INTERCOUNTRY AND INTERTEMPORAL PATTERNS OF INDUSTRIAL GROWTH*

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MEMORANDUM No. 15
September, 1966

PROJECT FOR QUANTITATIVE RESEARCH
IN ECONOMIC DEVELOPMENT,
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* Revised version of a paper presented to the United Nations Inter-Regional Seminar on Long-Term Economic Projections for the World Economy: Sectoral Aspects, Elsinore, Denmark, August, 1966.

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INTRODUCTION

There are two bases for projecting the future evolution of any social unit: its own past experience and the experience of other similar units. All economic forecasting methods represent some blend of these two approaches. At one extreme, the recent history of a country can be formalized in an econometric model; predictions are then determined from assumptions as to the future values of the exogenous variables in the model. In this approach, the experience of other economies is drawn on in estimating some of the parameters in the model, in choosing the values of exogenous variables, and in judging the plausibility of the results. At the other extreme, generalizations from common experience in the form of "patterns" or "stages" of growth form the analytical core around which projections are built up. In this case the relation between the two approaches is reversed; the model of the particular economy serves to modify the conclusions reached from comparative analysis.

The choice of analytical techniques is more limited in less developed countries than it is in advanced ones. Econometric models based on time series for the country concerned have proven to be of very limited value, both because of the scarcity of historical data and because some of the structural relations are undergoing significant changes. Therefore plans and projections for these countries must rely more heavily on international experience, both from countries at a similar stage of development and from those that are more advanced.

The historical experience of the more advanced countries and the current economic structures of countries at different income levels have recently been the subject of extensive statistical analysis and comparison.[1/] These analyses give the impression that the historical changes in the composition of output observed over the past fifty years are broadly similar to the intercountry pattern derivable from cross-section analysis. This similarity has lent considerable support to the use of the cross-section pattern either as a guide to the interpretation of past structural changes or as a basis for future projections.[2/] Recently, however, several authors have expressed doubt as to the validity of interpreting the intercountry pattern as being a reflection of common forces operating in each country and hence as to the usefulness of cross-country data for projections.[3/]

1/ Particularly by Kuznets /4/, Chenery /1, 2/, Maizels /6/, and the United Nations /10, 11/.

2/ Studies using the "normal patterns" as benchmarks include analyses of Japan /3/, Pakistan /5/, Greece /7/, Colombia /12/.

3/ Particularly Steuer and Voivodas /8/, and Peter Temin /9/.

The present paper will reexamine this question in the light of the more complete postwar data now available for less developed countries. The larger number of countries and longer time series make it possible to formulate a more satisfactory explanation of intercountry variation and also to establish some systematic relationships between intertemporal changes and cross-sectional patterns. The analysis is designed to lay the groundwork for empirically based theories of economic development as well as for economic planning and projections.

I. THE ANALYTICAL FRAMEWORK

Statistical analysis must be based on a fairly explicit set of hypotheses in order to contribute to the understanding of structural changes. Indiscriminate application of regression analysis based on measures of countries' size and income levels can be quite misleading, since there is a significant association between these two variables and most economic aggregates. The nature of the underlying causal relationships can only be adequately formulated and tested for individual countries. Such studies are necessary to the understanding and further refinement of intercountry results.

A preliminary analysis of the interrelations among the major factors which cause systematic changes in a country's economic structure as its income level rises was given in several earlier papers /1, 2, 3, 4/. Uniformities in the patterns of production and trade of countries having the same level of per capita income are attributed to a set of universal factors affecting all societies: (i) access to common technology, (ii) similarity in human wants, (iii) existence of international markets, and (iv) the accumulation of capital and skills that is a necessary concommitant of rising income. These factors affect both the pattern of domestic demand from consumers and producers and a country's comparative advantage in international trade. The "normal" structure of production for a given level of income therefore reflects both demand and supply factors.

In considering the relation between changes in output over time and the pattern of intercountry variation, it is useful to divide the sources of deviation from the statistical norm into two types: transitory and permanent. The sources of relatively <u>permanent deviations</u> are primarily locational factors and natural resources, whose effects change only slowly as technology and the location of population change. The <u>transitory factors</u> include the results of past economic policies (e.g. autarchy, colonial specialization) and changing political phenomena (e.g. changes in national territory). In previous tests, /1, 2, 10/ the size of the country and its natural resources were shown to have significant effects on the pattern of production.

The existing intercountry variation in levels of industrial production represents the cumulative effects of the increase in output in each country as its income has risen. Since the volume of world industrial output has quadrupled in the past twenty years the present industrial structure results largely from postwar influences. Assuming that the universal factors listed above have been the predominant influences during this period, we may expect to find (i) a fairly constant intercountry pattern of variation and (ii) substantial similarity between this pattern and the average intertemporal variation for all countries over the past ten to fifteen years. The hypotheses are tested in the next section.

The usefulness of intercountry analysis is not limited to the identification of the effects of universal factors on growth patterns. Of no less importance is the identification of differences among countries, which only become apparent after the systematic sources of variation have been allowed for. Apart from permanent differences due to resource endowments, we may expect that differences in the historical starting point, in national policies and perhaps in other factors will be reflected in the deviations from the norm. A quantitative analysis of these influences should contribute to our understanding of economic history as well as to establishing a better basis for development policy.

Our investigation of these phenomena will proceed in three stages. First, we will reformulate the earlier estimates of the basic intercountry pattern to determine more adequately the effects of the universal factors and of the relatively permanent differences among countries. Then we will compare the changes in the share of industry over time in each country to the cross-country pattern to determine the extent to which the former is explained by the universal factors underlying the cross-country pattern. Finally, we will examine some of the deviations from normal in both the time series and cross-section results to see whether other regularities can be identified.

II. INTERCOUNTRY VARIATION IN INDUSTRIAL OUTPUT.

A. The Statistical Analysis.[1]

Our statistical analysis of intercountry variation in industrial output starts from the hypotheses and results given in Chenery/1, 2/ and the United Nations /10/. The present analysis is concerned only with variation in total industrial output, defined as manufacturing plus construction.[2] It is based on 682 annual observations in 52 countries of the share of industry in GNP, covering the years 1950-1963. The mean values of the variables for each country for this period are given in table 1. The median country has a per capita income of $260, a population of 9 million, and an industrial share of GNP of 19.7%.

To start with, we repeated the previous regressions, using per capitaincome and population to explain the variation in the share of industry in GNP. Since the earlier analysis had suggested a significant non-linearity in the relation of industrial output to income level, the following modified form of the earlier regression equation was used:[3]

1/ Sources of data, discussion of statistical methods and additional results are given in the appendix.

2/ A further study disaggregated to the two digit level is planned when census data for 1963 become available. The present analysis is currently being extended to the other major sectors.

3/ This equation differs from the form used in /1, p. 630/ in two respects: (i) the use of the share of industry instead of its per capita value as the dependent variable, and (ii) the addition of $(\ln y)^2$ to allow for a non-linear relation to income. The elasticities estimated in the two forms are comparable, but the variance of the share of industry is much lower than the variance of the per capita value, which reduces the value of R^2.

Table 1

Means of Basic Country Data.

Country	Number of Observations a/ A	Number of Observations a/ B	Per capita GNP (y)	Population (millions) (N)	Percentage Share of GNP: Industry (M)	Percentage Share of GNP: Investment (I)	Percentage Share of GNP: Primary Exports (E_p)	Deviation from export equation $(\ln E_p - \ln \hat{E}_p)$
1. Nigeria	13	12	57.5	48.9	7.3	19.8	14.2	.2550
2. Burma	14	9	59.1	20.3	14.1	17.7	16.6	.0235
3. Pakistan	14	9	67.5	94.0	10.6	16.5	7.5	.1010
4. Haiti	11	8	70.7	3.7	13.1	6.9	13.0	-1.0003
5. Kenya	14	3	74.8	7.4	12.8	19.2	23.6	.0374
6. Cambodia	13		86.3	5.1	10.6			
7. Thailand	13	10	87.6	24.3	15.6	15.3	18.6	.5354
8. Leopoldville	10	9	92.4	12.5	13.1	26.1	32.6	.7719
9. Bolivia	14	12	120.2	3.3	14.4		15.3	-.5239
10. Taiwan	13	2	125.8	9.6	22.8	14.8	5.8	-.6903
11. South Korea	11	10	128.0	23.5	13.5	11.5	2.7	-1.2269
12. Ceylon	14	14	131.4	9.1	11.2	15.4	33.8	.8622
13. Rhodesia-Nyasaland	10	10	138.0	9.3	16.9	25.4	14.8	.0752
14. Paraguay	14	10	156.6	1.6	19.5	14.3	12.0	-.9521
15. Ecuador	14	13	164.8	3.9	18.9	15.2	16.2	-.1613
16. Tunisia	14	14	177.2	4.0	17.9	15.1	11.9	-.4408
17. Peru	14	8	182.2	9.4	21.6	23.0	13.3	.1560
18. Turkey	14	13	187.5	25.3	19.6	13.2	6.3	-.0819
19. Philippines	14	14	190.7	24.9	18.6	7.9	14.9	.7513
20. El Salvador	13	12	191.2	12.3	13.1	11.1	19.6	-.1901
21. Iraq	11	10	201.5	6.4	12.9	18.4	44.5	1.1788
22. Honduras	13	9	212.0	1.6	16.4	14.2	18.5	-.3787
23. Algeria	11	5	224.4	9.7	18.0	24.1	18.5	.6400
24. Portugal	14	13	239.8	8.7	35.6	15.2	8.0	-.2831
25. Guatemala	14	13	257.3	3.4	15.4	11.1	10.4	-.4464
26. Colombia	14	13	258.7	13.1	19.7	19.7	12.6	.4469
27. Malaya	8	8	267.8	6.6	11.7	13.1	39.2	1.2319
28. Mexico	14	14	316.9	31.7	25.3	14.5	7.4	.4371
29. Costa Rica	13	8	326.9	1.0	15.6	19.7	18.3	-.3616
30. Jamaica	14	14	329.2	1.5	25.4	20.8	26.6	.1334
31. Japan	14	13	344.0	89.9	31.8	25.1	1.4	-.6821

Table 1 (continued)

Means of Basic Country Data

Country	Number of Observations[a] A	Number of Observations[a] B	Per capita GNP (y)	Population (millions) (N)	Percentage Share of GNP: Industry (M)	Percentage Share of GNP: Investment (I)	Percentage Share of GNP: Primary Exports (E_p)	Deviation from export equation ($\ln E_p - \ln \hat{E}_p$)
32. Greece	14	12	344.4	8.1	21.9	15.7	8.3	-.1084
33. Spain	10	10	349.4	29.9	28.8	19.4	5.2	.0470
34. Uruguay	9		442.5	2.8	25.6			
35. Argentina	14	14	547.1	19.4	35.4	19.6	10.3	.6772
36. Italy	14	13	550.9	48.6	35.7	20.2	2.7	-.2064
37. Chile	14	11	557.0	7.1	20.9	10.4	6.7	-.2460
38. Israel	12	12	602.9	2.0	30.7	27.7	5.5	-1.1287
39. Puerto Rico	14		677.6	2.3	26.2			
40. Austria	14	12	732.6	7.0	46.4	21.4	4.8	.5821
41. Netherlands	12	11	864.5	10.8	36.9	22.3	15.6	.8768
42. Venezuela	14	14	847.7	6.5	18.1	26.6	32.2	1.3169
43. Finland	14	10	891.3	4.3	39.3	25.6	12.3	.1720
44. West Germany	14	14	1057.2	53.5	45.4	21.8	0.7	-1.3570
45. Denmark	14	13	1168.3	4.5	36.1	17.0	20.1	.6838
46. Belgium	14	14	1175.1	9.0	34.7	17.7	3.4	-.7498
47. France	14	14	1179.3	44.3	43.3	17.9	2.6	-.1854
48. Norway	14	14	1184.2	3.5	33.8	33.5	15.2	.2867
49. United Kingdom	14	14	1259.9	51.8	41.2	14.2	1.4	-.7382
50. Australia	14	12	1458.8	9.5	35.7	24.9	12.6	.6132
51. Canada	14	14	2046.3	16.4	32.7	23.2	10.0	.6092
52. U.S.A.	14	14	2710.1	170.4	33.5	16.8	1.2	-.3662

a/ Sample A: 682 annual observations on 52 countries for M, y, and N.
Sample B: 554 annual observations on 49 countries for M, y, N, E_p and D.
Sample B': 542 annual observations on 48 countries for M, y, N, E_p, D, and I.

Sources: See Statistical Appendix

$\tilde{R}^2 = 0.68$

(1) $\ln M = \alpha + \beta_1 \ln y + \beta_2 (\ln y)^2 + \gamma \ln N$ [1]

where: M is the share of industry (manufacturing plus construction) in GNP.

y is GNP per capita (in 1960 dollars)

N is population (in millions)

The analysis was initially carried out for each year separately to test whether there are significant differences in the cross-country pattern over time. Since the differences turned out to be quite insignificant, we pooled the data for all years in subsequent analyses.[2]

Estimates of the parameters in equation 1 are given in table 2. Since the variables are all in logarithmic form, the parameters are the elasticities of the share of industry with respect to each variable. Their significance is brought out in the next section.

The significance of a number of other explanatory variables has been tested in previous studies /2, 10/. The only factors which have shown a significant effect on the share of industry

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1/ In exponential form, this equation is

$$M = e^{\alpha} y^{(\beta_1 + \beta_2 \ln y)} N^{\gamma}$$

2/ As explained in the appendix, the stability of the results was tested by analysis of covariance of 14 yearly cross-section regressions.

are measures of resource endowments. Utilizing the results of Chenery /2/, we selected primary exports as the best single indicator of natural resource endowments. This variable was added to the analysis in two alternative forms: (i) as a ratio to GNP (E_p), and (ii) as a deviation from this ratio as predicted by the country's population and per capita income.[1/] The latter form is more satisfactory in distinguishing resource effects from other aspects of country size. The effect on the cross country regressions of introducing the deviation in primary exports is shown by the estimate of equations (2) and (4) in table 2.

The share of investment in GNP (I) is the only other structural characteristic which has been found to influence the share of industry. Its effect is shown in equations (3) and (4) of table 2. The most satisfactory explanation is obtained by the addition of primary exports and investment together. This has the effect of raising the proportion of the variance explained by y and N above from .73 in eq.(1) to .78 in eq.(4). This is comparable to the effect of the change from a linear to a non-linear regression on y, which increased the value of R^2 from .69 to .73. The theoretical gains from this reformulation are demonstrated in the next section.

[1/] The equation used for the export prediction is number (5) in Table 2. The deviation from the value predicted by equation (5) is: $(\ln Ep - \ln \hat{E}p)$

Table 2

Regression Equations for Industry (M) and Primary Exports (E_p)

Regression coefficients with respect to:

Equation	Sample	ln y (β_1)	$(\ln y)^2$ (β_2)	N (γ)	I (δ)	$(\ln E_p - \ln \hat{E}_p)$ (ε)	Intercept (α)	$\bar{R}^2$	Standard Error
Equations for M									
(1)	A	1.496	-.096	.066			-2.41	.73	.24
		(.11)	(.01)	(.01)					
(2)	B	1.620	-.106	.068		-.132	-2.81	.76	.23
		(.12)	(.01)	(.01)		(.01)			
(3)	B'	1.584	-.105	.073	.194		-3.21	.73	.24
		(.13)	(.01)	(.01)	(.03)				
(4)	B'	1.551	-.103	.072	.245	-.153	-3.21	.78	.21
		(.16)	(.01)	(.01)	(.03)	(.01)			
Equation for E_p									
(5)	B	-2.060	.146	.517			10.37	.52	.68
		(.37)	(.03)	(.03)					

Where I is share of investment in GNP, E_p is the share of primary exports in GNP and $(\ln E_p - \ln \hat{E}_p)$ is the deviation from the value predicted ($\hat{E}_p$) by eq.(5).
Standard errors of the coefficients are given immediately beneath them in parentheses.

Income elasticity = $\frac{y}{M} \cdot \frac{dM}{dy} = \beta_1 + 2\beta_2 \ln y$

B. Characteristics of the Intercountry Pattern

1. Income Effects

The intercountry pattern described by equation (4) is shown graphically in figure 1. The non-linear term in the income regression gives a rapid rise in the share of industry at low income levels and a slowing down in this rise as per capita income increases. The income elasticities for industry decline from 0.75 at an income level of $50 per capita to 0.13 at a level of $1,000, as shown in table 3.[1/] This decline is consistent with changes in both demand and supply conditions. On the demand side, declining elasticities are inevitable for all commodities having an income elasticity greater than one, since otherwise this group of commodities would take up an ever increasing share of total consumption. On the supply side, the possibilities of substituting local production for imports when import proportions are large account for the high growth elasticities, but these possibilities become less important as income increases and the proportion of imports declines. These two factors provide plausible explanations of the fact that the rise in industrialization is most pronounced at low income levels.

At the highest income levels, a third factor, the rise in the relative prices of services, is probably also significant in explaining the fall in the share of industry

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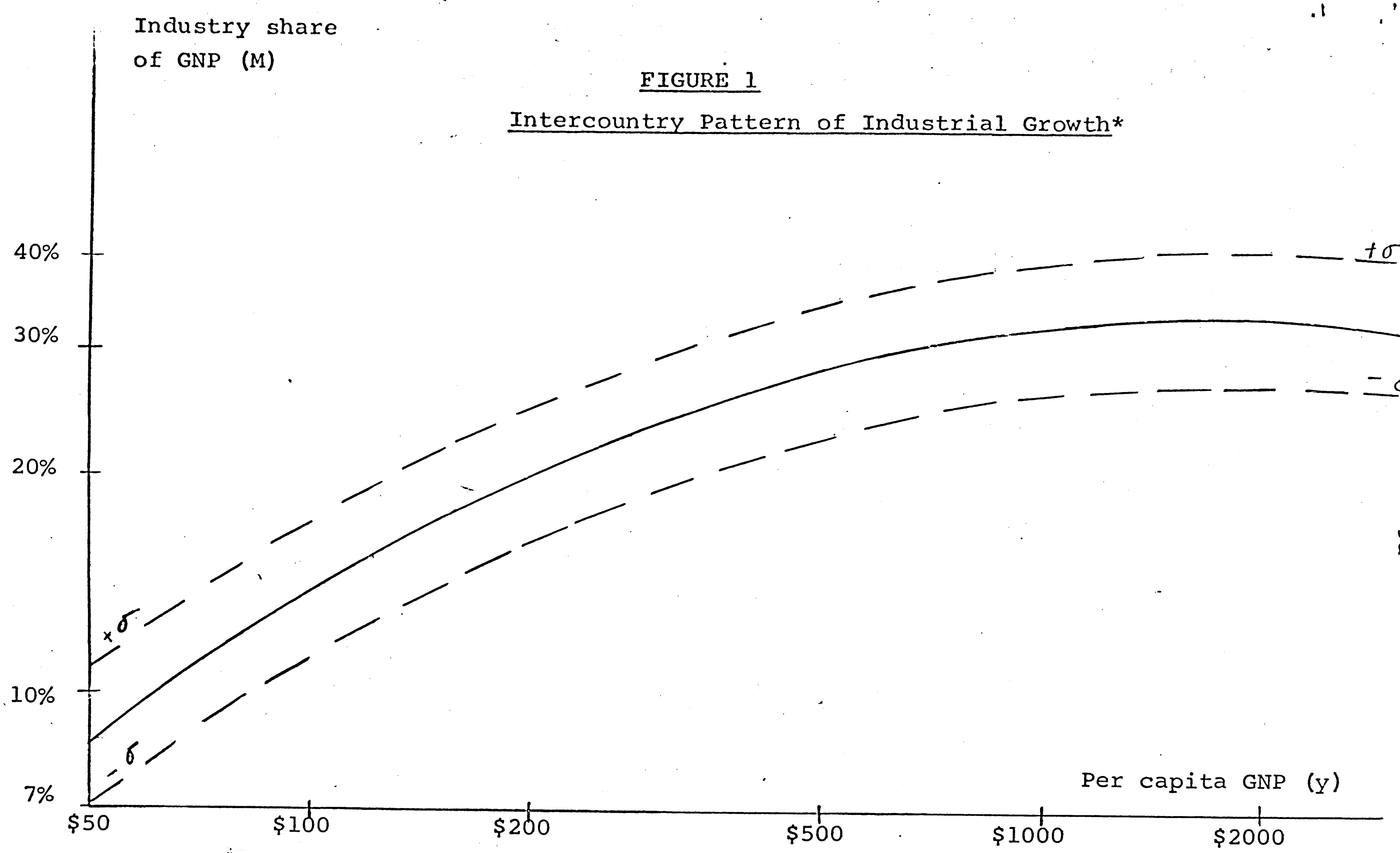
1/ In the formulation used in /1/ and /10/, these values correspond to elasticities of per capita industrial output with respect to per capita GNP of 1.75 and 1.13.

FIGURE 1

Intercountry Pattern of Industrial Growth*



* Calculated for
N = 10 million, I = 18.5%, $E_p/\hat{E}_p = 1.0$ (Source: Equation 4, Table 2.)
(Dashed lines indicate one standard deviation
above and below predicted values.)

TABLE 3

Elasticity of Industrial Share with respect to per capita GNP at varying levels of GNP[1/]

Per Capita GNP (y)	Elasticity
50	0.75
100	0.60
200	0.46
500	0.27
1,000	0.13
2,000	-0.01

1/ Derived from equation (4) of Table 2. The elasticity is (1.55 - .206 ln y) in Canada and the United States although this effect is not yet evident in the data for Europe. There are too few countries with incomes above $1200 per capita to have much confidence in the estimates above this level, but apart from the United States the regression fits the high income countries quite well.

2. Size Effects

The population of a country combined with its per capita income determines the size of the domestic market. This in turn has an effect on a country's comparative advantage in international trade, favoring the development of industries having economies of scale in large countries and discouraging them in small ones. The overall measure of this scale effect on the share of industry is given by the elasticity with respect to population size of about .07 in all four of the equations in table 2.[1] The observed variation in size of country accounts for a variation of about 20% above and below the share of industry predicted by per capita GNP alone.

The effect of size is most pronounced in basic metals, metal products, chemicals, paper, and rubber products, as shown in /1/ and /10/. In all cases it is greater at low income levels than at high income levels, which suggests that there is a minimum total market required for the establishment of each branch of

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1/ This is the same size elasticity as found in the United Nations study /10/ for 1953 in the unweighted regression. The value in the weighted regression was .12.

industry.[1] The most detailed analysis of size effects is given in /10, p. 40/, which includes separate regressions for each industrial sector and for high and low income countries.

3. Resource Effects

A country having relatively rich natural resources will tend to export a higher proportion of primary products and secure a higher proportion of its manufactured goods through imports. The isolation of this effect is complicated by the fact that all exports tend to decline as the size of the country increases. Primary exports tend to decline as per capita income rises and comparative advantage shifts toward manufactured goods although the rates of all exports to GNP is not affected by the level of per capita income.

We have isolated resource effects by first computing the expected value of primary exports for a country's size and population and then using the deviation from this predicted value as a measure of relative resource endowments. It was shown in /2/ that this was the best single measure of resources available for all countries.

1/ As observed below, high resource countries have an abnormally low industrial share of GNP. If scale economies exist, as suggested here, the stunted growth of industry in high resource countries can be attributed to the constriction of the domestic market created by specialization in export commodities.

The effect on the industrial share of variation in primary exports from their normal value is also shown in figure 2. The relative magnitude of this effect is comparable to that of size variation. In several countries having extremely high primary exports, such as Venezuela, Malaysia, Iraq and Ceylon, the share of industry is considerably less than predicted, suggesting that the effect on resources may be non-linear at high resource levels.

4. Deviations from the Normal Pattern. The variation in the degree of industrialization that is not explained by the four factors in equation (4) is shown by the difference between the actual and predicted value of the industry share for each country. The ratios of these values are given in table 5 below. The standard error of estimate in this equation is equal to a percentage variation of about 25% of the predicted value, which is shown by the two dashed lines in figure 1.

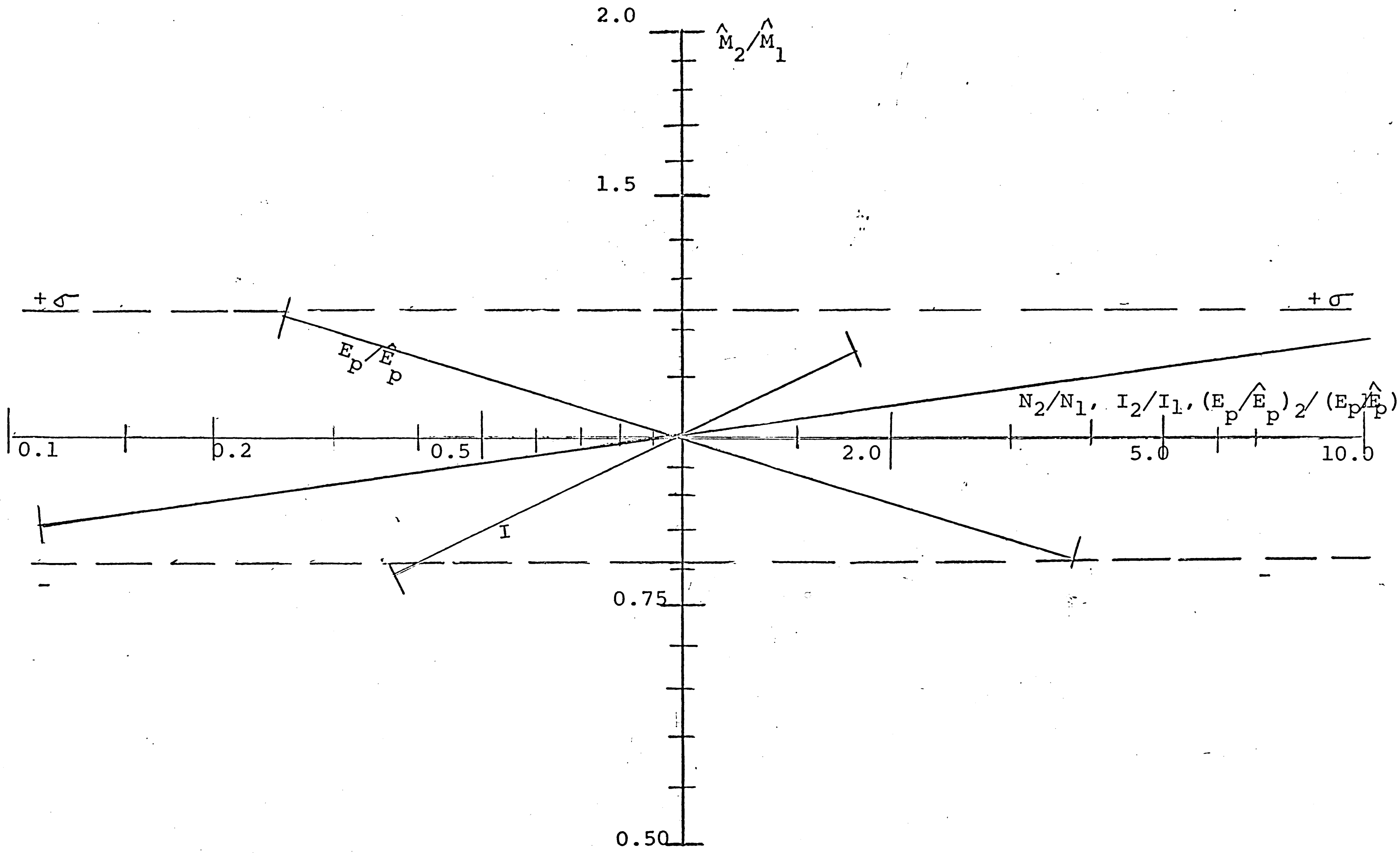
TABLE 4

Results of time series regressions for M

Country	Number of Observations	Elasticity with respect to y (β_1)	Standard Error of β_1	Intercept (α)	$\bar{R}^2$	Equation Standard Error	Durbin-Watson Statistic
Nigeria	13	2.0225	.543	-6.2110	.4784	.1237	.9343
Burma	14	1.6048	.167	-3.9125	.8652	.0949	1.8502
Pakistan	14	3.8977	1.062	-14.0783	.4494	.1507	.5675
Haiti	11	-.1936	.262	3.3934	0	.0235	1.8380
Kenya	14	.2674	.460	1.3920	0	.0938	.5700
Cambodia	13	1.1317	.232	-2.6874	.8641	.0622	1.9129
Thailand	13	.2729	.080	1.5295	.4250	.0319	1.2458
Congo	10	1.9897	.703	-6.4439	.3766	.1486	1.2220
Bolivia	14	.5586	.486	-0.0117	0	.1046	1.0528
Taiwan	13	.3187	.127	1.5874	.2469	.0714	1.6572
Korea	11	2.3585	.169	-8.8494	.9460	.0372	2.1812
Ceylon	14	1.3364	.488	-4.1058	.2829	.0777	1.3390
Rhodesia/ Nyassaland	10	.2712	.353	1.4853	0	.0906	.8901
Paraguay	14	-.2279	.155	4.1230	0	.0248	1.2900
Ecuador	14	.2307	.111	1.7596	.1234	.0247	1.2706
Tunisia	14	.3308	.262	1.1681	0	.0781	1.3560
Peru	14	.4736	.087	.6090	.6607	.0337	.4686
Turkey	14	.0193	1.123	2.8745	0	.0418	1.1278
Philippines	14	1.0984	.101	-2.8434	.8928	.0371	.8394
El Salvador	13	.3419	.210	.7757	.0483	.0624	1.3867
Iraq	11	.1920	.275	1.5353	0	.1363	.5811
Honduras	13	.4948	.456	.1669	0	.0732	.5393
Algeria	11	-.0945	.129	3.3973	0	.0687	1.0437
Portugal	14	.3711	.047	1.5410	.8119	.0295	1.4520
Guatemala	14	.2641	.192	1.2657	0	.0347	1.2276
Colombia	14	.8328	.069	-1.6445	.9109	.0232	.6282
Malaya	8	.9335	.244	-2.7624	.6116	.0336	1.6294
Mexico	14	.3745	.047	1.0742	.8045	.0206	1.2424
Costa Rica	13	.5354	.213	-.3536	.2499	.0596	.6212
Jamaica	14	.1471	.053	2.3853	.2918	.0428	.9492
Japan	14	.3204	.033	1.6001	.8709	.0396	.9048

TABLE 4 (continued)

Country	Number of Observations	Elasticity with respect to y (1)	Standard Error of 1	Intercept ( )	$\bar{R}^2$	Equation Standard Error	Durbin-Watson Statistic
Greece	14	.4287	.051	.5850	.8313	.0402	1.8804
Spain	10	.2117	.046	2.1208	.6459	.0166	2.0263
Uruguay	9	.3906	.296	.8624	0	.0377	.8359
Argentina	14	.5567	.129	.0574	.5437	.0262	1.9199
Italy	14	.6017	.022	-.2169	.9817	.0173	1.1490
Chile	14	.2777	.281	1.2840	0	.0514	.6458
Israel	12	.0727	.036	2.9604	.1470	.0259	.9103
Puerto Rico	14	.5718	.045	-.4573	.9198	.0319	.9101
Austria	14	.1325	.029	2.9651	.5854	.0221	1.2334
Netherlands	12	.2487	.039	1.9322	.7623	.0161	2.4929
Venezuela	14	.1231	.113	2.0642	0	.0548	.6327
Finland	14	.4516	.046	.6054	.8683	.0238	.6686
Germany	14	.2774	.019	1.8887	.9359	.0171	.3674
Denmark	14	.1820	.041	2.3009	.5630	.0201	.8564
Belgium	14	.3071	.505	1.3756	.7204	.0177	1.6710
France	14	.1788	.018	2.5060	.8748	.0094	1.3645
Norway	14	-.0777	.033	4.0685	.1986	.0129	1.8317
United Kingdom	14	.3174	.035	1.4545	.8508	.0106	1.0176
Australia	14	.8074	.218	-2.3085	.4951	.0508	1.5639
Canada	14	-.2464	.099	5.3644	.2302	.0205	.8785
United States of America	14	-.2390	.14	5.3946	.049	.03	1.538



Source: Equation (4) Table 2.

FIGURE 2.

Effects of changes in the explanatory variables on predicted industry share. (Lines are terminated at the extreme values in the sample with respect to the means of I and $E_p/\hat{E}_p$, and the median of N).

III. INDUSTRIAL GROWTH OVER TIME

The analysis of intercountry variation in the degree of industrialization suggests several factors affecting this increase of industry over time that can be tested by time series regressions. It is clear from the cross-section studies that income level, size of country, and export pattern have important effects on the initial share of industry. Of these variables, the income level is the only one which has the same economic significance when applied to short time-series. We do not expect to see the same short-run adaptation to small changes in market size and export levels as the long-term effects that are reflected in the cross-section results.

The fact that the cross-section pattern is quite stable over the period studied shows that differences in income elasticities among countries at the same initial level must be largely offsetting. We will test whether the initial deviation from the cross-section normal affects the subsequent income elasticity, since this factor should be taken into account in using the results for projections. We will also utilize the cross-sectional pattern to identify groups of countries that have shown similar patterns of industrialization.

A. Time Series for All Countries

The results of regressing the industrial share on per capita income are shown for each country in table 4 and graphically in figure 3. When all the observations are pooled in a single "time series" regression using dummy variables to allow for country levels, the income elasticity estimated is .39, almost identical to the elasticity for the comparable (linear) cross-section regression. However, there is such variability among countries that factors other than rising income level are clearly of great importance.

To try to explain the variation in growth elasticities, we have estimated the effect of the initial deviation of the share of industry from the level predicted by the intercountry analysis. The regression equations took the following form:

$$(6) \quad \beta_t = c_1 + c_2 D$$

$$(7) \quad \beta_t - \beta_c = d_1 + d_2 D$$

where:

β_t = time-series growth elasticity

β_c = cross-section growth elasticity at the country's mean level of per capita GNP

D = difference between actual mean industry share and predicted mean (in logarithmic form)

These equations were estimated for deviations from the cross-section equations (2) and (4) with similar results in each case.

For countries having positive deviations from their predicted industry share, there was no relation between the time series elasticity and deviation. However, for countries starting with less than the predicted amount of industry, the following estimates were obtained, using deviations from equation (2):

TABLE 5

Relationship of Cross-Section and Time Series Results

Country	Per Capita Income (y)	Cross-Section Elas. from Eq. (2) at Y ($\beta_c = \beta_{1c} + 2\beta_{2c} \ln y$)	Time Series Growth Elasticity ($\beta_1 t$)	Time Series Elas. Minus Cross-Section Elas. ($\beta_{1t} - \beta_c$)	Ratio of Actual M to Predicted M from Eq(4) ($M/\hat{M}$)	Ratio of Actual E_p to Predicted Ep ($E_p/\hat{E}_p$)	Population (N)
Group A							
1. Nigeria	57.5	.76	2.02	1.26	.82	1.28	48.9
2. Burma	59.1	.74	1.60	.86	1.45	1.02	20.3
3. Pakistan	67.5	.73	3.90	3.17	.95	1.11	94.0
6. Cambodia	86.3	(a)	1.13	(a)	(a)	(a)	5.1
8. Congo	92.4	.66	1.99	1.33	1.01	2.18	12.5
11. Korea	128.0	.60	2.36	1.76	.71	.29	23.5
12. Ceylon	131.4	.59	1.34	.75	.82	2.36	9.1
19. Philippines	190.7	.51	1.10	.59	1.21	2.12	24.9
26. Colombia	258.7	.44	.83	.39	.90	1.57	13.1
27. Malaya	267.8	.44	.93	.49	.68	3.42	6.6
Common Elasticity for Group A.			1.51 (b)				
Group B							
5. Kenya	74.8	.72	.27	-.45	1.21	1.04	7.4
7. Thailand	87.6	.65	.27	-.38	1.28	1.72	24.3
9. Bolivia	120.2	.61	.56	-.05	(a)	.59	3.3
10. Taiwan	125.8	.56	.32	-.24	1.32	.50	9.6
13. Rhodesia/ Nyasaland	138.0	.58	.27	-.31	.94	1.08	9.3
15. Ecuador	164.8	.54	.23	-.31	1.12	.85	3.9
16. Tunisia	177.2	.52	.33	-.19	.98	.64	4.0
17. Peru	182.2	.52	.47	-.05	1.11	1.17	9.4
18. Turkey	187.5	.51	.02	-.49	.99	.92	25.3
22. Honduras	202.0	.49	.49	0.0	.94	.68	1.6
24. Portugal	239.8	.48	.37	-.09	1.65	.76	8.7
28. Mexico	316.9	.40	.37	-.03	1.08	1.55	31.7
30. Jamaica	329.2	.40	.15	-.25	1.17	1.14	1.5
31. Japan	344.0	.39	.32	-.07	.90	.51	89.9

TABLE 5 (continued)

Country	Per Capita Income (y)	Cross-Section Elas. from Eq. (2) at Y ($\beta_c = \beta_{1c} - 2\beta_{2c} \ln y$)	Time Series Growth Elasticity ($\beta_1 t$)	Time Series Elas. Minus Cross-Section Elas. ($\beta_{1t} - \beta_c$)	Ratio of Actual M to Predicted M from Eq (4) ($M/\hat{M}$)	Ratio of Actual E_p to Predicted $\hat{E}_p$ ($E_p/\hat{E}_p$)	Population (N)
32. Greece	344.4	.38	.43	.05	.90	.90	8.1
33. Spain	349.4	.38	.21	-.17	1.04	1.05	29.9
34. Uruguay	442.5	(a)	.39	(a)	(a)	(a)	2.8
35. Argentina	547.1	.29	.56	.27	1.27	1.97	19.4
36. Italy	550.9	.29	.60	.31	1.04	.81	48.6
38. Israel	602.9	.27	.07	-.20	.89	.32	2.0
Common Elasticity for Group B.			.36 (c)				
Group C							
20. El Salvador	191.2	.51	.34	-.17	.81	.83	12.3
21. Iraq	201.5	.50	.19	-.31	.79	3.25	6.4
25. Guatemala	257.3	.44	.26	-.18	.78	.64	3.4
29. Costa Rica	326.9	.39	.54	.15	.69	.70	1.0
37. Chile	557.0	.28	.28	0.0	.83	.78	7.1
42. Venezuela	847.7	.19	.12	-.07	.66	3.74	6.5
Common Elasticity for Group C.			.23				
Group D							
40. Austria	732.6	.24	.13	-.11	1.36	.60	7.0
41. Netherlands	846.5	.20	.25	.05	1.26	2.41	10.8
43. Finland	891.3	.17	.45	.28	1.28	1.19	4.3
44. Germany	1057.2	.16	.28	.12	.95	.26	53.5
45. Denmark	1168.3	.13	.18	.05	1.30	1.98	4.5
46. Belgium	1175.1	.13	.31	.18	.95	.47	9.0
47. France	1179.3	.13	.18	.05	1.15	.83	44.3
48. Norway	1184.2	.13	-.08	-.21	1.01	1.34	3.5
49. United King.	1259.9	.12	.32	.20	1.04	.48	51.8
Common Elasticity for Group D.			.22				

TABLE 5 (continued)

Country	Per Capita Income (y)	Cross-Section Elas. from Eq. (2) at Y ($\beta_c = \beta_{1c} - 2\beta_{2c} \ln y$)	Time Series Growth Elasticity ($\beta_1 t$)	Time Series Elas. Minus Cross-Section Elas. ($\beta_{1t} - \beta_c$)	Ratio of Actual M to Predicted M from Eq (4) ($M/\hat{M}$)	Ratio of Actual E_p to Predicted E ($E_p/\hat{E}_p$)	Population (N)
Not Grouped							
4. Haiti	70.7	.72	-.19	-.91	1.35	.37	3.7
14. Paraguay	156.6	.55	-.23	-.78	1.12	.39	1.6
23. Algeria	224.4	.46	-.09	-.55	.80	1.90	9.7
39. Puerto Rico	677.6	(a)	.57	(a)	(a)	(a)	2.3
50. Australia	1458.8	.08	.81	.73	1.09	1.84	9.5
51. Canada	2046.3	.01	-.25	-.26	.96	1.84	16.4
52. U.S.A.	2710.1	-.05	-.24	-.19	.78	.69	170.4

(a) Data not available for making a prediction from cross-section equations.

(b) Common elasticity not including Colombia, whose growth elasticity is significantly less than those of the other countries in Group A. With Colombia the common elasticity is 1.46.

(c) Common elasticity computed without Turkey and Israel, which have growth elasticities significantly less than the other countries in Group B. With Turkey and Israel, the common elasticity is .32.

$$(6')\quad \rho_t = \underset{(.23)}{.21} - \underset{(0.95)}{1.54}\,D \qquad R^2 = .12$$

$$(7')\quad \rho_t - \rho_c = \underset{(.19)}{-.11} - \underset{(0.80)}{1.42}\,D \qquad R^2 = .14$$

Both equations show a definite movement of countries having less than the normal amount of industry toward the normal. The coefficient is significantly different from zero and the phenomenon appears strongly in 8 of the 22 countries having negative deviations. The only countries having time series elasticities much lower than normal despite a significantly low initial share of industry are Algeria, Iraq, and Turkey. This tendency for less industrialized countries to approach the cross-sectional normal is therefore sufficiently pronounced to be taken into account in making projections.

B. Postwar Growth Patterns

We have not succeeded in explaining the remaining differences between time series and cross-section growth elasticities by adding other variables to the regression analysis. However, a rough classification of countries into four groups according to their structural characteristics and postwar growth patterns is suggested by the analysis in table 5 and figure 3. The countries in each group are given in table 5. Their common characteristics are as follows:

Country Index

Group A

1-Nigeria
2-Burma
3-Pakistan
6-Cambodia
8-Congo
11-Korea
12-Ceylon
19-Philippines
26-Colombia
27-Malaya

Group B

5-Kenya
7-Thailand
9-Bolivia
10-Taiwan
13-Rhodesia-Nyasaland
15-Ecuador
16-Tunisia
17-Peru
18-Turkey
22-Honduras
24-Portugal
28-Mexico
30-Jamaica
31-Japan
32-Greece
33-Spain
34-Uruguay
35-Argentina
36-Italy
38-Israel

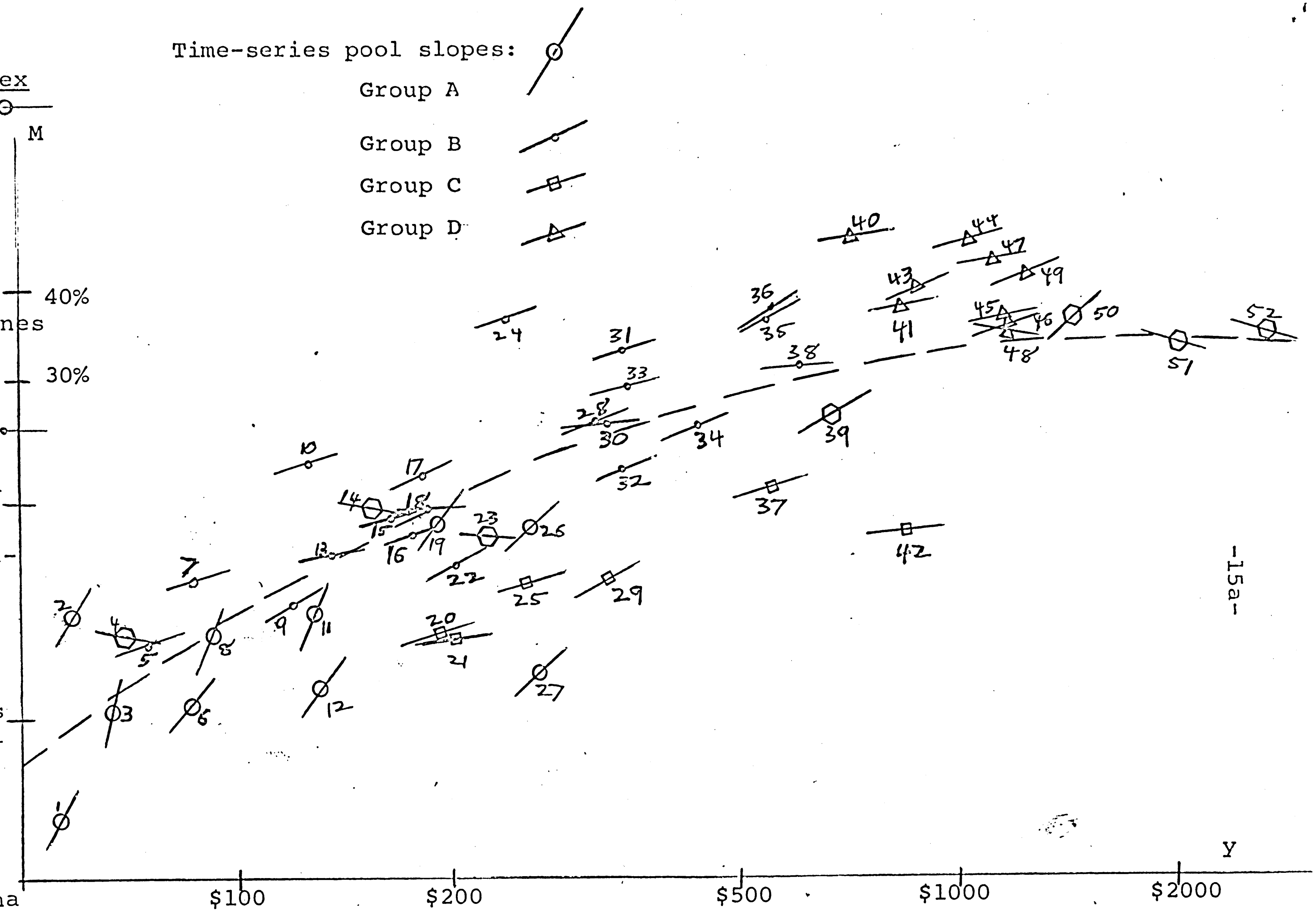


FIGURE 3. Time-series Growth Patterns.

Group C

20-El Salvador
21-Iraq
25-Guatamala
29-Costa Rica
37-Chile
42-Venezuela

Group D

40-Austria
41-Netherlands
43-Finland
44-Germany
45-Denmark
46-Belgium
47-France
48-Norway
49-United Kingdom

Not Grouped

4- Haiti
14-Paraguay
23-Algeria
39-Puerto Rico
50-Australia
51-Canada
52-U.S.A.

Group A: Low income, rapidly industrializing countries; with relatively high primary exports.[1] Average growth elasticity 1.51.

Group B: Low and middle income (y = 100 to 600), normally industrializing countries. Average growth elasticity .36.

Group C: Middle income, small, high resource countries with relatively slow industrialization. Average growth elasticity .23.

Group D: High income, normally industrializing countries. Average growth elasticity .22.

To test the validity of these categories, we fitted a single regression to each group, using dummy variables for country levels. The common elasticities are given above, and the four representative growth paths plotted in figure 3. For Groups B and D, the elasticities are not significantly different from the corresponding cross-section results.[2] For these groups of countries, therefore, the cross-section pattern provides a good basis for time-series projections.

Group A includes a number of countries -- Nigeria, Pakistan, Korea, Ceylon, Malaya, Colombia -- having less than normal amounts of industry but approaching the normal rapidly. It includes three others -- Burma, Congo and the Philippines -- which do not start with negative deviations and for which other reasons for high elasticities must be sought.

1/ In the case of Korea foreign aid takes the place of primary exports.

2/ When the non-linearity in the cross-section is taken into account.

The behavior of Group C countries is the opposite of that in Group A: slower industrialization than that predicted by the cross-section pattern. This group comprises six small countries which have tended until recently to maintain their previous pattern of primary exports rather than to industrialize. In earlier periods primary exports had been relatively high, but this condition has only continued into the 1950's in Venezuela and Iraq.

While the remaining countries in table 3 do not fit well in any of these groups, they suggest other possible patterns of which there may be only a few examples. Haiti, Paraguay and Algeria have negative income elasticities that are plausibly explained by political disruption. Except for their high income levels, Puerto Rico and Australia would fit in Group A. The negative elasticities of Canada and the United States may be the result of rising prices in the service sectors.

The net effect of this comparison of the time series and cross-section growth elasticities is to suggest that for most low and middle income countries the cross-section pattern would provide some assistance in making projections if used with caution. Regional differences are largely explainable by initial income levels and export patterns. While there is nothing immutable about the long-term relationships reflected in the cross-section pattern, neither is there evidence of a systematic change during recent years.

C. Historical Patterns of Industrialization

Some further support for the use of the cross-section pattern for long-term projections is given by the comparison in figure 4 of growth patterns over 50 year or more of six presently advanced countries. Plotted for comparison are the cross-sectional norms for low resource $(+\delta)$ and high resource $(-\delta)$ countries of 50 million population. The historical similarities to the cross-section pattern are particularly close for Japan (low resource) and Canada (high resource). Some of the changes in relative position, such as those of Argentina and Germany, reflect changes in markets for their primary exports. While it should not be pretended that there is a close fit between the country growth patterns over long periods and the present cross-country pattern, there is certainly a general similarity.

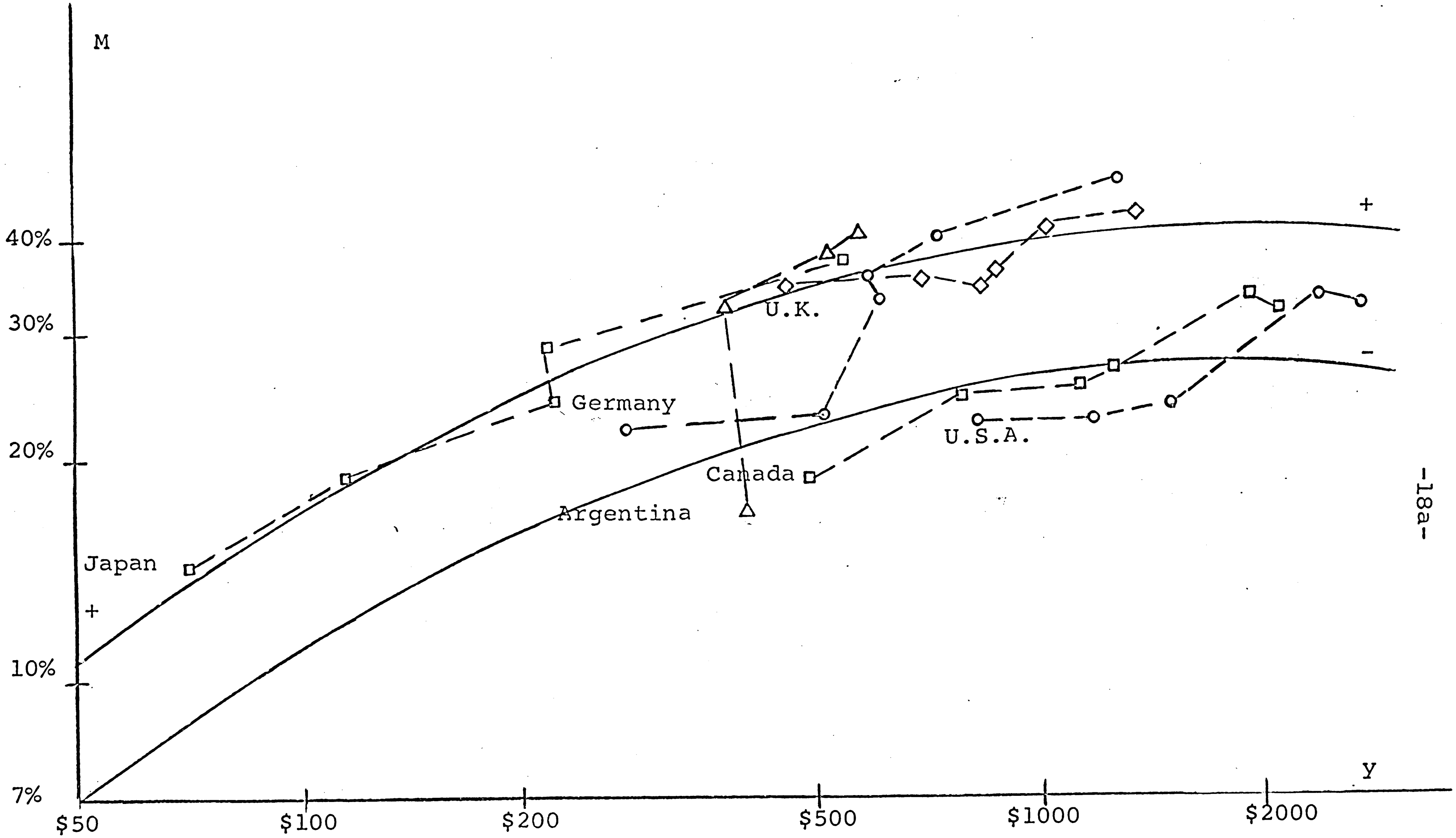


FIGURE 4.

Historical growth patterns (reference lines indicate ± one standard deviation from eq. (4)). Source: P.Temin (9), and references cited therein: Canada, O.J. Firestone, Income and Wealth, Series VII; Germany, P.Jostock, Income and Wealth, Series V; Japan, K. Ohkawa, Growth Rate of the Japanese Economy; U.K., P. Deane and W. A. Coale, British Economic Growth: U.S.A., Historical Statistics; Argentina, Unpublished manuscript by C. Diaz-Alejandro.

IV. CONCLUSIONS

When considering all industry, we conclude that the overall pattern of change in the postwar world bears a marked similarity to the average cross-sectional pattern. Since industry is growing at 7-8% per year, this similarity is likely to persist because the intercountry pattern at any moment will be dominated by events of the recent past. There is, however, a substantial amount of intercountry variation in industrial growth that is not associated with the variables we have considered.

When industry is disaggregated, we must expect to find greater variability and less uniformity in the time series relationships.[1] We do not anticipate that disaggregated studies will show the lack of correspondence found by Steuer and Voivodas in their indirect test of industrial patterns by means of import ratios over a seven year period. It is clear, however, that intercountry relations alone do not provide a good basis for short-term forecasting.

The most useful policy results of our study lie in the area of perspective planning for 10-20 year periods. At this distance the model approach to forecasting tends to break down because of cumulative changes in the structural relationships on which it is based. Greater resort must therefore be made to the experience of other countries.

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[1] This analysis will be undertaken as soon as the UN tabulation of data for 1963 is completed.

Most developing countries should be able to get some useful insights into the range of industrial output that they should plan for from the results given here. For countries aiming at rapid industrialization to correct an initial structural imbalance, the experience of countries in our Group A should be enlightening.

Finally, we would stress the inherent limitation of statistical analysis in providing guides to policy. The "normal pattern," however regular it may be, tells us little about optimal resource allocation. It merely summarizes the experience that countries have had to date.

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STATISTICAL APPENDIX

I. Statistical Data

Our chief source of data was worksheets provided by the Economic Projections Section, Center for Development Planning, Projections, and Policies, United Nations, which provided us with time series for most of the 52 countries on GNP, population, GDP by industrial origin, exports, and gross fixed capital formation, all expressed in 1960 U.S. dollars. For some countries, we derived additional data on industrial value added from the U.N. Statistical Yearbooks. Data on the ratio of primary exports[1/] to total exports in current prices came from the U.N. Yearbooks of International Trade Statistics, and we applied this ratio to our constant dollar export data to derive our series of primary exports in final form.

As indicated in table 1 we worked from three separate samples, as follows:

Sample A: 682 observations, 52 countries
Variables: M, y, N

Sample B: 542 observations, 49 countries (Cambodia, Uruguay and Puerto Rico missing from sample A)
Variables: M, y, N, E_p

Sample B': 542 observations, 48 countries (Bolivia missing from sample B)
Variables: M, y, N, E_p, I

[1/] We defined primary exports as being classes 0, 121, 2 (not including 266), 331, 341.1, 4, and 941 of the Revised Standard International Trade Classification.

TABLE A-1

MATRIX OF SIMPLE CORRELATION COEFFICIENTS OF VARIABLES USE D IN REGRESSION ANALYSIS

	ln M	ln y	$(\ln y)^2$	ln N	ln E_p	ln I	$(\ln E_p - \ln \hat{E}_p)$
ln M	1.00	.81	.80	.19	-.56	.45	-.22
ln y		1.00	.99	.13	-.43	.40	0.00
$(\ln y)^2$			1.00	.16	-.43	.40	0.00
ln N				1.00	-.62	-.01	0.00
ln E_p					1.00	-.03	.78
ln I						1.00	.10
$(\ln E_p - \ln \hat{E}_p)$							1.00

SOURCE: Calculations from Sample B'.

The standard measures of central tendency for the basic variables of sample B' are:

	Mean	Median
M	25.4%	19.7%
y	\$580.6	\$260.0
N	23.0 million	9.1 million
E_p	13.0%	12.6%
I	18.4%	17.8%

Table A-1 gives the simple correlation coefficients among the variables actually used for regression analysis. Because of the high collinearity between ln y and $(\ln y)^2$, a double-precision regression program[1] was used throughout the analysis.

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[1] SLAP-C, coded by John Brode for the IBM 7094 at the Harvard Computing Center.

II. Pooling of Yearly Samples

All of the many-countries regressions of table 2 were fitted to our entire sample of data, ignoring any effects of time, which could conceivably cause changes in the coefficients of the 14 yearly cross-sections. To test against such time effects, we did an analysis of covariance of the yearly cross-sectional groups. The technique is standard, and is well described in the literature.[1/]

The results of the 14 yearly cross-section regressions of ln M on y, $(\ln y)^2$, and ln N are given in table A-2.[2/] To test whether the regressions can be pooled, one finds the total unexplained sum-of-squares of the 14 separate regressions with their individual sets of coefficients, and then the unexplained sum-of-squares of a pool regression where equality is forced on the yearly coefficients. The difference of these two sums-of-squares, corrected for degrees of freedom, provides the numerator of an F-ratio.

1/ See Gregory Chow, "Tests of Equality Between Sets of Coefficients in Two Linear Regressions," Econometrica, Vol. 28, No. 3, July, 1960, for an excellent theoretical treatment of analysis of covariance as applied to regression equations.

2/ Simple inspection of the coefficients in table A-2 seems to suggest that time trends are present -- in particular a decline in β_1 and increases in α and β_2. However, the relatively large standard errors of these coefficients imply that the trends are more apparent than real.

TABLE A-2

YEARLY CROSS-SECTION REGRESSIONS FOR ln M

Year	Number of Obs.	Regression Coefficient with Respect to: ln y (β_1)	(ln y)^2 (β_2)	ln N (γ)	Intercept (α)	$\bar{R}^2$	Standard Error
1950	43	2.09 (.46)	-.15 (.04)	.07 (.04)	-4.15 (1.31)	.75	.26
1951	45	1.80 (.47)	-.12 (.04)	.06 (.04)	-3.26 (1.36)	.72	.27
1952	46	1.88 (.45)	-.13 (.04)	.06 (.03)	-3.47 (1.31)	.73	.26
1953	47	1.82 (.45)	-.12 (.04)	.05 (.03)	-3.39 (1.30)	.75	.25
1954	50	1.58 (.45)	-.10 (.04)	.06 (.03)	-2.66 (1.29)	.72	.25
1955	52	1.36 (.43)	-.08 (.04)	.06 (.03)	-2.00 (1.26)	.71	.25
1956	52	1.33 (.43)	-.08 (.04)	.06 (.03)	-1.88 (1.27)	.70	.25
1957	52	1.30 (.44)	-.08 (.04)	.07 (.03)	-1.82 (1.30)	.69	.25
1958	52	1.28 (.43)	-.08 (.04)	.07 (.03)	-1.75 (1.27)	.69	.25
1959	52	1.20 (.43)	-.07 (.04)	.07 (.03)	-1.50 (1.25)	.69	.25

TABLE A-2 (continued)

Year	Number of Obs.	Regression Coefficient with Respect to: ln y (β_1)	(ln y)^2 (β_2)	ln N (γ)	Intercept (α)	$\bar{R}^2$	Standard Error
1960	51	1.26 (.44)	-.08 (.04)	.07 (.03)	-1.50 (1.29)	.69	.24
1961	49	1.29 (.48)	-.08 (.04)	.08 (.03)	-1.70 (1.42)	.67	.25
1962	45	1.25 (.47)	-.08 (.04)	.08 (.03)	-1.70 (1.40)	.67	.25
1963	43	1.14 (.46)	-.07 (.04)	.06 (.03)	-1.24 (1.37)	.66	.24
Pool	622	1.50 (.11)	-.10 (.01)	.07 (.01)	-2.41 (.33)	.73	.24

The denominator is the total variance of the 14 separate regressions, from the alternative hypothesis that there really are different cross-sectional elasticities in separate years.

For our equations, estimated on Sample A (682 observations), the results of this testing procedure are summarized in the following analysis of variance table.

Variation due to	Unexplained Sum-of-squares	D.F.	F
H_{null}: $\alpha_t = \alpha$, $\beta_{1t} = \beta_1$, $\beta_{2t} = \beta_2$, $\gamma_t = \gamma$	39.8378	678	
H_{alt}: $\alpha_t = \alpha_t$, $\beta_{1t} = \beta_{1t}$, $\beta_{2t} = \beta_{2t}$, $\gamma_t = \gamma_t$	39.0628	626	
Difference	.7750	52	0.26

Clearly, we cannot reject the null hypothesis of no year effects on the cross-section regression coefficients.

Similar results obtained in the regression of the log of primary exports on ln y, $(\ln y)^2$, and ln N, with the analysis of variance table as follows:

Variation due to		Unexplained Sums-of-squares	D.F.	F
H_{null}:	No year effects	269.6713	550	
H_{alt}:	Separate coeffs. for all years	243.0949	498	
Difference		26.5764	52	1.05 1/

Although we did not test explicitly for the absence of time-effects when investment is included in the equation for M, it seems clear from the data and the tests given here that such effects could not be very important.

1/ For 52 and 498 degrees of freedom, the rejection levels for F are 1.38 (5%) and 1.57 (1%).