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Faculty Working Papers

THE RELATIONSHIP BETWEEN POPULATION AND ECONOMIC GROWTH IN LDC'S

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#530

College of Commerce and Business Administration
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Summary:

The relationship of population to economic growth is studied in cross-sections of LDC countries for 1960-1970, 1950-1960, and 1950-1970, in a multivariate fashion. The non-correlation of population growth with economic growth found by previous investigators in bivariate studies is confirmed here. And population size is found to have no effect. But population density is found to have an unequivocal and strong positive effect upon economic growth.

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THE RELATIONSHIP BETWEEN POPULATION AND ECONOMIC GROWTH IN LDC'S

Julian L. Simon and Roy Gobin*

INTRODUCTION

Does a larger number of people in a country imply poorer or better economic performance? That is the general question this paper addresses. It is the same question that has itched such students of population as Aristotle and Plato, William Petty, and Robert Malthus.

The answer we offer is that more people mean better economic performance. The benefit arises from greater population density. Total population size, and the rate of population growth, have little independent effect on economic growth, we find.

How to evaluate the effect of population on a country's economy is far from obvious. A key issue is the choice of variable used to measure population--total population, or population density, or the population growth rate, or some combination of the measures. Obviously the choice of proxy must depend on what we want to know, as well as upon the availability of data.

Total population, population density, and population growth rate clearly are interrelated statistically and economically, however. Their effects therefore must overlap. In this paper we consider <u>all</u> of these variables together, in order to sort out their effects.

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THEORY AND PAST WORK

1. One way of thinking about the effect of the number of people abstracts from the spatial dimension of a country and the rate of change of population, and considers total population size as an independent variable. The implicit theoretical justification is that there are economies to scale in infra-structure and specialization, and benefits from a larger domestic market, independent of the physical size of the country, which promote economic growth.

An important empirical investigation of this relationship is that of Chenery (1960), who found the elasticity of manufacturing output with respect to total population size to be .20 in a sample of 20 LDC's.

2. A second way to think about the number of people is to abstract from the total size and the population density, and examine the effect of the rate of growth of population on economic growth. The theoretical basis is that a higher rate of growth implies a higher dependency rate, with greater need for housing and other "demographic capital" which is provided at the expense of "productive capital" (Coale and Hoover, 1958).

There is an extensive literature on the effects of the rate of population growth on the rate of economic growth, in national time series and international cross-sections, as summarized in Simon (Chapters 3 and 7). There is solid consensus among those studies that the population growth rate is not associated negatively with the economic growth rate, in contradiction to the widely-accepted theory.

3. A third way to think about the number of people is to abstract from the total number and the rate of growth and to consider the number per unit of land--that is, population density. The theoretical basis

is that density can create economies of scale in social physical in structure such as transportation, as well as in personal and mass communications (Glover and Simon, 1975; Simon, 1975; Salehi Isfahani, 1976). On the other hand, density can have negative congestion effects.

The effect of density on the growth rate of per capita income has been studied graphically by Hagen (1975, p. 189); no pronounced effect is visually obvious, except that in the very low-density range, economic growth seems to be lower than at higher densities. And recently Stryker (1977) showed that in the Francophone countries, population density has a positive effect upon agricultural productivity.

THE METHOD

The method is the cross-country comparison of changes in per capita income and in the population variables, over the periods 1960-1970, 1950-1960, and 1950-1970. Our data are drawn from basic UN and World Bank sources. The samples are limited to countries that average less than $1000 income per capita over the sample period, and with more than half a million persons. Some of our samples are further limited to the countries included in the UN sample, and to those countries with data on income per worker. The composition of the various samples is given in Appendix A.

Our analyses are based on ordinary-least-squares regressions, using contemporaneous variables. The reader may worry about possible mutual causation between the poulation and economic variables, which would suggest the use of simultaneous-equations analysis. But in our judgment, causation running from economic growth to the population variables can

be ruled out a priori. With respect to the population growth rate, the observed correlation between it and the economic growth rate will be seen below to be very low, suggesting no causation in either direction and hence no confusion in identification. With respect to population density, the variations among nations are so great that the possible changes within one or two decades could not alter the relative levels enough to affect the results. With respect to population size, both of the above arguments apply.

As independent variables we worked with population--total, growth rate, and density--rather than with the fertility, mortality, migration, and labor force components. A study that worked with these components would be statistically clearer, and would permit sharper interpretations. But our results are sufficiently robust that it is unlikely that they would be altered by finer demographic catagories.

ANALYSIS AND RESULTS

The Effect of Population Growth

The Simple Effect. We begin by replicating the bivariate total-population analyses of Kuznets and others. The model is simply

$$(1) \qquad \left(\frac{Y}{P}\right)' = f(P)'$$

where Y = national income

P = population

Later, L = land area

′ signifies rate of change of a variable

As a check on our data and procedure, we used the same 50-country sample as did the UN study. And we obtained much the same result: a positive

sign, without statistical significance, for the three sorts of specifications we use throughout: "Lin-Lin," linear in both dependent and independent varialbes; "Lin-Log," linear in the dependent variable and logarithmic in the independent variables, and "Log-Log," logarithmic in all variables (column 1 in panel 1 in Table 1a). The R^2 are generally highest for the Lin-Lin regressions, but the comparison is within the order of very small numbers. And the results for the various forms are usually very much alike for any given sample and variable set.

Table 1

Next we expand our sample to include all 66 countries for which data are available for 1960-70. This will be our "standard sample." The results in column 1 in panel 2--a non-significant negative sign--show that the result found in the UN sample is not sensitive to the samply expansion, which is reassuring. The relationship is displayed in Figure 1.

Figure 1

As an additional sensitivity check, we examined data for the 54 countries for which data are available for the full period 1950-1970. Again agreement: statistical non-significance, with a positive sign, (panel 3, column 1). As a last check, we ran these 54 countries for 1960-1970; still no relationship (data not shown).

Per-capita income growth has shortcomings as a measure of economic performance. Especially relevant here is that per-capita income tells more about changes in welfare, and less about changes in economic productivity, than does per-worker output. Therefore we also ran similar regressions using the latter as the dependent variable; data for 60 countries were available for 1960-1970. The coefficients for per-worker in Table 1b.

Table 1a

Effects of Population Growth on [illegible]
t ratios

	[illegible]	[illegible]	[illegible]
UN Sample			
n=51, 1960-1970			
Lin-Lin	1.2	1.6	(1.5)
Lin-Log	1.4	1.3	1.3
Log-Log	1.1	[illegible]	(1.1)
Basic Sample			
n=66, 1960-1970			
Lin-Lin	-.1	-.4	(-.3)
Lin-Log	-1.1	-1.9	(-1.9)
Log-Log	-.7	-1.3	(-1.3)
Long-period Sample			
n=54, 1950-1970			
Lin-Lin	1.2	-.1	(-.1)
Lin-Log	.7	-.3	(-.3)
Log-Log	1.03	-.2	(-.2)

Table 1b

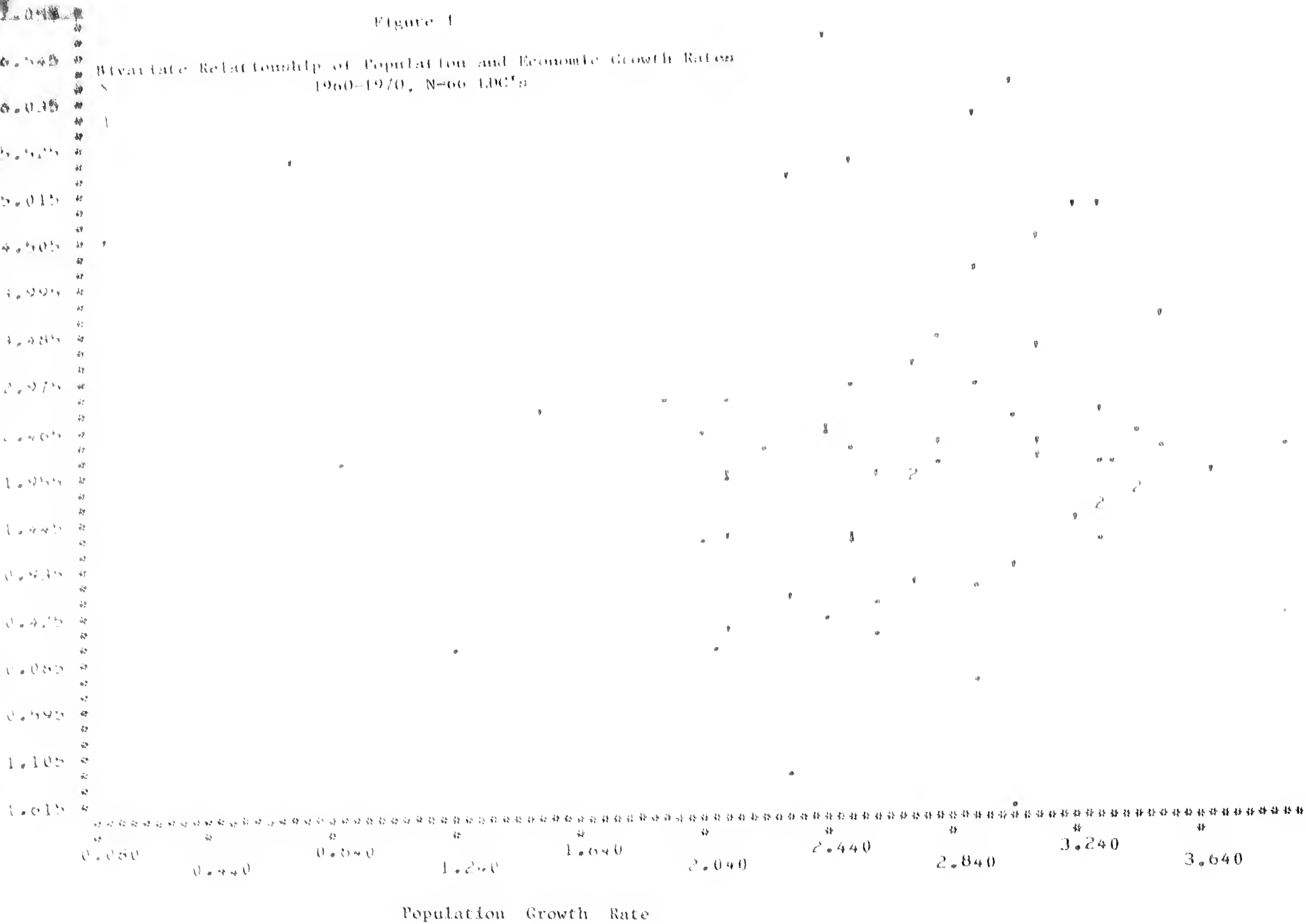
[illegible]
[illegible]

n=61			
Lin-Lin	.3	(.3)	(.3)
Lin-Log	-.6	-1.1	-1.0
Log-Log	-.4	-.4	(-.7)

Note: For unstandardized and standardized regressi coefficients, and R^2, see Appendix Tables.

Figure 1

Bivariate Relationship of Population and Economic Growth Rates
1960-1970, N=66 LDC's



output are mixed in signs, and statistically insignificant, thus confirming the conclusion drawn from per-capita income data.

We may safely conclude from these experiments that, as previous work has suggested, there is no statistically-proven simple relationship between population growth and economic growth.

The Ceteris Paribus Effect of Population Growth. Though it is unusual for uncorrelated bivariate relationships to show meaningful partial relationships when other variables are added, we nevertheless wish to check the matter here.

Columns 2 and 3 in Table 1 show the partial effect of population growth holding constant, alternatively, (a) population density, and (b) population density and population size. (The reasons for using trivariate runs with density but not with total population will be apparent later.) The results confirm the simple regression results. It is perhaps worth noting, however, that in every run except one, the addition of density pushes the population growth rate in the negative direction, though to a trivial extent. Figure 2 shows the residuals (from the bivariate relationship between density and income growth) plotted against population growth. Surely no effect of population growth on income growth is seen here.

Figure 2

The Effect of Total Population Size

The effect of total population size is shown in Table 2. It may be examined quickly and then dismissed with dispatch: No consistent effect is found, and by no stretch of analytic logic could the effect be viewed as statistically or economically significant.

Table 2

Table 2a

Effects of Population Size on Per-Capita-Income Growth

"t" ratios

	P	$\left(P \mid \bar{P}, \frac{P}{L}\right)$
n=50, 1960-70		
Lin-Lin	(-0.33)	(-0.1)
Lin-Log	(0.14)	(0.2)
Log-Log	(0.2)	(0.2)
n=66, 1960-70		
Lin-Lin	(-0.29)	(-0.21)
Lin-Log	(0.24)	(0.22)
Log-Log	(0.20)	(0.14)
n=54, 1950-70		
Lin-Lin	(-0.26)	(-.11)
Lin-Log	(-0.05)	(-.12)
Log-Log	(.36)	(.41)

Table 2b

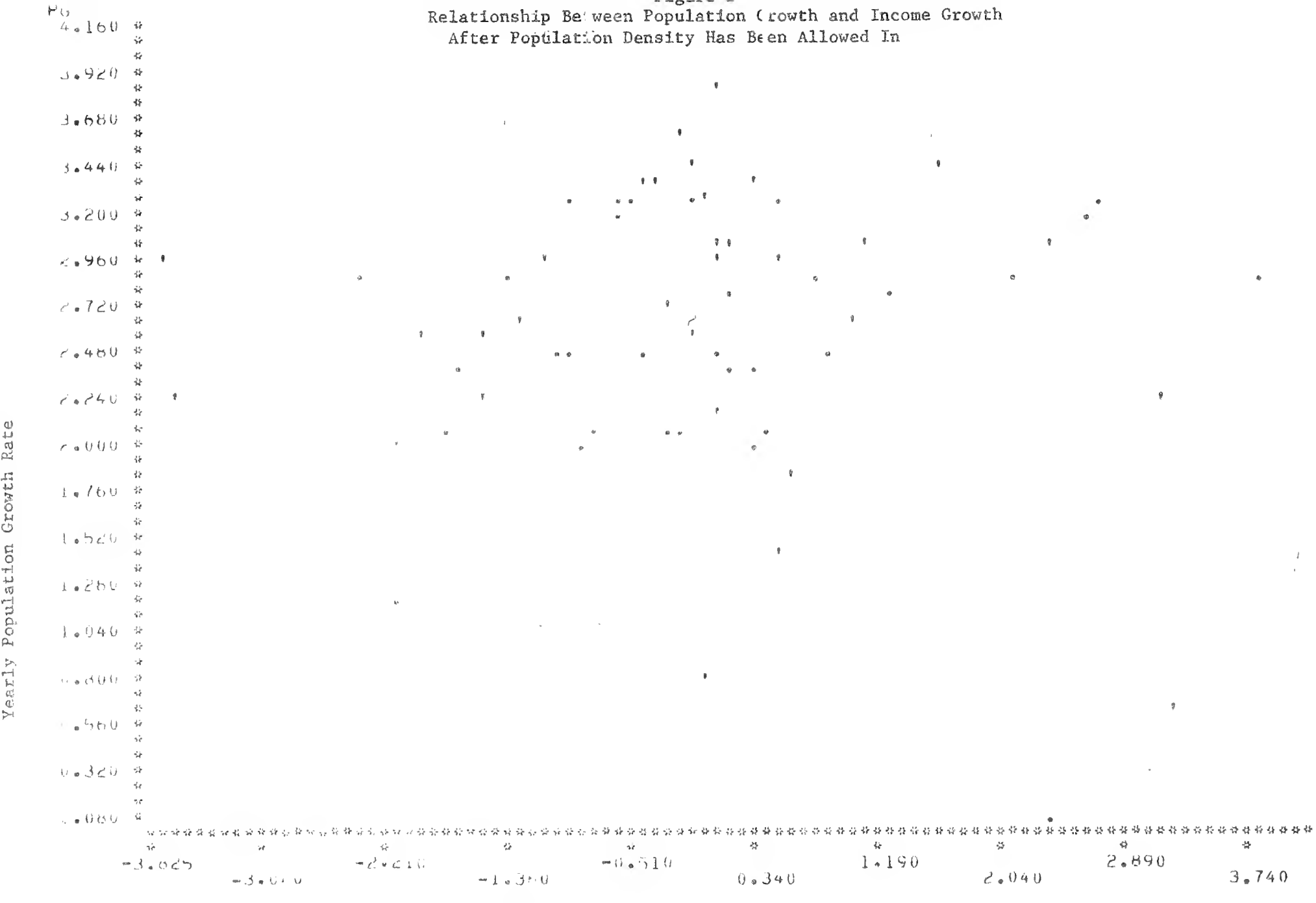
Effects of Population Size on Per-Worker-Output Growth

"t" ratios

n=60, 1960-70		
Lin-Lin	(-0.33)	(-0.29)
Lin-Log		(-0.18)
Log-Log		(0.03)

Figure 1

Relationship Between Population Growth and Income Growth
After Population Density Has Been Allowed In



The Effect of Population Density

The effect of population density upon economic growth is positive--and the finding is consistent, statistically significant, and economically significant. This is clear in Table 3, and fairly obvious in Figure 3. That is, higher population density implies faster economic growth.

Figure 3

The positive effect is similar in the bivariate and the multivariate regressions. This suggests that density is the main operative variable, rather than it being a proxy for other measures of population. Figure 4 shows (with the residuals after income has been regressed on population growth) the relationship of density to income growth. The effect is not sharp, but some effect can be seen.

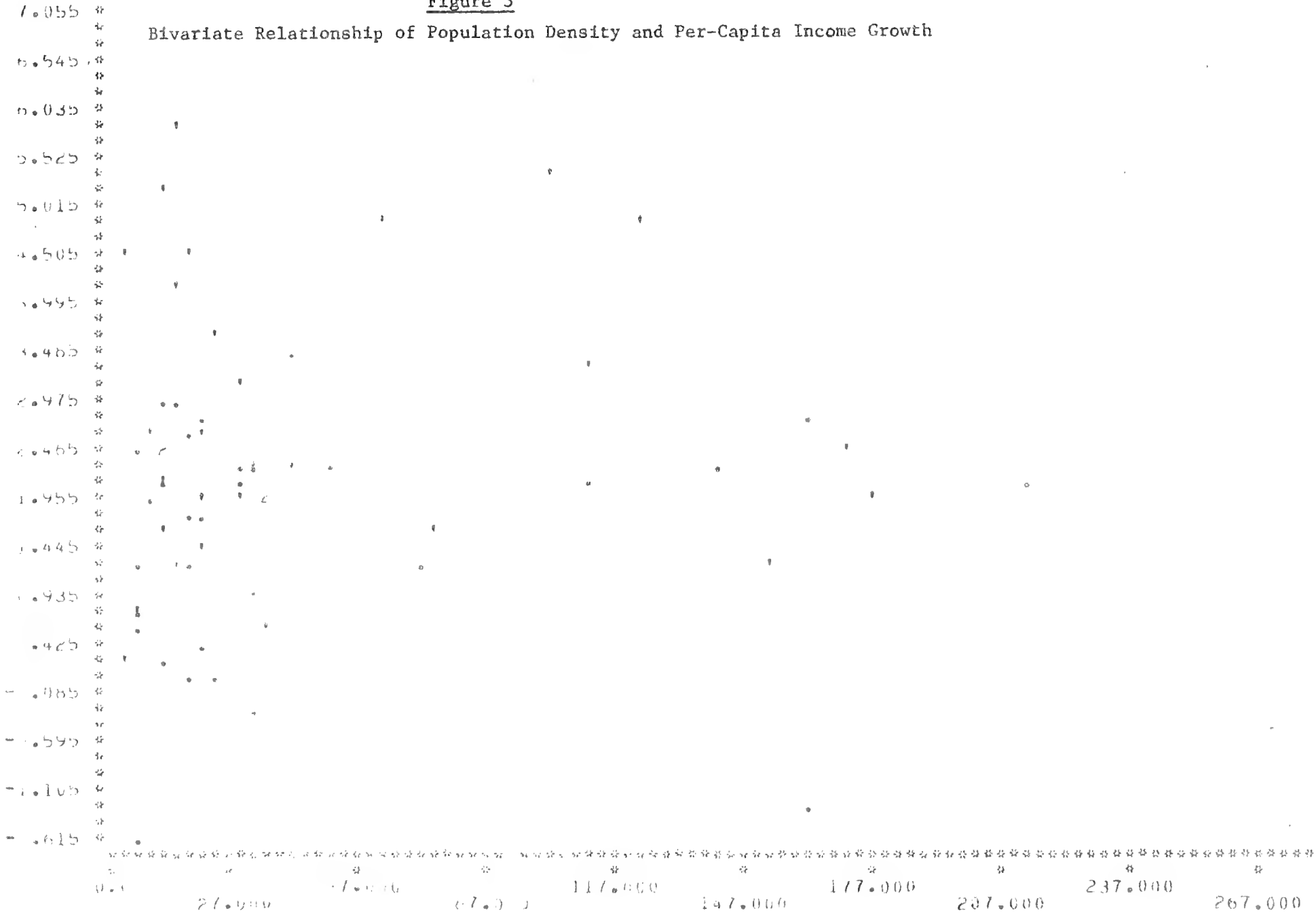
Figure 4

Perhaps most important, the effect of density is economically significant. The elasticity ranges from .07 to .14. That is, doubling a country's population, with fixed borders, could increase the rate of yearly economic growth by 10%.

Hagen's diagram suggests that the density-growth relationship is strongest at low densities. We therefore omitted the 13 countries with densities of 10 persons per square kilometers or less. But the outcome is unaffected; the t ratio in the bivariate analysis is 3.2, comparable to that obtained with the full sample. So density's positive effect is not just at very low densities.

Figure 3

Bivariate Relationship of Population Density and Per-Capita Income Growth



Persons Per Square Kilometer

Table 3a

Effects of Population Density Upon Per-Capita Income

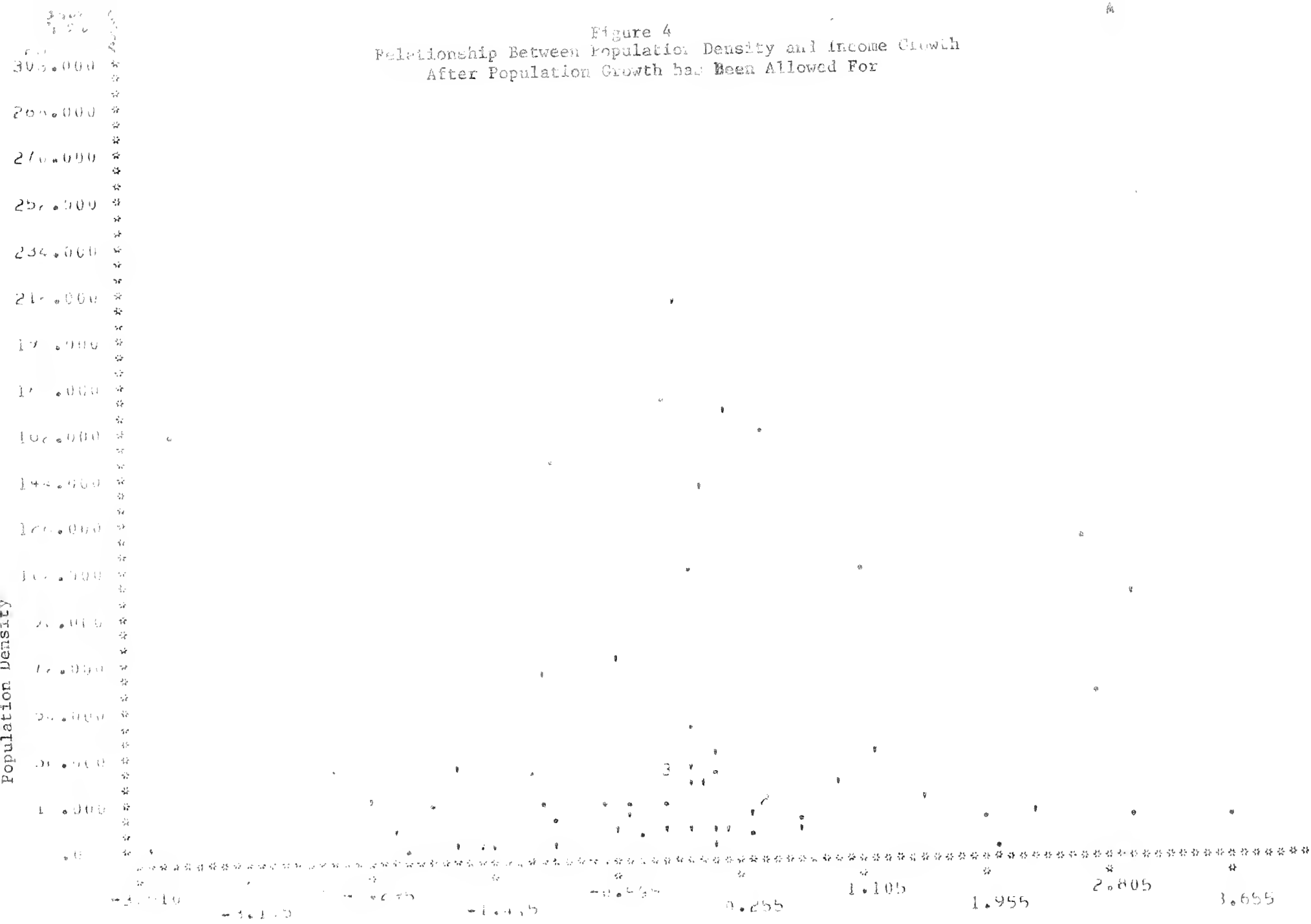
	$\frac{P}{L}$	$\left(\frac{P}{L} \mid P'\right)$	$\left(\frac{P}{L} \mid P', P\right)$
UN n=50, 1960-70			
Lin-Lin (βetas)	0.47	0.47	0.47
t-ratios	(3.65)	(3.71)	(3.66)
Lin-Log (βetas)	0.34	0.33	0.33
t-ratios	(2.52)	(2.45)	(2.42)
Log-Log (elasticities)	0.08	0.08	0.08
t-ratios	(1.7)	(1.60)	(1.60)
n=66, 1960-70			
Lin-Lin (βetas)	.387	.39	.39
t-ratios	(3.36)	(3.3)	(3.3)
Lin-Log (βetas)	.35	.41	.41
t-ratios	(3.03)	(3.5)	(3.4)
Log-Log (elasticities)	.09	.10	.10
t-ratios	(2.19)	(2.5)	(2.4)
n=54, 1950-70			
Lin-Lin (βetas)	0.299	0.265	.27
t-ratios	(2.27)	(1.93)	(1.91)
Lin-Log (βetas)	.39	.39	.39
t-ratios	(3.03)	(3.0)	(3.0)
Log-Log (esasticities)	.09	.09	.09
t-ratios	(2.68)	(2.68)	(2.6)

Table 3b

Effects of Population Density Upon Per Worker Output Growth

n=60, 1960-70			
Lin-Lin (βetas)	.191	.19	.19
t-ratios	(1.48)	(1.46)	(1.44)
Lin-Log (βetas)	.19	0.22	0.22
t-ratios	(1.46)	(1.67)	(1.67)
Log-Log (elasticities)	0.04	0.04	0.04
t-ratios	(1.03)	(1.17)	(1.16)

Figure 4
Relationship Between Population Density and Income Growth
After Population Growth has Been Allowed For



DISCUSSION

1. Why does population density reveal so much stronger an effect than population size, when--all else equal--greater size implies greater density? The answer is that all else is not equal. Population size is not highly correlated with population density in our samples of countries; the r is .20 in our basic sample, for example.

As to why population growth does not show a (positive) effect though population density does, the explanation would seem to lie in the difference between the short-run and long-run effects of additional people. More births this year mean more dependents rather than more workers per areal unit, and though it is conceivable that more dependents can stimulate economic activity, it is more likely that they will have no net effect or a negative net effect. Furthermore, a higher population growth rate this year may be negatively correlated with a higher population growth rate in earlier decades, and it is the births in earlier decades that are the cause of the present increase in economic growth due to higher population density.

2. No non-population independent variables were included in the regressions, on the grounds that no single one of them--and not even a small set of them--plays a large role in influencing economic growth, as Adelman and Morris (1966) and others have shown. It would have been worthwhile to include per-capita income in experimental regressions to prove this point more conclusively, but by the time we thought to do so we had run out of resources.

3. Comparable analysis of MDC's would be interesting, and we hope to carry it out in the future. It might also be useful to experiment

with other criteria for grouping nations to check for sensitivity in the results.

4. Many people find it impossible to take seriously the notion that population growth might have a positive effect on economic growth in the long run, as our findings about population density imply. In fact, such a possibility seems downright preposterous to many economists as well as laymen. Their reasoning is usually theoretical and short run, founded on the notion of diminishing returns: more persons working with fixed resources imply less per person. But there is also theory working in the other direction (see Simon, 1977, Chapters 7 and 13). The empirical data should be more reliable than any particular theoretical element for describing history until now. But perhaps the future will differ from the past due to some discontinuities. Ultimately, each person must judge what conclusions about the future seems most reasonable given the theory and the empirical evidence available.

SUMMARY AND CONCLUSIONS

Higher population density implies faster economic growth in LDC's; this result comes out of our data unequivocally and strongly; the finding is economically as well as statistically significant. This result for all sectors of the economy considered together, drawn from a cross-section of all LDC's for which data were available for 1960-1970 and 1950-1970 and holding other population variables constant, agrees with Strycker's recent finding for agricultural productivity in Francophone countries. It also fits with Glover and Simon's finding of higher road density accompanying higher population density.

No relationship was found between the population growth rate and economic growth. This confirms a long series of previous studies using other samples and other periods.

No relationship also was found between total population size and economic growth. This apparently contradicts Chenery's finding; it is possible that the effect Chenery found was actually due to population density rather than to total population size.

The main finding for the positive effect of population density suggests that in the long run population growth has a positive effect upon per-capita income.

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Appendix A

Sample Composition

Countries	N=66 1960-70	1960-70 N=50 UN Sample	1950-60 1960-70 1950-70 N=54	1960-70 N=60
Costa Rica	x	x	x	x
Iraq	x	x	x	x
Jordan	x	x	x	x
Mexico	x	x	x	x
Syria	x	x		x
Honduras	x	x	x	x
Philippines	x	x	x	x
Dominican Republic	x	x	x	x
Paraguay	x	x	x	x
Columbia	x	x	x	x
Ecuador	x	x	x	x
El Salvador	x	x	x	x
Panama	x	x	x	x
Thailand	x	x	x	x
Pakistan	x	x		x
Lebanon	x	x	x	x
Hong Kong	x	x	x	x
Morocco	x	x	x	x
Nicaragua	x	x	x	x
Kenya	x	x	x	x
Tunisia	x	x		x
Sudan	x	x	x	x
Guatemala	x	x	x	x
Zambia	x	x	x	
Brazil	x	x	x	x
Ghana	x	x	x	x
Malaysia	x	x	x	x
Turkey	x	x	x	x
Peru	x	x	x	x
Iran	x	x	x	x
Guyana	x	x	x	x
Egypt	x	x	x	x
Indonesia	x	x	x	x
Singapore	x	x		x
Uganda	x	x	x	
Nigeria	x	x	x	x
India	x	x	x	x
Tanzania	x	x	x	x
Sri Lanka	x	x	x	x
Chile	x	x	x	x
Haiti	x	x		x

Appendix A (cont.)

Countries				
Bolivia	x	x		x
Burma	x	x	x	x
Sierra Leone	x	x		x
Zaire	x	x	x	x
Afghanistan	x	x	x	x
Jamaica	x	x	x	x
Ethiopia	x	x	x	x
Argentina	x	x	x	x
Uruguay	x	x	x	x
Republic of Korea	x		x	x
Mali	x		x	x
Portugal	x		x	x
Upper Volta	x		x	x
Madagascar	x		x	x
Trinidad	x		x	x
Venezuela	x		x	x
Ivory Coast	x		x	x
Israel	x		x	x
Botswana	x			x
Dahomey	x			x
Liberia	x			x
Niger	x			
Guiana	x			
Algeria	x		x	
Malawi	x		x	

Appendix B

Complete Results of Regressions - Standardized Regression Coefficients

Independent Population Variables

Sample	Dependent Variable	Constant	Lin Growth	Lin Density	Lin Size	Log Growth	Log Density	Log Size	R^2
n=50 1960-70	$(\frac{Y}{L})$	.875	0.18 (1.3)						.03
n=50 1960-70	$(\frac{Y}{L})$	2.11		0.47 (3.6)					.22
n=50 1969-70	$(\frac{Y}{L})$	2.34			-0.47 (-0.33)				.00
n=50 1960-70	$(\frac{Y}{L})$	6.28	.19 (1.48)	.47 (3.71)					.25
n=50 1960-70	$(\frac{Y}{L})$	2.34	.19 (1.45)	.48 (3.7)	-0.013 (-0.10)				.25
n=50 1960-70	$(\frac{Y}{L})$					.19 (1.4)			.04
n=50 1960-70	$(\frac{Y}{L})$						0.34 (2.5)		.12
n=50 1969-70	$(\frac{Y}{L})$							.02 (0.14)	.00
n=50 1960-70	$(\frac{Y}{L})$					0.17 (1.3)	0.33 (2.45)		.15
n=50 1960-70	$(\frac{Y}{L})$					0.18 (1.27)	0.33 (2.42)	.023 (.17)	.15
				Unstandardized Coefficients: Elasticities					
n=50 1960-70	$\log(\frac{Y}{L})$	.43				.38 (1.19)			.03
n=50 1960-70	$\log(\frac{Y}{L})$	.47					.08 (1.68)		.06
n=50 1960-70	$\log(\frac{Y}{L})$	.58						.001 (.21)	.00
n=50 1960-70	$\log(\frac{Y}{L})$	.32				.35 (1.1)	.08 (1.6)		.08
n=50 1960-70	$\log(\frac{Y}{L})$	.31				.35 (1.1)	.08 (1.6)	.001 (.24)	.08

Appendix B (continued)

Complete Results of Regressions - Standardized Regression Coefficients

Independent Population Variables

Sample	Dependent Variable	Constant	Lin Growth	Lin Density	Lin Size	Log Growth	Log Density	Log Size	R^2
n=66 1960-70	$(\frac{Y}{L})$	2.59	-0.03 (-0.24)						
n=66 1960-70	$(\frac{Y}{L})$	2.23		.387 (3.6)					
n=66 1960-70	$(\frac{Y}{L})$	2.42			-0.36 (-0.29)				
n=66 1960-70	$(\frac{Y}{L})$	2.49	-0.04 (-0.35)	0.39 (3.34)					
n=66 1960-70	$(\frac{Y}{L})$	2.50	-0.05 (-0.34)	0.39 (3.31)	-0.03 (-0.21)				
n=66 1960-70	$(\frac{Y}{L})$					-0.13 (-1.03)			.02
n=66 1960-70	$(\frac{Y}{L})$						0.35 (3.03)		.13
n=66 1960-70	$(\frac{Y}{L})$							0.03 (.24)	.06
n=66 1960-70	$(\frac{Y}{L})$					-0.23 (-1.92)	0.41 (3.5)		.17
n=66 1960-70	$(\frac{Y}{L})$					-0.23 (-1.95)	0.41 (3.4)	0.03 (0.2)	.18
					Unstandardized Coefficients: Elasticities				
n=66 1960-70	$\log(\frac{Y}{L})$	.64				-0.09 (-0.71)			.00
n=66 1960-70	$\log(\frac{Y}{L})$	.48					.09 (2.2)		.07
n=66 1960-70	$\log(\frac{Y}{L})$	.48						.008 (1.18)	.00
n=66 1960-70	$\log(\frac{Y}{L})$	.52				-0.15 (-1.3)	.10 (2.45)		.09
n=66 1960-70	$\log(\frac{Y}{L})$	.51				-0.15 (-1.3)	.10 (2.41)	.007 (.14)	.09

Appendix B (continued)

Complete Results of Regressions - Standardized Regression Coefficients

Independent Population Variables

Sample	Dependent Variable	Constant	Lin Growth	Lin Density	Lin Size	Log Growth	Log Density	Log Size	R^2
n=54 1950-70	$(\frac{Y}{L})$	1.22	.20 (1.49)						
n=54 1950-70	$(\frac{Y}{L})$	2.31		.30 (2.27)					
n=54 1950-70	$(\frac{Y}{L})$	2.43			-0.04 (-0.26)				
n=54 1950-70	$(\frac{Y}{L})$	1.54	0.13 (.96)	.265 (1.93)					
n=54 1950-70	$(\frac{Y}{L})$	1.56	0.13 (.93)	0.27 (1.91)	-0.02 (-1.11)				
n=54 1950-70	$(\frac{Y}{L})$					.09 (.67)			.00
n=54 1950-70	$(\frac{Y}{L})$						.39 (3.03)		.15
n=54 1950-70	$(\frac{Y}{L})$							-.007 (-.05)	.00
n=54 1950-70	$(\frac{Y}{L})$					.083 (.64)	.39 (3.01)		.16
n=54 1950-70	$(\frac{Y}{L})$					.08 (.60)	.39 (3.0)	-0.02 (-0.1)	.16
					Unstandardized coefficients: Elasticities				
n=54 1950-70	log $(\frac{Y}{L})$	.55				.16 (1.0)			.02
n=54 1950-70	log $(\frac{Y}{L})$	.49					0.08 (2.68)		.12
n=54 1950-70	log $(\frac{Y}{L})$	.61						.02 (.36)	.00
n=54 1950-70	log $(\frac{Y}{L})$	.42				.16 (1.05)	.09 (2.68)		.14
n=54 1950-70	log $(\frac{Y}{L})$	.47				.17 (1.0)	.09 (2.7)	.015 (.36)	.14


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