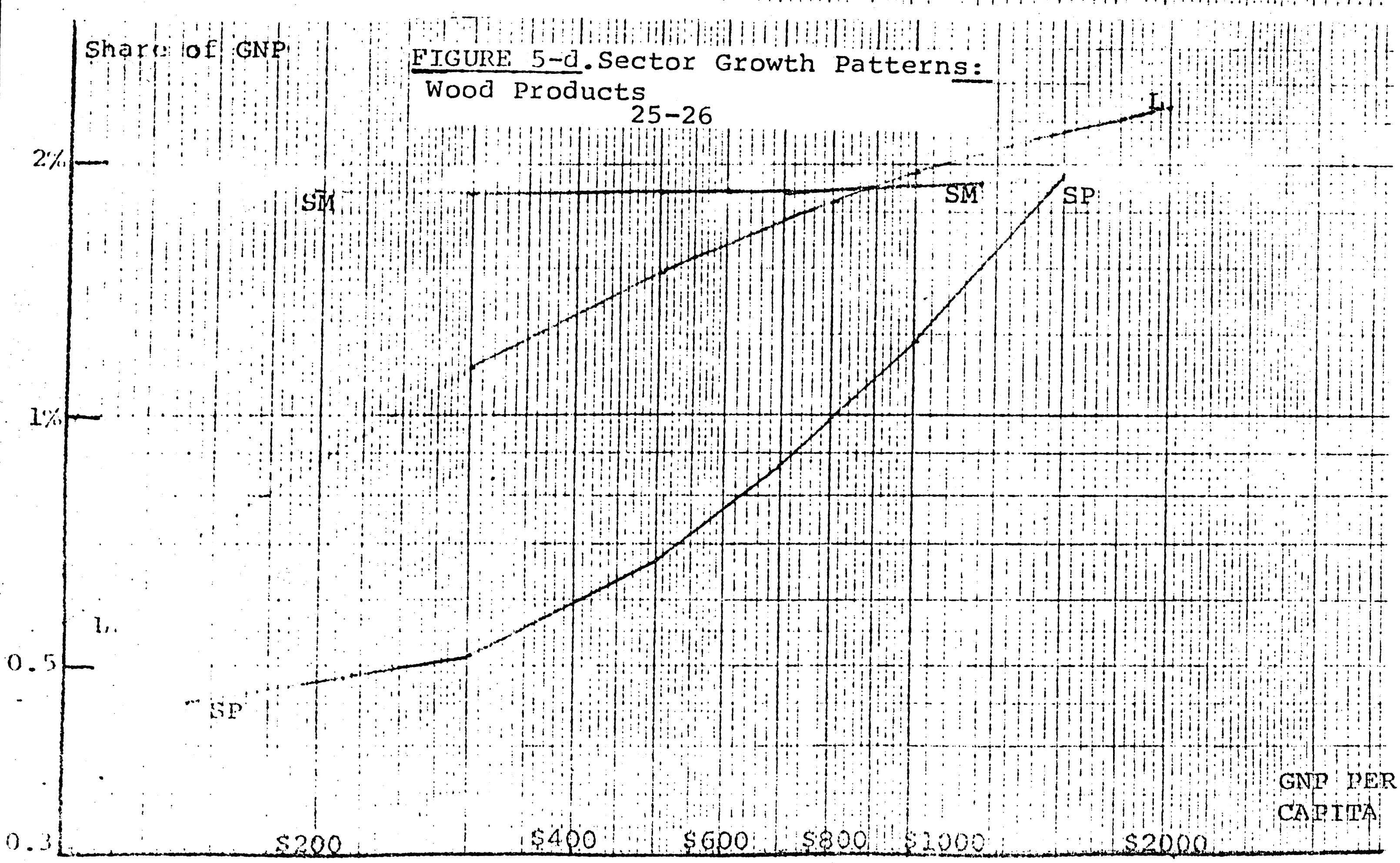


FIGURE 5-b. Sector Growth Patterns:
Textiles
23
Share of GNP
5%
4%
3%
2%
1.5%
1%
.7
SM
L
SP
$200
$400
$600
$800
$1000
$2000
GNP PER CAPITA



Share of GNP
FIGURE 5-c. Sector Growth Patterns: Clothing and Footwear
24
3%
2%
1%
0.5
0.4
L
SM
SP
$200
$400
$600
$800
$1000
$2000
GNP PER CAPITA



Share of GNP
FIGURE 5-d. Sector Growth Patterns: Wood Products
25-26
2%
1%
0.5
0.3
L
SM
SP
$200
$400
$600
$800
$1000
$2000
GNP PER CAPITA

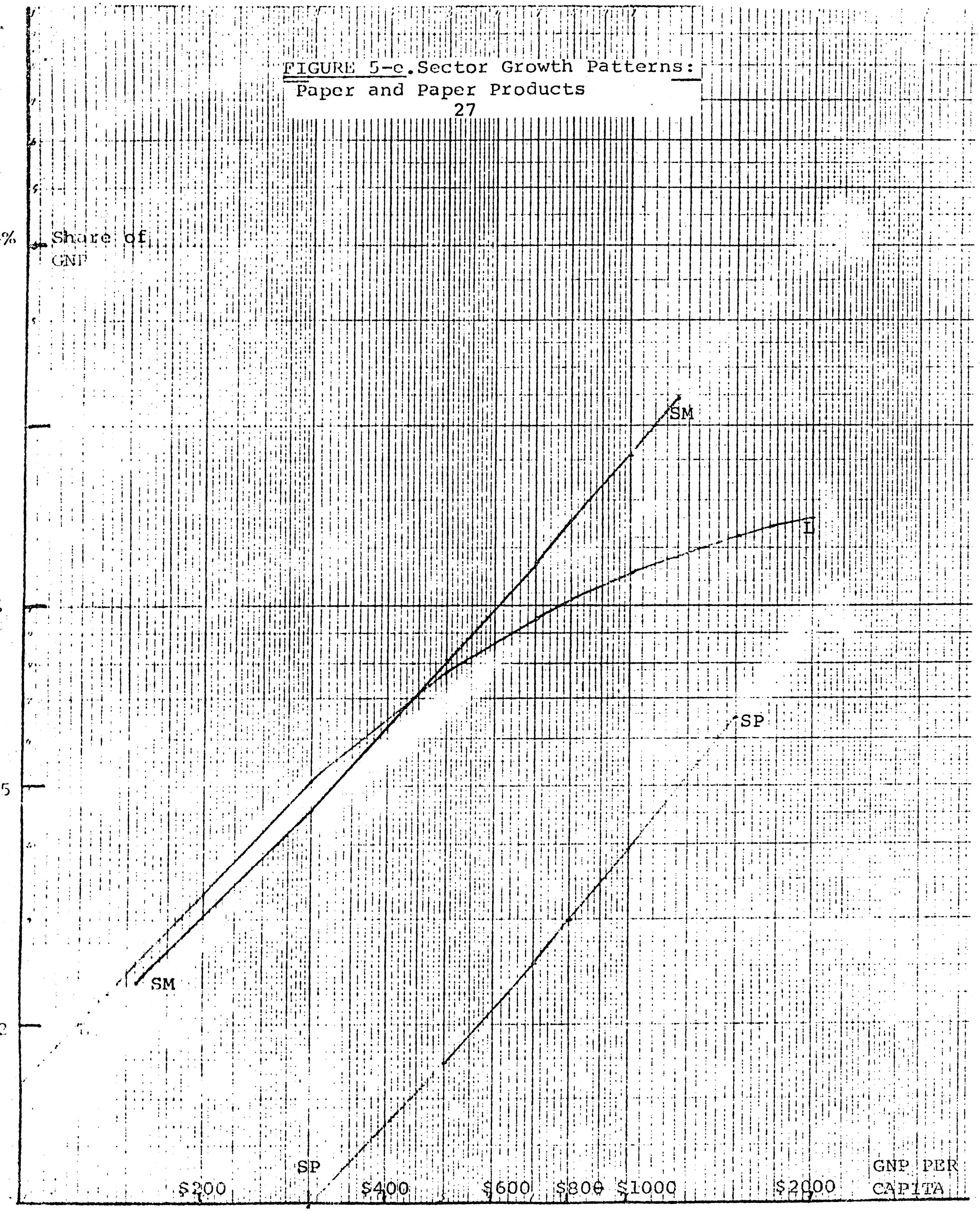


FIGURE 5-e. Sector Growth Patterns: Paper and Paper Products

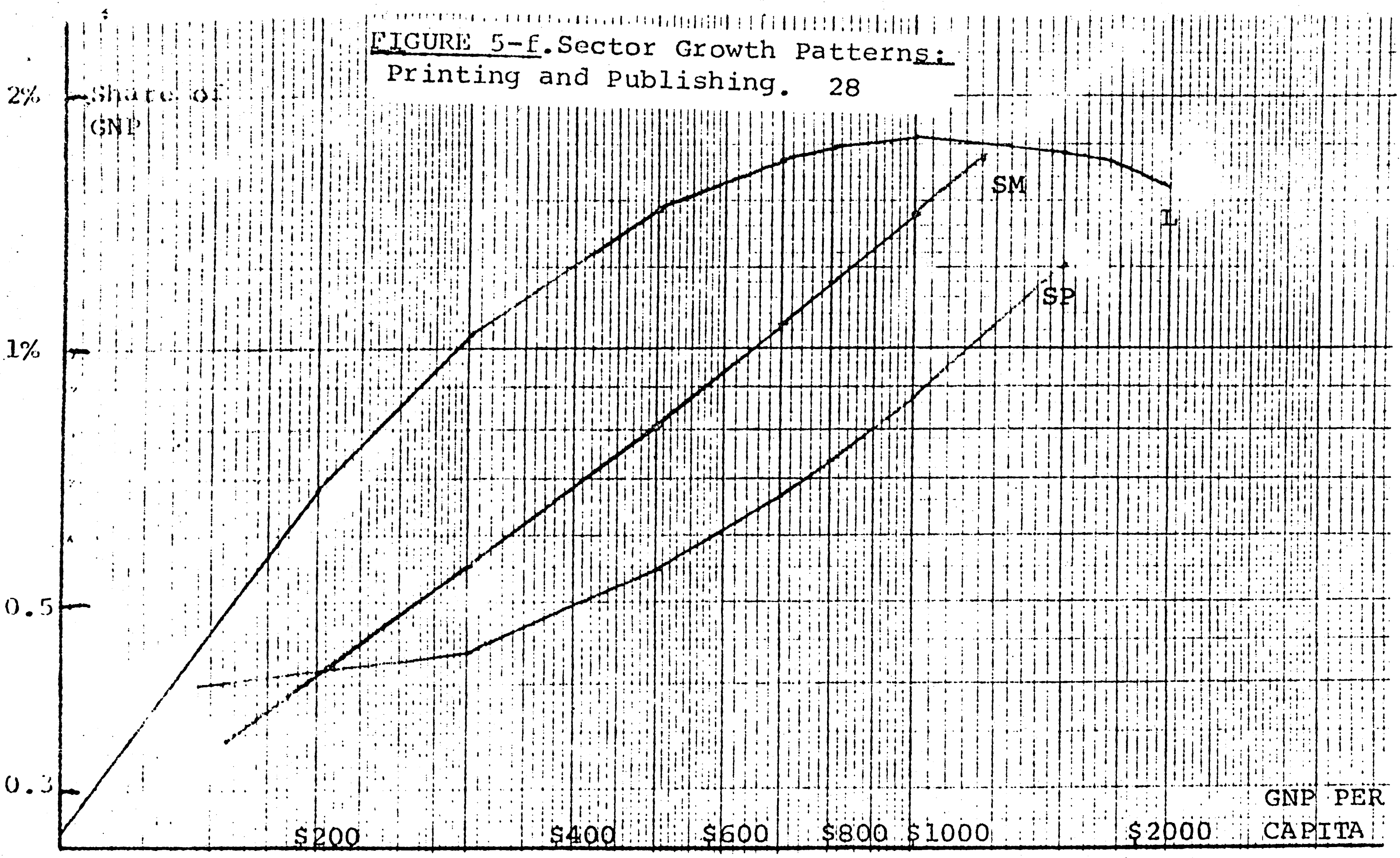
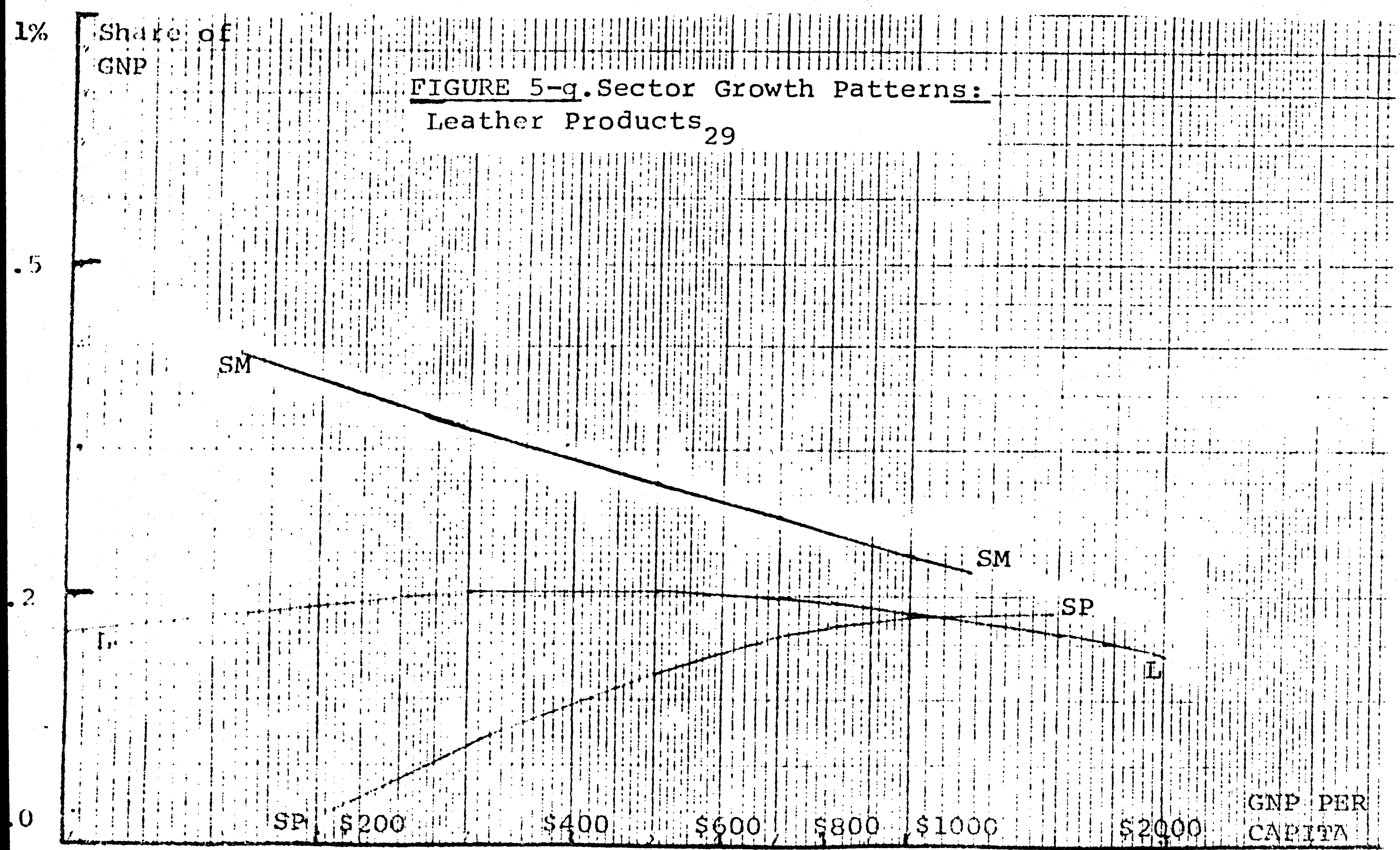
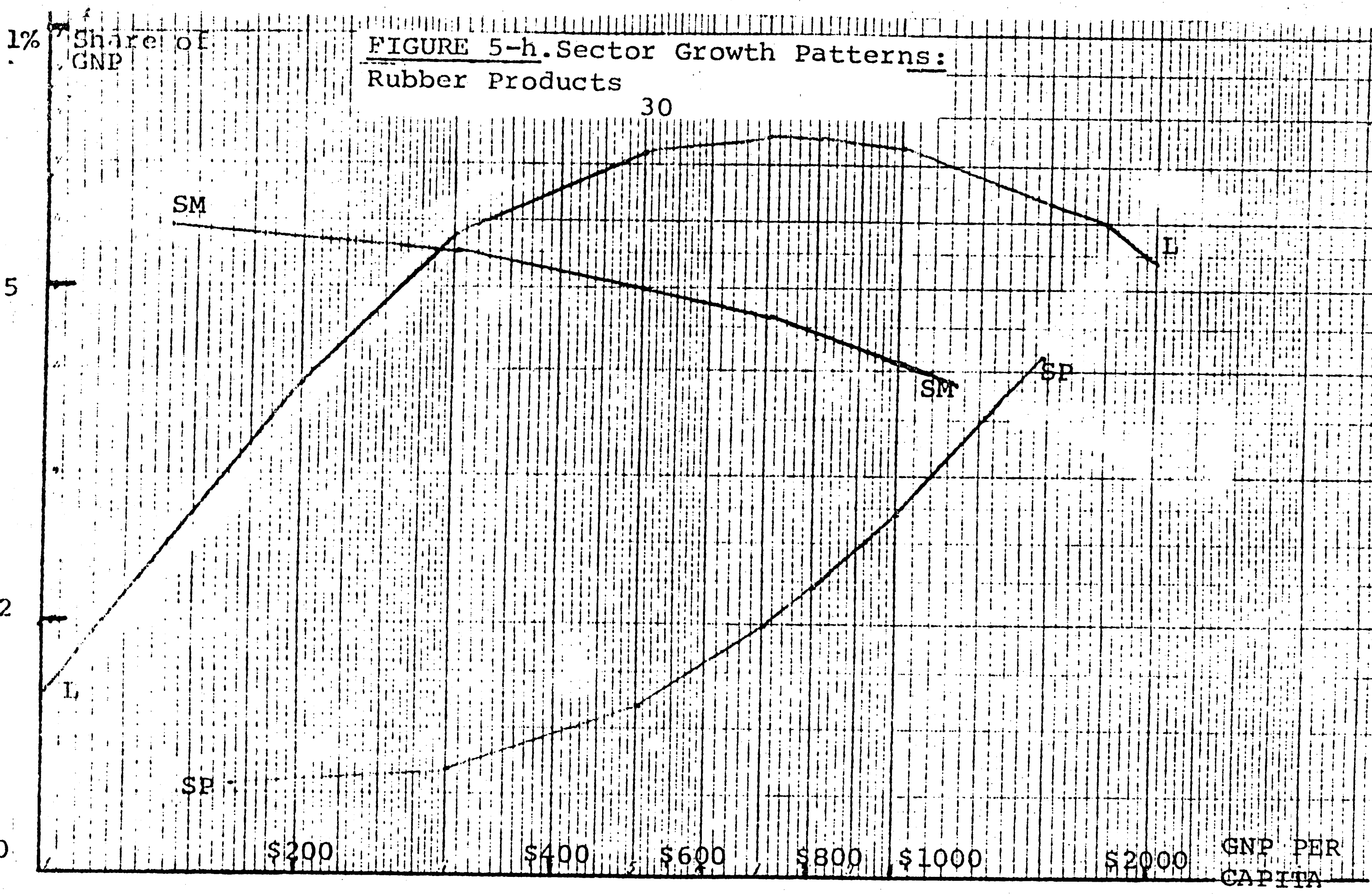


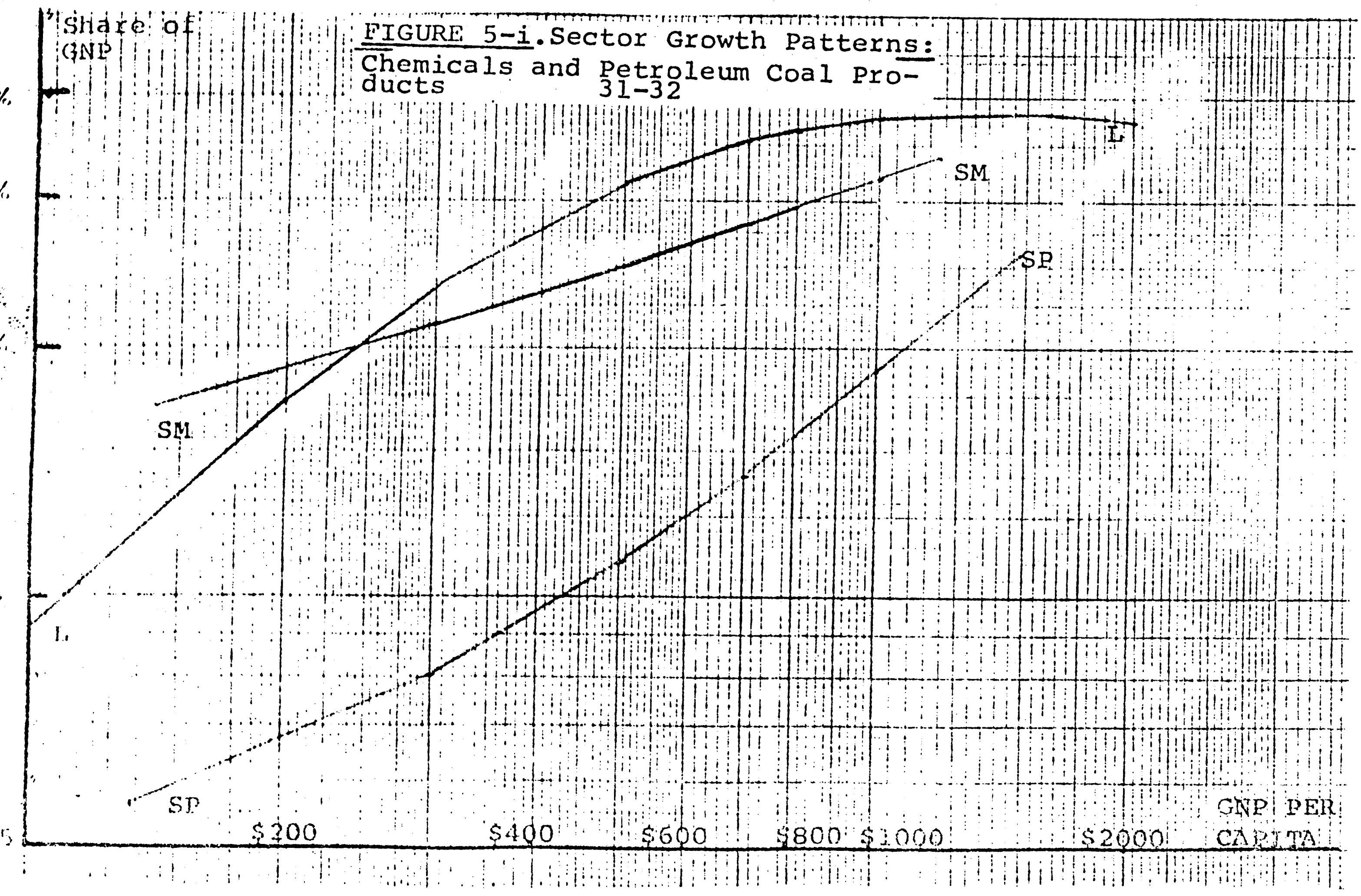
FIGURE 5-f. Sector Growth Patterns: Printing and Publishing. 28
2%
Share of GNP
1%
0.5
0.3
SM
L
SP
$200
$400
$600
$800
$1000
$2000
GNP PER CAPITA



1%
Share of GNP
FIGURE 5-g. Sector Growth Patterns: Leather Products 29
.5
SM
.2
L
SP
.0
$200
$400
$600
$800
$1000
$2000
GNP PER CAPITA



1%
Share of GNP
FIGURE 5-h. Sector Growth Patterns: Rubber Products
30
SM
L
0.5
SM
SP
0.2
L
SP
0.0
$200
$400
$600
$800
$1000
$2000
GNP PER CAPITA



Share of GNP
FIGURE 5-i. Sector Growth Patterns: Chemicals and Petroleum Coal Products
31-32
4%
L
3%
SM
SP
2%
SM
1%
L
SP
0.5
$200
$400
$600
$800
$1000
$2000
GNP PER CAPITA

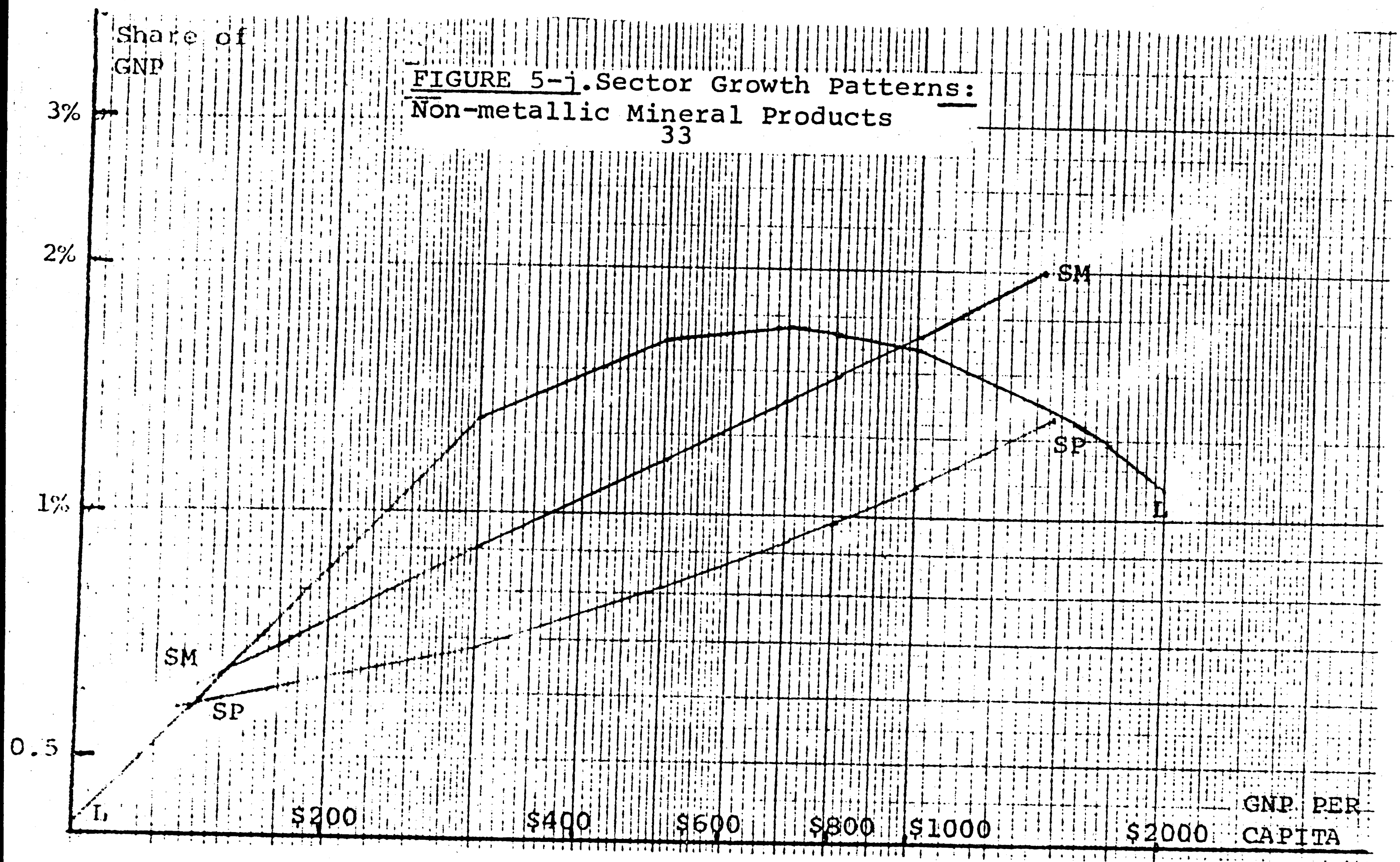
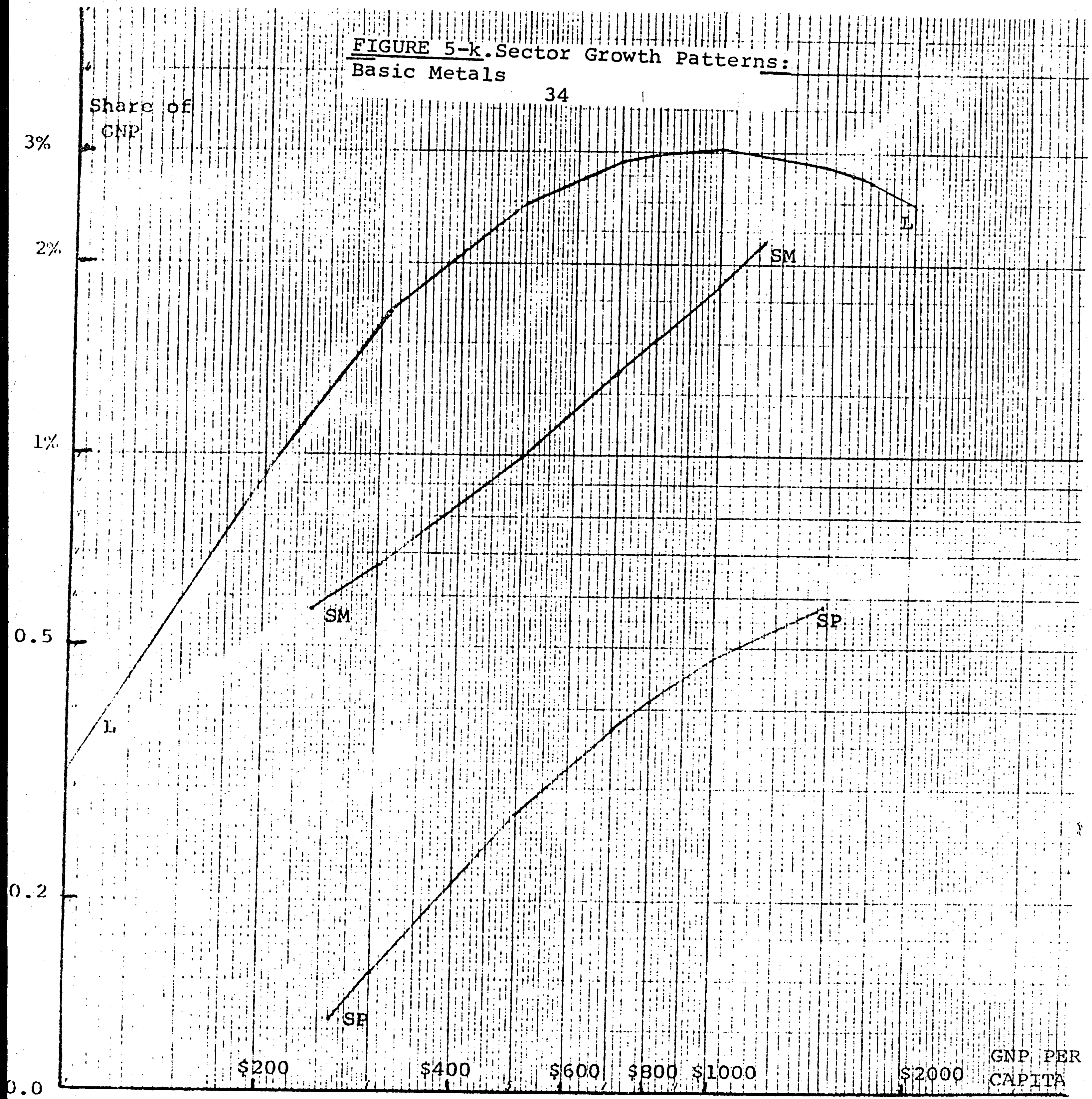


FIGURE 5-j. Sector Growth Patterns: Non-metallic Mineral Products

33

FIGURE 5-k. Sector Growth Patterns: Basic Metals



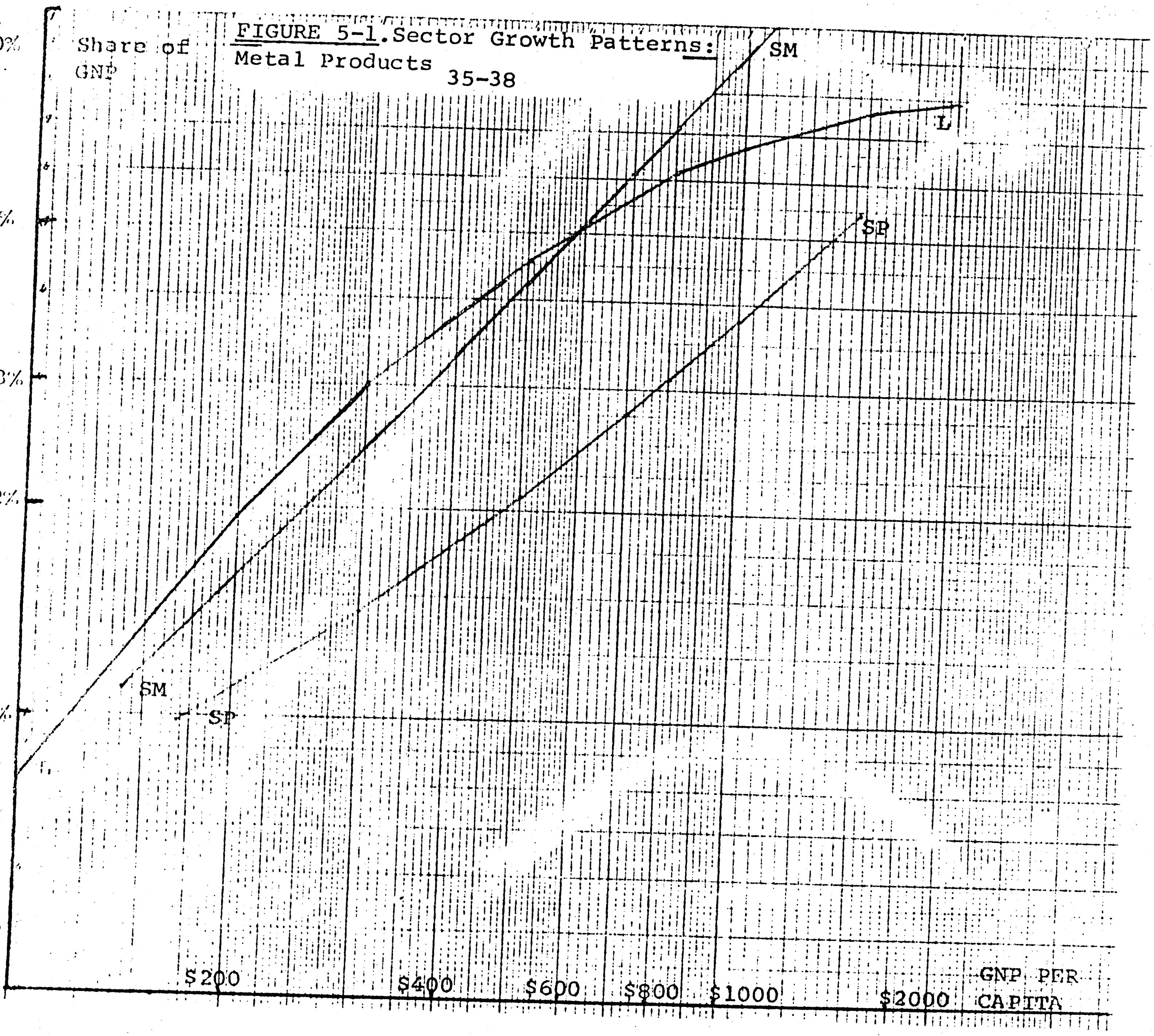


FIGURE 5-1. Sector Growth Patterns: Metal Products
35-38
Share of GNP
10%
5%
3%
2%
1%
.5
SM
L
SP
SM
SP
$200
$400
$600
$800
$1000
$2000
GNP PER CAPITA

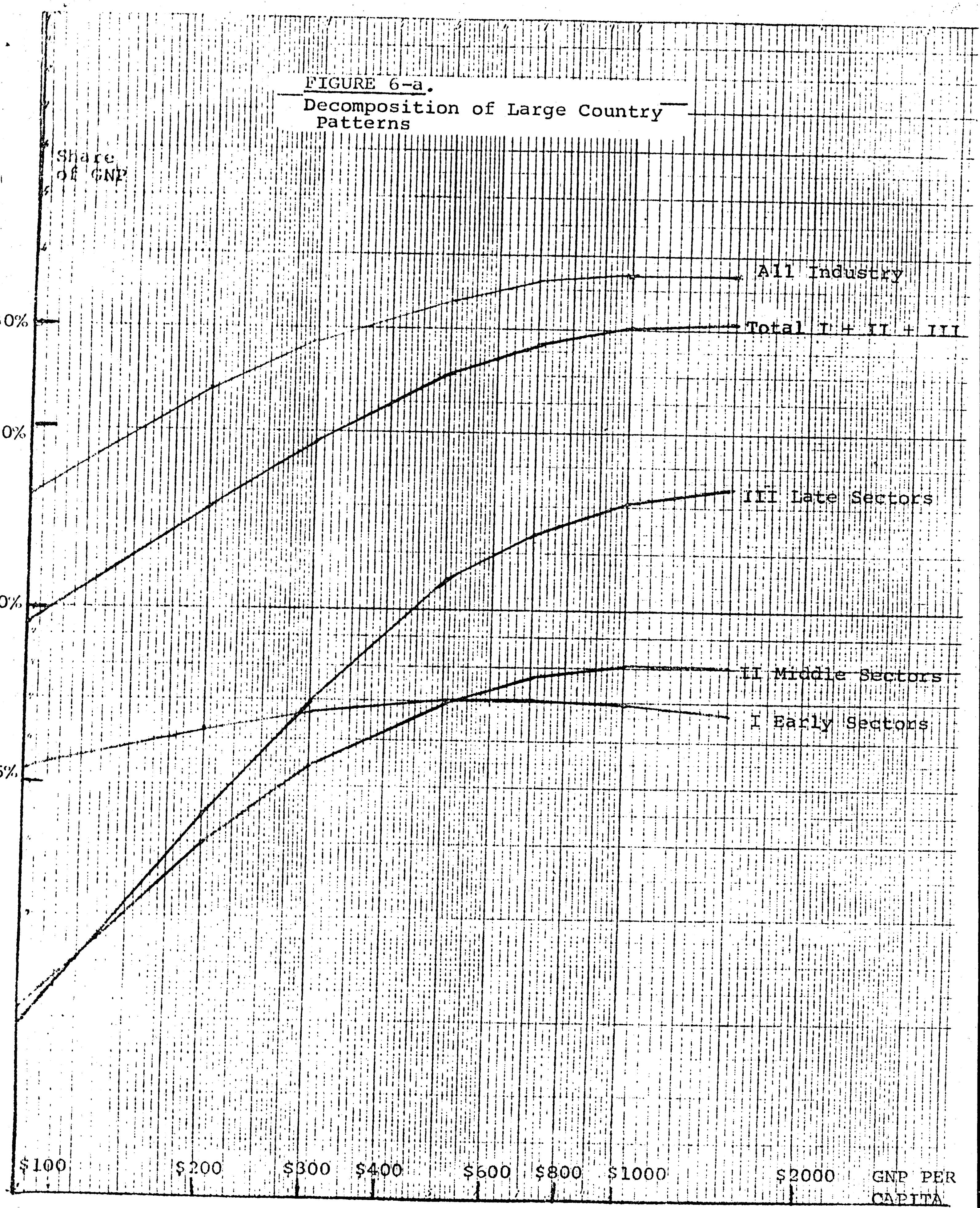


FIGURE 6-a.
Decomposition of Large Country Patterns
Share of GNP
30%
20%
10%
5%
All Industry
Total I + II + III
III Late Sectors
II Middle Sectors
I Early Sectors
$100
$200
$300
$400
$600
$800
$1000
$2000
GNP PER CAPITA

FIGURE 6-b.
Decomposition of Small Industry-Oriented Patterns

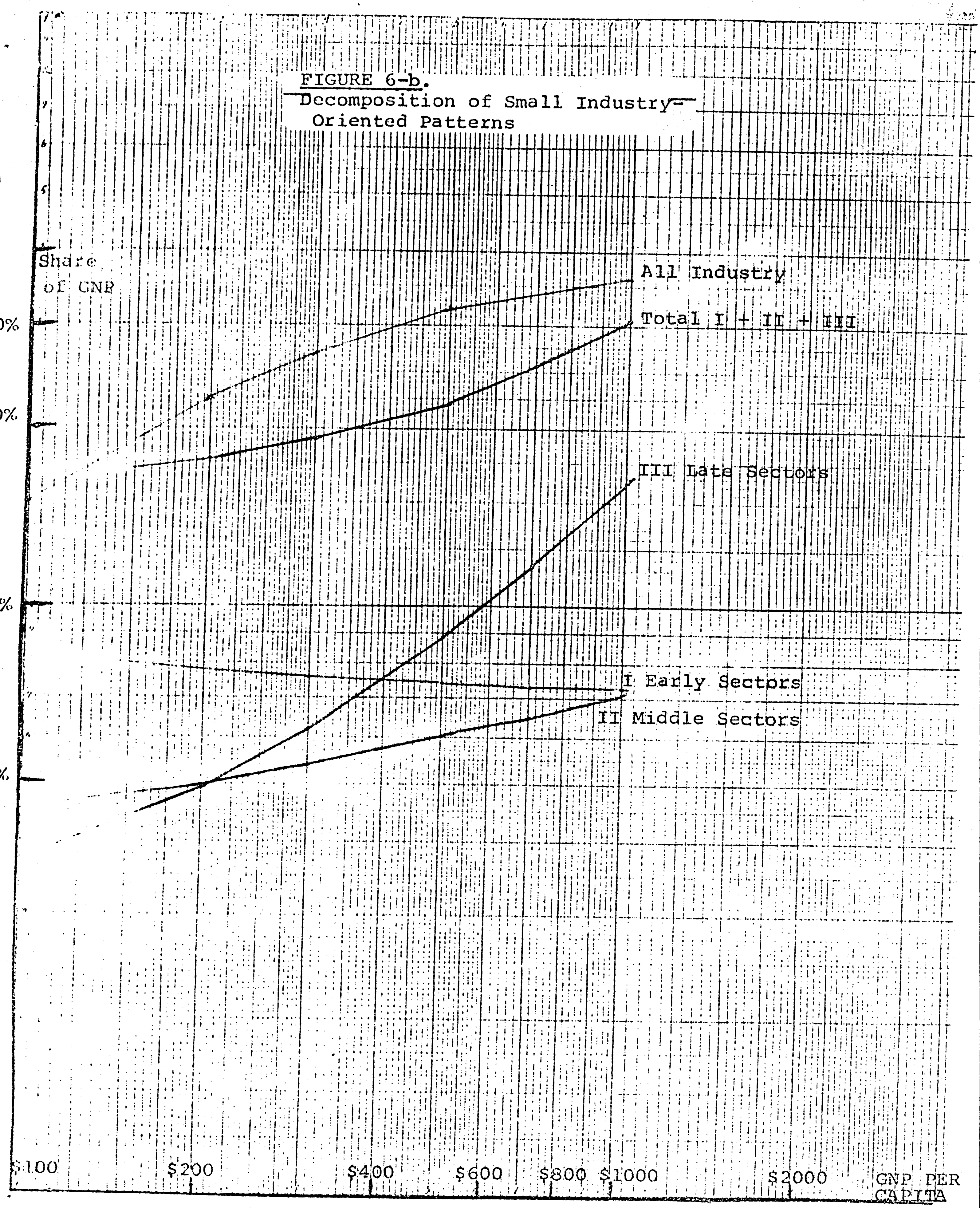


FIGURE 6-c.
Decomposition of Small Primary-Oriented Patterns