# Population, Institutions, and Human Well-Being

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Abstract

Contemporary research stresses the importance of economic institutions in enhancing economic growth and human well-being. The present paper builds on that research by integrating the economics of institutions with the economics of population. Empirical analysis in this paper shows that strong property rights in a country reduce fertility rates even after accounting for other factors. Empirical analysis also shows that population growth has only modest adverse effects on cross-national poverty measures while stronger property rights have powerful positive effects in reducing poverty. The data also show that while population growth does have some adverse effects on the environment, stronger property rights can ameliorate those adverse effects.

Few domains of intellectual inquiry are as demanding as the systematic study of population. The subject is extraordinarily complex. The complexity stems, *inter alia*, from the interaction of the physical and biological sciences on one hand and behavioral approaches on the other. The former document the forces underlying resource scarcity while the later document mechanisms and strategies of dealing with resource scarcity.

The details related to the economics of population are correspondingly complex. Economic analysis rests on both theory and empirical evidence. The intractable complexity of the economic theory of population is evident by examining just one feature of the economics of population—fertility. An established procedure in developing any theory involving maximization and derivation of equilibrium conditions is for theorists to employ "simplifying assumptions." Consider, then, the simplifying assumptions regarding human motives for having children. One tradition, evident in Malthus, views children as a factor of production and stresses the material benefits of procreation. Another view, evident in Becker (1960), views children as a consumption good generating satisfaction apart from purely material benefits. Similarly, other scholars stress the old age security motive for having children. A third view evident in Becker, Murphy and Tamura (1990) ascribes an "altruistic" motive to having children. The upshot of alternative views of the motive for having children is that our ability to simplify is impaired and thus our ability to understand conflicting patterns and predictions regarding fertility is limited. Moreover, the complexity extends well beyond fertility to include population density, disease and disaster, migration and war. Interestingly, the population questions are also confounded by questions of levels versus changes in population.

The complexity also extends beyond economic theory; it also entails examination of evidence regarding populations and changes in them. Despite the powerful biological side of

population studies, the human dimensions have not (so far) fit well with experimental design at least for experimental economics. More to the point, the difficulty in drawing conclusions from limited data on population data or even extensive data for limited periods has often led to superficial analysis and false conclusions. Notably, the "identification problem" in econometrics is a barrier to understanding important issues in population economics. The point holds in the classic sense regarding sufficient knowledge and information about structural equations, but it holds more generally. Fertility and population growth are often highly correlated with many other variables. Accordingly, high levels of correlation can easily confound our judgments regarding population economics. Indeed, important questions regarding the causes and effects of population growth have confused policy makers and academics for much of the last half century.[1]

This paper attempts to reduce the confusion regarding the causes and effect of population growth by focusing on economic institutions—an important subfield within the economics profession, but as yet not a part of mainstream population economics. Specifically, the paper examines the effects of economic institutions on fertility and examines the role of economic institutions in softening adverse effects of population growth on human well-being.

The point of departure for the analysis is the widely heralded and still acknowledged "population problem." Numerous opinion leaders view population growth as a major, if not the major, threat to human well-being. Consider the view of Robert McNamera, "…the threat of unmanageable population pressures is much like the threat of nuclear war…"[2] The fact that McNamera made his comments during the middle of cold war underscores his apocalyptic perspective. The view is well represented among scholars and policy makers. For example,

[1] See Robert Cassen, Population and Development: Old Debates and New Conclusions (1994).
[2] See Kelley (1988) for a description.

Todaro (1996), in a leading textbook on development economics, argues that population growth lowers per capita GDP in less developed countries, causes inequality at least within the family, reduces educational attainment, and hurts the environment. However, the negative perspective on population growth is not the only perspective.

## 1. Perspectives on the Population Problem

There are at least two views of the effects of population growth. The intellectual history merits a brief review. The "traditional view" of population growth stems from Thomas Malthus who pessimistically saw population growth as a source of perpetual poverty. Expanding population would run into constraints of limited food supplies and lead to the subsistence living for the vast majority of the populace. A visible expression of the traditional view was National Academy of Sciences report, *Rapid Population Growth: Consequences and Policy Implications*, published in 1971. Ostensibly, the report was pure contemporary Malthusian. The report identifies no less than 17 benefits for less developed countries from reduced population growth.[3]

The report is a fascinating example of opinion formation and leadership. The core of the report—the scientific papers, was not so alarmist and not nearly as traditional as the short executive summary that nearly reversed the substance of many of the component papers.[4] However, the summary "findings" diffused widely through the mass media and underscored if not amplified the neomalthusian perspective.

The traditional view also found modern support among economists specializing in economic development and growth. The former noted that decreasing mortality rates without

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[3] See Kelley and McGreevey (1994) for an account of these reports.
[4] Kelley and McGreevey (1994) provide an account of the discrepancy between the component papers and the executive summary and provide a number of useful references on this episode.

corresponding reductions in fertility rates lead to a "poverty cycle," wherein people's prospects for a better life are limited because governments' limited resources are spread too thin, savings rates are reduced, educational attainments are diminished, and growth in per capita income is retarded. The last conclusion is particularly noteworthy because distinguished economists in the post World War II era developed elegant economic models ("neoclassical growth models") that argued per capita incomes would decrease as population increases. The elegance of the economic theories and some documentation of adverse effects of population growth mean that the traditional, somewhat alarmist view is still wildly held and affirms that reduction in fertility rates is essential for the human well-being.

An alternative view, sometimes labeled "the revisionist view," notes that there are numerous benefits to population growth as well as costs. This perspective is well represented by the subsequent National Academy of Sciences Report, *Population Growth and Economic Development: Policy Questions*, published in 1986. Population growth permits the achievement of large scale business operations and enhanced agricultural productivity and induced technological innovation. Moreover, some of the adverse effects of population growth—reduced capital labor ratios, savings, and investment, are shown to be either not supported by the facts or are modest in magnitude. These arguments acknowledge the sanguine views of Boserup (1965), who argues that population growth induces technological change in agriculture and Simon (1981), who documents numerous historical cases where population growth is associated with enhanced well-being. In addition, the elegant neoclassical growth models were found to be incomplete. Finally, even if one assumed, arguendo, that population growth is deleterious to human well-being, the evidence that economic growth leads to lower fertility rates should assuage some Malthusian fears.

Two revisionist observations noted in the 1986 National Academy of Sciences report merit special attention. First, population growth in poor countries may make other problems worse or more evident. Second, many maladies of the less developed countries are often associated with population growth, but should be attributed to other causes. Thus, the possibility exists that various observed problems are incorrectly inferred to stem from population growth, while in reality more fundamental forces are both at fault and more importantly, the logical focus of remedial actions.

Whatever the box score between the conflicting views, the fact is that many people who are not strong apocalyptic believers still conclude that population growth retards economic development and causes discernible harm to the environment. Hence, even if population growth is reasonably benign or at least less than devastating in pecuniary terms, it may still have substantial adverse effects on poverty and the environment. These conclusions are sufficiently well-founded that many observers adhere to a third view of the population problem that is characterized by peaceful coexistence between the traditionalist and revisionist views. In this perspective, neomalthusian fears are presumed to be overstated but potential adverse effects of population growth are plausible. Most importantly, favorable economic institutions can offset these adverse effects.[5]

## 2. Economics and Fertility

Acceptance of the third view fits well with economic approaches to the study of population. Apocalypticism still reigns among numerous opinion leaders, but the scholarly world is more cautious. One reason for caution is the well-documented fact that economic growth reduces

[5] See the contributions in Robert Cassen, ed. Population and Development: Old Debates and New Conclusions, New Brunswick. Transactions Publishers, 1994.

fertility rates, except at the lowest levels of income. Hence, if nation-states succeed in generating growth, a substantial part of the "population problem" would be solved.

## 2.1 Fertility and Growth

The population/growth nexus is noteworthy because there is a growing body of serious scholarly research showing that certain economic institutions—property rights, the rule of law, and economic freedom are crucial prerequisites for economic growth and therefore also prerequisites for growth induced lower fertility rates. Hence, there is a foundation for viewing sustainable population growth as linked to economic growth enhancing institutions. Accordingly, an examination of the institutions/fertility nexus is an appropriate research task and essential to understanding the factors that affect population growth. However, establishing a link between fertility and growth enhancing institutions is not sufficient to end the apocalyptic nightmare. There is also substantial concern that population growth harms the environment. This is a well-established view among both unspecialized opinion leaders and attentive, serious scholars. Notably, this view ignores the argument that the same institutions that favor economic growth may also reduce the negative environmental consequences of population growth. While scholarly and popular opinions vary, the effects of population growth are an empirical question.

## 2.2 Economics and Population Growth

Many economists treat population as something determined outside the economic system. For example, "cultural forces" might lead some people to choose large families. While the traditionalist view suggests that people do so to their own misery, there was no explicit recognition that people would choose their family size based on economic maximizing behavior.

Recent, formal economic theory views fertility decisions as closely linked to people's economic circumstances. Becker and Barro (1988) provide a perspective on household's fertility choices. They argue that fertility decisions entail balancing income, the value of time, and work. In this framework, there are clear reasons for fertility to decline with income, especially income associated with female educational rates. Thus, one linchpin in the apocalyptic vision is undermined. If economic growth occurs, alarming fertility rates should stabilize at not so alarming rates.

The theory that population growth falls with income seems to fit the facts. Barro and Sala-I-Martin (1995) show that for a broad cross section of countries, increases in income (per capita GDP) are generally associated with decreases in fertility. The results hold true except for the people in countries with very low incomes—beneath $767 ($1985) per year, where fertility increases with income. Thus, a solution to some apocalyptic fears is simply high growth policies.

Other theoretical research on population economics is more ambitious. Works by Becker, Murphy, and Tamura (1990) and Ehrlich and Lui (1991) attempt to unify the theory of population growth and economic growth and to explain the behavior of both in economies across the world and within economies over time. The models affirm the crucial role of human capital as an engine of economic growth, a trade-off between the quantity and quality of children, and mixed motives for procreation. No single, specific causal relationship exists between population and economic growth. Moreover, both Malthusian and sustained high growth equilibria with declining fertility rates are possible.

Despite the elegance of theoretical advances in population economics, one remarkable fact that is evident in this research is that institutions play only a marginal role. Optimization and equilibrium conditions drive the models. To be sure, institutions are relevant in related work. For

example, Barro and Salia-I-Martin (1995) find that measures of the rule of law are important determinants of economic growth. In modern fertility models, economic growth in-turn would permit a host of substitutions—e.g. the quality for quantity of children or investment in health, that would lead to declines of fertility. In essence, institutions could play an indirect role in population economics. Moreover, the role of institutions in stimulating human capital accumulation also gets short shrift in contemporary economics of fertility. The literature seems to affirm Douglass C. North's (1981, 5) assertion that "…neoclassical economics appears to beg all the interesting questions."

While North's observation applies well to the economics of fertility, there is one important exception. Considerable research on fertility focuses on the old age material support motive for having children (e.g. Caldwell 1976, 1982; Willis, 1986; Nerlove Razin, and Sadka, 1986, 1987). The role of institutions in facilitating or obstructing intergenerational transfers is hardly fully developed in that literature, but the importance of those transfers underscores the importance of developing an institutional approach to population economics.

### 2.3 Institutions, Fertility, and the Tragedy of the Commons

Besides the indirect link between economic institutions and population growth—i.e. the transmission of institutions to growth to reduced fertility, there are arguments for a direct link. The absence of basic market enhancing institutions effect fertility, primarily in poor countries. Panayotou (1994) asserts that poorly defined or attenuated property rights encourage a demographic variant of the "tragedy of the commons." Panayotou (1994,151) states:

> Notice, however, that most contributions by children consist of capturing and appropriating open-access natural resources such as water, fodder, pastures, fish,

fuelwood, and other forest products, and clearing open-access land for cultivation. This has two critical implications:

> 1) Appropriation by capture makes the number of children the decisive instrument in the hands of the household: the household's share of open-access property depends on the number of hands it employs to convert open-access resources into private property. This is not unlike the case of the common pasture, where the share of each household depends on the number of animals it grazes.
>
> 2) While having a large number of children (or animals) exploiting the commons is optimal from the individual household's perspective, it is not optimal socially, and in the long run could become devastating for the resource, the community, and eventually the individual household. The rule of capture puts a premium on the deployment of as many hands as possible, in order to appropriate open-access resources before others do.

Panayotou clearly identifies population growth as deleterious to the community. He does not demonstrate the favorable perspective regarding population growth that Boserup and Simon affirm. Nevertheless, he attributes the absence of economic institutions—specifically, property rights, as a crucial factor in causing unhealthy population growth.

## 2.4 Institutions and Economic Growth

In the last decade or so, scholars have documented a strong link between economic institutions and economic growth... Easton and Walker (1997) Dawson (1998) show important affects of economic freedom measures on growth. The data include several varieties of institutional measures. Knack and Keefer (1995) and Barro and Salia-I- Martin (1995) show a

powerful link between the rule of law and growth. Indeed, the rule of law dominates other institutional measures. Knack and Keefer use measures from the International Country Risk Guide (ICRG).[6] The measure is an assessment of a country's commitment to established institutions that adhere to due process and orderly succession between old and new regimes and the rejection of physical force to settle disputes. The assessment is scaled from zero to six with increasing values indicating greater adherence to the rule of law. Their evidence suggests that among the ICRG variables, the rule of law captures the maximum explanatory power in cross-national growth equations and the other variables add no explanatory power.

Norton (2003) uses several ICRG measures of institutional quality and economic freedom in a range of estimates of the determinants of human well-being. A property rights measure appears to have the greatest affect in reducing the incidence of poverty. The measure is an equally weighted composite of two original rankings by experts at the PRS Group, Inc in generating the ICRG. The first measure is a cross-national ranking of the probability that private property will be confiscated by the government. The second measure is a ranking of the probability that the government will renege on contracts. The combined property rights measure of the two rankings is normalized between zero and one. The measure represents the simplest form of institutional quality and has powerful affects on human well-being (Norton 2003).

## 3. Empirical Evidence

### 3.1 Evidence on Institutions and Fertility

Because economic growth systematically lowers fertility rates at most levels of income, growth enhancing institutions should be negatively related to fertility rates. To test that hypothesis, equation (1) is estimated:

[6] The rule of law measure was originally labels as "law and order tradition."

$$\ln(\text{TFR}) = \beta_0 + \beta_1 \text{ Property Rights} + \beta_2 \text{ Control Variables} + \varepsilon_1 \quad (1),$$

where TFR is the total fertility rate.[7] Because property rights are a component of an institutional infrastructure that facilitates economic growth and because economic growth often is linked with series of substitutions that lower fertility, better specified property rights should be associated with lower fertility. The existence of property rights should also support the existence of markets that permit the intergenerational transfer of resources. Accordingly, the old-age income support motive for bearing children would be attenuated and fertility should fall correspondingly. Moreover, if the institutions/fertility link stemming from the open access resource/tragedy of the commons motive for fertility exists, we might expect the effect of well-specified property rights will especially reduce fertility in comparatively poor countries.

The case for the control variables is straightforward, but merits some discussion. In the modern theories of fertility, variables that affect the nature of constraints of potential parents—factors that ultimately affect agents' opportunity sets will in-turn affect their maximizing behavior, including the quantity and quality of children. A number of scholars have noted hypothetical types of variables that could affect economic agents' constraints. Jeffery Sachs (1997) and Sachs and Andrew Warner (1997) argue that all productive economic behavior is more costly in tropical environments. Accordingly, health would be lower, death rates higher, and birth rates also higher. If this contention is correct, increasing the tropical proportion of a nation-state should increase the fertility rate in that country.

[7] The total fertility rate is the number of children that would be born to a woman if she were to live to the end of her childbearing years and bear children at each age in accordance with the prevailing age specific fertility rates.

Modern theories of growth and fertility stress the role of human capital. Human capital expands opportunity sets and is powerfully linked with economic development and thus can be presumed to lower fertility rates. Indeed, Barro and Sala-I-Martin (1995) find that fertility rates in countries fall with greater stocks of human capital. Moreover, human capital accumulation can be expected to encourage the substitution of the quality of children for the quantity. Thus, measures of the stock of human capital or its absence should affect fertility. The greater fraction of unschooled, the higher the expected fertility rates. In a related vein, Lucas (1988) observes that economic growth rests firmly on human capital investment and that human capital investment is strongly related to urbanization. Urbanization magnifies the external effects of human capital. Thus, measures of human well-being should also increase as urbanization increases. Increased urbanization should increase wealth, human capital, and presumably will lower fertility rates.

Sowell (1994), Sachs (1997) and Sachs and Warner (1997) also argue that geographic isolation hurts economic well-being. Isolation retards the development of market enhancing institutions and reduces the flow of technological and organizational innovations that enhance human well-being. Accordingly, isolation should reduce economic well being. To the extent fertility is higher where well-being is lower, landlocked countries should have higher fertility rates.

The last control variable is ethnic fractionalization. Easterly and Levine (1997) note that ethnic fractionalization inhibits the scale of cooperative behavior and leads to a broad range of deleterious economic behavior and outcomes. Norton (2000, 2003) shows that ethnic fractionalization inhibits economic institutional development and impoverishes inhabitants of

fractionalized nations. Accordingly, ethnic fractionalization may retard economic development and lead to higher fertility rates.

Equation (1) is estimated with various specifications.[8] The estimates of equation are reported in table 1. The estimates are reported separately for property rights and no schooling in the first three columns. Property rights reduce fertility and no schooling increases fertility. Those two variables combined "explain" nearly 45 percent of the variation in fertility rates. Estimates for the other control variables are shown in column four. Landlocked countries have higher fertility rates. Similarly, ethnic fractionalization increases fertility, while urbanization lowers fertility. The results generally are the same in column five where property rights and control variables are included in the estimates. Adding the log of GDP and its squared value result in little change in the property rights coefficient. The results in column eleven are especially noteworthy. These estimates include only the poorest countries—those with per capita GDP beneath the sample median of $580. In this estimate, all variables appear to be statistically significant except urbanization. Fertility falls with GDP and rises with its squared value. The most relevant result is that property rights reduce fertility—as in all 11 estimates and the coefficient has its highest absolute value for the poorest countries. The estimate is consistent with the proposition that strengthening property rights in the poorest countries lowers fertility by reducing the old-age security motive for having children and with Pantayotou's tragedy of the commons hypothesis.

[8] These estimates are made only for the countries for which the United Nations Organization provides human poverty index measures.

Table 1

Fertility Regressions

| Independent Variable | Regression Coefficient/(t-statistic) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Intercept Term | 2.01 | 0.34 | 0.88 | 1.63 | 2.02 | 2.95 | 3.10 | 3.33 | 4.07 | 0.12 | 12.32 |
| | (13.23) | (2.08) | (3.24) | (9.32) | (13.10) | (13.14) | (15.35) | (2.98) | (4.14) | (0.09) | (2.18) |
| Property Rights | -1.04** | | -0.72* | | -1.19** | | -0.71* | | -0.79* | -0.69* | -1.41** |
| | (-3.18) | | (-1.93) | | (-4.36) | | (-2.44) | | (-2.13) | (-1.86) | (-3.53) |
| No Schooling | | 0.32** | 0.27** | | 0.20** | | | | | 0.17** | 0.41** |
| | | (7.59) | (6.04) | | (2.87) | | | | | (3.33) | (4.89) |
| Landlocked | | | | 0.18** | 0.20** | | | | | 0.24** | 0.16** |
| | | | | (3.18) | (2.87) | | | | | (2.49) | (2.66) |
| Urbanization | | | | -0.62** | -0.27 | | | | | 0.44 | -0.02 |
| | | | | (-2.90) | (-1.36) | | | | | (1.52) | (-0.01) |
| Tropics | | | | -0.02 | -0.11 | | | | | -0.02 | 0.22* |
| | | | | (-0.14) | (-1.40) | | | | | (-0.19) | (2.40) |
| Ethnic Fractionalization | | | | 0.29** | 0.58** | | | | | 0.42** | 0.60** |
| | | | | (2.64) | (5.02) | | | | | (3.49) | (5.94) |
| Log(GDP) | | | | | | -0.21** | -0.18** | -0.32 | -0.46* | -0.32 | -4.36* |
| | | | | | | (-6.23) | (-5.50) | (-0.96) | (-1.71) | (-1.02) | (-2.25) |
| Log(GDP) Squared | | | | | | | | 0.01 | 0.02 | -0.03 | 0.39* |
| | | | | | | | | (0.31) | (0.98) | (-1.40) | (2.28) |
| Adj. $R^2$ | 0.118 | 0.426 | 0.448 | 0.349 | 0.580 | 0.438 | 0.444 | 0.431 | 0.444 | 0.681 | 0.871 |
| S.E.R. | 0.336 | 0.273 | 0.263 | 0.281 | 0.223 | 0.264 | 0.259 | 0.265 | 0.259 | 0.206 | 0.111 |
| No. of Observations | 67 | 58 | 52 | 73 | 64 | 71 | 62 | 71 | 62 | 68 | 17 |

*Significant at the .05 level. **Significant at the .01 level or lower.

3.2. Institutions and Human Well-being

While the fertility reducing effect of property rights is notable and offers an alternative to interventionist population policies to reduce population growth in the world's poorest countries, the effect of economic institutions in ameliorating deleterious effects of population growth also warrants attention. The bulk of the analysis below examines the link between population growth and human well-being. The strategy is to estimate the following equation:

$$\text{HWB} = \beta_0 + \beta_1 \text{Population Growth} + \varepsilon_2 \quad (2),$$

where HWB is some nonpecuniary measure of human well-being. Many observers conclude that increasing population growth reduces human well-being. That conclusion holds for revisionists as well as neomalthusian adherents, although much less so for the former. One primary distinction centers on the magnitude of $\beta_1$. Neomalthusian believers presume it is negative and dangerously high in absolute terms. The revisionist view seems to accept a negative $\beta_1$, but presumes its absolute magnitude is small.

A more relevant hypothesis that is well represented among some segments of the scholarly community is that if population growth negatively affects human well-being, high quality economic institutions can offset the negative effects. Moreover, as in the fertility estimates in table 1, there are compelling reasons to examine the role of other variables besides population growth and the quality of property rights specification and enforcement. For example, there are simple econometric reasons to include such variables and thus estimate equation (3).

$$\text{HWB} = \beta_0 + \beta_1 \text{ Population Growth} + \beta_2 \text{ Property Rights} + \beta_3 \text{Control Variables} + \varepsilon_3 \quad (3).$$

A common contention is that population growth increases the incidence of poverty and environmental degradation, and reduces productivity. The analysis below examines a broad range of dependent variables. Specifically, the following measures are examined:

*Poverty Measures:*

These measures include the United Nations' Human Poverty Index and its components—the proportion of the population not expected to survive to age 40, the proportion of the adult population that is illiterate, the proportion of the population without access to safe water, the proportion of the population without access to health services, and the proportion of underweight children under age five. Data are for 1990 or between 1990-95.

*Environmental Degradation*:

These measures include deforestation—the percentage change in forest land between 1990 and 1995. Positive values indicate growing forests and negative values indicated deforestation. The measures also include water pollution—organic (BOD) emissions in kg per day per worker, averaged between 1990 and 1995. Finally, the measures include CO2 industrial emissions in kg per $US of 1995 GDP.

*Environmental Enhancement*:

The environmental enhancement measure is agricultural productivity—value added in 1995 $US divided by the number of workers in agriculture.

3.3 Poverty

The case for examining poverty is especially strong. Current poverty levels are widely thought to be aggravated by recent population growth although longer-term population growth rates may be neutral or be associated with poverty reductions. The human poverty index is a

measure designed by the United Nations to quantify human deprivation. It excludes explicit income measures and instead focuses on nonpecuiniary measures of well-being. It is a weighted average of survival deprivation, deprivation in education and knowledge, and deprivation in economic provisioning. The weighted average is then used for a composite measure of poverty. The index constitutes the first dependent variable in estimating equations (2) and (3). Because the index measures poverty as increasing with the index, the hypothesized signs of the betas in the equations (2) and (3) are reversed.

The relationship between the poverty index and population growth and the institutional and control variables is important because of the wide application of this index. However, the use of the index is clouded by a somewhat arbitrary weighting scheme and the results are not easily interpreted. Because it is easier to interpret the poverty/population growth nexus for the components, equations (2) and (3) are also estimated for the component measures. Because poverty levels increase with this measure, the testable (alternative) hypotheses are that $\beta_1$ is positive and $\beta_2$ is negative. The log-odds ratios for the poverty index and its components are used as dependent variables because the dependent variables are percentages.[9]

The sample of countries consists of all countries for which the United Nations reports the Human Poverty Index and its components. The sample includes a few relatively rich countries, e.g. Singapore, but the overwhelming majority of countries are relatively poor.[10] Descriptive statistics of the Human Poverty Index and its components are shown in the appendix. Two population growth measures are used. The first is the short-term rate—the percentage change in

[9] The log-odds ratio for (e.g.) the Human Poverty Index (HPI) is log(HPI/(100-HPI)). The reported proportion for people without access to save water is zero for Singapore and the reported proportion of people without access to health services is zero in Cuba, Singapore, and Trinidad and Tobago. For these two measures, the number 1 is added to the observation for all countries.

[10] In preliminary analysis, I used the UN's Food and Agricultural Organization 's categorization for developing countries. However, the categorization seems somewhat arbitrary and the grouping is not the same as UNICEF's

population for the five years prior to the period used for the dependent variable (1985-90), and the long-term rate—1970-90. Previous research suggests that the effects of population should be examined for both the long-run and short-run (Ahlburg, 1994; Kelley, 1988).

Table 2 contains estimates of equation (2) in columns one and two. The data show that short term (1985-1990) population growth increases the poverty index, but long term population growth (1970-1990) has no effect. Columns three and four contain estimates of equation (3) using the same control variables as in equation (1). In the equation (3) estimates, neither population growth variable is significant—the adverse effects of population growth are nonexistent. Indeed, both estimates are negative and the result for long term population growth is negative and (marginally) statistically significant. The result gives no support to the neomalthusian view. On the other hand, stronger property rights reduce the poverty index in a country and the absence of schooling increases the poverty index. Ethnic fractionalization tends to have the similar effect. Poverty is notably greater in countries that are more fractionalized.

To get a sense of the magnitude of the offsetting effects, the impact of $\beta_1$ versus $\beta_2$ can be examined by assuming some hypothetical institutional reform wherein property rights become stronger. The measure is obtained by calculating:

$$\Delta HPI = \beta_2 \; x \; \Delta \text{ Property Rights} \quad (6),$$

and then using the change in the HPI to ascertain the quantity population increase that would not increase the Human Poverty Index:

$$\Delta HPI = \beta_1 \; x \; \Delta \; Population \quad (7).$$

Using the estimate for short term growth in column 1, the increase in the HPI from a one standard deviation increase in short term population growth would be about six percent. Using

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Developing Countries category. Consequently, the sample is restricted to the UN's Human Poverty Index sample.

Table 2

Poverty Regressions

| Independent Variable | Regression Coefficient/(t-statistic) | | | |
|---|---|---|---|---|
| Intercept Term | -1.86 | -1.09 | -2.05 | -1.82 |
| | (-4.18) | (-3.12) | (-3.73) | (-3.11) |
| Population Growth | | | | |
| Short-term | 7.54* | | -3.04 | |
| | (2.11) | | (-1.33) | |
| Long-term | | 0.30 | | -1.12* |
| | | (0.48) | | (-1.76) |
| Property Rights | | | -1.54** | -1.65** |
| | | | (-2.99) | (-3.04) |
| No Schooling | | | 0.63** | 0.64** |
| | | | (5.07) | (5.15) |
| Landlocked | | | 0.27 | 0.26 |
| | | | (1.34) | (1.25) |
| Urbanization | | | -1.04 | -1.06* |
| | | | (-1.34) | (-2.43) |
| Tropics | | | 0.01 | 0.01 |
| | | | (0.14) | (0.03) |
| Ethnic Fractionalization | | | 0.55* | 0.55* |
| | | | (2.25) | (2.38) |
| Adj. $R^2$ | 0.116 | -0.007 | 0.763 | 0.773 |
| S.E.R./ No. | 0.807/78 | 0.861/78 | 0.417/51 | 0.408/51 |

Short term population growth is from 1985-90. Long term population growth is from 1970-1990.

* Significant at the .05 level. **Significant at the .01 level or lower.

the reported estimate for the property rights coefficient in column three, a one standard deviation increase in the property rights measures would decrease the HPI by about five percent.[11] Thus, hypothetical institutional reform could largely offset the adverse effects of population growth. However, two points merit attention. First, institutional reform would likely lower the fertility rate as indicated in table 1 and thus lower population growth. More importantly, when the control variables are included, short term population growth has no discernible relationship with the poverty index. No offset is required. The better specified regression estimate renders population growth irrelevant or in the case of the long term measure, long term population growth actually lowers the poverty index.

Interpretative difficulties for the human poverty index certainly exist. The meaning of a change in the coefficient is difficult to map into understandable terms. However, that observation does not apply to the components of the index. In these cases, the measures are much easier to relate to human deprivation. Table 3 contains estimates of equations (2) and (3) for the components of the poverty index.

The first component of the HPI is the proportion of the country not expected to survive to the age of 40. The results reported in table 3 do not show that population growth—long term or short term, increase the probability of not surviving until the age of 40. None of the estimates is positive and statistically significant. In contrast, stronger property rights reduce the probability of not living to age 40. Similarly, the proportion of the population that is unschooled increases the probability of not surviving as does the degree of ethnic fractionalization and being landlocked. Increased urbanization also lowers the probability of not surviving.

[11] The coefficient is multiplied by the change in population or property rights at the mean of the HPI sample measure.

Table 3

Determinants of Human Poverty Measures

| | Regression Coefficient/( t-statistic) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Population Growth | | Property | | | | | | | | |
| Dependent Variable | Constant | Short Term | Long Term | Rights | No Schooling | Landlocked | Urban | Tropics | Ethnic Frac. | Adj. $R^2$ | S.E.R. | N |
| Death by Age 40 | -2.24 | 5.79 | | | | | | | | 0.064 | 0.825 | 78 |
| | (-4.41) | (1.38) | | | | | | | | | | |
| | -1.50 | | -0.05 | | | | | | | -0.012 | 0.858 | 78 |
| | (-3.74) | | (-0.06) | | | | | | | | | |
| | -2.70 | -2.41 | | -1.22* | .49** | 0.32* | -0.90* | 0.06 | 1.09** | 0.815 | 0.361 | 51 |
| | (-4.22) | (-1.34) | | (-2.39) | (4.78) | (2.10) | (-2.09) | (0.40) | (4.69) | | | |
| | -2.60 | -0.66 | | -1.26* | 0.48** | 0.29* | -0.92* | 0.06 | 1.08** | 0.815 | 0.361 | 51 |
| | (-3.89) | (-1.21) | | (-2.37) | (4.60) | (1.90) | (-2.14) | (0.44) | (4.89) | | | |
| Adult Illiteracy | -2.24 | 11.52** | | | | | | | | 0.135 | 1.136 | 78 |
| | (-4.00) | (2.59) | | | | | | | | | | |
| | -1.22 | | 0.77 | | | | | | | 0.007 | 1.217 | 78 |
| | (-2.59) | | (0.91) | | | | | | | | | |
| | 0.87 | 5.84* | | -2.50* | | -0.01 | -2.26** | -0.68** | 0.86 | 0.438 | 0.932 | 65 |
| | (1.09) | (2.28) | | (-2.44) | | (-.03) | (-3.47) | (-2.54) | (1.62) | | | |
| | | | 0.77** | -2.63** | | 0.09 | -2.74** | -0.73** | 0.99* | 0.426 | 0.942 | 65 |
| | | | (2.83) | (-2.48) | | (0.26) | (-3.31) | (-2.68) | (1.89) | | | |
| No Safe Water | -1.45 | 4.65 | | | | | | | | 0.010 | 1.25 | 78 |
| | (-2.45) | (0.96) | | | | | | | | | | |
| | -0.59 | | -0.56 | | | | | | | -0.003 | 1.26 | 78 |
| | (-1.62) | | (-0.92) | | | | | | | | | |
| | 0.77 | -5.56 | | -2.67* | 0.02 | 0.34 | -1.52 | -0.11 | 2.03* | 0.378 | 1.01 | 51 |
| | (0.39) | (-1.26) | | (-1.67) | (0.06) | (0.89) | (-1.31) | (-0.23) | (2.40) | | | |
| | 1.26 | | -2.23* | -2.90* | 0.05 | 0.33 | -1.54 | -0.14 | 2.05** | 0.400 | 0.99 | 51 |
| | (0.63) | | (-1.73) | (-1.81) | (0.14) | (0.84) | (-1.34) | (-0.32) | (2.54) | | | |

Table 3 continued

| Dependent Variable | Constant | Population Growth Short Term | Population Growth Long Term | Property Rights | No Schooling | Landlocked | Urban | Tropics | Ethnic Frac. | Adj. $R^2$ | S.E.R. | N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| No Health Service | -2.21 | 7.52 | | | | | | | | 0.034 | 1.387 | 78 |
| | (-2.67) | (1.12) | | | | | | | | | | |
| | -1.24 | | -0.10 | | | | | | | -0.012 | 1.420 | 78 |
| | (-2.00) | | (-0.08) | | | | | | | | | |
| | 0.05 | -1.28 | | -4.73** | 0.12 | 0.50 | -1.79* | 1.01** | 0.58 | 0.488 | 0.968 | 51 |
| | (0.36) | (-0.24) | | (-4.38) | (0.48) | (1.34) | (-2.10) | (2.78) | (1.07) | | | |
| | 0.66 | | -0.77 | -4.84** | 0.14 | 0.52 | -1.78* | 0.99** | 0.60 | 0.492 | 0.965 | 51 |
| | (0.50) | | (-0.61) | (-4.46) | (0.58) | (1.37) | (-2.12) | (2.76) | (1.14) | | | |
| Underweight Children | -1.89 | 3.69 | | | | | | | | 0.011 | 0.969 | 78 |
| | (-5.34) | (1.36) | | | | | | | | | | |
| | -1.32 | | -0.22 | | | | | | | -0.011 | 0.979 | 78 |
| | (-4.72) | | (-0.45) | | | | | | | | | |
| | -2.52 | -4.79 | | -0.27 | 0.54** | -0.242 | -1.86** | 0.47* | 0.618 | 0.615 | 0.594 | 51 |
| | (-2.74) | (-1.63) | | (-0.33) | (3.36) | (-0.93) | (-3.31) | (1.83) | (1.62) | | | |
| | -2.37 | | -1.16 | -0.308 | 0.52** | -0.312 | -1.93** | 0.48* | 0.59 | 0.610 | 0.598 | 51 |
| | (-2.49) | | (-1.43) | (-0.38) | (3.25) | (-1.27) | (-3.43) | (1.88) | (1.53) | | | |

* Significant at the 5 percent level or lower (one tailed test). The estimates use OLS with the dependent variables in log-odds form. The dependent variable for safe water and health service is the observed value plus 1.

With respect to the other poverty index components, there is little evidence of adverse population effects. The poverty increasing effects of population are only evident for adult illiteracy where the coefficients for the short term growth are positive and statistically significant for both estimates and the coefficient for long term growth is positive and significant for the full model estimates. The estimated coefficients for property rights are also statistically significant for adult illiteracy, indicating that improved property rights reduces illiteracy. Moreover, the magnitudes of the coefficients indicate that a one standard deviation improvement in property rights would more than offset a one standard deviation increase population growth—short term or long term, (by factors of 60 to more than 100 percent). So modest institutional reform could more than offset population growth, again ignoring the likely result from table 1 that institutional reform would also probably lower fertility.

It also merits noting that while property rights are not statistically significant in reducing the proportion of underweight children, improved property rights lower the proportion of the population without access to safe water and dramatically decreases the fraction of the population without access to health service. In a related vein, the absence of schooling notably increases the fraction of underweight, young children while increased urbanization decreases illiteracy, the fraction of the population without access to health care and the proportion of underweight young children.[12] Ethnic fractionalization increases the proportion of a country's population without access to safe water. Countries with a greater proportion of the population living in tropical areas have greater proportions of their populations that are without access to health services and a greater proportion of underweight children—consistent with Sachs and Warner. However, estimating the adult illiteracy relationship without the unschooled variable included leads to a

[12] The absence of schooling is excluded in the adult literacy estimates, because in that estimate the relationship is virtually tautological.

negative link between adult illiteracy the proportion of the population living in the tropics—a result contrary to the Sachs and Warner perspective.[13]

What emerges from the estimates reported in tables 2 and 3 is that population growth does not have a strong effect on poverty. These measures indicate that human capital, geographic variables and one institutional variable—the strength of property rights, are far more important than population growth in affecting the United Nations' poverty measures. Because geographic variables tend to be outside of the policy domain, the case for institutional reform of property rights systems would seem to be a fruitful avenue of policy analysis.

In summary, population growth does not have a persistent or uniform effect on poverty. For some measures, e.g. illiteracy, the effect of population growth on poverty is statistically and economically significant. For other measures, e.g. childhood malnutrition, population growth appears to have no effect. In contrast, the results for economic institutions are nearly always significant in the estimated models except for the full estimates in the case of undernourished children. These results are broadly consistent with the view of various scholars who argue that the negative effects of population growth are *de minimus* or the effects can be offset by sound economic institutions.

### 3.4 Environmental Degradation

As in the case of poverty, there is wide support among scholars that population growth results in environmental degradation (Kelley and McGreevey, 1994). While this view is presumed to apply to a broad range of measures of environmental degradation, water and $CO_2$

[13] Retaining the unschooled variable in the estimate makes both the property rights and tropical variable insignificant.

pollution have a *prima facie* case for analysis and deforestation is commonly thought to be particularly adversely effected by population growth (Panayotou, 1994).

Table 4 contains results of estimating equations (2)-(3) for those variables. The estimates are made for an expanded sample, including all available countries for which the independent variables are also available. The data in table 4 show a different pattern than the poverty data. Adverse environmental effects are evident for at least some estimates for water pollution, deforestation, and $CO_2$ emissions. In the case of water pollution, the estimated effects are fragile to the inclusion of the property rights and control variables. When these variables are included, population growth has no significant effect—similar to the pattern for the poverty estimates. However, in the case of the deforestation variable, the estimates indicate a powerful adverse effect for both short term and long term population growth. Moreover, although property rights decrease deforestation, they do not fully offset the adverse effects of population growth, especially in the case of long term growth where a one standard deviation increase in long term population growth would dominate a one standard deviation increase in the property rights measure by nearly threefold. In the case of $CO_2$ emissions, short term population growth does not seem to have a significant effect, but long term is significant and at least marginally so for the estimates that include the control variables. In this case, institutional reform would have to be more than 1.25 of a standard deviation level to offset the effects of population growth. In both the deforestation and $CO_2$ cases, institutional reform could readily offset the adverse affects of population growth, but the reform would be more than a modest level. Again, this conclusion ignores the fact that making property rights stronger would reduce population growth by reducing fertility rates.

Table 4

Determinants of Human Poverty Measures

| | Regression Coefficient/( t-statistic) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Population Growth | | Property | | | | | | | | |
| Dependent Variable | Constant | Short Term | Long Term | Rights | No Schooling | Landlocked | Urban | Tropics | Ethnic Frac. | Adj. $R^2$ | S.E.R. | N |
| Water Pollution | -1.78 | 1.00* | | | | | | | | 0.040 | 0.242 | 78 |
| | (-46.11) | (2.09) | | | | | | | | | | |
| | -1.80 | | 0.29** | | | | | | | 0.060 | 0.240 | 78 |
| | (-42.04) | | (2.49) | | | | | | | | | |
| | -1.08 | 0.56 | | -0.71* | -0.10* | -0.06 | -0.01 | 0.11 | 0.15 | 0.185 | 0.226 | 57 |
| | (-2.53) | (0.65) | | (-2.03) | (-1.91) | (-1.00) | (0.06) | (1.15) | (1.02) | | | |
| | -1.11 | | 0.24 | -0.67* | -0.11* | -0.05 | 0.10 | 0.10 | 0.15 | 0.19 | 0.225 | 57 |
| | (-2.70) | | (1.26) | (-1.99) | (-1.99) | (-0.85) | (1.05) | (1.00) | (1.00) | | | |
| Deforestation | 0.00 | -0.30** | | | | | | | | 0.020 | 0.110 | 172 |
| | (0.24) | (-4.21) | | | | | | | | | | |
| | 0.00 | | -0.06* | | | | | | | 0.015 | 0.109 | 171 |
| | (0.01) | | (-2.22) | | | | | | | | | |
| | -0.14 | -0.44* | | 0.10* | 0.17 | 0.02 | 0.07* | -0.05** | 0.06* | 0.351 | 0.069 | 85 |
| | (-2.10) | (-2.76) | | (2.17) | (1.63) | (1.52) | (1.76) | (-2.57) | (2.02) | | | |
| | -0.12 | | -0.12** | 0.08* | 0.02 | 0.02 | 0.07 | '-0.05** | 0.057* | 0.343 | 0.056 | 85 |
| | (-1.81) | | (-2.32) | (1.87) | (1.47) | (1.08) | (1.60) | (-2.62) | (1.86) | | | |
| $CO_2$ Emissions | -0.51 | 1.42 | | | | | | | | 0.002 | 0.873 | 147 |
| | (-3.54) | (1.15) | | | | | | | | | | |
| | -0.64 | | 0.68** | | | | | | | 0.034 | 0.859 | 146 |
| | (-5.05) | | (2.91) | | | | | | | | | |
| | 1.37 | 1.98 | | -1.78** | -0.04 | 0.48* | -0.49 | -0.48* | -0.26 | 0.154 | 0.700 | 84 |
| | (1.65) | (0.86) | | (-2.77) | (-0.43) | (-1.89) | (-0.86) | (-1.88) | (0.66) | | | |
| | 1.21 | | 1.15* | -1.60* | -0.10 | -0.48* | -0.55 | -0.51* | -0.31 | 0.181 | 0.689 | 84 |
| | (1.40) | | (1.80) | (-2.45) | (-0.88) | (-1.93) | (-0.98) | (-2.05) | (-0.84) | | | |

Table 4 continued

| Dependent Variable | Constant | Population Growth Short Term | Population Growth Long Term | Property Rights | No Schooling | Landlocked | Urban | Tropics | Ethnic Frac. | Adj. $R^2$ | S.E.R. | N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Agricultural Prod. | 8.98 | -16.43** | | | | | | | | 0.314 | 1.339 | 128 |
| | (33.73) | (-6.57) | | | | | | | | | | |
| | 8.97 | | -4.00** | | | | | | | 0.260 | 1.368 | 127 |
| | (30.17) | | (-5.50) | | | | | | | | | |
| | 5.48 | -0.64 | | 2.96** | -0.25** | -0.26 | 3.27** | -0.15 | -0.61* | 0.875 | 0.598 | 75 |
| | (6.83) | (-0.24) | | (4.21) | (-2.39) | (-1.26) | (6.65) | (-0.70) | (-1.98) | | | |
| | 5.57 | | -0.70 | 2.46** | -0.21* | -0.24 | 3.34** | -0.13 | -0.55* | 0.877 | 0.592 | 75 |
| | (6.99) | | (-1.18) | (4.02) | (-2.08) | (-1.20) | (7.05) | (-0.60) | (-1.95) | | | |

* Significant at the 5 percent level or lower (one tailed test). The estimates use OLS with the dependent variables in log-odds form. The dependent variable for safe water and health service is the observed value plus 1.

3.5 Environment Enhancement

The literature on population growth also views population growth as a problem because in addition to its direct, negative effects, it also reduces activities that have positive effects on well-being. Included here are activities that expand the long-run supply in an economy or that increase productivity. Agricultural productivity would be an example (Todaro, 1996).

It is widely asserted that if agriculture is more productive, then resources can be released for other activities, including enhancing the quality of the environment (Kelley and McGreevey, 1994) [14] Because much of the developing world have agriculturally based economies, this measure would seem to be strongly related to human well being. The measure of productivity used to estimate equations (2)-(3) is agricultural valued added per worker in 1995 $US. For the period 1990-95, the measure ranges from $93.5—Malawi to $63,878 in Brunei.

The results of estimates of agricultural productivity on population growth, population growth and the control variables are also shown in table 4. The estimates are informative. There is a strong negative relationship between population growth and agricultural productivity. The simple link between population growth and agricultural productivity seems quite robust. However, when the property rights and control variables are included, the population growth variables are "fragile." They are no longer significant and the robustness of the entire estimate is substantially enhanced compared to the simple estimates. Property rights, schooling, urbanization, and ethnic fractionalization appear far more important than population growth in accounting for agricultural productivity.

## 4. Summary and Conclusions

The relationship between population growth and human well-being is one of the most controversial topics in modern economics. The nexus extends to issues of public policy and even aesthetics. Numerous opinion leaders, policy makers, and scholars have viewed population growth, especially in developing countries, through an apocalyptic lens. A contrary view also exists. It stresses the benefits of population growth. Much of the existing research on these topics has ignored the role of economic institutions on population matters. An emerging perspective on population growth views its effects as largely benign although entailing some negative effects with respect to poverty, environmental degradation, and forgone production opportunities. Included in the emerging literature are the hypotheses that growth enhancing institutions such as well-specified property rights reduce fertility by reducing some of the motives for having children and that property rights ameliorate the adverse effects of population growth.

The empirical tests above support these hypotheses. There is strong evidence that fertility rates are lower when property rights are more prevalent or more developed. That result is not surprising for higher income countries, but it is especially remarkable for the very low income countries documented above.

The results documented above are also consistent with the view that population growth is benign in some cases. In other cases—adult illiteracy or deforestation, population growth is not benign; it results in some potential reduction in human well-being. However, in most cases, stronger property rights can offset the adverse effects of population growth.

The policy effects should be straightforward. The benefits of successful institutional reform would enhance human well-being. Of course, institutional reform may be difficult or even impossible in some countries. Nevertheless, the problems of population growth should be

[14] Provided that the productivity in agriculture does not generate significant negative externalities.

interpreted in light of economic institutions. In many cases, what appears as problems of growing population are more appropriately viewed as inadequate economic institutions.

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Table A1

Data Definition and Sources

| | |
|---|---|
| Total Fertility Rate | Total fertility rate is the number of children that would be born to a woman if she were to live to the end of her childbearing years and bear children in accordance with current age-specific fertility rates. Source: World Bank, World Development Indicators, various years. |
| Human Poverty Index | An index of human well being that focuses on human deprivation of survival, education and knowledge, and economic provisioning. Source: United Nations, Human Development Report, 1997. |
| Death by 40 | The proportion of people not expected to survive to age 40. Source: United Nations, Human Development Report, 1997. |
| Adult Illiteracy | The proportion of adults classified as illiterate. Source: United Nations Human Development Report, 1997. |
| Safe Water | Proportion of the population without access to safe water. Source: United Nations, Human Development Report, 1997 |
| Health Service | Proportion of the population without access to health service. Source: United Nations, Human Development Report, 1997. |
| Underweight Children Under Age Five | Proportion of children under age five who are underweight. Source: United Nations, Human Development Report, 1997 |
| Deforestation Rate | Percentage change in forests between 1990 and 1995. Source: World Bank, World Development Indicators, various years. |
| Water Pollution | Organic water pollution (BOD) emissions in kg. per day per worker. Source: World Bank, World Development Indicators, various years. |
| $CO_2$ Emissions | Industrial emissions in kg per $ of 1995 US GDP. Source: World Bank, World Development Indicators, various years. |
| Agricultural Productivity | Value added in 1995 $US divided by the number of workers in agriculture. Source: World Bank, World Development Indicators, various years. |
| Ethnic Fractionalization | Atlas Narodov Mira data created by the Mikulukho-Maklai-Ethnological Institute of the Soviet Union. Source: Taylor and Hudson (1972). |
| GDP | Gross Domestic Product per capita in $US(1995). Data are for 1990. Source: World Bank, World Development Indicators, 2001. |
| Landlocked | Munro (1996). |
| Property Rights | Constructed from International Courntry Risk Guide, PRS Service, East Syracuse, New York. |
| No Schooling | Barro and Lee data set. Available from Robert Barro's web page. |
| Urbanization | Percentage of the population living in urban areas. Source: World Bank, World Development Indicators, 2001. |

Table A2
Descriptive Statistics: Dependent Variables

| Variable | Mean | Std. Dev. | Minimum | Country | Maximum | Country |
|---|---|---|---|---|---|---|
| Total Fertility Rate | 4.83 | 1.51 | 1.69 | Cuba | 7.53 | Yemen Rep. |
| Human Poverty Index | 31 | 15.36 | 4.1 | Trinidad & Tobago | 66 | Niger |
| Death by 40 | 20.84 | 12.18 | 3.2 | Singapore | 52.1 | Sierra Leone |
| Adult Illiteracy | 35.14 | 21.96 | 2.1 | Niger | 86.9 | Trinidad & Tobago |
| No Access to Safe Water | 34.29 | 20.99 | 0 | Singapore | 75 | Ethiopia |
| No Access to Health Services | 28.1 | 21.4 | 0 | Cuba Mauritius Singapore | 74.0 | Democratic Rep. Congo |
| Underweight Child. Under Age Five | 22.9 | 13.3 | 1 | Chile Cuba | 67 | Bangladesh |
| Agricultural Production | $6,047 | | $94 | Malawi | $63,874 | Brunei |
| CO2 Emissions | 1.064 | 1.353 | 0.11 | Chad | 9.24 | Mongolia |
| Deforestation Rate | -0.026 | 0.110 | -0.406 | Lebanon | 1.078 | Cape Verde |
| Water Pollution | 0.189 | 0.049 | 0.09 | Singapore | 0.32 | Senegal |

N=78 for poverty measures. N=128 for agricultural productivity. N=148 for CO2 emissions. N=177 for deforestation. N=79 for water pollution. Data are for 1990-1995.

Table A3

Descriptive Statistics: Independent Variables

| Variable | Mean | Std. Dev. | Minimum | Country | Maximum | Country |
|---|---|---|---|---|---|---|
| Percent Population Growth: 1985-90-Poverty/Fertility Regressions N=78 | 0.123 | 0.041 | 0.03 | Trinidad & Tobago | 0.29 | United Arab Emirates |
| Percent Population Growth: 1970-1990-Poverty/Fertility Regressions N=78 | 0.519 | 0.227 | 0.10 | Uruguay | 2.13 | United Arab Emirates |
| Percent Population Growth: 1985-90-Environmental Regressions N=172 | 0.094 | 0.060 | -0.034 | Macedonia | 0.291 | United Arab Emirates |
| Percent Population Growth: 1970-1990-Environmental Gregressions N=172 | 0.400 | 0.261 | -0.031 | Antigua & Barbados | 2.126 | United Arab Emirates |
| Ethnic Fractionalization N=157 | 0.329 | 0.303 | 0.00 | Numerous | 1.00 | Comoros |
| GDP N=169 | $5,743 | $8,814 | $100 | Ethiopia | $45,952 | Switzer. |
| Landlocked | 0.231 | 0.424 | 0.00 | Numerous | 1.00 | Numerous |
| No Schooling N=107 | 31.9 | 27 | 0.00 | Numerous | 88.90 | Niger |
| Property Rights | 0.597 | 0.151 | 0.202 | New Caled. | 1.00 | Luxem. |
| Tropics | 0.485 | 0.474 | 0.00 | Numerous | 1.00 | Numerous |
| Urbanization | 39.68 | 21.58 | 5.00 | Rwanda | 100.00 | Singapore |