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Population Pressures, Saving, and Investment in the Third World: Some Puzzles*

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Introduction

Two arguments are often made concerning the adverse impacts of rapid population growth on the rate of economic development.¹ The first is Malthusian in origin: a relatively “fixed” (or slow growing) resource (land, according to Malthus, or other renewable and non-renewable resources, according to neo-Malthusians) coupled with rapid population growth causes a reduction in output per worker. The second is neoclassical in origin: rapid population growth leads to increasing scarcity of “productive capital” per worker and thereby to declining worker productivity. Overall the Malthusian argument has dominated the literature, but in the postwar period the neoclassical perspective has gained substantial attention. This is due to the prominent role economists have attributed to capital formation in economic growth as well as to the emergence of several important pieces of research, the most influential of which was the pioneering work of Ansley J. Coale and Edgar M. Hoover, who considered three adverse impacts of population growth on savings and capital formation.

1. *Age-dependency effect.* Rapid population growth leads to a high ratio of children to working adults and diverts household income from saving toward consumption.

2. *Capital-shallowing effect.* Rapid population growth lowers the ratio of capital to labor since there is nothing about population growth per se that increases the amount of savings.

3. *Investment-diversion effect.* Rapid population growth generates a strong demand for government expenditures in areas such as education and health, thereby diverting funds from relatively more productive, growth-oriented public and private investments.²

So persuasive was the Coale-Hoover thesis that population analyst Phyllis Piotrow observed that it “eventually provided the justifica-

tion for birth control as part of U.S. foreign policy” (p. 15).³ It also provided the key ideas embedded in a large number of economic simulation models that reveal the adverse impacts of population on development.⁴

In this article I will examine the analytical and empirical bases for these arguments. I will conclude that the adverse impact of population growth on savings, investment, and consequently on economic growth must be qualified on analytical grounds and, moreover, that the existing empirical evidence does not persuasively show that the savings/investment and population growth connections have been quantitatively important. Lest this conclusion sound “radical,” I should point out that a careful reading of recent studies by population specialists on both sides of the “population debate” reveals this same theme. I am simply documenting what appears to be increasingly (albeit reluctantly) accepted, yet controversial, wisdom.⁵

Consider several examples. Referring to the age-dependency effect, the World Bank’s *WDR 1984 (World Development Report 1984)* concludes, “Recent empirical studies find only minor support for this view.” Similarly, Timothy King, senior population analyst at the World Bank, observes, “In the litany of antinatalist argument, this one bears little weight. . . . most modern theories suggest that the proportion of children in the population is not very important.” In a detailed assessment of the empirical literature, Geoffrey McNicoll of the Population Council poses the problem in summary fashion: “What then can be said about the net savings or investment impact of rapid population growth? The answer appears to be rather little.” And Jeffrey Hammer of the World Bank, after his exhaustive survey of the literature, concludes: “While there is much evidence to indicate that these two aspects of development [population and savings] are intertwined in many ways, no simple generalizations are justified.”⁶ Referring to the investment-diversion effect, the results of a recent study by T. Paul Schultz “directly challenges the working assumption . . . that linked population growth to the share of income allocated by poor countries to unproductive expenditures.” Indeed, physical capital is increasingly deemphasized as the critical link in the population-savings-growth nexus. The *WDR 1984* reaffirms, “There is little doubt that the key to economic growth is the advance of human knowledge.”⁷ Investments in education are recognized as highly productive, and the investment-diversion effect can be questioned. The puzzle posed in this article is to reconcile the seemingly straightforward and plausible arguments of Coale and Hoover, as well as others (including many macroeconomic modelers), with the recent modified assessments by population specialists.

Three points provide the key to this reconciliation. First, previous analytical formulations may not have been sufficiently detailed to reveal the full range of population-economic interactions of savings, in-

vestment, and growth. Second, the empirical strength of the postulated relationships may simply not be strong. Third, the role of financial savings and investment, and especially of “physical capital,” may be overemphasized as a source of economic growth; when “human capital investments” are taken into account, a modified assessment of the impacts of population growth may emerge.

Population Growth, Savings, and Investment: Microeconomics

Age-Dependency Effect

In its usual form, the age-dependency formulation recognizes that an additional child has an incremental claim on household consumption, and asserts that, *ceteris paribus*, this claim is financed by drawing down household saving. Empirical representations of this framework have typically relied on the “adult equivalency” idea whereby each child’s consumption is taken as a fixed proportion of an adult’s. Given household income, the impact of additional children is unequivocal: they reduce household savings and the household saving rate.

The problem with this formulation is that it is narrow. Families may, in fact, be so poor that they accumulate little or nothing, making the options for financing additional children virtually nonexistent—they must be financed out of existing household consumption. However, the assumption of “*ceteris paribus*” and the fixed-coefficient adult equivalency impact on consumption may not constitute a realistic representation of household behavior. The impact of children on the household may be much more complex: (1) children may substitute for other forms of consumption; (2) children may contribute directly to household market and nonmarket income; (3) children may encourage parents to work more (or less) and/or harder; (4) children may encourage the accumulation of certain types of investments and assets (e.g., education); and (5) children may stimulate the amassing (or reduction) of estates.⁸

The impact of family size on household savings can be negative, negligible, or positive; the issue is an empirical one. A positive impact of children on saving can result if their presence increases family income more than their impact on consumption, if the bequest motive is strong (e.g., the desire to leave improved land to surviving sons), and/or if the definition of saving includes human capital (e.g., education). Since imperfect capital markets and economic and social institutions in the Third World encourage the amassing of assets in human rather than physical form, children may represent a means by which saving can take place.

These results have been formalized in life-cycle models that have been extended to account for differing family types and differing income-earnings profiles.⁹ With respect to the first extension, Ronald Lee examines three stylized families: one where an individual plans

from birth; a second where the individual plans from household formation (children ignored); and a third where the child's consumption is a fixed percentage of an adult's. The impact on saving varies dramatically with household forms and the value of the adult-equivalency weight. In a hypothetical example, if the child's consumption relative to an adult's falls by two percentage points, the impact on saving could switch from negative to positive.

In an extension of the life-cycle model that accounts for the impact of children on household income, Mason shows not only that such an effect can be important but also that there is a notable systematic relationship. In particular, in slow-growing economies the positive "income effect" of faster population growth is likely to dominate the "dependency effect," and savings in the aggregate will be increased. (Saving is assumed to be higher out of transitory income, so upward deviations of income due to population growth can have a stimulating effect on saving.) At any rate, the net quantitative impact of the two offsetting effects—life-cycle consumption versus life-cycle income—is not likely to be large.¹⁰

Microeconomic studies that confront the age-dependency hypothesis using Third World data are almost nonexistent. A study using Kenyan household data shows that children have a negligible impact on household saving when the induced impact of children on household income is considered. And if the concept of accumulation is expanded to include human as well as financial forms, children have a positive impact on household saving.¹¹ In another study of nineteenth-century laborers in the iron, steel, glass, and textile industries, the results are similar: children have a negligible or positive impact on household saving.¹² Finally, there is a rich literature on budget weights in which the impact of children on household consumption is considered.¹³ Unfortunately, these studies are unable to confront the hypotheses under test since no allowance is made for the effect of children on household income. Thus, the resulting estimates do not reveal the full impact of children on household accumulation. Put differently, at the empirical level, they all employ the "ceteris paribus" assumption, yet it is this very assumption that requires relaxation in order to reveal the full impact of children on household-saving behavior. I conclude that the empirical literature relating to the age-dependency effects on saving and investment at the household level is not extensive or broad enough to reveal the impacts of children on saving. Those few studies which do exist show this impact to be weak, or even positive.¹⁴

Capital-shallowing Effect

The theory of saving that gives rise to the capital-shallowing effect, like the theory of saving that gives rise to the age-dependency effect, is quite narrow. If children have a negative or negligible impact on, say,

household saving, then when these extra children enter the work force they will have less capital with which to work. This capital shallowing results in lower average labor productivity. However, the extent of capital shallowing can be mitigated, or even offset, if the theory of saving is broadened to include the distribution as well as the level of income.

The basis of the broader saving theory is straightforward. One impact of rapid population growth is a relative abundance of labor vis-à-vis capital and land, which raises the returns to these factors and increases the income of their owners.¹⁵ Since owners of capital and land are likely to be the larger savers, the distribution-of-income effect on saving (and thereby on investment) caused by population growth may offset the forces of capital shallowing.

A second, more speculative impact of population growth on capital shallowing derives from the joint circumstance of counting educational investments as a part of the capital stock and using a “vintage” model of capital accumulation. In such a framework, a fast-growing young population possesses skills (human capital) of relatively high value which can increase the total capital/unaugmented-labor ratio when the broader measure of capital is taken into account.¹⁶

The evidence on the impacts of population on saving and capital shallowing is almost nonexistent. An adequate test of the formulation requires a general equilibrium model that reveals not only the initial impacts of population growth but the induced effects through income distribution as well. Two such models (one using Japan as a case study) show that when relevant feedbacks are taken into account, the long-run capital-shallowing effect of rapid population growth is quantitatively unimportant.¹⁷ While not confronting the issue of capital shallowing directly, other computable general equilibrium models also tend to show that second-order effects (or feedbacks) can be surprisingly large in countries as diverse as Turkey, Korea, and nineteenth-century United States.¹⁸

In short, capital-shallowing effects of population growth are likely to be quantitatively strong only under rather extreme and narrow assumptions. Under more likely conditions where (1) the impact of children on saving is rather small, (2) the income distribution effects of population growth on saving are positive, and (3) macroeconomic feedbacks are taken into account (e.g., accounting for “efficiency capital” where technical change is embodied), the quantitative size and direction of the impact of population growth on capital shallowing is by no means certain.

Investment-Diversion Effect

The investment-diversion effect focuses on the impact of population growth on the allocation of government budgets to population-sensitive

expenditures such as education, health, and housing. It is hypothesized that these population pressures divert funds from more productive public and private spending. And if, for example, expenditures on education are considered as (nonproductive) consumption and not (productive) investment, then population growth has an adverse impact on aggregate savings.

Again, this formulation appears to be analytically narrow. First, it assumes that expenditures in the area of human capital are to be considered as (nonproductive) consumption. While this may have been a popular idea in the 1960s when planning models highlighting sectoral capital-investment coefficients were in vogue, in the 1970s research revealed high returns on human capital and the critical role of knowledge creation and technology in economic development. Indeed, if there is anything to the notion of diminishing returns, one would think that the returns to human capital investments would be high in Third World countries where the levels of education are low. All of this would call for broadening the definition of accumulation to include human-capital investments and to consider the possibility that human and physical capital are separate arguments in the production function.¹⁹ Robert Cassen summarizes this point well: "The real question [is] that of whether such educated and healthy people make a greater contribution to the economy than would be achieved by using the capital to raise the output of a smaller population."²⁰

A second problem with the investment-diversion argument is that it ignores the impact of slowing population growth. While a rapidly growing population generates demands for youth-oriented expenditures, a slowly growing population exerts demand for expenditures for the elderly. It is not clear which composition of spending is more "growth oriented." For example, population-sensitive investments in countries with rapidly growing populations are skewed toward schooling, whereas such investments in countries with slowly growing populations are skewed toward health and facilities for the elderly. If the latter expenditures are largely considered as "consumption" (i.e., they have relatively small impacts on worker productivity), and the former as "investment" (i.e., education has a positive impact on worker productivity), then aggregate saving, broadly conceived, can be *reduced* by slowing population growth. Whether this is the case is an empirical issue.

A third problem with the investment-diversion argument relates to the model of government behavior implied in such formulations. It assumes that, if population pressures were not as great, governments would allocate their budgets to more "productive" forms. There is no compelling reason why this should be the case, and thus the issue again becomes an empirical one: it turns on what governments *do*, and not what they *might* do, in the face of declining population-growth rates.

Many studies, including the *WDR 1984*, have shown that the costs of educating a rapidly growing population can be substantial. This, however, avoids the relevant empirical test. Instead, studies are needed that demonstrate that such expenditures come at the expense of relatively more productive investment (public and/or private).²¹ The research must be constructed in such a way as to reveal the trade-offs within and between government and private spending, and the relative productivity (effect on economic growth) of these trade-offs.²²

The empirical evidence on the impact of population on saving through the investment-diversion effect is inconclusive. While there is almost no evidence on the impact of demographic factors on the total share of government spending in Third World countries, that which exists shows the government's share to be relatively insensitive to a youthful age of the population and more sensitive to, say, urbanization.²³

Population Growth, Savings, and Investment: A Broader Framework

Because the impact of age on savings can be positive, negative, or negligible, the relationship can be identified only by an appeal to data. Studies that have attempted to identify this empirical relationship have for the most part used international cross-section data where savings rates are explained by dependency rates (young dependents, old dependents), per capita income, and income growth (to distinguish permanent from transitory income). Because of data problems and econometric controversy, the findings of these studies are as inconclusive as the theory under test. The results are sensitive to the sample drawn, the definition of saving, functional form, the stage of development, and the extent of the postulated feedbacks. The most common finding is a small or negligible impact of young dependents; where a negative dependency effect does emerge, it almost invariably shows up for old dependents as well. What is clear is that, if a negative dependency effect exists, it is not quantitatively strong, nor is it pervasive or robust with respect to the various data sets and model specifications.²⁴

While empirical research has focused on econometrics, an equally or more relevant issue lies in the conceptualization of the problem and the formulation of the appropriate hypothesis under test. In particular, the objective of these studies is to identify the impact of dependency on economic growth through the impact on investment and accumulation (saving). However, a narrow definition of saving is employed that, for the most part, excludes investments in human capital. An interesting issue thus arises as to the impact of dependency on saving where the latter is more broadly measured to include, for example, expenditures on education.²⁵ It is plausible that an increase in the proportion of young dependents would decrease financial savings but increase savings (via investments) in the form of education, and thus the impact of

dependency may be less to change the level of accumulation and more to alter its composition. Indeed, the increase in human capital accumulation may be facilitated by the reduction in financial saving. The net impact on growth of this transfer of resources depends in part on the relative productivity of human, rather than physical, capital formation.

I have undertaken an exploratory empirical analysis of this issue by comparing estimates of financial with "total" savings (including expenditures on public education) by estimating dependency-rate regressions using variables commonly employed in the literature.²⁶ In addition to the reconceptualization of the problem, my empirical results include several other features: they employ more recent and complete data (for 1980); they use a linear functional form and (where appropriate) correct for heteroscedasticity;²⁷ and they examine the impact of urbanization, not only to identify its effect directly (i.e., the possibility of higher savings rates due to more developed capital markets in urban centers), but also to (imperfectly) control for the impact of location on the measurement of saving (i.e., distinguish between financial savings in the city vs. saving in kind on the farm).

Because my objective is to examine the relationships of age dependency on savings when educational investments are taken into account, I have drawn the sample of countries to correspond to that employed by T. Paul Schultz in a recent study showing the relationship of population growth to intercountry expenditures on education.²⁸ Having sample comparability adds validity to a comparison of my results with his, yielding greater insight and understanding of both studies.

Table 1 presents the results for the model most commonly tested in the literature, for two definitions of saving, and for the total sample and LDCs separately. Other models were evaluated that included urbanization and per capita income squared, but the results with respect to the impact of dependency rates are invariant to these modifications. Moreover, two countries, Algeria and Kuwait, exhibited rather extreme values of saving, so regressions were run excluding these countries. The key results were invariant to such a sample reduction, and the findings reported in table 1 represent the entire data set.²⁹

The first two models are formulations most commonly found in the literature. Here it is seen that, in Third World countries, youth dependency does not exert a statistically significant impact on financial saving; only when developed countries are added to the sample is such a negative relationship revealed. The most interesting result pertains to the size of the estimated dependency effects of D1. Even where statistically significant, they are quantitatively unimportant. For example, for the total sample it would take a reduction of 13.8 percentage points of the D1 cohort (0–15) to increase the aggregate saving rate by 1%. And since such a reduction in D1 would necessarily be associated with

TABLE 1
THE IMPACT OF AGE DEPENDENCY ON THIRD WORLD SAVING

Variable and Sample	D1	D2	Y/N	Y/N Growth	Constant	R2(adj)/OBS
Financial saving (all observed)	-.0072 (-2.32)	-.0270 (-3.53)	.0000201 (6.14)	.00737 (3.30)	.5063 (3.23)	.43
Financial saving (LDCs)	-.0045 (-1.12)	-.0248 (-2.03)	.0000495 (3.87)	.00658 (2.78)	.3520 (1.67)	.83
Total saving (all observed)	-.0083 (-2.66)	-.0297 (-3.88)	.0000181 (6.48)	.00306 (1.36)	.6121 (3.89)	.65
Total saving (LDCs)	-.0112 (-2.88)	-.0388 (-2.26)	.0000239 (1.61)	.00347 (1.45)	.7615 (3.79)	.52
						.51
						.25
						.38

NOTE.—*t*-values are in parentheses. Financial saving is gross national saving excluding transfers from abroad; total saving in addition includes central government expenditures on education. D1 = % population 0–15; D2 = % population greater than 65. Y/N = income per capita in U.S. dollars; Y/N growth, in constant prices, is for the period 1979–80. The data, taken from *World Tables 1984*, apply to 1980. Heteroscedasticity was rejected in all but the last model at the 95% level.

an increase in D2, where there would be an induced reduction of saving, the net impact of any plausible change in the age structure on financial saving due to a change in birth rates is likely to be negligible. This result is seldom drawn out from the various empirical studies of dependency, yet it is, possibly, the only conclusion that holds for most studies of this relationship.³⁰

This conclusion holds with equal force when considering the impact of dependency on the broader measure of saving that includes expenditures on education. However, here the impact of D1 is statistically significant albeit, as just noted, quantitatively unimportant. Such a finding implies that population pressures have a weak negative impact on educational expenditures. This result is broadly consistent with T. Paul Schultz's recent study, which shows that the relative size of the school-aged population has no statistically significant effect on the shares of GNP expended on education, although the signs for the primary, secondary, and total samples are all negative.³¹ Schultz notes that this finding directly challenges the working assumption of Coale and Hoover that linked population growth to the share of income allocated by poor countries to "unproductive" expenditures on education and social welfare programs.³²

Our findings can be further interpreted by comparing them to other results in the Schultz paper. In particular, Schultz shows that enrollment rates have increased substantially in the Third World in the last two decades, indicating an increase in the amount of investment in human capital, but that expenditures per child have decreased. His paper is devoted to untangling whether these two trends represent a trade-off between the quantity and quality of education in the face of population pressures. Employing econometric models that attempt to capture relevant feedbacks in varying degrees, he finds that demographic effects are statistically weaker for the dominant educational sector (primary education, varying from no significance when feedbacks are absent to significant when they are considered), but they depress expenditures per child in the secondary sector. However, the quantitative impact of the diminishing-expenditure-per-child effect on the quality of education may be small, especially in light of the results of microlevel studies showing the impact of expenditures on educational attainments. A significant reason for the reduction of educational expenditures per child is the reduction of teachers' salaries in urban areas where teachers appear to be willing to accept lower compensation in exchange for the benefits of location. Thus, urbanizing Third World countries have in general been able to cope with population pressures by utilizing educational capital and labor more intensively, possibly without substantial impacts on the quality of education (although research is much less certain on this latter point).³³

What can be concluded about the macro studies of the relation-

ships between dependency and saving and investment? First, whether the measurements of savings are narrowly or broadly defined, the quantitative impacts of dependency are small. Second, this result is reinforced by the relatively greater negative impacts on the savings rates of an aging population than of a youthful one. Third, the negative impact of dependency is greater when the concept of saving is broadened to include educational expenditures. However, recent research indicates that this may result in factors giving rise to an increased efficiency in providing educational services associated with population pressures (especially urbanization), and not necessarily to the reduction in the value of the accumulated investments in human capital.

Puzzles Revisited: Population Pressures, Saving, and Investment

For over 25 years economists and population specialists have generally embraced the plausible notion that rapid rates of population growth exert a quantitatively significant adverse impact on the pace of economic growth through the effects of age dependency, capital shallowing, and investment diversion. However, empirical research has not sustained these hypotheses, individually or collectively. One general factor appears to account for this variance between theory and facts—the tendency to develop analyses with simplifying assumptions that are not then subjected to adequate empirical test.

At its most fundamental level, economics is about making choices in the face of scarcity. In the literature relating population growth, saving, and investment, the modeling of choices has been amazingly narrow—indeed, almost a-economic. At the household level, population pressures are usually modeled by engineering-like, fixed-coefficients formulae (e.g., the adult-equivalency hypothesis). In contrast, trade-offs between quantities or qualities of consumption are seldom admitted, parents' work force behavior is usually taken to be uninfluenced by family size, and children are typically assumed to contribute nothing productively. Similarly, at the government level, population pressures are modeled to show population-sensitive expenditures taking priority and crowding out more productive spending. In reality, governments respond with more flexibility than the models suggest, and, moreover, some of the population-sensitive expenditures may be growth-enhancing. At the macroeconomic level, population pressures are often modeled to change the ratios between resources and population, where the initial impact on growth is unequivocally adverse. In contrast, more elaborate analyses reveal second-order effects: economizing on scarce resources and an expansion in supply. This is true whether the resources are renewable or nonrenewable, or whether they are physical or human capital. In summary, when more economics is built into the micro and macro relationships between population,

saving, and investment, the puzzle of reconciling the apparent divergence between theory and fact disappears.

This conclusion is not meant to discount the importance of earlier analyses of population. These studies have been invaluable in our quest for an appropriately complex specification of the relevant relationships. Indeed, all good theorizing begins from simplification and is then modified in response to subsequent empirical test and evaluation. Such is the case with work relating saving, investment, and population. The current state of knowledge justifies an expanded research agenda involving (1) analyses of household behavior using micro data sets for Third World countries, (2) study of government responses to population pressures (using time-series data and involving individual country case studies), and (3) development of macroeconomic paradigms that highlight (not suppress) price-responsive feedbacks due to resource scarcity. Only when progress is made in these areas can we begin to have substantial confidence in the economic-demographic relationships between population, saving, investment, and growth.

Notes

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1. Recent reviews of the consequences of population growth include Allen C. Kelley, "The Population Debate: A Status Report and Revisionist Interpretation," in *The New Population Debate 7*, ed. Paola M. Scommegna (Washington, D.C.: Population Reference Bureau, 1985), pp. 12–23; Timothy King, "Population and Development: Back to First Principles," in Scommegna, ed., pp. 2–11; G. McNicoll, "Consequences of Rapid Population Growth: Overview and Assessment," *Population and Development Review* 10 (1984): 177–240; and World Bank, *World Development Report* (New York: Oxford University Press, 1984).

2. Ansley J. Coale and E. M. Hoover, *Population Growth and Economic Development in Low Income Countries* (Princeton, N.J.: Princeton University Press, 1958).

3. P. T. Piotrow, *World Population Crisis: The United States Response* (New York: Praeger Publishers, 1973).

4. For example, Robin Barlow, "The Economic Effects of Malaria Eradication," *American Economic Review* 57 (May 1967): 130–57; Robin Barlow and Gordon Davies, "Policy Analysis with a Disaggregated Economic-Demographic Model," *Journal of Public Economics* 3 (February 1974): 43–70; Frank T. Denton and Byron G. Spencer, "Some Government Budget Consequences of Population Change" (Hamilton, Ontario: McMaster University, Department of Economics, 1974, mimeographed); S. Enke, *Description of the Economic-Demographic Model* (Santa Barbara, Calif.: General Electric Company, Tempo Center for Advanced Studies, 1971); and William E. McFarland, James P. Bennett, and Richard Brown, *Description of the TEMPO II Budget Allocation and Human Resources Model* (Santa Barbara, Calif.: General Electric Company, Tempo Center for Advanced Studies, 1973). For an evaluation of these and other models, see W. Brian Arthur and Geoffrey McNicoll,

"Large-Scale Simulation Models in Population and Development: What Use to Planners?" *Population and Development Review* 1 (1979): 151–265; and Warren C. Sanderson, *Economic-Demographic Simulation Models: A Review of Their Usefulness for Policy Analysis* (Laxenburg, Austria: International Institute for Applied Systems Analysis, 1980).

5. For a more detailed analysis, see Kelley.

6. World Bank, p. 82; King, p. 4; McNicoll, p. 206; Jeffrey Hammer, "Population Growth and Savings in LDC's: A Survey Article" (Washington, D.C.: World Bank, 1983, mimeographed), p. 3.

7. T. Paul Schultz, "School Expenditures and Enrollments, 1960–1980: The Effects of Income, Prices, and Population Growth" (New Haven, Conn.: Yale Growth Center, December 1984, mimeographed); World Bank, p. 80.

8. An early analysis of these issues is provided by Paul Demeny, "Investment Allocation and Population Growth," *Demography* 2 (1965): 203–32, and "Demographic Aspects of Saving, Investment, Employment and Productivity," *World Population Conference 1965* (New York: United Nations, 1967).

9. An excellent review of the life-cycle literature as it pertains to the impact of family size on saving is provided by Hammer, pp. 3–11. For early formulations, see F. Modigliani and R. Brumberg, "Utility Analysis and the Consumption Function: An Interpretation of Cross Section Data," in *Post Keynesian Economics*, ed. K. Kurihara (New Brunswick, N.J.: Rutgers University Press, 1954); and F. Modigliani and A. Ando, "Tests of the Life Cycle Hypothesis of Saving," *Bulletin of the Oxford University Institute of Statistics* 19 (May 1957): 99–124.

10. Ronald Lee, "Age Structure, Intergenerational Transfers and Economic Growth: An Overview," *Revue économique* 31 (November 1980): 1129–56; Andrew Mason, "An Extension of the Life Cycle Model and Its Application to Population Growth and Aggregate Saving" (East-West Population Institute, Honolulu, June 1980, mimeographed).

11. Allen C. Kelley, "Interactions of Economic and Demographic Household Behavior," in *Population and Economic Change in Developing Countries*, ed. R. A. Easterlin (Chicago: University of Chicago Press, 1980). This data set is particularly interesting since in Kenya school fees were substantial, and households routinely spent upward of 5%–15% of their income on education. Since at the time of the study schooling was not compulsory, such household budget allocations can be considered as discretionary investments in human capital, vis-à-vis alternative forms of spending and saving.

12. Allen C. Kelley, "Savings, Demographic Change, and Economic Development," *Economic Development and Cultural Change* 24 (July 1976): 683–93.

13. Classic studies include A. M. Henderson, "The Cost of a Family," *Review of Economic Studies* 17 (1949–50): 127–48; H. S. Houthakker and S. J. Prais, *The Analysis of Family Budgets* (Cambridge: Cambridge University Press, 1955); H. S. Houthakker, "An International Comparison of Household Expenditure Patterns, Commemorating the Centenary of Engel's Law," *Econometrica* 25 (October 1957): 532–51, and "An International Comparison of Personal Savings," *Bulletin de L'Institute Internationale Statistique* 38, pt. 2 (1961): 55–69.

14. This conclusion also holds with respect to empirical studies of U.S. data, that is, the timing of childbearing appears to be more important than family size. For example, T. Espenshade shows that younger (older) children reduce (increase) saving, and so the timing of saving is mainly affected by family size. T. Espenshade, "The Impact of Children on Household Saving: Age Effects versus Family Size," *Population Studies* 29 (1975): 123–25. J.

Smith and M. Ward find that consumption is smaller in families with young children, where marriage duration is shorter, in part because families are saving for housing. Again, it is the timing of saving that is primarily influenced by family size. J. Smith and M. Ward, "Asset Accumulation and Family Size," *Demography* 17 (August 1980): 243–60. See also W. Eizenga, *Demographic Factors and Savings* (Amsterdam: North-Holland, 1961).

15. R. Repetto, *Economic Equality and Fertility in Developing Countries* (Baltimore: Johns Hopkins University Press, 1979).

16. H. Leibenstein, "The Impact of Population Growth on Economic Welfare—Nontraditional Elements," in *Rapid Population Growth*, ed. R. Ravelle (Baltimore: Johns Hopkins University Press, 1971).

17. Allen C. Kelley and J. G. Williamson, *Lessons from Japanese Development: An Analytical Economic History* (Chicago: University of Chicago Press, 1974), and *What Drives Third World City Growth? A Dynamic General Equilibrium Approach* (Princeton, N.J.: Princeton University Press, 1984).

18. K. Dervis, J. de Melo, and S. Robinson, *General Equilibrium Models for Development Policy* (Cambridge: Cambridge University Press, 1982); I. Adelman and S. Robinson, *Income Distribution in Developing Countries: A Case Study of Korea* (Stanford, Calif.: Stanford University Press, 1978); and J. G. Williamson, *Late 19th Century American Development: A General Equilibrium History* (Cambridge: Cambridge University Press, 1974).

19. Theodore W. Schultz, "Investment in Human Capital," *American Economic Review* 51 (March 1961): 1–17, and "The Value of Children: An Economic Perspective," *Journal of Political Economy* 81, pt. 2 (March/April 1973): S2–S13; and R. Ram and Theodore W. Schultz, "Life Span, Health, Savings, and Productivity," *Economic Development and Cultural Change* 27, no. 3 (April 1979): 399–421.

20. Robert Cassen, *India: Population, Economy, and Society* (New York: Holmes & Meier, 1978), p. 225.

21. Cassen argues that focusing on the direct impact of population growth on investment (e.g., "unproductive" education vs. "productive" factors) has probably missed the most relevant impact of population on investment. In the context of Indian experience, he highlights the increased capital and foreign exchange costs required to maintain or increase agricultural productivity in the face of population pressures. He thus emphasizes that the narrow approach of "investment-diversion" needs broadening to other factors as well as to second-order effects (Cassen, esp. pp. 225–36).

22. The data presented are often not directly relevant or are circumstantial. For example, calculations are made of the cost of accommodating larger school enrollments engendered by high fertility rates. Next, a "counterfactual" is posed of lower fertility rates, showing "educational savings." Speculations are then offered on how such savings "could have been" used in various productive ways. The relevant issue is whether such savings "would have been" used in productive ways. The *World Development Report 1984* provides examples of this counterfactual approach. For Egypt, it is noted "less rapidly growing enrollment produces considerable saving; these can be used to improve school quality" (p. 85); and "with the money saved by lower fertility, the Malawi government could afford to enroll" (p. 85; emphasis mine). Of course, the savings could also be used for other things, many of which are "unproductive." Instead, the relevant test would be to demonstrate how a group of countries do in fact reallocate resources, public and/or private, in response to changing population growth rates.

23. Allen C. Kelley, "Economic Change and the Size of the Government

Sector," *Southern Economic Journal* 43, no. 2 (1976): 1056–66. See also T. P. Schultz (n. 7 above).

24. The first study was by Nathaniel H. Leff, "Dependency Rates and Savings Rates," *American Economic Review* 59 (December 1969): 886–96. Subsequent critiques and additional empirical work have been provided by Nassau A. Adams, "Dependency Rates and Savings Rates: Comment," *American Economic Review* 59 (June 1971): 472; K. L. Gupta, "Dependency Rates and Savings Rates: Comment," *American Economic Review* 59 (June 1971): 469–71, and "Foreign Capital Inflows, Dependency Burden, and Savings Rate in Developing Countries: A Simultaneous Equation Model," *Kyklos* 28 (1975): 358–74; A. Goldberger, "Dependency Rates and Savings Rates: Further Comment," *American Economic Review* 63, no. 1 (March 1973): 232–33; Richard E. Bilsborrow, "Age Distribution and Savings Rates in Less Developed Countries," *Economic Development and Cultural Change* 28 (October 1979): 23–45, and "Dependency Rates and Aggregate Savings Revisited," *Research in Population Economics*, ed. J. Simon and J. Da Vanzo (Greenwich, Conn.: JAI Press, 1980); R. Ram, "Dependency Rates and Aggregate Savings: A New International Cross-Section Study," *American Economic Review* 72 (June 1982): 537–44; Nathaniel H. Leff, "Dependency Rates and Savings Rates: Reply," *American Economic Review* 61 (June 1971): 476–480; Nathaniel H. Leff, "Dependency Rates and Savings Rates: Reply," *American Economic Review* 63 (March 1973): 234, and "Dependency Rates and Savings Rates: A New Look," in *Research in Population Economics*, ed. J. Simon and J. Da Vanzo (Greenwich, Conn.: JAI Press, 1980). A useful summary of this literature is found in Hammer (n. 6 above).

25. Actual expenditures on education represent a lower bound on the estimates of human capital. If the value of the student's time is included, the estimates are much higher. This more comprehensive measure was computed for India to be 55% of physical capital accumulation in the 1970s. D. Sharma and R. Ram, "Suggestions for Treatment of Human Capital in National Accounts—with Illustration from Indian Data," *Review of Income and Wealth* 20 (December 1974): 501–14; and Ram and T. W. Schultz (n. 19 above).

26. The treatment of all educational expenditures as investment may be somewhat extreme, although such an approach is more realistic than to consider education solely as consumption in the Third World. See Sharma and Ram. For a justification of the income-growth variable, see S. Bhalla, "The Measurement of Permanent Income and Its Application to Savings Behavior," *Journal of Political Economy* 88 (August 1980): 722–44; Raymond Micksell and James Zinser, "The Nature of the Savings Function in Developing Countries: A Survey of the Theoretical and Empirical Literature," *Journal of Economic Literature* 2 (March 1973): 1–20; and Andrew Mason, "National Saving Rates and Population Growth: A New Model and New Evidence" (East-West Population Institute, Honolulu, 1984, mimeographed).

27. The double-log form, commonly used in the literature to skirt problems of heteroscedasticity, has proven to be a liability given the presence of negative observations and values close to zero. Arbitrary techniques to accommodate this problem have typically resulted in data reduction or in a transformation that has subjected the estimates to considerable criticism. Since tests on our linear regressions reject the presence of heteroscedasticity in all but one case, there is little reason to use the elasticity (double-log) formulation other than for the convenience of interpreting the parameters. However, in the present case, even elasticities are less interesting than the metric versions of the estimated parameters.

28. T. P. Schultz (n. 7 above). His sample represents countries over the period 1960–80 in which for at least 1 year (at quinquennial points, 1960, . . .) there exist data on educational expenditures, whose estimated population in 1983 exceeds 1 million people, where data gaps are minimal, and in which market allocations dominate.

29. Countries in our data set include (developed countries are noted with an asterisk): Afghanistan, Algeria, Argentina, Australia,* Austria,* Bangladesh, Belgium,* Bolivia,* Brazil, Burma, Burundi, Cameroon, Canada,* Central African Republic, Chad, Colombia, Congo, Costa Rica, Denmark,* Dominican Republic, Ecuador, Egypt, El Salvador, Ethiopia, Finland,* France,* Federal Republic of Germany,* Ghana, Greece, Guatemala, Haiti, Honduras, Hong Kong, Iran, Iraq, Ireland,* Israel, Italy,* Ivory Coast, Jamaica, Japan,* Kenya, Republic of Korea, Kuwait, Lebanon, Liberia, Madagascar, Malawi, Malaysia, Mali, Mauritania, Nicaragua, Niger, Nigeria, Norway,* Pakistan, Panama, Paraguay, Peru, Philippines, Portugal, Rwanda, Senegal, Sierra Leone, Singapore, Somalia, Spain,* Sri Lanka, Sudan, Sweden,* Switzerland,* Syrian Arab Republic, Tanzania, Thailand, Togo, Trinidad and Tobago, Tunisia, Turkey, Uganda, Venezuela, Yugoslavia, Zambia, and Zimbabwe.

30. It is notable that the average negative impact of D2 is four times the negative impact of D1. While demographic change exerts a smaller impact on the D2 cohort than on the D1 cohort, the larger weight of D2's parameter greatly amplifies the impact of aging. An analysis of such a scenario is provided in Allen C. Kelley, "Population Growth, the Dependency Rate, and the Pace of Economic Development," *Population Studies* 27 (November 1973): 406–20.

31. T. P. Schultz's (n. 7 above) result can be reconciled with ours since all of his estimated parameters on school-aged population were negative, albeit statistically insignificant for the primary ages, and for all school ages combined. He also finds that fertility is uncorrelated with the share of GNP allocated to public education.

32. T. P. Schultz (n. 7 above), esp. pp. 40–41, 59; Coale and Hoover (n. 2 above).

33. In a detailed study of 15 developing countries for the 1970s, Manuel Zymelman asserts that there is no basis for concluding in general that reduced expenditures per child are associated with lower educational outputs per child. This is because high growth in the education sector results in rapid entry of young (and possibly relatively qualified) teachers whose salaries are low not because they are less productive but because salary rates depend on age and experience. Thus, the lower average salary noted by T. P. Schultz may not accurately represent the qualitative impact of teachers (and education budgets) on educational outputs. Manuel Zymelman, "Educational Expenditures in the 1970's" (Washington, D.C.: World Bank, Economics Department, 1982, mimeographed), and "Educational Budgets and Quality of Instruction: Are They Unequivocally Related?" (Washington, D.C.: World Bank, Education Department, 1985, mimeographed).