

INCOME, MORTALITY AND FERTILITY IN LATIN AMERICA: COUNTRY-LEVEL PERFORMANCE, 1960-1990^{1,2}

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Abstract

That higher levels of national income per capita are associated with better health conditions and lower fertility is more than evident: recent analyses provide quantification of the magnitude of the effects and adduce strong evidence for its causal nature (at least for health). This paper extends previous analyses by assessing regional and temporal differences in the income - health/fertility relationship (differences are pronounced) and by using deviations from this estimated relationship to construct measures of performance at five year intervals from 1960 to 1990 for 19 countries of Latin America and the Caribbean. Performance for each country on under-5 mortality and total fertility rates, relative to other Latin American countries and controlling for income levels. Changes in performance, from one five-year period to the next, are highlighted in order to pose questions about the response of performance to changes in policy. Some results are expected (e.g. the relatively good performance of Colombia and Costa Rica for much of the period); other results are surprising (e.g. the sharp deterioration in performance of Argentina and Chile in the late 1980s). Health expenditures are then used to predict performance levels in 1990: for

under-5 mortality rates, public sector expenditures on health are found to have a significant beneficial effect. The magnitude of the estimated effect is substantial: Over 10,000 child deaths in 1990 would have been averted in Latin America if public sector expenditures on health increased from 3.5% to 4.0% of GDP while holding total expenditures constant.

I. Introduction

Income levels powerfully influence countries' health status; and whether a country's mortality rate is high or low relative to its income has for some time been used as a suggestive indicator of the adequacy of its health policies (see, for examples, Halstead, Walsh, and Warren, 1985; World Bank, 1993; and Inter-American Development Bank, 1996). Obviously these deviations can only be suggestive — they provide examples of success (or failure) that the policy analyst can attempt to associate with country characteristics, health policies and other conditions to gain insight into the consequences of policy. This paper's purposes are simple: it first uses newly available data to estimate time and region specific relations between income, under five mortality rates and total fertility rates; it then constructs country specific measures of performance (and change in performance) at 5 year intervals from 1960 to 1990 for 19 countries of Latin America and the Caribbean. Performance on under-5 mortality and total fertility rate are assessed relative to income adjusted for purchasing power. From the estimated model time-specific income residuals are calculated as the basis for performance indicators. We use country residuals and an elaboration of the models for infant mortality described and estimated in Pritchett and Summers (1996); that paper also provides a valuable guide to the available literature. Hill and Maeda (1996) have recently prepared, for China, estimates of country performance on mortality that are similar to those reported here. The final section of the paper examines health expenditures (public and private) as potential determinants of performance in 1990.

II. Data and Methods

Data

The dataset used here includes the individual country's under-5 mortality rate³ (Hill et al. forthcoming), total fertility rate (from updated World Bank demographic files), and per capita income figures from the Penn World Tables, Version 5.6 (Summers and Heston, 1994) for time points separated by five years, starting in 1960. There are 64 countries in the dataset, with 20 countries in the Sub-Saharan Africa region, five in the South Asia region, 9 in the East Asia region, 11 in the Middle East region, and 19 countries in the Latin America and

the Caribbean region. Table 1 lists the included countries by region. The focus of this analysis is on the low- and middle-income developing countries; the dataset includes no high-income countries or countries from Eastern Europe or the former Soviet Union. The variables used in this paper are defined in Table 2.

Methods

The cross-sectional time-series regression analysis method is used to estimate the effect of real income, region, and time (a proxy for technical progress) on the under-5 mortality rate and the total fertility rate. This method is designed to analyze data on n units—individual countries—over T time periods and is robust to the problem that data for some time periods might be missing. (Fuller, 1976; Hannan, 1960; Mills, 1990; Ostrom, 1990; and STATA, 1995). These are two main reasons that cross-sectional time-series analysis method is preferred. By taking into consideration that each country is observed multiple times and the observations are nested within the country, the standard errors derived from this analysis method will be properly adjusted. Additionally, by allowing that data for some periods might be missing increases the precision of the result estimates, since countries with some missing data do not have to be automatically discarded.

III. Results: Country Performance in Reducing Under-5 Mortality and Fertility

Descriptive Results

To get an overview of the under-5 mortality rate, total fertility rate, and real income in all five regions, their means for each time period and region are provided in Table 3. One could observe from Table 3 that the overall trend for the under-5 mortality rate is declining and the trend for real income is increasing over the 30-year period, for all five regions. However, it is not a given that the negative relationship between mortality rate and income is true for any two time periods, for each region. There are some exceptions. For example, in the Latin America and the Caribbean (LAC) region, there is a drop in real income from \$3,435 in 1980 to \$3,037 in 1985 while the mortality rate is continually decreasing, from 78 to 62 per thousand. East Asia and the Pacific region is the only one that uniformly demonstrates the negative relationship. The real income is continually increasing and the child mortality rate is always declining. Figures 1 and 2 show country-specific changes in income and under-5 mortality and income and fertility, respectively, for Latin America countries from 1960 to 1990.

Cross-sectional Time-series Analysis Results

Since the main purpose of this paper is to estimate the performance of LAC countries in decreasing their under-5 mortality and total fertility rates as com-

pared to the others in the region, the countries in the analysis are grouped into two regions: LAC and non-LAC. Considering the differing relationship between real income and the child mortality rate over time periods and regions, we include region and time indicators in the analysis model. The interaction variables between real income and time indicators ($\lnrgdp*11$, $\lnrgdp*12$, $\lnrgdp*13$, $\lnrgdp*14$, $\lnrgdp*15$, and $\lnrgdp*16$), real income and region indicator ($\lnrgdp*1ac$), and, time and region indicators ($lac*11$, $lac*12$, $lac*13$, $lac*14$, $lac*15$, and $lac*16$) are also created and entered into the model. The purpose for this is to minimize errors of the estimates and to provide quantitative estimates of the different effects of income on mortality and fertility in different regions and at different points in time over the 30-year span analyzed.

The interaction variables between LAC and time indicators are added to examine whether the pace of technical progress is the same for LAC and non-LAC regions. To see whether the income effect is consistent across regions, the interaction between income and region indicator is included in the model to monitor this potential difference. Finally, to model the possible different effect of income on mortality rate in different time periods, the interaction variables between income and time indicators are also added to the final equation. The resulting equation is:

$$\ln Q_{5,t,i} = A + B*(\ln RGDP_{t,i}) + \Sigma C_r*(TIME_r) + D*(LAC) + \Sigma F_r*(TIME_r)*(LAC) + \Sigma G_r*(\ln RGDP_{t,i})*(TIME_r) + H*(\ln RGDP_{t,i})*(LAC) + \epsilon$$

where:

- $\ln Q_{5,t,i}$: natural log of under-5 mortality rate at time t in country i ;
 $\ln RGDP_{t,i}$: natural log of real income at time t in country i ;
 $TIME_r$: time period indicator, $r = 1, \dots, 6$ (Time₀, 1960, is omitted);
 LAC_r : Latin America and the Caribbean region indicator ($r = i$ if the country is in the region and 0 otherwise);
 ϵ : error term.

The variables A , B , C_r , D , F_r , G_r , and H are the coefficients to be estimated. Two comments on specification of this equation are in order. First, the equation is in levels rather than first differences because we wish to include country fixed effects within the residuals as part of the measure of performance. Second, we use the conclusions of the instrumental variable analysis of Pritchett and Summers (1996) to allow us to view the income-mortality relation as genuinely causal.

In the above equation, the coefficient for the LAC region, D , is an estimate of the overall difference between LAC and non-LAC countries in their child mortality rates; the coefficients of the interaction terms between LAC and time period (F_r) show how the difference between LAC and other countries varies over time. The coefficients of the time indicators could be interpreted as the technical progress relative to 1960, but this would be technical progress broadly defined—changes in education levels and levels of health expenditure could account for

part of the "progress". The income coefficient is an elasticity, showing how much mortality rate could be reduced by increasing real income per capita when all the other variables in the equation are held constant; interaction terms with time and region give time-specific relations between income and mortality for LAC and, separately, for all other countries. An analogous equation is used to model TFR.

The results for mortality are shown in Table 4. The overall R^2 , based on the above equation, is 63%, meaning 63% of the variation in under-5 mortality rate are explained by the predictors used in the model. Moreover, the proposed equation explained 88% of the variation in mortality rate within countries and 55% of the variation between countries.

As expected, there is a negative relationship between real income and under-5 mortality rate; the elasticity is -0.40. An increase in income is expected to reduce child mortality significantly. Countries in the LAC region benefit significantly less from income increase in terms of reducing the child mortality rate ($\lnrgdp*1ac = 0.19$), compared to countries in the other regions.⁴ The income elasticity, including this interaction, for the LAC region is, then, -0.21. Overall, the countries in the LAC region have a lower child mortality rate as indicated by the negative coefficient of LAC, as compared to countries in other regions, particularly for the 1980s. The effect of income is also found to be varying over time: a given income change decreases the mortality rate more in 1990 than it would have in 1960. The overall effect of time (or technical progress) is much stronger after 1975 than before.

The results for fertility are shown in Table 5. The income elasticity is similar across the LAC and non-LAC regions; the elasticity is -0.21 for LAC countries and -0.17 for the other countries. Holding other variables constant, an increase of income from \$403 ($\lnrgdp = 6$) to \$1,097 ($\lnrgdp = 7$) decreases the total fertility rate by 1.2 [$\exp(0.21) = 1.2$] for the LAC region. The income effect is also increasing over time, as found in the analysis for the under-5 mortality rate. For both fertility and mortality it is interesting to note that the main (or direct) effects of time are positive, i.e., mortality *increasing*; the overall improvement in the income-fertility and income-mortality relations over time results from the strength of the estimated interactions.

To illustrate that, we take a LAC country with real income set at \$ 2,000 for both 1985 and 1990, the net time effect from 1985 to 1990 then could be calculated using the coefficients reported in Table 4:

$$\begin{aligned} \text{time effect} &= \text{predicted log mortality in 1990} - \text{predicted log mortality in 1985} \\ &= (\text{constant} + \lnrgdp + lac + t6 + \lnrgdp*1ac + lac*t6 + \lnrgdp*16) - \\ &\quad (\text{constant} + \lnrgdp + lac + t5 + \lnrgdp*1ac + lac*t5 + \lnrgdp*15) \\ &= 4.3094 - 4.3914 \\ &= -0.7602 \\ \text{mortality reduction} &= \exp(\log \text{ mortality in 1990}) - \exp(\log \text{ mortality in 1985}) \\ &= \exp(4.3094) - \exp(4.3914) \\ &= 74.4 - 80.8 \\ &= -6.4 \end{aligned}$$

As shown, even when a country, a LAC country here, has the same income of \$ 2,000 for both 1985 and 1990, its mortality rate should reduce by 6.4 per thousand births.

Figure 3 compares the predicted mortality regression lines for LAC and other regions in 1990. As shown in the figure, the mortality rate decreases with the increase of real income in all regions, with LAC and East Asia performing significantly better than others. However, the improvement in income only accounts for part of the mortality rate decline. A LAC country with an income of \$4,000 has an expected mortality rate of about 121, in 1960, while it is expected to be 50 in 1985. Time, or technical progress, does make a difference. Figure 4 illustrates how much the income-mortality relation has improved in LAC over three decades. Figures 5 and 6 illustrate how the income-fertility relation differs between LAC and other regions, and, within LAC, over time.

Each individual country is also examined to determine whether it is performing as expected at a given time considering its income level. The percentage difference between the observed and predicted mortality rate, termed relative performance, is calculated using the following formula:

$$\text{Relative Performance (\%)} = (\text{predicted} - \text{observed}) * 100 / \text{observed}.$$

A positive percentage indicates better performance and a negative percentage indicates worse performance. The relative performance at each time period is calculated for each of the 19 countries in LAC region. Tables 6 and 7 show, for under-5 mortality and total fertility respectively, the relative performance of each country in 1960 and 1990; for the years in between, the *change* in relative performance between successive five year times is shown. These changes in performance, if large, suggest changes in the policy or external environment. Figure 7 shows relative performance on mortality for Chile (Panel A), changes in relative performance (Panel B) and the combination as shown in Table 6 (Panel C).

Looking through these figures, one could observe that the performance of the individual LAC countries varies substantially, both across time periods within the country and the overall performance across countries. For example, Brazil has lower performance than expected across the period from 1960 to 1985 (the under-5 mortality rate is missing for 1990); Colombia, in the other hand, performed from 6% to 100% better than expected across these three decades. Appendix A provides a country-by-country graphical depiction of 1960 and 1990 levels of relative performance (on both under-5 mortality and fertility) as well as the changes in intervening periods (analogous to Panel C of Figure 7).⁵

How, then, do countries perform? On relative mortality, Chile, Colombia and Costa Rica do the best in 1990; Bolivia, Brazil, Haiti, and Mexico do the worst. In terms of recent *changes* in performance the story differs. Chile, for example, had a dramatic *decline* in relative performance between 1985 and 1990; its good status in 1990 resulted from steady, substantial improvements in relative performance through 1985 substantially offset by the 1985 to 1990 decline. Table 8 shows countries having major changes in relative performance (at the end year

for the 5-year period of change) for both under-5 mortality and fertility. The table provides empirical measures that pose (but do not answer) questions relevant to policy: e.g. what policies of the late 1980s might account for the sharp performance declines (on mortality) in Argentina and Chile? Why do Colombia and Costa Rica perform so well from 1975 on? The next section suggests that a substantial public sector role in finance may be partially responsible for good performance in Costa Rica and Colombia, and that the late 1980s move toward greater reliance on the private sector in Argentina and Chile may have had adverse effects on child health.

IV. Public and Private Health Expenditures as Determinants of Performance in 1990

This section seeks to explain the relative performance indicators obtained in the previous section in terms of health expenditures as a percentage of GDP in both the public and the private sector in 1990 (Govindaraj et al. 1995). Because we have good cross country expenditure data only for 1990, we are only able to assess determinants of 1990 system relative performance — on under-5 mortality (rp90q5) and total fertility rates in 1990 (rp90tfr). The following equation is estimated:

$$\text{rp90q5} = \alpha_0 + \alpha_1 * \text{epub} + \alpha_2 * \text{epri} + \varepsilon,$$

where the values of epub (% of GDP spent on health by the public sector) and epri (% spent by the private sector) are all for 1990. Regression analyses were run for both under-5 mortality and total fertility rates; and they were also run with etot (the sum of public and private expenditures) replacing epub and epri. Table 9 summarizes the results.

As shown in Table 9, health expenditures (separated into public and private) explain 44% of the variation in country relative performance on under-5 mortality rate, but only 20% of that for total fertility rate. *Total* health expenditures, however, are insignificant in explaining under-5 mortality. When public and private sector expenditures are separated, however, this lack of aggregate effect is seen to result from the counterbalancing of a statistically significant favorable effect of expenditures in the public sector and a not-quite statistically significant *negative* effect of private sector expenditures. The quantitative effect is substantial: if total health expenditures are held constant at the current average of 6.5% of GDP, and if this amount is reallocated toward the public sector by 1% (i.e. the public share increases from 3.5% to 4% of GDP and the private share decreases from 3% to 2.5% of GDP) then the 1990 performance average for LAC would go up 18 percentage points. In human terms this reallocation would be predicted to have reduced the number of under-5 deaths in Latin America by 10,600 in 1990. Similar results concerning the importance of public sector expenditure have previously appeared (Ayer et al., 1995; Anand and Ravallion, 1993; Gerttham et al., 1992;

and World Bank, 1993). Health expenditures do not significantly predict country relative performance on total fertility rate, although the estimated impact of public expenditures has some effect in the predicted direction.

If time series data on health expenditures were available to complement the performance measures we have reported, a more thorough and nuanced assessment of the impact of health expenditure policy could replace the static ones described for 1990. The newly available time series on performance reported earlier in this paper do, however, create the capacity for partial statistical analysis of the determinants of performance (as here for 1990); they allow qualitative judgments concerning the policy correlates of a country's changing performance over time; and they set the stage for more thorough-going assessments of policy later as the relevant data sets expand.

TABLE 1
LIST OF COUNTRY NAMES BY REGION

Latin America	South Asia	East Asia	Middle East	Africa
Argentina Bolivia Brazil Chile Colombia Costa Rica Dominican Republic Ecuador El Salvador Guatemala Honduras Haiti Mexico Nicaragua Panama Peru Paraguay Uruguay Venezuela	Bangladesh India Nepal Pakistan Sri Lanka	China Hong Kong Indonesia Myanmar Philippines Papua New Guinea Republic of Korea Singapore Thailand	Algeria Egypt Iran Iraq Israel Jordan Morocco Syria Tunisia Turkey All Yemen	Benin Burkino Faso Burundi Cameroon Central Africa Chad Ethiopia Ghana Kenya Madagascar Malawi Mauritius Mozambique Namibia Nigeria Rwanda Senegal Sierra Leone Tanzania Uganda

TABLE 2
VARIABLES USED IN THE ANALYSIS, DEFINITIONS,
MEANS AND STANDARD DEVIATIONS

Variables	Definition	Mean	Standard Deviation
q5	under-5 mortality rate	140.2	84.2
ifr	total fertility rate	5.48	1.59
rgdp	real per capita income in 1985 dollars after adjustment for purchasing power parity	2126	1871
lnq5	natural log of under-5 mortality rate (q5)	4.69	0.80
lnifr	natural log of total fertility rate (ifr)	1.65	0.36
lnrgdp	natural log of real per capita income in 1985 dollars after adjustment for purchasing power parity (rgdp)	7.35	0.79
epub	public expenditures on health in 1990 as a percentage of GDP	3.51	1.92
epri	private expenditures on health in 1990 as a percentage of GDP	3.01	1.29
etot	total health expenditure in 1990 as a percentage of GDP	6.52	2.58
cup	= 1 if the country is in the East Asia and the Pacific region		
lac	= 1 if the country is in the Latin America and the Caribbean region		
mec	= 1 if the country is in the Middle East/North Africa region		
ssa	= 1 if the country is in the Sub-Saharan Africa region		
sas	= 1 if the country is in the South Asia region		
10	= 1 if year is 1960		
11	= 1 if year is 1965		
12	= 1 if year is 1970		
13	= 1 if year is 1975		
14	= 1 if year is 1980		
15	= 1 if year is 1985		
16	= 1 if year is 1990		
rp90q5	system relative performance on under-5 mortality rate in 1990	9.63	56.4
rp90ifr	system relative performance on total fertility rate in 1990	0.68	15.2

Notes:

- The variables for q5, ifr, rgdp, and their logarithms are defined for each country and time period; see Table 3 for the relevant mean values.
- The variables epub, epri, etot, rp90q5 and rp90ifr are defined only for countries of Latin America and the Caribbean in 1990.

TABLE 3
MEANS OF UNDER-5 MORTALITY RATE, TOTAL FERTILITY RATE, REAL INCOME,
AND THEIR LOG TRANSFORMATIONS FOR EACH TIME PERIOD AND REGION

	YEAR						
	1960	1965	1970	1975	1980	1985	1990
East Asia and the Pacific							
q5	134.63	114.13	94.06	75.24	60.90	54.11	41.36
tfr	5.63	5.72	5.15	4.35	3.74	3.27	2.92
rgdp	1071.22	1343.67	1761.44	2291.00	3051.00	3618.67	5412.25
lng5	4.78	4.54	4.31	3.79	3.79	3.60	3.38
lnfr	1.71	1.74	1.61	1.41	1.24	1.10	0.98
lnrgdp	6.83	7.01	7.24	7.43	7.66	7.80	8.18
Latin America and the Caribbean							
q5	133.73	127.61	114.91	97.35	78.48	62.14	47.10
tfr	5.99	5.81	5.33	4.77	4.28	3.85	3.52
rgdp	2172.84	2461.58	2765.74	3056.63	3435.47	3056.74	3154.11
lng5	4.77	4.72	4.61	4.43	4.17	3.92	3.62
lnfr	1.76	1.73	1.64	1.52	1.41	1.30	1.21
lnrgdp	7.54	7.66	7.78	7.90	8.02	7.90	7.95
Middle East/North Africa							
q5	188.77	166.33	146.62	123.08	104.50	80.25	61.73
tfr	6.76	6.77	6.53	6.17	5.81	5.36	4.79
rgdp	1865.70	2291.20	2525.36	3257.27	3589.09	3519.00	3666.33
lng5	5.13	4.99	4.85	4.65	4.45	4.20	3.96
lnfr	1.90	1.90	1.86	1.80	1.73	1.65	1.53
lnrgdp	7.39	7.60	7.64	7.91	8.04	8.06	8.10
South Asia							
q5	252.33	230.67	190.80	174.40	153.60	128.20	128.75
tfr	6.38	6.32	6.23	6.07	5.82	5.38	4.83
rgdp	848.60	921.00	1004.80	930.40	1120.80	1301.80	1536.00
lng5	5.49	5.39	5.21	5.08	4.93	4.71	4.85
lnfr	1.85	1.84	1.82	1.78	1.73	1.64	1.52
lnrgdp	6.71	6.80	6.88	6.81	7.00	7.13	7.32
Sub-Saharan Africa							
q5	252.33	230.67	190.80	174.40	153.60	128.20	128.75
tfr	6.38	6.32	6.23	6.07	5.82	5.38	4.83
rgdp	848.60	921.00	1004.80	930.40	1120.80	1301.80	1536.00
lng5	5.49	5.39	5.21	5.08	4.93	4.71	4.85
lnfr	1.85	1.84	1.82	1.78	1.73	1.64	1.52
lnrgdp	6.71	6.80	6.88	6.81	7.00	7.13	7.32

TABLE 4
COEFFICIENT ESTIMATES OF THE EQUATION USING INCOME, REGION,
AND TIME TO MODEL THE UNDER 5 MORTALITY RATE

	Coefficient	Standard Error	T-value
Constant	8.11	0.45	-6.30
lnrgdp	-0.40	0.06	-1.93
lnac	-1.50	0.78	-0.35
t1	-0.13	0.36	0.03
t2	0.01	0.35	0.33
t3	0.12	0.35	1.97
t4	0.69	0.35	3.03
t5	1.07	0.35	3.00
t6	1.14	0.38	1.79
lnrgdp*lnac	0.19	0.10	0.49
lnac*t1	0.04	0.07	0.69
lnac*t2	0.05	0.08	0.24
lnac*t3	0.02	0.08	-0.04
lnac*t4	0.00	0.09	-1.30
lnac*t5	-0.11	0.09	-3.22
lnac*t6	-0.28	0.09	0.06
lnrgdp*t1	0.00	0.05	-0.51
lnrgdp*t2	-0.03	0.05	-1.08
lnrgdp*t3	-0.05	0.05	-3.00
lnrgdp*t4	-0.15	0.05	-4.46
lnrgdp*t5	-0.23	0.05	-4.74
lnrgdp*t6	-0.25	0.05	

Notes:
1. Interaction terms are written with '*' to denote product.
2. The overall R² for this estimation is 0.63.

TABLE 5

COEFFICIENT ESTIMATES OF THE EQUATION USING INCOME, REGION,
AND TIME TO MODEL TOTAL FERTILITY RATE

	Coefficient	Standard Error	T-value
Constant	3.00	0.27	-4.39
lnrgdp	-0.17	0.04	0.73
lac	0.34	0.47	0.57
t1	0.14	0.25	0.57
t2	0.38	0.24	1.58
t3	0.24	0.24	2.36
t4	0.56	0.24	3.67
t5	0.85	0.24	4.71
t6	1.12	0.25	4.37
lnrgdp*lac	-0.04	0.07	-0.57
lac*t1	-0.01	0.06	-0.18
lac*t2	-0.01	0.06	-0.15
lac*t3	-0.02	0.06	-0.41
lac*t4	-0.02	0.06	-0.37
lac*t5	-0.07	0.06	-1.28
lac*t6	-0.08	0.06	-1.30
lnrgdp*t1	-0.02	0.04	-0.51
lnrgdp*t2	-0.06	0.03	-1.59
lnrgdp*t3	-0.09	0.03	-2.56
lnrgdp*t4	-0.13	0.03	-3.91
lnrgdp*t5	-0.18	0.03	-5.19
lnrgdp*t6	-0.18	0.04	-5.20

Notes:

1. Interaction terms are written with '*' to denote product.

2. The overall R² for this estimation is 0.49.

TABLE 6

PERFORMANCE, RELATIVE TO OTHER LATIN AMERICA COUNTRIES AND INCOME, IN
REDUCING UNDER-5 MORTALITY RATE, BY COUNTRY, 1960-90

Country	Relative Performance in		Change in relative performance in the Five Years Ending in					Relative Performance in	
	1960	1965	1970	1975	1980	1985	1990	1990	
Argentina	64%	0%	-29%	15%	3%	-4%	-33%	15%	
Bolivia	-38%	-5%	-4%	0%	-1%	-5%	-5%	-58%	
Brazil*	-18%	3%	3%	-4%	-4%	-18%	-5%	-40%	
Chile	-16%	14%	12%	33%	46%	27%	-40%	76%	
Colombia	20%	-14%	1%	3%	23%	21%	46%	100%	
Costa Rica	12%	9%	11%	40%	73%	24%	-5%	164%	
Dominican Rep.	6%	-6%	3%	-6%	-6%	-3%	-9%	-20%	
Ecuador	-15%	3%	3%	-6%	-8%	1%	5%	-17%	
El Salvador	-21%	2%	-2%	-7%	-7%	11%	11%	-7%	
Guatemala	-28%	0%	1%	-4%	-10%	4%	2%	-36%	
Haiti*	-34%	-1%	3%	-5%	-7%	2%	2%	-41%	
Honduras	-20%	-1%	3%	18%	-1%	7%	7%	13%	
Mexico	-3%	-1%	-2%	-5%	-11%	-1%	-16%	-9%	
Nicaragua	-23%	-3%	-1%	-5%	10%	2%	13%	-38%	
Panama	69%	-2%	4%	13%	-26%	-21%	14%	50%	
Paraguay	72%	1%	4%	-16%	-22%	-3%	-13%	23%	
Peru	-40%	-1%	5%	-5%	3%	-4%	5%	-37%	
Uruguay	116%	-24%	-8%	-24%	-13%	5%	-17%	35%	
Venezuela	46%	19%	-23%	-14%	2%	-10%	-12%	10%	

Notes:

1. The Brazil numbers are for 1960-85.

2. The Haiti numbers are for 1965-85.

TABLE 7

PERFORMANCE, RELATIVE TO OTHER LATIN AMERICA COUNTRIES AND INCOME, IN
REDUCING TOTAL FERTILITY RATE, BY COUNTRY, 1960-90

Country	Change in relative performance in the Five Years Ending in					Relative Performance in 1990
	1960	1965	1970	1975	1980	
Argentina	64%	-2%	-21%	-23%	-14%	-1%
Bolivia	2%	-3%	-6%	-2%	3%	2%
Brazil	1%	6%	2%	-5%	-2%	-3%
Chile	7%	5%	11%	27%	-3%	3%
Colombia	-7%	1%	10%	10%	-1%	16%
Costa Rica	-15%	6%	13%	9%	4%	8%
Dominican Rep.	-9%	3%	6%	5%	-1%	-8%
Ecuador	-7%	0%	1%	-7%	10%	-2%
El Salvador	-6%	-3%	1%	-3%	0%	8%
Guatemala	-8%	0%	-4%	-7%	6%	5%
Haiti*	11%	6%	3%	-5%	-7%	-6%
Honduras	-5%	-2%	-5%	1%	-9%	2%
Mexico	-17%	-4%	-6%	0%	3%	1%
Nicaragua	-14%	-5%	-1%	-3%	9%	4%
Panama	7%	-2%	-2%	4%	8%	9%
Paraguay	-2%	2%	5%	5%	-11%	8%
Peru	-12%	-3%	2%	4%	8%	-5%
Uruguay	86%	0%	-23%	-15%	-10%	8%
Venezuela	-26%	-1%	2%	4%	2%	-10%
						-1%
						-22%

Note:
1. The Haiti numbers are for 1960-85.

TABLE 8

COUNTRIES SHOWING MAJOR CHANGES IN RELATIVE PERFORMANCE ON UNDER-5
MORTALITY RATE AND TOTAL FERTILITY RATE, BY PERIOD

	Dramatic Improvement	Substantial Improvement	Substantial Decline	Dramatic Decline
Panel A - Under-5 Mortality Rate (from Table 6)	Chile - 75 Costa Rica - 75 Chile - 80 Costa Rica - 80 Chile - 85 Colombia - 90	Chile - 65 Venezuela - 65 Chile - 70 Argentina - 75 Honduras - 75 Panama - 75 Colombia - 80 Colombia - 85 Costa Rica - 85 Nicaragua - 90 Panama - 90	Colombia - 65 Uruguay - 65 Venezuela - 70 Paraguay - 75 Uruguay - 75 Venezuela - 75 Paraguay - 80 Uruguay - 80 Brazil - 85 Panama - 85 Mexico - 85 Paraguay - 90 Uruguay - 90	Argentina - 70 Panama - 80 Argentina - 90 Chile - 90
Panel B - Total Fertility Rate (from Table 7)	Chile - 75	Chile - 70 Colombia - 70 Costa Rica - 70 Colombia - 75 Costa Rica - 75 Dominican Rep. - 80 Ecuador - 90 Nicaragua - 90 Panama - 90 Peru - 90	Argentina - 80 Guatemala - 80 Paraguay - 80 Uruguay - 80 Chile - 85 Costa Rica - 90 Colombia - 90 Uruguay - 90	Argentina - 70 Uruguay - 70 Argentina - 75 Uruguay - 75 Chile - 90

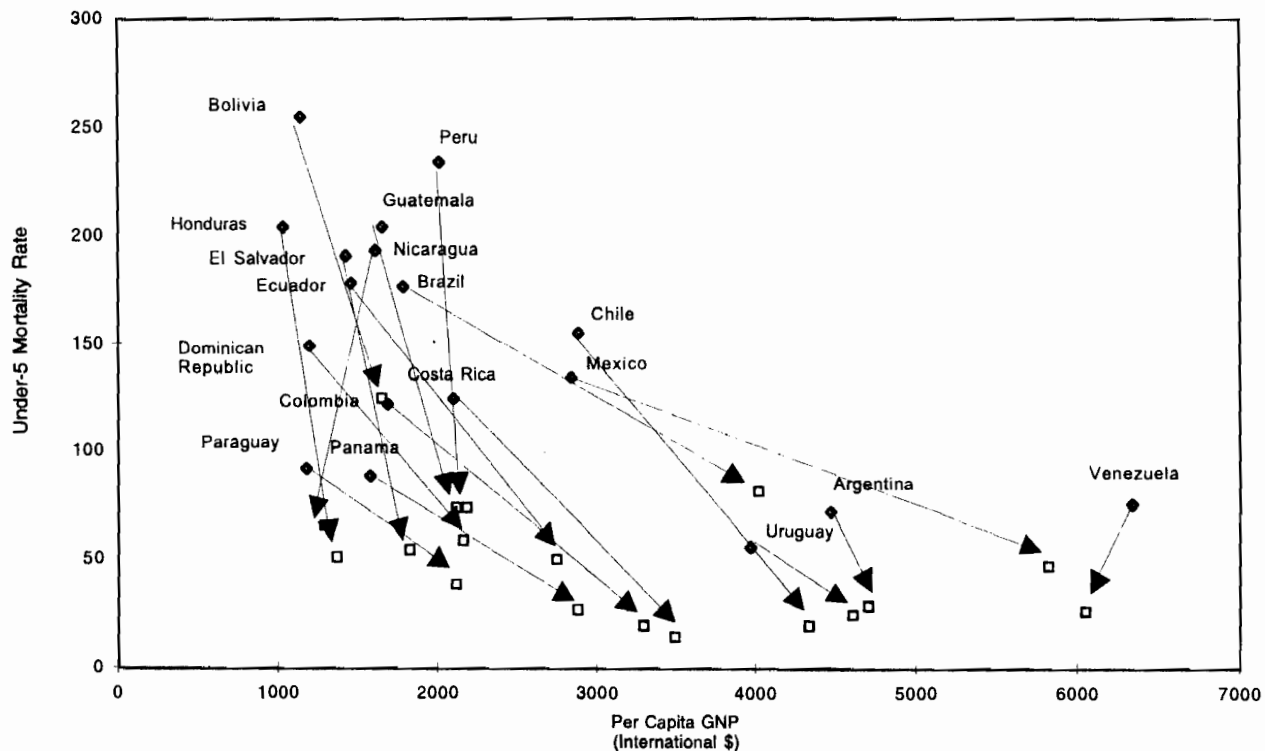
Note: "Dramatic" improvements (or declines) are defined as exceeding a 25% change in relative performance for mortality and as exceeding 15% for fertility; "substantial" falls in the range of 12-24% for mortality and 8-14% for fertility. The number after the country name is the end year of the indicated 5-year change in relative performance.

TABLE 9
PUBLIC AND PRIVATE HEALTH EXPENDITURES AS PREDICTORS OF RELATIVE PERFORMANCE ON UNDER-5 MORTALITY AND FERTILITY RATES

	Coefficient	Standard Error	T-value
Under-5 Mortality Rate			
Constant	-4.67	5.70	3.30
epub	18.79	8.49	-2.02
epri	-17.13		
R ² = .44			
Total Fertility Rate			
Constant	-4.04	1.94	1.38
epub	2.66	2.88	-0.53
epri	-1.53		
R ² = .20			
Under-5 Mortality Rate			
Constant	-31.61	5.08	1.25
etot	6.33		
R ² = .08			
Total Fertility Rate			
Constant	-7.19	1.40	0.86
etot	1.21		
R ² = .04			

FIGURE 1

CHANGES IN INCOME AND UNDER-5 MORTALITY RATE, 1960 TO 1990



Note: The Brazil numbers are for 1960 and 1985.

FIGURE 2

CHANGES IN INCOME AND TOTAL FERTILITY RATE, 1960 TO 1990

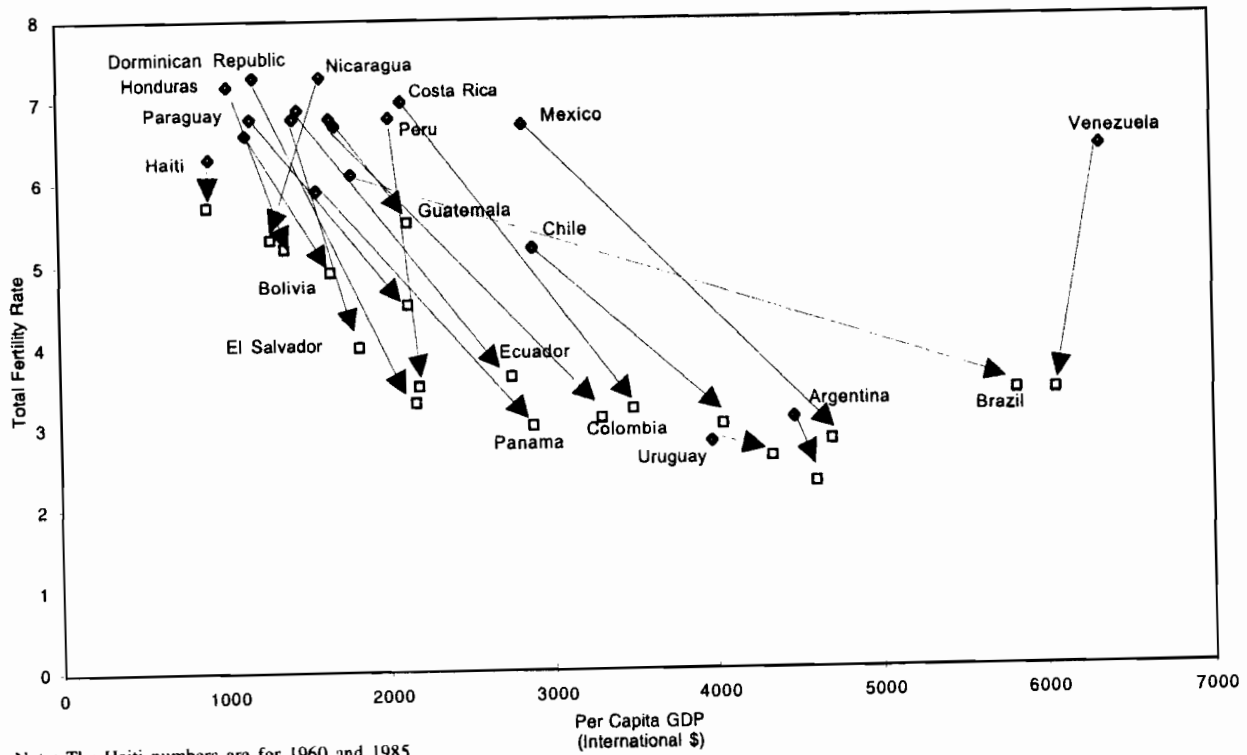
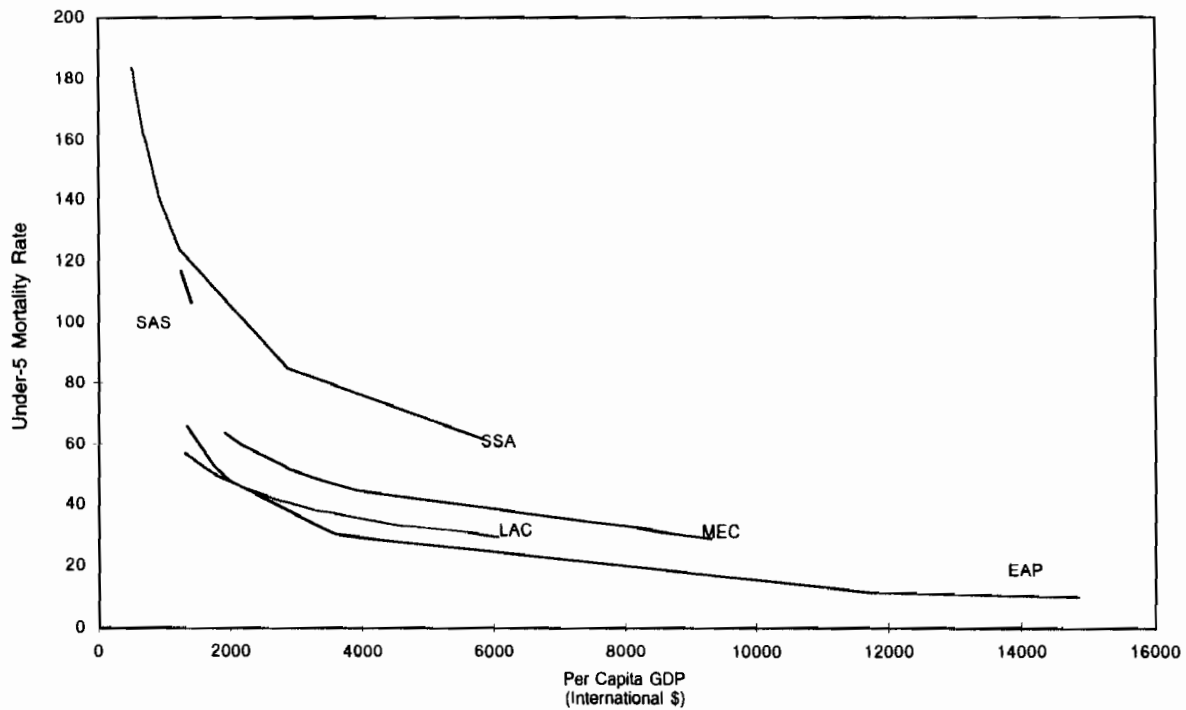


FIGURE 3

INCOME AND UNDER-5 MORTALITY RATE, LATIN AMERICA AND OTHER REGIONS, 1990



Notes: EAP - East Asia and the Pacific Region; LAC - Latin America and the Caribbean Region; SAS - South Asia Region; SSA - Sub Saharan Africa Region; MEC - Middle East/North Africa Region.

FIGURE 4

THE CHANGING RELATION BETWEEN INCOME AND UNDER-5 MORTALITY RATE IN LAC, 1960-1990

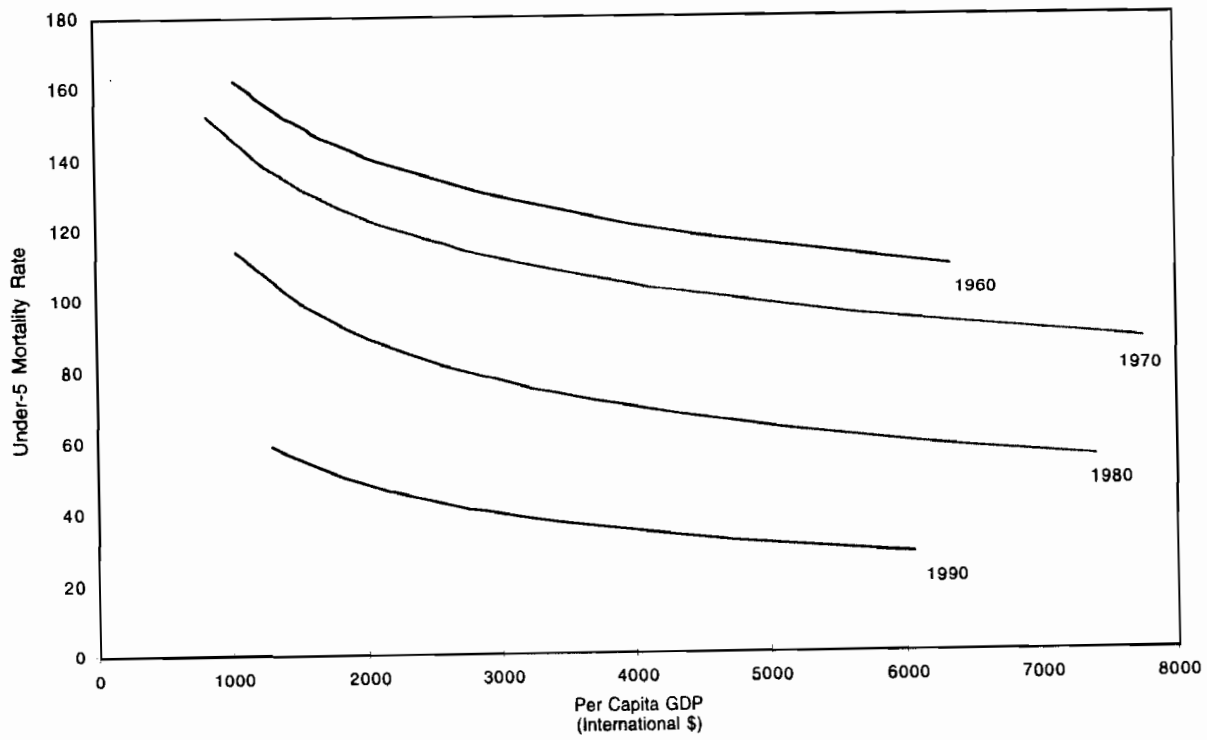
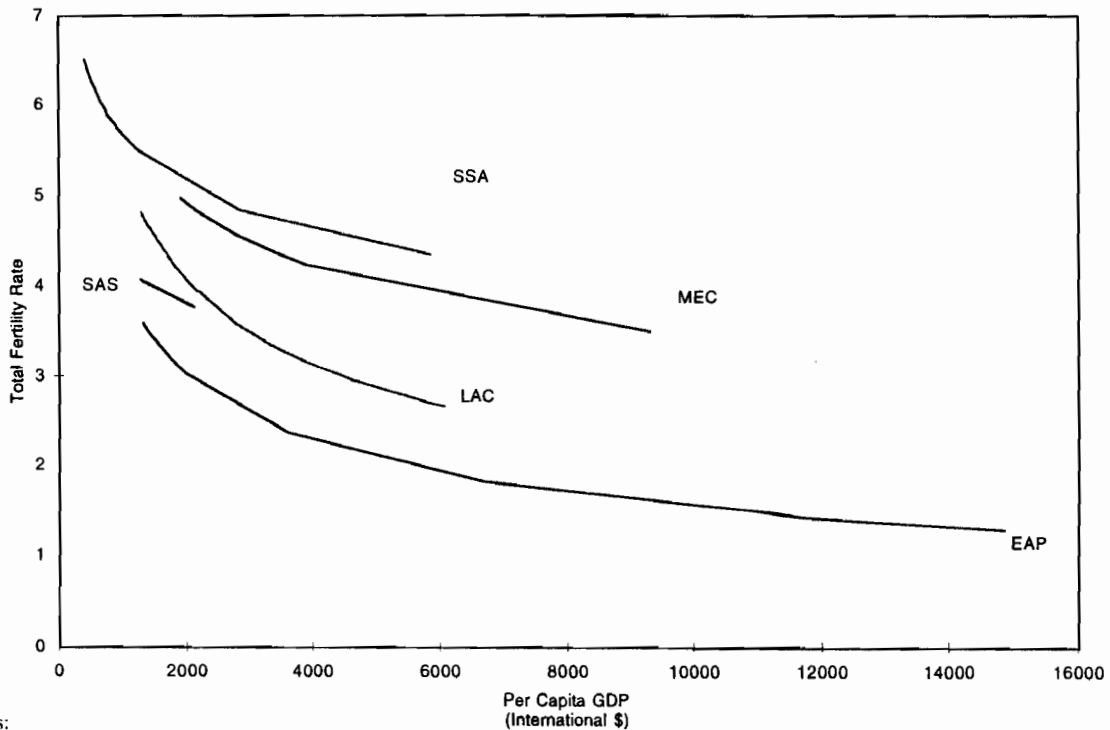


FIGURE 5

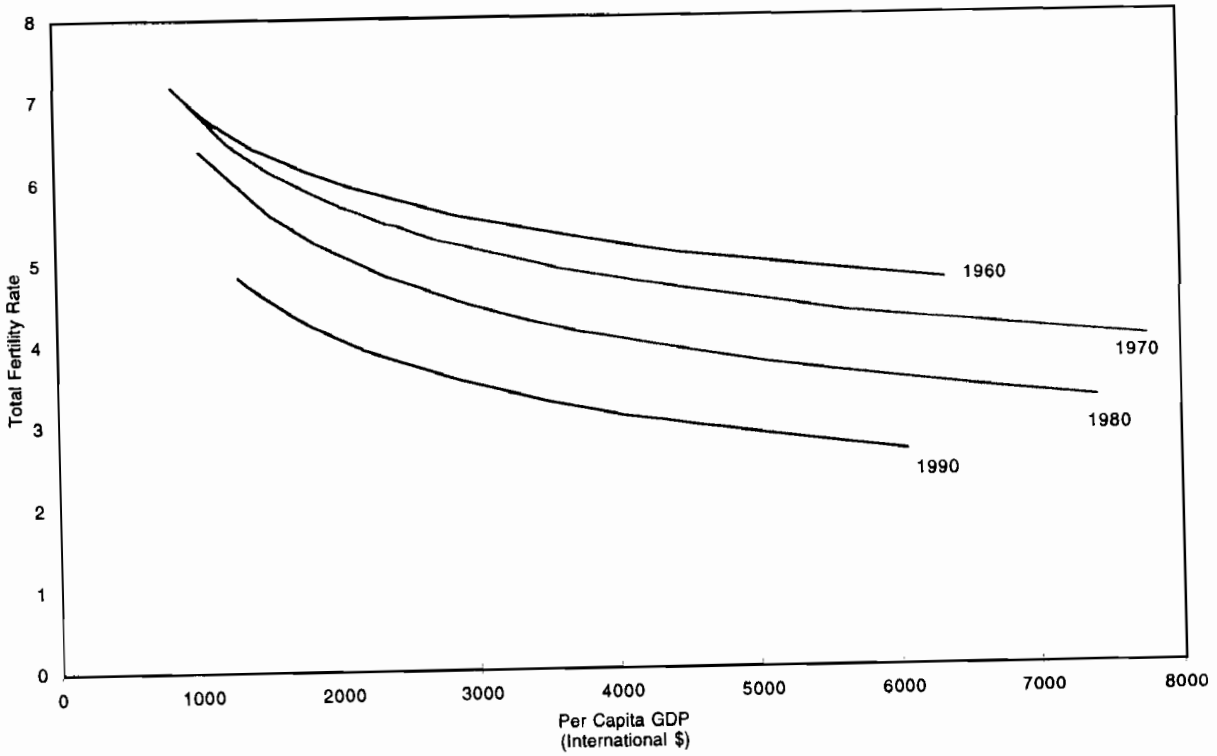
INCOME AND TOTAL FERTILITY RATE, LATIN AMERICA AND OTHER REGIONS, 1990



Notes:
EAP - East Asia and the Pacific Region; LAC - Latin America and the Caribbean Region; SAS - South Asia Region; SSA - Sub Saharan Africa Region; MEC - Middle East/North Africa Region.

FIGURE 6

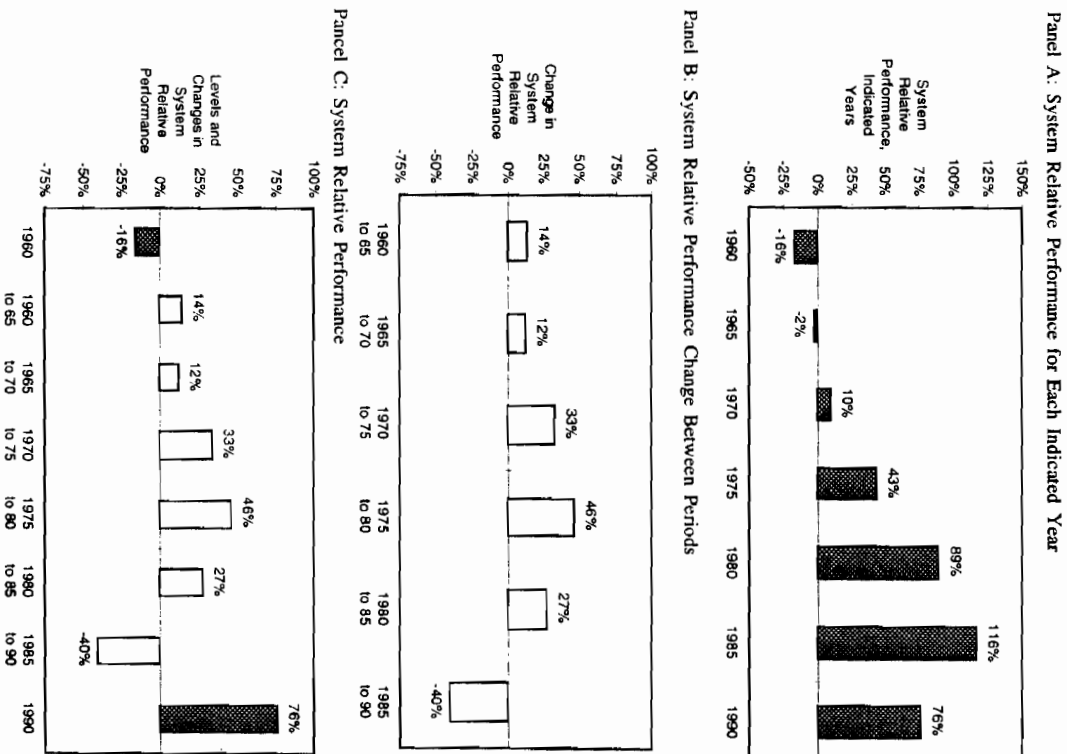
THE CHANGING RELATION BETWEEN INCOME AND TOTAL FERTILITY RATE IN LAC, 1960-1990



INCOME, MORTALITY AND FERTILITY IN LATIN AMERICA

FIGURE 7: CHILE

SYSTEM RELATIVE PERFORMANCE FOR EACH INDICATED YEAR
(in Relation To Income and Other Latin America Countries)
ON UNDER FIVE MORTALITY RATE, 1960 to 1990



Notes

- 1 An earlier version of this paper was presented (by Jamison) as an invited lecture at the Latin America Meetings of the Econometric Society, Rio de Janeiro, August 1996.
- 2 The authors are indebted to Eduard Bos, Laura Shrestha and Akiko Maeda for valuable discussions and for making various of the data sets available to us. Support for preparation of the paper was provided by the Health, Nutrition and Population Sector Assistance Strategy Team of the World Bank, by the Office of the Chief Economist of the Inter-American Development Bank and by the Technical Department of the Regional Office of the World Bank for Latin America and the Caribbean. The work was initiated under the general leadership of the Director of that Department, Sri-Ram Aiyer. Needless to say, the views and conclusions expressed in this paper are those of the authors and do not necessarily reflect those of the Inter-American Development Bank or the World Bank group.
- 3 The under-5 mortality rate is increasingly viewed by demographers as technically superior to the still widely used infant mortality rate (IMR). The main reason has to do with measurement error: accurate measurement of IMR relies far more than does measurement of under-5 mortality on accurate reporting of age of death. Resulting measurement errors in IMR can be substantial for countries with high mortality levels, low educational levels or poor vital registration. Hence our analysis uses under-5 mortality.
- 4 If performance were weighted by country population, LAC's performance would appear less attractive relative to other regions because of the poor performance of the two most populous countries, Brazil and Mexico.
- 5 An analogous country-by-country set of graphs on absolute performance can be obtained from the authors upon request.

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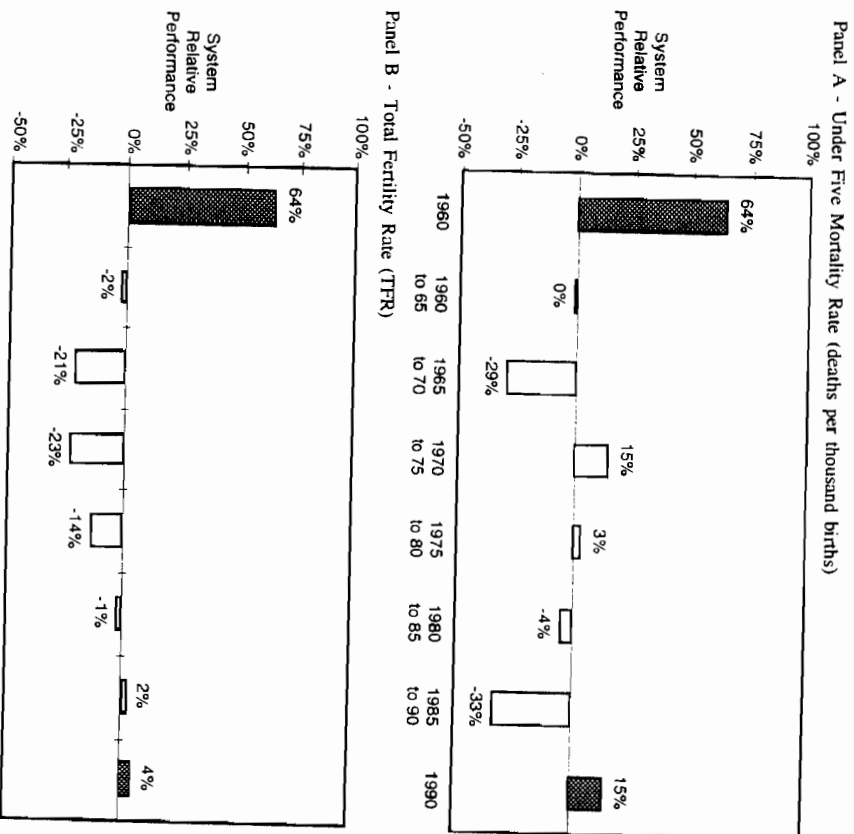
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APPENDIX

Graphs of System Relative Performance, by Country

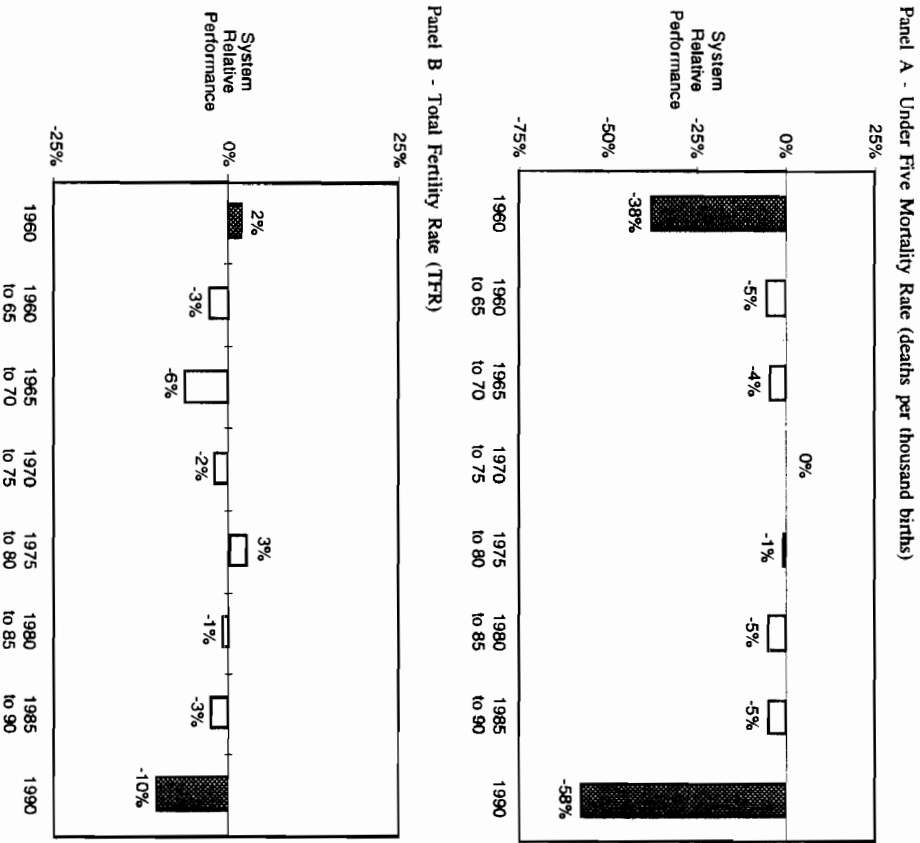
FIGURE 1. ARGENTINA

SYSTEM RELATIVE PERFORMANCE
(in Relation to Income and Other Latin America Countries)
ON UNDER FIVE MORTALITY RATE AND TOTAL FERTILITY RATE, 1960 TO 1990



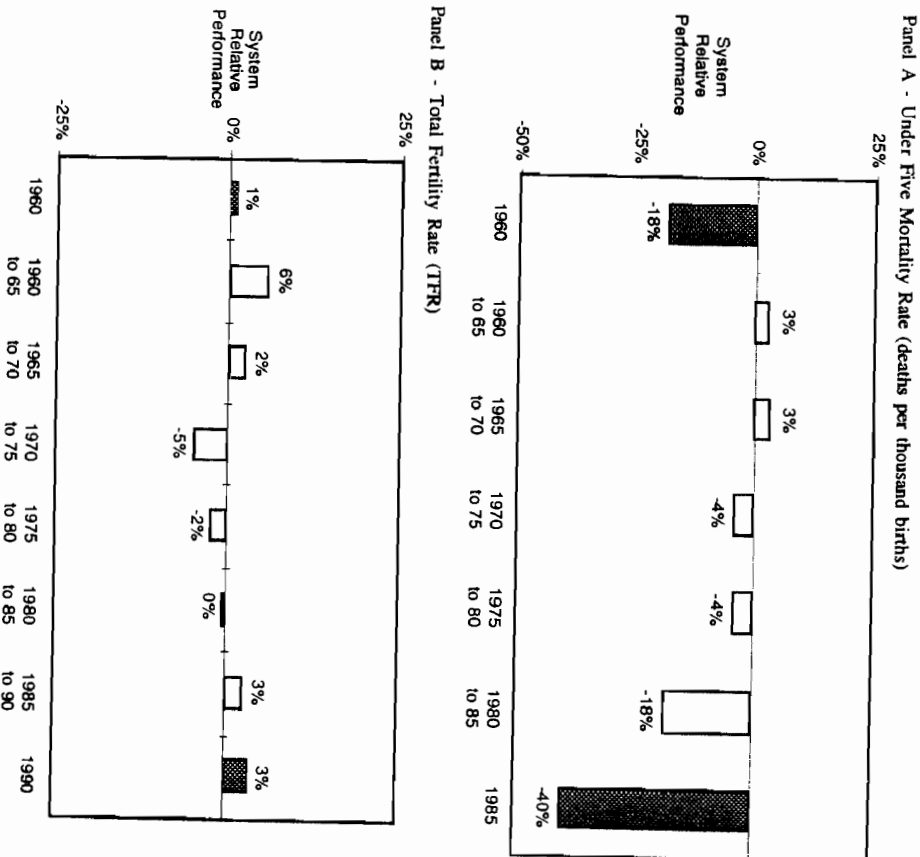
- Notes:
1. System relative performance: amount that predicted is higher than actual as a percent of actual.
 2. Solid bars show system relative performance in 1960 and 1990; open bars show the change in performance between the indicated years.

FIGURE 2: BOLIVIA
 SYSTEM RELATIVE PERFORMANCE
 (in Relation to Income and Other Latin America Countries)
 ON UNDER FIVE MORTALITY RATE AND TOTAL FERTILITY RATE, 1960 TO 1990



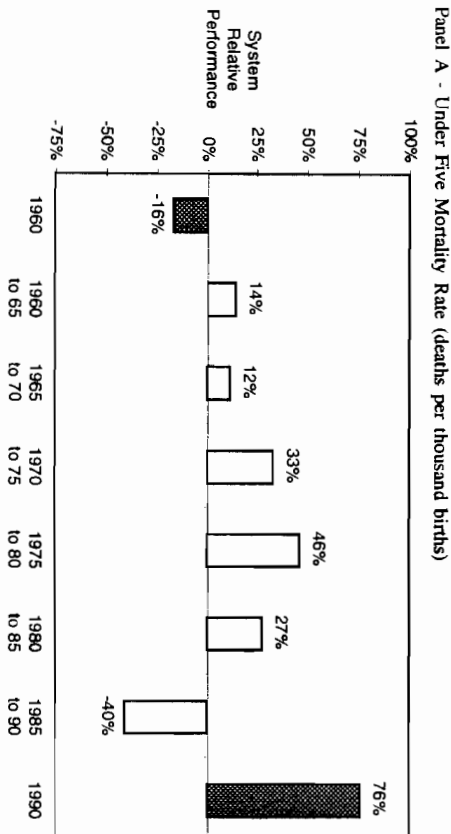
Notes:
 1. System relative performance: amount that predicted is higher than actual as a percent of actual.
 2. Solid bars show system relative performance in 1960 and 1990; open bars show the change in performance between the indicated years.

FIGURE 3: BRAZIL
 SYSTEM RELATIVE PERFORMANCE
 (in Relation to Income and Other Latin America Countries)
 ON UNDER FIVE MORTALITY RATE AND TOTAL FERTILITY RATE, 1960 TO 1990

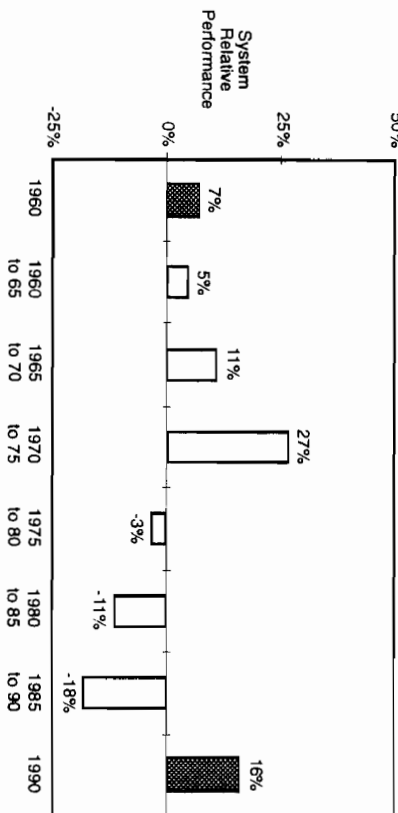


Notes:
 1. System relative performance: amount that predicted is higher than actual as a percent of actual.
 2. Solid bars show system relative performance in 1960 and 1990; open bars show the change in performance between the indicated years.

FIGURE 4: CHILE
SYSTEM RELATIVE PERFORMANCE
(in Relation to Income and Other Latin America Countries)
ON UNDER FIVE MORTALITY RATE AND TOTAL FERTILITY RATE, 1960 TO 1990

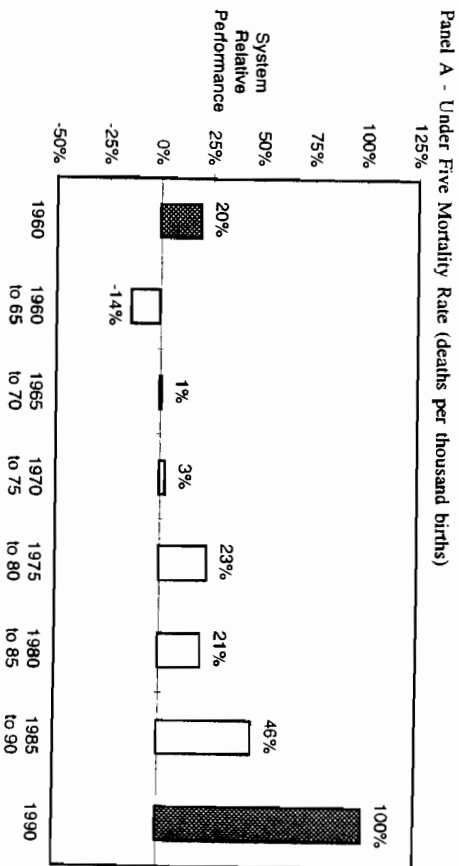


Panel B - Total Fertility Rate (TFR)



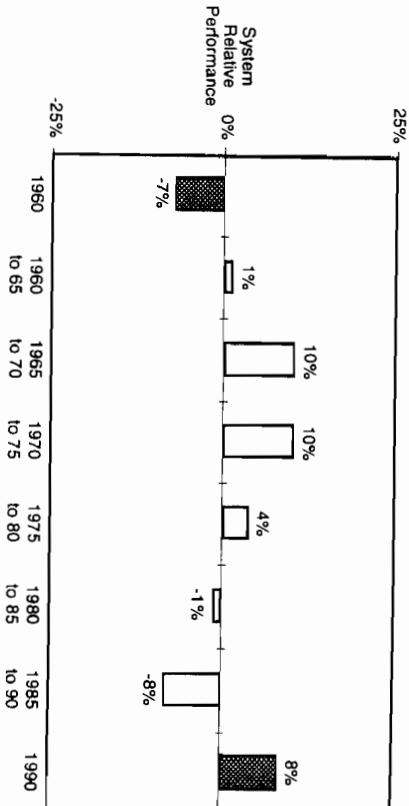
Notes:
1. System relative performance: amount that predicted is higher than actual as a percent of actual.
2. Solid bars show system relative performance in 1960 and 1990; open bars show the change in performance between the indicated years.

FIGURE 5: COLOMBIA
SYSTEM RELATIVE PERFORMANCE
(in Relation to Income and Other Latin America Countries)
ON UNDER FIVE MORTALITY RATE AND TOTAL FERTILITY RATE, 1960 TO 1990



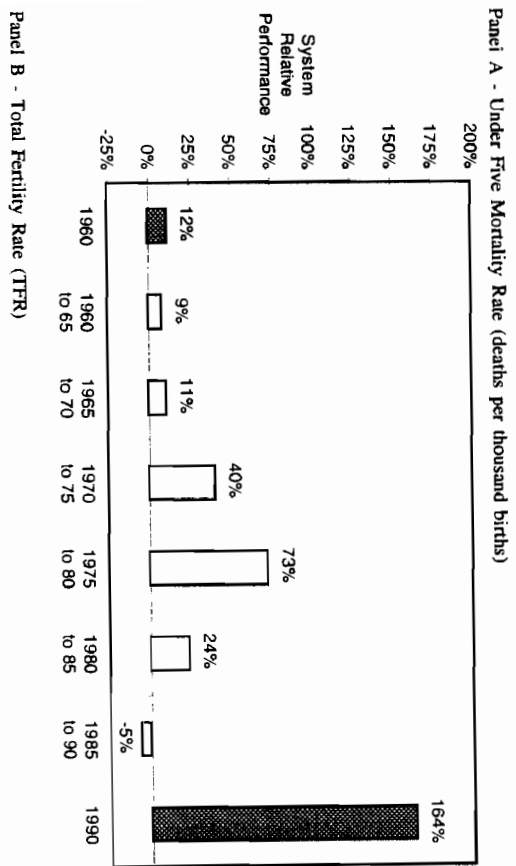
Panel A - Under Five Mortality Rate (deaths per thousand births)

Panel B - Total Fertility Rate (TFR)



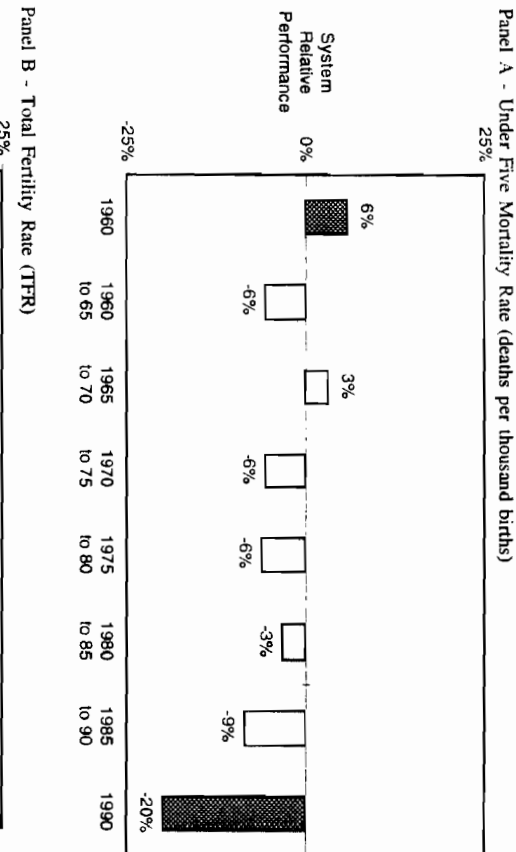
Notes:
1. System relative performance: amount that predicted is higher than actual as a percent of actual.
2. Solid bars show system relative performance in 1960 and 1990; open bars show the change in performance between the indicated years.

FIGURE 6: COSTA RICA
SYSTEM RELATIVE PERFORMANCE
(in Relation to Income and Other Latin America Countries)
ON UNDER FIVE MORTALITY RATE AND TOTAL FERTILITY RATE, 1960 TO 1990



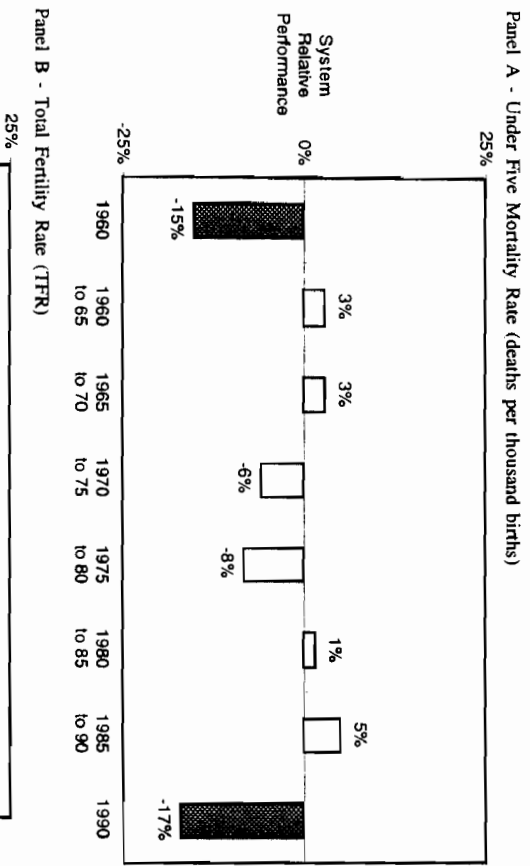
Notes:
1. System relative performance: amount that predicted is higher than actual as a percent of actual.
2. Solid bars show system relative performance in 1960 and 1990; open bars show the change in performance between the indicated years.

FIGURE 7: DOMINICAN REPUBLIC
SYSTEM RELATIVE PERFORMANCE
(in Relation to Income and Other Latin America Countries)
ON UNDER FIVE MORTALITY RATE AND TOTAL FERTILITY RATE, 1960 TO 1990



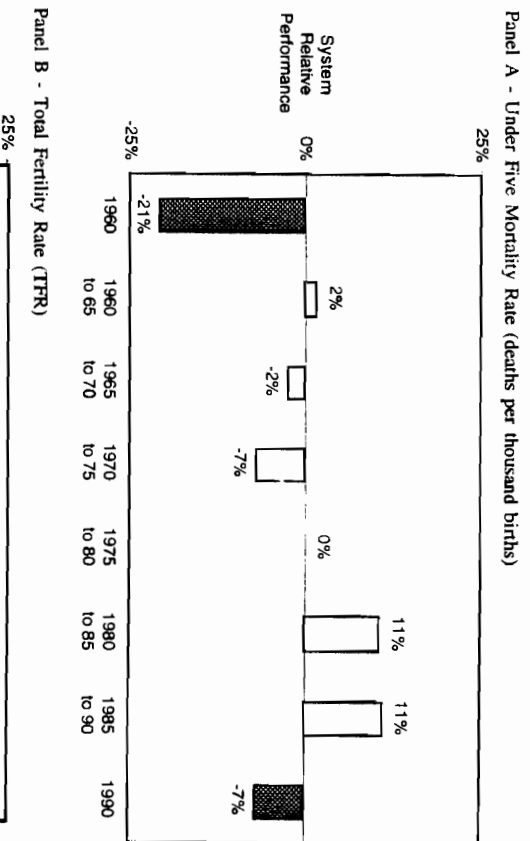
Notes:
1. System relative performance: amount that predicted is higher than actual as a percent of actual.
2. Solid bars show system relative performance in 1960 and 1990; open bars show the change in performance between the indicated years.

FIGURE 8: ECUADOR
 SYSTEM RELATIVE PERFORMANCE
 (in Relation to Income and Other Latin America Countries)
 ON UNDER FIVE MORTALITY RATE AND TOTAL FERTILITY RATE, 1960 TO 1990



Notes:
 1. System relative performance: amount that predicted is higher than actual as a percent of actual.
 2. Solid bars show system relative performance in 1960 and 1990; open bars show the change in performance between the indicated years.

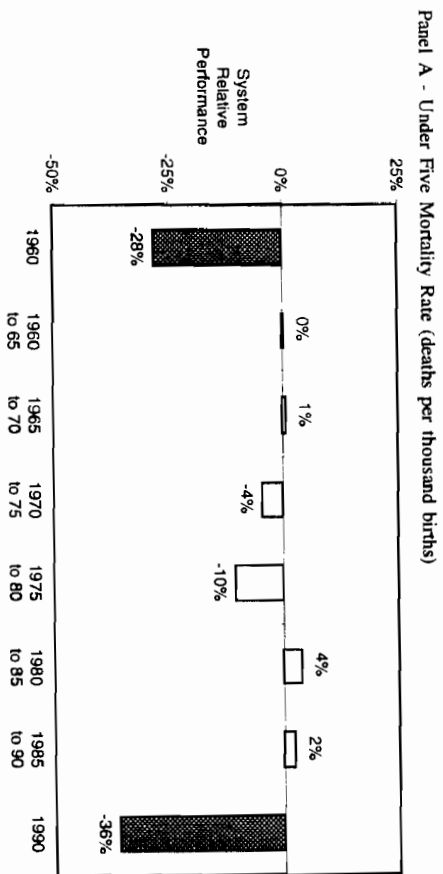
FIGURE 9: EL SALVADOR
 SYSTEM RELATIVE PERFORMANCE
 (in Relation to Income and Other Latin America Countries)
 ON UNDER FIVE MORTALITY RATE AND TOTAL FERTILITY RATE, 1960 TO 1990



Notes:
 1. System relative performance: amount that predicted is higher than actual as a percent of actual.
 2. Solid bars show system relative performance in 1960 and 1990; open bars show the change in performance between the indicated years.

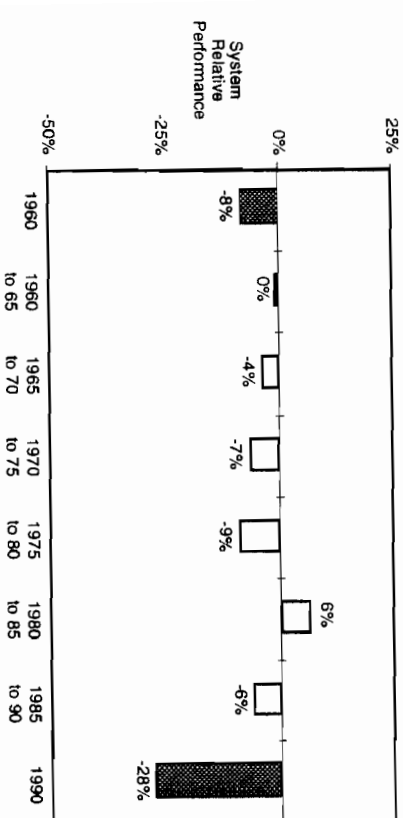
FIGURE 10: GUATEMALA

SYSTEM RELATIVE PERFORMANCE
(in Relation to Income and Other Latin America Countries)
ON UNDER FIVE MORTALITY RATE AND TOTAL FERTILITY RATE, 1960 TO 1990



Panel A - Under Five Mortality Rate (deaths per thousand births)

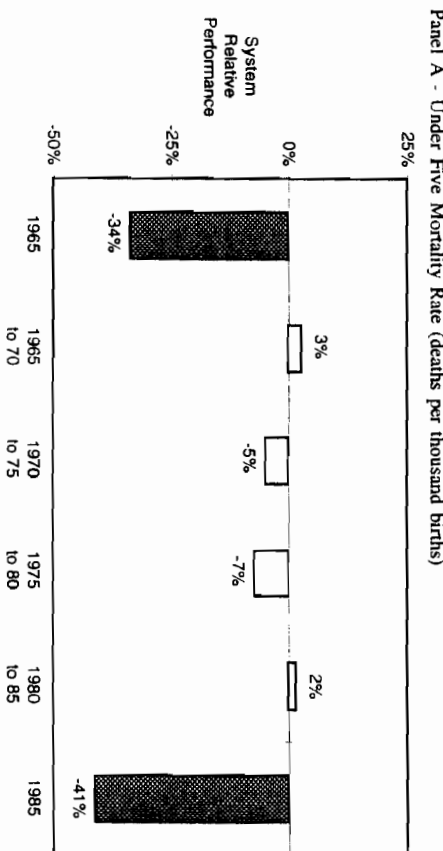
Panel B - Total Fertility Rate (TFR)



- Notes:
1. System relative performance: amount that predicted is higher than actual as a percent of actual.
 2. Solid bars show system relative performance in 1960 and 1990; open bars show the change in performance between the indicated years.

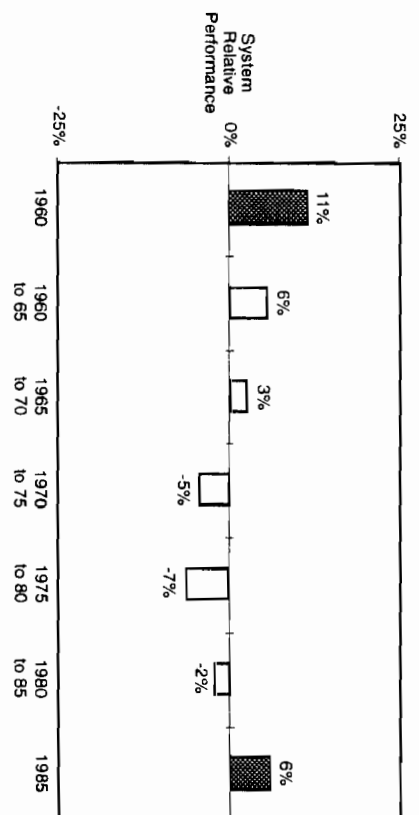
FIGURE 11: HAITI

SYSTEM RELATIVE PERFORMANCE
(in Relation to Income and Other Latin America Countries)
ON UNDER FIVE MORTALITY RATE AND TOTAL FERTILITY RATE, 1960 TO 1990



Panel A - Under Five Mortality Rate (deaths per thousand births)

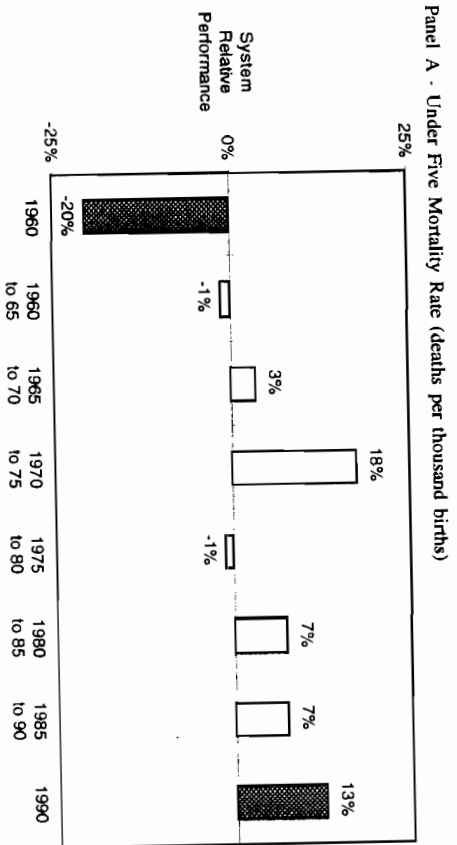
Panel B - Total Fertility Rate (TFR)



- Notes:
1. System relative performance: amount that predicted is higher than actual as a percent of actual.
 2. Solid bars show system relative performance in 1960 and 1990; open bars show the change in performance between the indicated years.

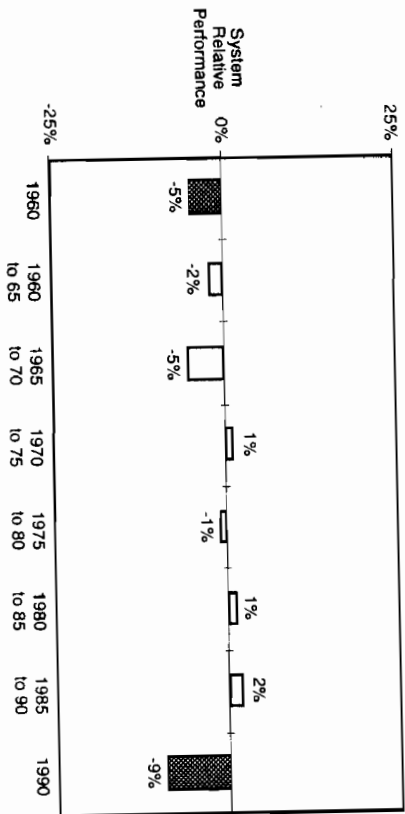
FIGURE 12: HONDURAS

SYSTEM RELATIVE PERFORMANCE
(in Relation to Income and Other Latin America Countries)
ON UNDER FIVE MORTALITY RATE AND TOTAL FERTILITY RATE, 1960 TO 1990



Panel A - Under Five Mortality Rate (deaths per thousand births)

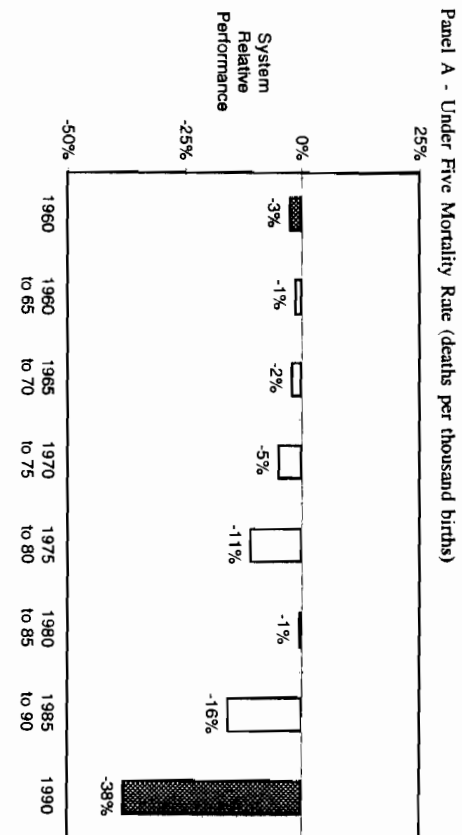
Panel B - Total Fertility Rate (TFR)



- Notes:
1. System relative performance: amount that predicted is higher than actual as a percent of actual.
 2. Solid bars show system relative performance in 1960 and 1990; open bars show the change in performance between the indicated years.

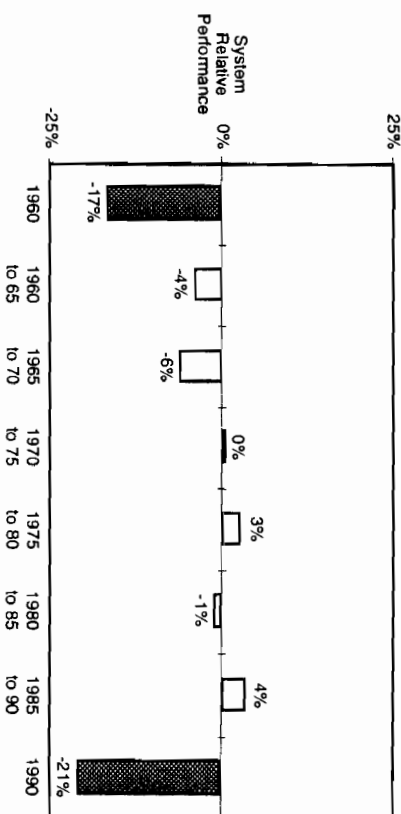
FIGURE 13: MEXICO

SYSTEM RELATIVE PERFORMANCE
(in Relation to Income and Other Latin America Countries)
ON UNDER FIVE MORTALITY RATE AND TOTAL FERTILITY RATE, 1960 TO 1990



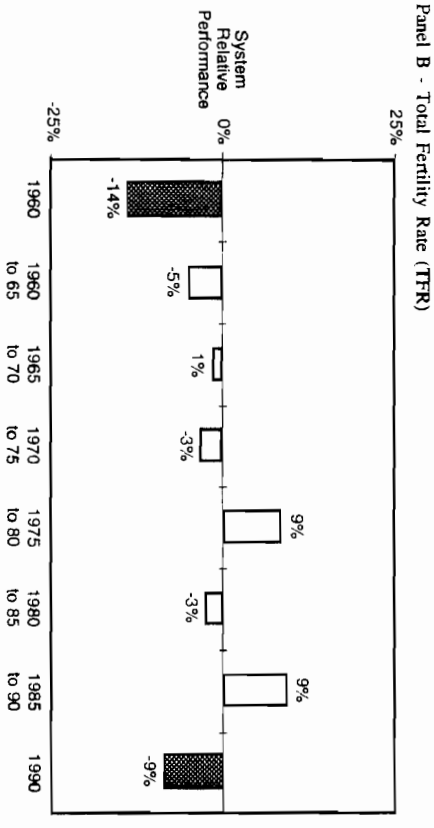
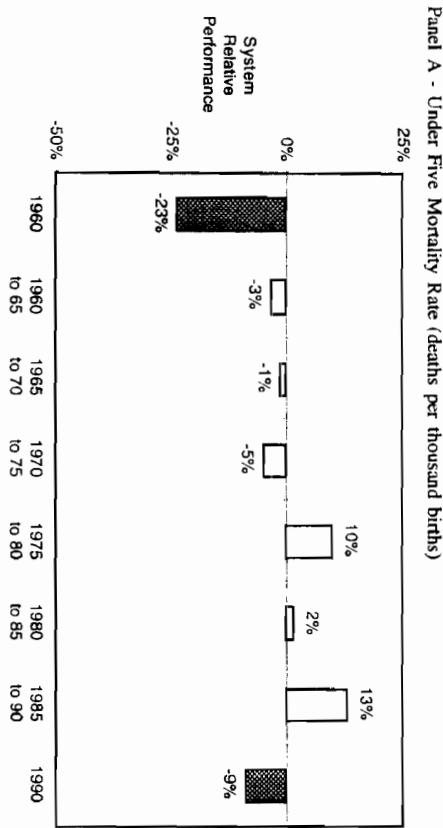
Panel A - Under Five Mortality Rate (deaths per thousand births)

Panel B - Total Fertility Rate (TFR)



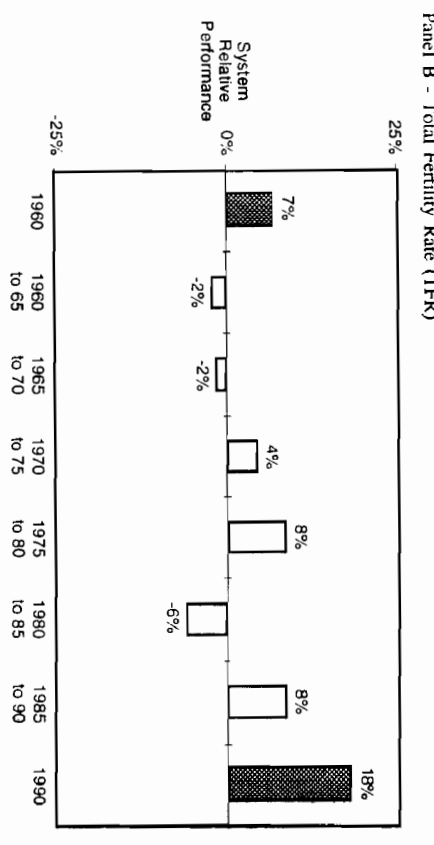
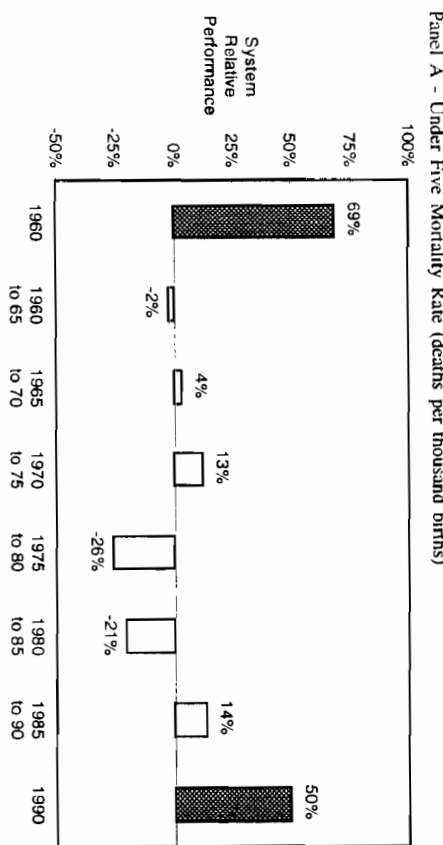
- Notes:
1. System relative performance: amount that predicted is higher than actual as a percent of actual.
 2. Solid bars show system relative performance in 1960 and 1990; open bars show the change in performance between the indicated years.

FIGURE 14: NICARAGUA
 SYSTEM RELATIVE PERFORMANCE
 (in Relation to Income and Other Latin America Countries)
 ON UNDER FIVE MORTALITY RATE AND TOTAL FERTILITY RATE, 1960 TO 1990



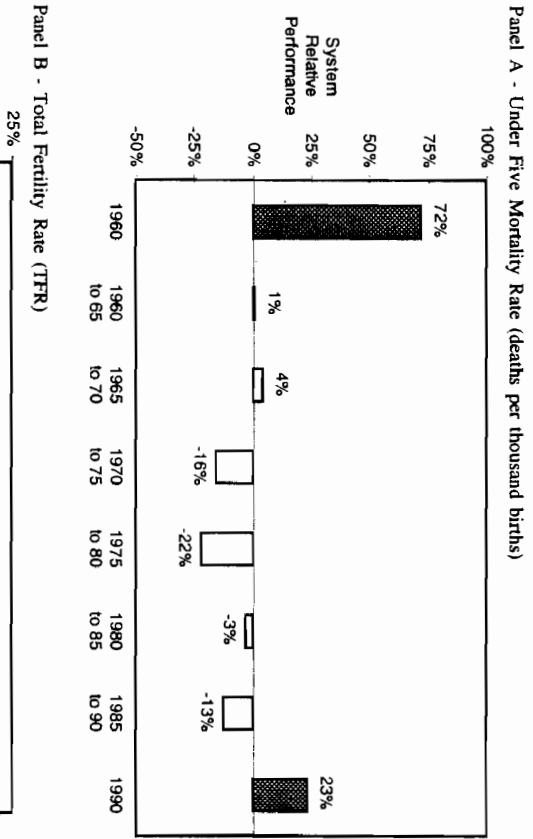
Notes:
 1. System relative performance: amount that predicted is higher than actual as a percent of actual.
 2. Solid bars show system relative performance in 1960 and 1990: open bars show the change in performance between the indicated years.

FIGURE 15: PANAMA
 SYSTEM RELATIVE PERFORMANCE
 (in Relation to Income and Other Latin America Countries)
 ON UNDER FIVE MORTALITY RATE AND TOTAL FERTILITY RATE, 1960 TO 1990



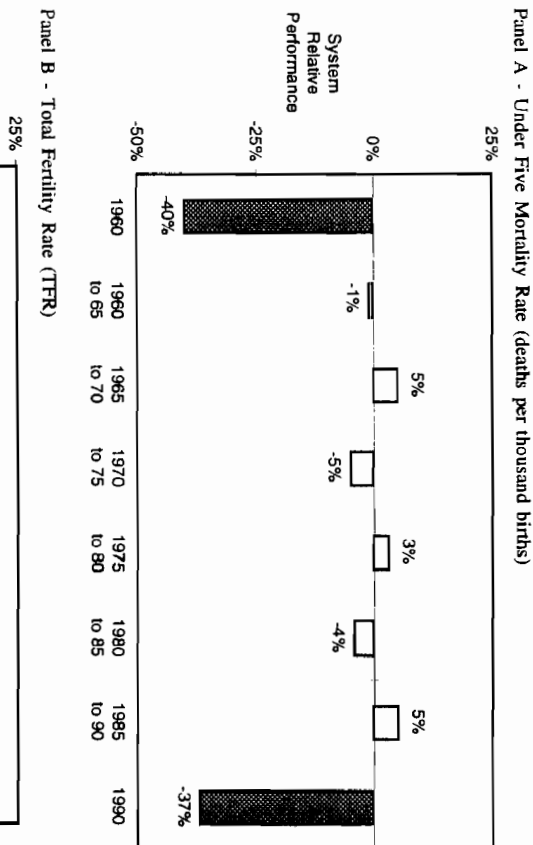
Notes:
 1. System relative performance: amount that predicted is higher than actual as a percent of actual.
 2. Solid bars show system relative performance in 1960 and 1990: open bars show the change in performance between the indicated years.

FIGURE 16: PARAGUAY
SYSTEM RELATIVE PERFORMANCE
(in Relation to Income and Other Latin America Countries)
ON UNDER FIVE MORTALITY RATE AND TOTAL FERTILITY RATE, 1960 TO 1990



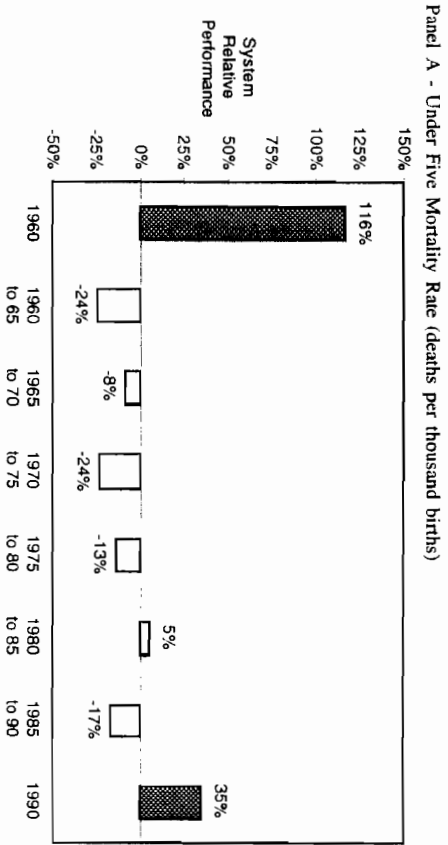
Notes:
1. System relative performance: amount that predicted is higher than actual as a percent of actual.
2. Solid bars show system relative performance in 1960 and 1990; open bars show the change in performance between the indicated years.

FIGURE 17: PERU
SYSTEM RELATIVE PERFORMANCE
(in Relation to Income and Other Latin America Countries)
ON UNDER FIVE MORTALITY RATE AND TOTAL FERTILITY RATE, 1960 TO 1990



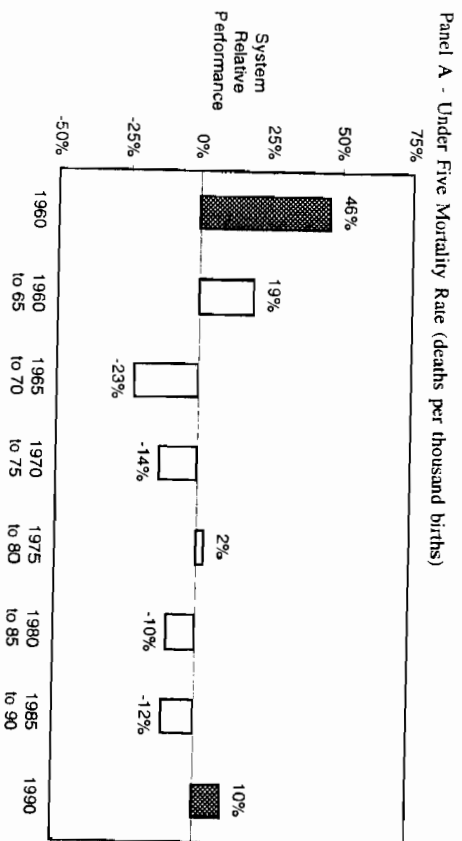
Notes:
1. System relative performance: amount that predicted is higher than actual as a percent of actual.
2. Solid bars show system relative performance in 1960 and 1990; open bars show the change in performance between the indicated years.

FIGURE 18: URUGUAY
SYSTEM RELATIVE PERFORMANCE
(in Relation to Income and Other Latin America Countries)
ON UNDER FIVE MORTALITY RATE AND TOTAL FERTILITY RATE, 1960 TO 1990



Notes:
1. System relative performance: amount that predicted is higher than actual as a percent of actual.
2. Solid bars show system relative performance in 1960 and 1990; open bars show the change in performance between the indicated years.

FIGURE 19: VENEZUELA
SYSTEM RELATIVE PERFORMANCE
(in Relation to Income and Other Latin America Countries)
ON UNDER FIVE MORTALITY RATE AND TOTAL FERTILITY RATE, 1960 TO 1990



Notes:
1. System relative performance: amount that predicted is higher than actual as a percent of actual.
2. Solid bars show system relative performance in 1960 and 1990; open bars show the change in performance between the indicated years.