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The Role of Relative Cohort Size and Relative Income in the Demographic Transition

Diane J. Macunovich
University of Redlands, Department of Economics, diane_macunovich@redlands.edu

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Diane Macunovich

Center for Policy Research
Maxwell School of Citizenship and Public Affairs
Syracuse University
Syracuse, New York 13244-1020

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Abstract

This paper summarizes the results of other analyses by the author with regard to the importance of relative cohort size (RCS) in determining male relative income (the income of young adults relative to prime-age workers) and general patterns of economic growth, and in turn influencing fertility in the currently more-developed nations. It then goes on to demonstrate that these same effects appear to have been operating in all of the 100-odd nations which have experienced the fertility transition since 1950. Parameter estimates based on the experience of all 189 countries identified by the United Nations between 1950 and 1995 are used to simulate the effects on fertility of migration from Third to First World countries. This exercise suggests that we get the best of all possible outcomes with migration: population is reduced in "overcrowded" Third World nations, total world population growth is substantially reduced, and scores of children are given the opportunity of growing up with all the educational and health advantages of United States residents.

Introduction

Over the past 50 years we have heard doomsayers prophecy the destruction of civilization as we know it, both through over- and under-population. As mortality rates in less developed countries began to fall in the 1960s, population growth rates in those parts of the world mushroomed, and it became popular to speak of a "population explosion" which might lead to "standing room only" in the next century. Hard on the heels of that worry came the concern that the more developed countries would disappear altogether, as their birth rates sank below replacement level.

Such fears are not new: similar ones can be identified going back through the 1930s, when scholars here and abroad worried that low rates of population growth would bring about a collapse of the economic system, and at least as far back as the eighteenth century, when Thomas Malthus turned economics into "the dismal science" with his worries about the ills of overpopulation. These types of fears tend to be based on simple extrapolations of current growth rates: are they realistic? Is it possible that human beings might reproduce like cells in a petri dish—or sit watching as their numbers dwindle to nothingness?

The simple answers are "no," "no," and "no." Based on the evidence of our history over the past century, it seems clear that there are fundamental self-regulating mechanisms underlying and intertwining population and economic growth, which would prevent such catastrophic movements in either direction. Like Adam Smith's "invisible hand," they have operated to maintain a long-term equilibrium in those growth rates, at least since the demographic transition.

One of the most basic mechanisms regulating the pace of growth appears to be the proportion of the population aged about 15-24[1]—especially relative to the proportion of prime-aged adults. (The ratio of this group to the population aged 25 to 59 in the United States is illustrated in Figure 1, along with another "more precise" labor market indicator: the ratio of those aged 20 to 22 to those aged 45 to 49.) In previous work this author has demonstrated the pronounced pattern of consumption and dis-saving associated with this age group (Macunovich 1998d), their effects on overall economic growth and on their own income relative to that of prime age workers (Macunovich 1998a, 1999a, 1999b), and the tendency for fertility to respond directly to changes in male relative income (Macunovich 1996, 1998b, 1998c). In this paper I will quickly summarize some of the findings from those studies, and then illustrate how they appear to create a self-regulating mechanism which can be traced through the demographic transition in scores of countries, just as they can be traced through baby booms and busts in more developed countries.

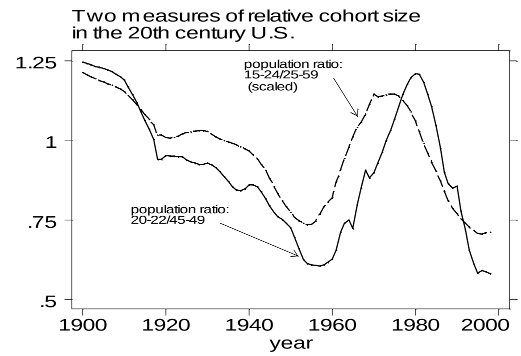

Figure 1: Relative cohort size in the United States, using two alternative age ratios. The dashed line indicates the ratio of those aged 15 to 24 to those aged 25 to 59 (scaled by multiplying by 2.5). The solid line indicates the ratio of those aged 20 to 22 relative to those aged 45 to 49.

Summary of Earlier Findings

Macunovich (1998d) demonstrates strong age-specific patterns of expenditure, holding income constant, using state-level data during the whole of this century in the United

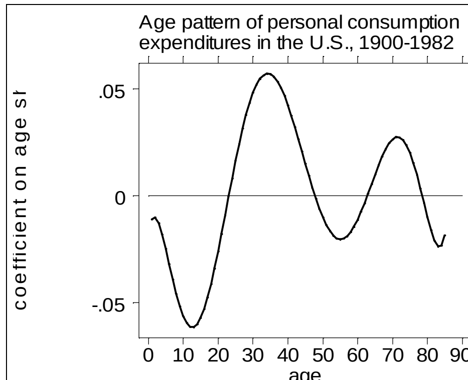

Figure 2: Estimated coefficients on age shares in a regression of state-level personal consumption expenditures per adult on state-level income per adult and age distribution in the U.S.: 1900, 1929, 1970, 1977 and 1982. *(Source: Macunovich, 1998d).*

States. As illustrated in Figure 2, these results support the idea of "life cycle" saving and spending, with younger and older adults spending heavily and prime-aged adults tending to save a larger proportion of their income. A novel finding in this study, however, relates to patterns of expenditure generated by children. It has been assumed traditionally that children cause parents to "dis-save" at high rates, but this study demonstrates that parents' patterns of expenditure differ dramatically depending on the age of the children, and that the "dis-saving" traditionally associated with children is instead a result of the (highly correlated) age patterns of their *parents*. Those with very young children save much less—and in most recent years do "dis-save" to some extent—as do those with teenagers. But those with children aged about 5 to 15 *save heavily*, on average—probably in preparation for expected higher levels of spending as the children grow older.

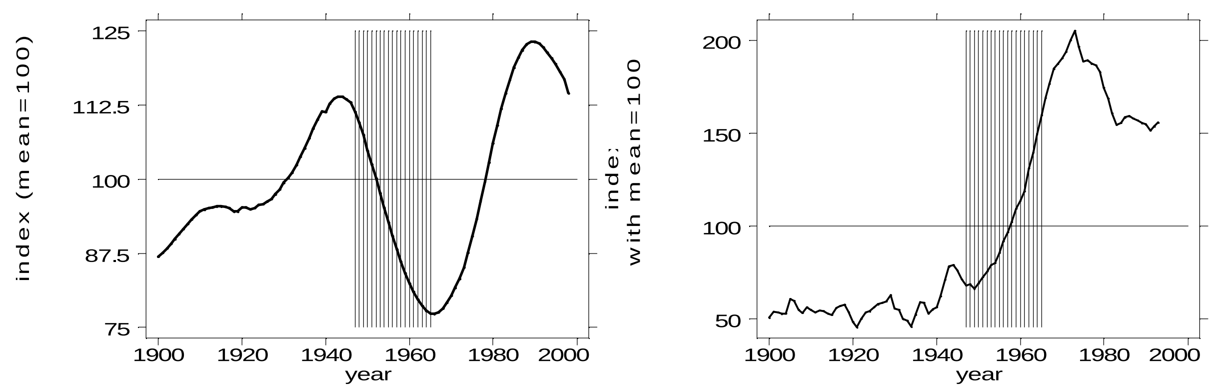

Figure 3: Simulated effects of changing age structure on United States expenditures and income. Left: Index of simulated real per capita consumption expenditures in the United States as a function of age structure in the population—holding all other factors constant. Right: Index of "age adjusted income": residuals after regressing ln(real income per adult aged 16 to 64) on the age distribution of adults aged 16 to 64.

The shaded portion of each graph indicates the period of increased rates of saving and productivity growth induced by age structure when the baby boomers were younger. The period to the right of the shaded area indicates the increasing level of per capita expenditures generated by the baby boomers as they entered the "young adult" years, which spurred overall economic growth but reduced savings—and hence productivity growth and the growth in real per capita incomes. *(Source: Macunovich, 1998d).*

These differential patterns of expenditure by age of child mean that the passage of the Baby Boom from infancy through the teen years generated strong fluctuations in savings and expenditure, and simulations demonstrate that these patterns appear to explain a large proportion of observed changes in the economy in the postwar period (see Figure 3).

The primary labor market effect of relative birth cohort size (RCS), as postulated by Easterlin (1968, 1978, 1980, 1987) and demonstrated for the United States by Welch (1979) and Freeman (1979), among others, is on the relative earnings of young males—that is, on their earnings relative to those of older males.[2] This effect occurs largely because of the fact that young, less experienced workers are not perfect substitutes in the labor market for older, more experienced workers, and the production function' is sensitive to the balance of these two types of workers. If we have an oversupply of one type of worker relative to the other (think of it as an oversupply of assembly-line workers relative to management) the wages of the oversupplied group will tend to go down relative to the wages of the under-supplied group.

This effect of imperfect substitutability has been documented by labor economists, as noted above. However, because relative wages and employment prospects did not begin to improve when relative cohort size declined in the United States (i.e., once the peak of the baby boom had entered the labor market in 1979/80), labor economists began to assume that they had overestimated relative

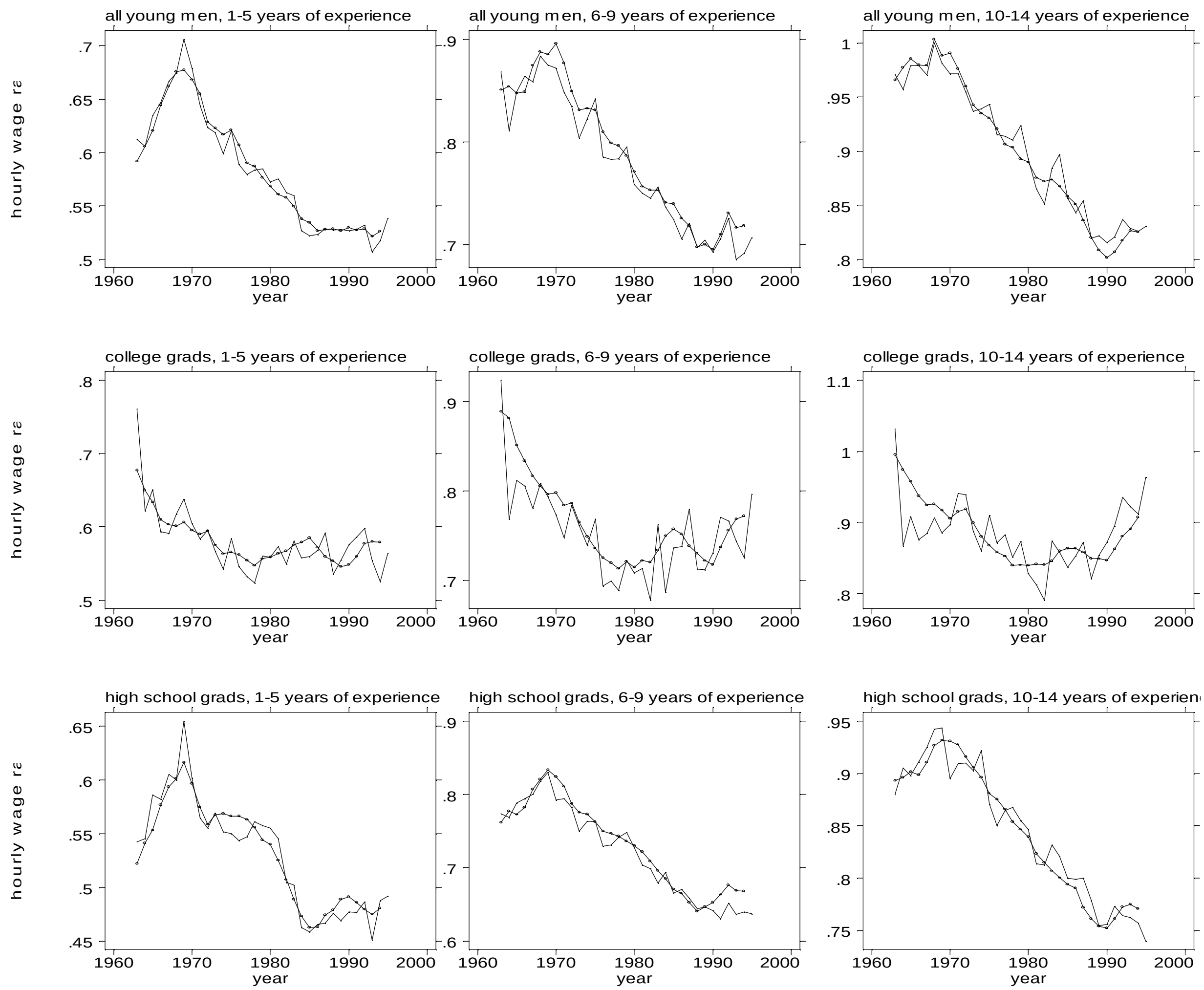

Figure 4: Predicted (+) and actual hourly wages of young men by experience and education, relative to those of prime-aged males with 25 to 34 years of work experience. Predicted values are based on the relative cohort size model presented in Macunovich (1999a).

cohort size effects, and turned to other factors for analysis. Macunovich (1998a, 1999a, 1999b) demonstrates however that relative cohort size effects on relative male wages continue to be very strong, once allowance is made for *asymmetry* in those effects: the fact that positive aggregate demand effects of cohort size tend to buoy up the economy and buffer relative wages when cohort size is increasing, while the shock of any turnaround in this increase tends to slow the economy, with young workers hardest hit in the slowdown. Figure 4 illustrates the historic pattern of male relative wages for a number of different education and experience groups, together with fitted values based on the relative cohort size model in Macunovich (1999a).

Richard Easterlin (1987) hypothesized that we tend to evaluate our earnings relative to some internalized measure of our desired standard of living. This internalized standard will be strongly affected by the standard of living we have experienced in our parents' homes. Because of this, and because relative earnings are a measure of the earnings of young males relative to those of older males, then, on average the pattern of male relative earnings gives us a good indication of the pattern of male earnings relative to material aspirations in aggregate in the population.

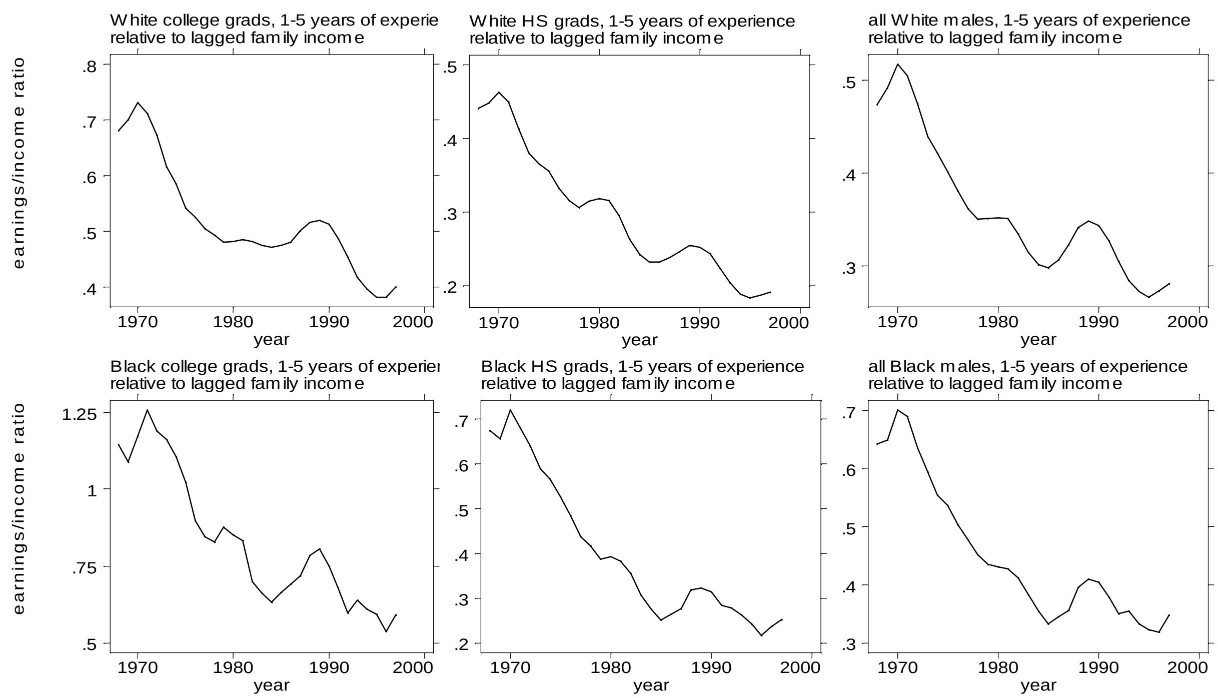

Figure 5: Male relative income (annual earnings of men with 1 to 5 years of work experience, relative to the annual income five years earlier of families with children, with head of either sex aged 45 to 54), by race and educational attainment *(source: author's tabulations of March Current Population Survey public use tapes).*

Figure 5 illustrates the observed pattern of male relative *income* (an annualized equivalent of the male relative *wages* in Figure 4) among white and African American high school and college graduates, estimated using Easterlin's definition.[3] What happens when these relative earnings decline by about 50 percent—as they did from the 1960s through the 1980s? (This ratio indicates the proportion of *recent* parental annual income that a young man can reproduce in his *first few years* out in the labor market: for African-American college graduates this declined from 125 percent to only about 65 percent during this period—and from about 75 percent to only 40 percent for white college graduates.)

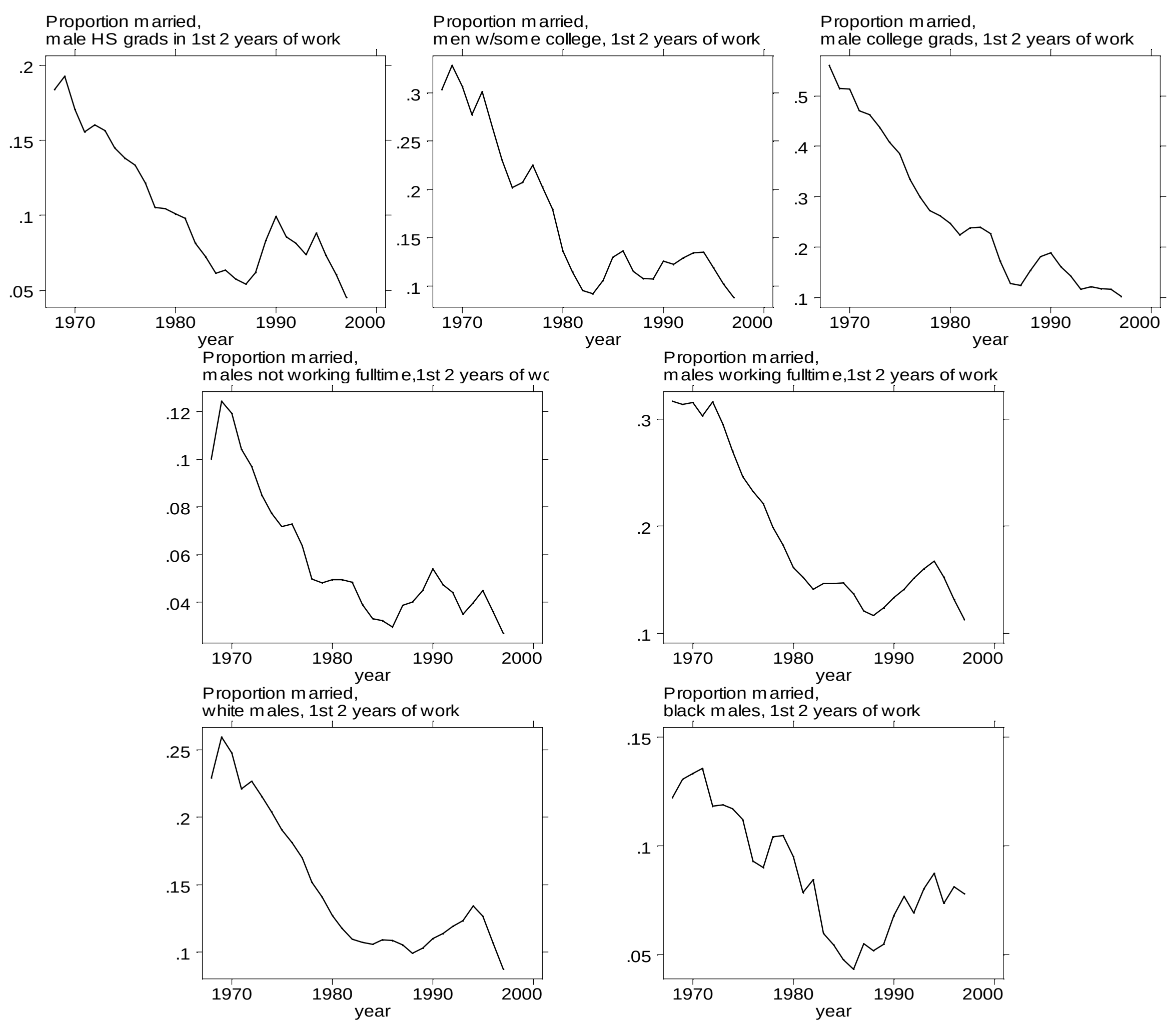

Figure 6: Proportions of men married in their first two years out of school, by level of education, full time work status and race *(source: author's tabulations from March CPS public use tapes).*

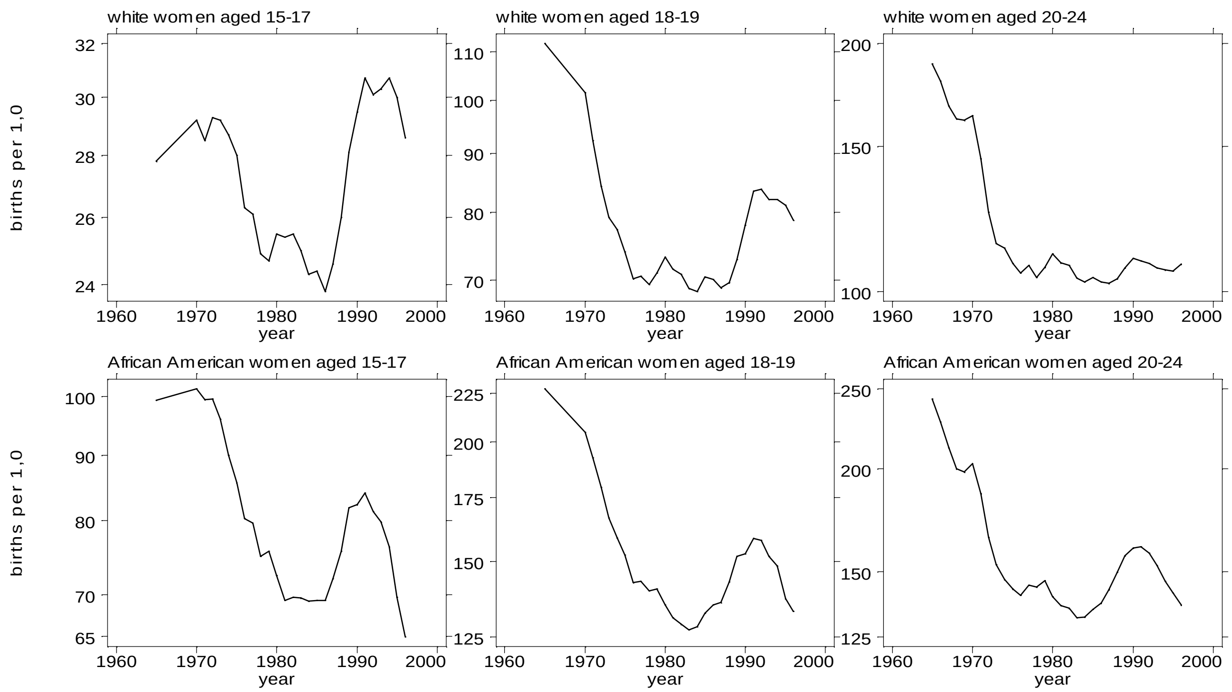

Figure 7: Race- and age-specific fertility rates, for women aged 15-24. *[Source: Ventura et al (1998) for 15-17 and 18-19; Ventura et al (1996) and Peters et al (1997) for 20-24.]*

Easterlin hypothesized that, in an attempt to close the gap between income and aspirations, members of relatively large cohorts will tend to make a number of adjustments including increased female labor force participation and delayed/reduced marriage and childbearing. The results in Macunovch (1996, 1998b, 1998c) support this hypothesis: a model based only on male relative income and women's hourly wage is able to predict over 99 percent of the variation in fertility and labor force participation among women aged 20 to 24: those with the highest reproductive potential, who are expected to be most strongly affected by Easterlin's hypothesis. Figures 6 and 7 demonstrate the similarity of patterns of marriage and fertility among various groups. We can also see how similar these patterns are to that of male relative income: the long decline prior to about 1985, and then the "hump" in most of these series in the late 1980s and early 1990s.

The Role of Age Structure in Promoting the Demographic Transition

"Demographic transition" is the period during which a country passes from high to low birth and death rates. Prior to the transition there is little if any population growth, often despite fertility rates of seven births per woman or more, because of high mortality—especially infant mortality. This was the case in the currently developed countries prior to the nineteenth century, and in many developing countries as recently as the middle of this century.

Characteristically the transition to lower death rates precedes the transition to lower fertility, and this imbalance between the two rates produces rapid population growth until fertility rates begin to decline. This has been the situation in currently developing countries, which led to the widely-publicized fears about "population explosion" in the 1970s. Exacerbating this effect, improvements in health which tend to accompany mortality decline often lead to temporary *increases* in the fertility rate, until couples' concerns about excessive family size provide motivation for the use of contraceptives.

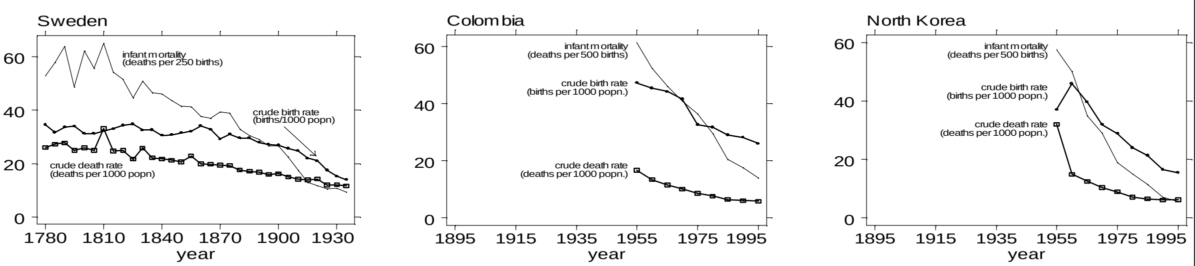

Figure 8: Patterns of demographic transition for Sweden, Colombia and North Korea. Note the long period of decline in the death rate in Sweden before the fertility transition began.

Most of the population growth which the human species has experienced—and probably *will ever* experience—occurs as a result of this transition. Because of this, an important aspect of demographic research has been the attempt to identify factors which determine the length of the gap between mortality decline and fertility decline. In general, the currently developed countries took 50 years or more to pass through the transition, while in a number of developing countries the transition has occurred in a single decade (Figure 8).

Demographers and economists have demonstrated a strong correlation between fertility and infant mortality rates (deaths per 1000 live births), suggesting that the motivation to control fertility arises from parents' concerns about excessive family size. And yet, despite the correlation between fertility and infant mortality, decline in the latter has not been a good predictor of the initiation of decline in the former, in currently developing countries. By the late 1980s many countries—especially in Sub-Saharan Africa—had not yet experienced any fertility decline despite decreasing infant mortality, as in the case of Mozambique (Figure 9).

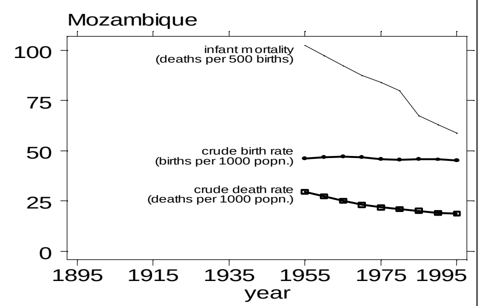

Figure 9: Vital rates in Mozambique, a country which has not yet begun the fertility transition, despite declines in infant mortality.

In addition, standard economic measures appear not to be good predictors of the start of the fertility transition, as evidenced by the following statement from Caldwell (1997:20-21):

> "The search for materialist thresholds is frustrating. If we compare Britain in 1871 with a range of countries in Asia and Africa a century later when their fertility was beginning to fall or soon would fall, some surprising findings emerge. . .In terms of real per capita income. . . Britain was at the start of its fertility decline, ten times as wealthy as Bangladesh, and almost twice as rich as Thailand. The proportion of its workforce working outside agriculture was four times that in Bangladesh or Kenya and more than double Sri Lanka's proportion. Its proportion of population living in conurbations with more than half a million inhabitants was eighteen times the proportion in Sri Lanka and even six times that in Thailand."

We know that the reduction in infant mortality occurs as a result of the spread of modern medicine and hygiene, but what causes fertility rates finally to take the plunge?

The United Nations (1998) provides estimates for nearly 200 nations at five year intervals from 1950 through 1995, of some of the vital rates used by economists and demographers in analyzing this question: crude birth and death rates (births and deaths per 1000 population), infant mortality, total fertility rates and life expectancy. More importantly, from the perspective of this analysis, they provide data on population age structure (the proportion of the total population aged under 5, 5 to 14, 15 to 24 and 60+). These data suggest that relative cohort size (RCS, approximated using the ratio of 15 to 24 year olds to those aged 25 to 59[4])—probably acting through effects on male relative income—has played a crucial role in bringing about the fertility transition in developing countries during that period.

Relative Cohort Size Effects—in the Third World?

The mechanism is hypothesized to be similar to that observed in the United States and other industrialized nations: an excess supply of young relative to prime-age males depresses the relative wages of the young men, thereby reducing their earning potential relative to their material aspirations as shaped in their parental households. This would lead young couples to delay or forego marriage and/or reduce fertility in an attempt to maintain a higher level of per capita disposable income. The surprise here is not that we can observe the relative income effect operating on fertility in newly developing economies, but rather that such a strong market mechanism should be observable there—one which differentiates workers by age and level of experience in order to translate changes in relative cohort size into changes in relative income. But the evidence, as we shall see, appears overwhelming.

Undoubtedly institutional and cultural differences among countries must temper the relationship between relative cohort size and relative income across nations and regions. Strong unions, for example, which maintain high wages for current members at the expense of new labor market entrants (probably as a protective measure during periods of large relative cohort size), would tend to counteract positive effects of subsequent smaller relative cohort size.

Similarly, countries with strong policies encouraging wage cuts rather than layoffs during periods of excess labor supply might dilute relative cohort size effects, if wage cuts occur across all experience groups. Studies have found that while the United States tends to have "sticky wages" that promote high unemployment during such periods, many European countries trade that unemployment for lower wages.

Japan, too, must experience more diluted effects of relative cohort size on relative income, because of widespread adherence to rigid pay scales which are tipped strongly in favor of older more experienced workers, in order to entice employees into long-term commitment. Here again, young workers would rarely experience the benefits of smaller cohort size. That wage structure appears to have sent fertility rates in Japan into a tailspin which not even declining relative cohort size has been able to remedy.

The rigidity of a nation's boundaries with respect to immigration, and its policies toward "guest workers" as for example in Germany, Austria and Oman, would also impinge on the relative cohort size/wage relationship. Tests for any relationship would be most appropriate at a regional rather than a national level, when workers can cross international boundaries fairly freely. And conversely, it is possible that very large countries such as China or the former USSR might contain many sub-national "markets" in which any relative cohort size effects would emerge most clearly—especially if the movements of their citizens are restricted by government.

And at the other end of the causal network it goes without saying that cultural and institutional differences must impinge on the relationship between relative income and factors such as marriage and childbearing. These cultural effects may show up only as differences in the overall *levels* of marriage and fertility, however, rather than in the response to changing economic circumstances.

But we're getting ahead of ourselves. Let's look at the evidence.

The Evidence

Countries appear not to begin reducing their fertility, despite reductions in infant mortality, until mortality rates fall among children and young adults, permitting the proportion of those aged 15 to 24 to rise relative to those aged 25 and over. This is seen in country after country which has begun the fertility transition since 1950—more than 100 in all. Several which have not yet begun the transition, such as Ethiopia, Nigeria and Mozambique, have not yet experienced any increase in the ratio of 15 to 24 year olds to those aged 25 and over, despite marked and prolonged reductions in infant mortality in many cases.

It is even common to observe a *decline* in relative cohort size in most countries immediately before it begins to increase, suggesting that mortality rates among older adults tend to fall more quickly during the transition, than mortality rates among children and young adults.

The relationship between fertility and relative cohort size in these Third World countries highlights the tragic human toll exacted by the high mortality rates associated with lack of education, poverty and internal strife. In country after country we will see a constant—or even declining—ratio of 15 to 24 year olds to those aged 25 to 59 over many decades despite TFRs of 6.0 or even 7.0 and above. These nations are producing scores of infants and children who will never live to make a productive economic contribution, but who nevertheless consume resources.

Of course, emigration may contribute to the initial short period of decline in relative cohort size in these countries, since immigrants are traditionally drawn from the younger age groups of adults, but it cannot explain the subsequent sharp *increase* in RCS. It is more likely that any tendency toward an increase in the RCS promotes internal and external political strife leading to increased mortality among young adults, especially in countries with weak and/or corrupt governments. This hypothesis is maintained by many theorists who have demonstrated a strong correlation between cycles of population growth and warfare, such as Goldstein (1988).

But we will return to this question of emigration as a "release valve" encouraging high fertility, later in this paper. For now we will simply examine the effects on fertility, of increases in RCS when they *do* occur.

The very pronounced relationship between relative cohort size and the Total Fertility Rate is evident both in the aggregate and in country-specific data, even using data reported at five-year intervals. Figure 10 presents graphs for a selection of Third World nations around the globe, where we can see what will emerge as a characteristic relationship. We see Total Fertility Rates which are constant or even increasing until relative cohort size begins to increase: at that point, the Total Fertility Rate begins to decline. Although the trend in infant mortality might affect the overall rate of decline, the *pattern* of decline and its point of initiation seem in all cases to be set by the trend in relative cohort size.

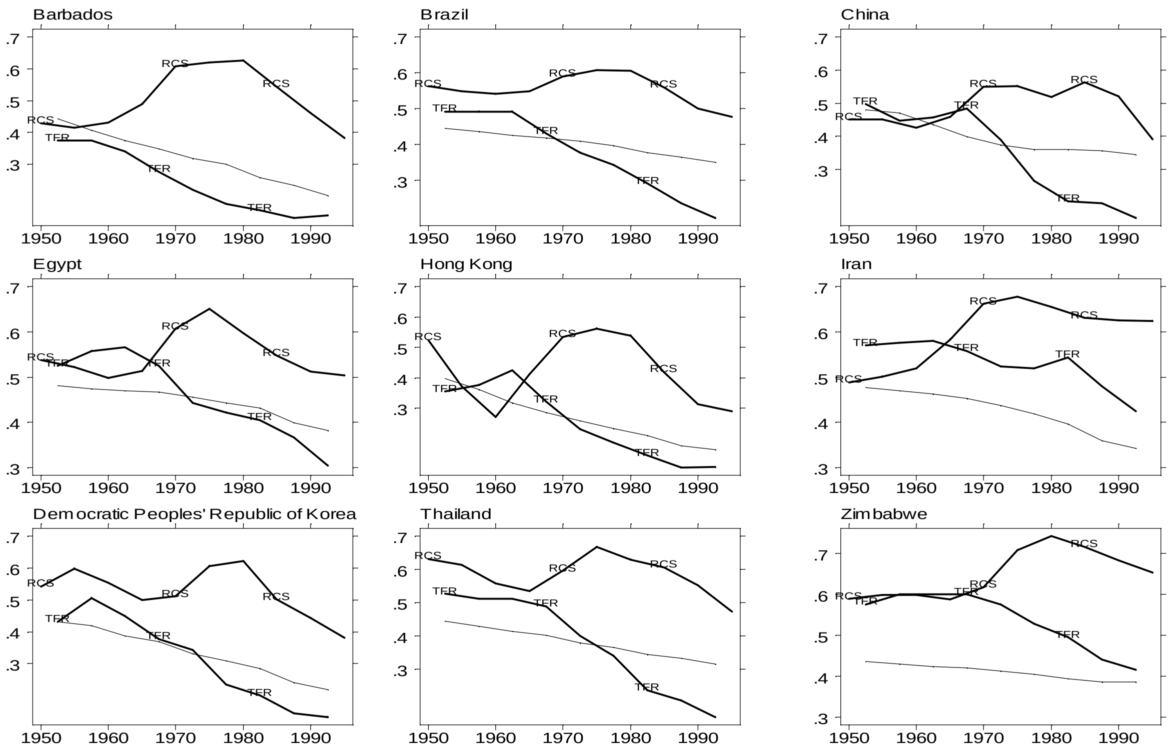

Figure 10: The relationship between the Total Fertility Rate (TFR), relative cohort size (RCS), and infant mortality (the unmarked solid line) in various individual countries, 1950 to 1995.
(Source: World Population Prospects, the 1998 revision, United Nations: New York, 1998. RCS = ratio of population aged 15 to 24 to population aged 25 to 59; TFR has been scaled by dividing by 12.5; infant mortality (in deaths per 1000) has been scaled by logging and dividing by 11)

This relationship has been demonstrated around the globe, in country after country both small and large, regardless of religious or political orientation. Figure 11 shows that it emerges even at the regional level, in all developing parts of the world. It is important to note that the characteristic shape evident in these graphs is not a statistical artifact: the relative cohort size variable used here is calculated relative only to *prime aged adults*, not to the total population—thus RCS is not increasing as a result of the decline in the proportion of children.

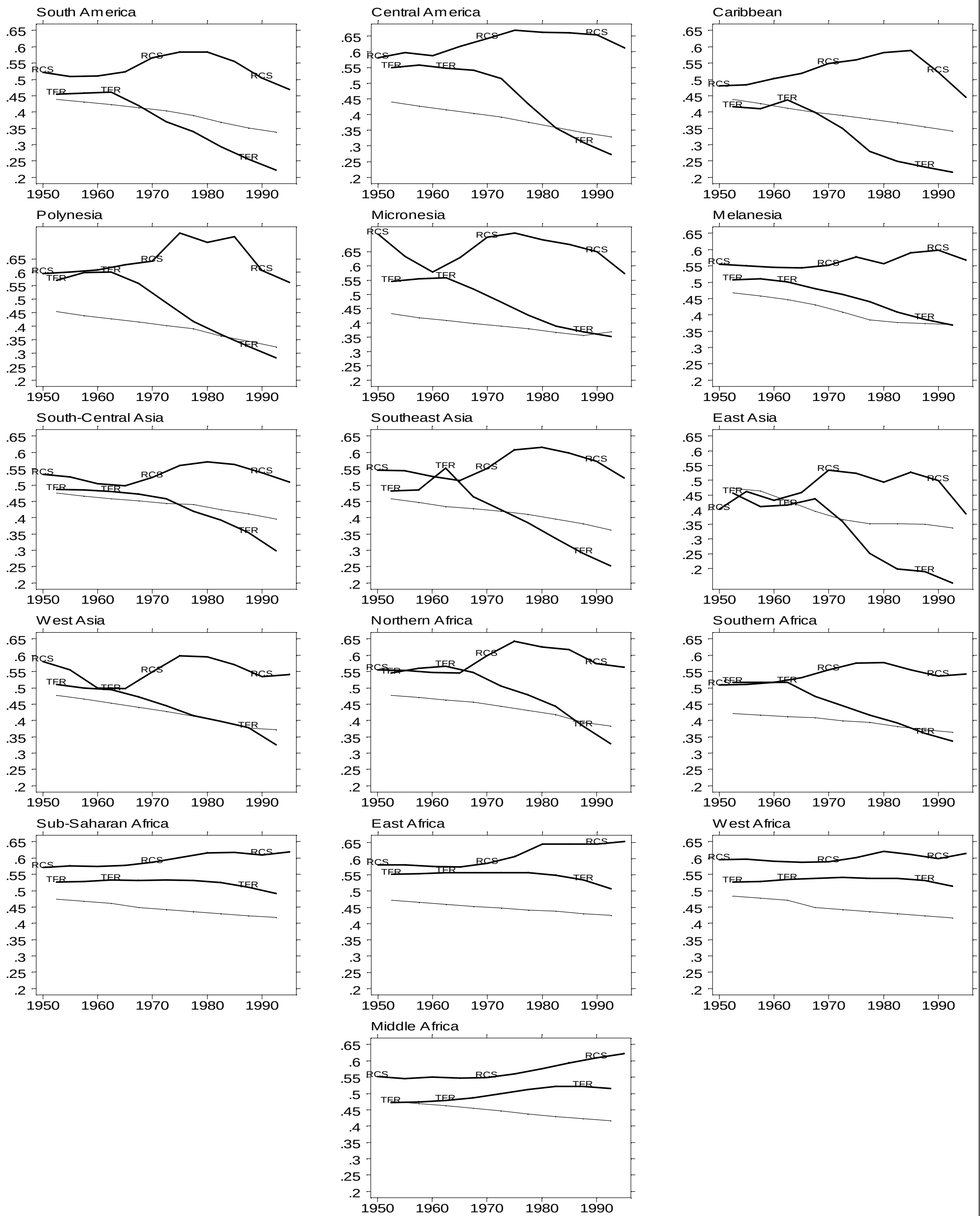

Figure 11: The relationship between the Total Fertility Rate (TFR), relative cohort size (RCS), and infant mortality (the unmarked solid line) in developing regions of the world, 1950-1995.
(Source: World Population Prospects, the 1998 revision, United Nations: New York, 1998.
RCS = ratio of population aged 15-24 to population aged 25-59;
TFR has been scaled by dividing by 12.5;
infant mortality (in deaths per 1000) has been scaled by logging and dividing by 11)

(Scaled) infant mortality rates are also presented in Figures 10 and 11, and although not immediately obvious because of the scaling, the levels vary widely from country to country, both at the point of initiation of fertility decline, and throughout its full extent. Thus, in Table 1 for example, the transition in Hong Kong did not begin until infant mortality was down to 33, while in Egypt it began at the very high level of 175. And although Brazil and Iran exhibit very similar infant mortality rates in 1990 to 95 (47 and 43, respectively), the TFR in Iran (5.3) is more than twice that in Brazil (2.44).

Country	**Infant Mortality Rates**		
	1950-55	*1990-95*	*at the start of the fertility transition*
Barbados	132	9	87
Brazil	135	47	109
China	195	44	81
Egypt	200	67	175
Hong Kong	79	6	33
Iran	190	43	78
North Korea	115	24	58
Thailand	132	32	84
Zimbabwe	120	70	101

Table 1: Infant mortality rates (deaths per 1000 live births) in countries presented in Figure 10.

One should also note other aspects of the diversity among the nine countries in Figure 10. Population size (in 1995) ranged from only 260,000 in Barbados, to 1.2 billion in China. Hong Kong is only a city-state and Barbados only an island, as compared with the large geographic areas of the other seven countries. Iran is a predominately Muslim nation, while Brazil has large proportions of Roman Catholics. China and North Korea are not free-market economies—yet they still exhibit this characteristic pattern. China is now famous—or infamous—for its draconian “one child” policy, and many demographers and environmentalists tend to credit that policy with China’s dramatic fertility decline. However, several recent studies have indicated that the decline began—at least in urban areas—prior to that policy,[5] and the data presented here suggest that the underlying motivation for such an urban fertility decline was the increase in relative cohort size.

Macunovich (1999c) presents graphs like those in Figures 10 and 11 for all of the 136 countries which had not experienced a fertility transition prior to 1950. Nearly all have by now begun the transition, and conform with the pattern discussed above. A few have not yet experienced any fertility decline, but many appear to be on the threshold.

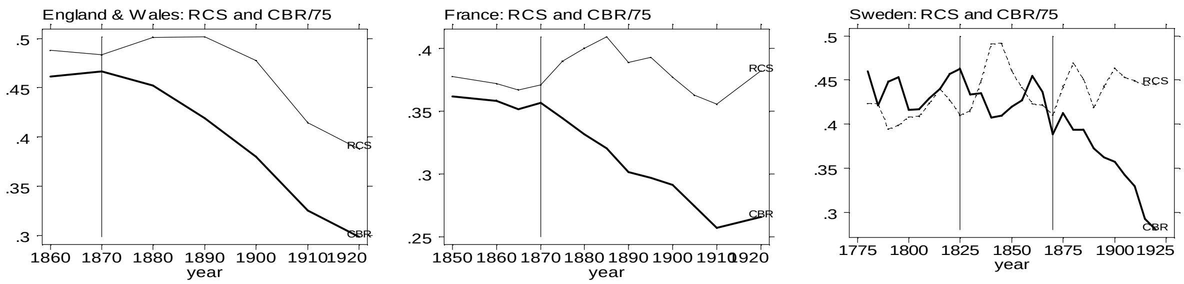

Figure 12: Relative cohort size and the crude birth rate during the fertility transition in England and Wales, France and Sweden. *(Crude birth rate is births per 1000 population, but is scaled by dividing by 75. Relative cohort size is the population aged 15 to 24 relative to the population aged 25 to 59. Source: Keyfitz and Flieger, 1968).*

In addition, Keyfitz and Flieger (1968) provide historical data for three of the currently industrialized nations around the time of their own fertility transitions: Sweden, France, and England and Wales. Although they do not provide the TFR, unfortunately, they do provide information on age composition, together with the crude birth rate (births per 1000 population). These data are presented in Figure 12: although not as conclusive, perhaps, as the patterns exhibited in most of the currently developing countries, these graphs do demonstrate a similar tendency for the fertility transition to begin just at the point where relative cohort size starts to increase. Only decennial observations are available for England and Wales, so it's possible we miss some of the increase there, but we see a decided increase in RCS in France. Sweden experienced a sharp jump in RCS after 1825 which seemed to initiate a tendency for fertility to decline, but this was followed by an equally sharp drop in RCS which generated some recovery in fertility, so that the real fertility transition only occurred after 1870—when RCS increased once again

Statistical Tests

For those who are uncomfortable with a simple visual analysis of the relationship between RCS and fertility, we can use regression analysis to determine whether the apparent relationship is statistically significant. The model we wish to test is very simplistic, containing only RCS and infant mortality as explanatory variables, in attempting to explain the trend in the total fertility rate (TFR). In order to control for the many other factors which are thought to play a role in fertility determination, we can include a lag of TFR itself, which contains information about these other factors. That is, the value of the TFR in time *t-1* is used as another variable in explaining the TFR in time *t*. This is a very stringent test, and we will see that infant mortality often loses its significance under these circumstances—but the estimated effect of RCS remains quite strong.

Relative Cohort Size	**-1.355** -0.189 (-8.0)
infant mortality	**0.276** *0.090* *(3.1)*
lagged TFR	**0.371** *0.374* *(7.0)*
No. of obs	**1316**
adj R-sq	**0.3385**

The dependent variable is the first difference of the Total Fertility Rate (TFR).
All independent variables are expressed as first differences.
t-statistics are italicized in parentheses , and normalized coefficient estimates are in italics.

Table 2: Estimation of the effect of relative cohort size and infant mortality on the Total Fertility Rate in 189 countries between 1950 and 1995, using OLS regression.

Another hurdle has been created in the tests conducted here, by examining only *changes* in TFR, RCS and infant mortality. This has the effect of removing any possible relationship flowing *from* past values of fertility and infant mortality *to* RCS, since generally we would expect to see lower RCS when fertility is low and infant mortality is high. These changes in the value of each variable are calculated as what are termed “first differences” by subtracting the value of each variable in time *t-1* from its value in time *t*.

Table 2 provides an abbreviated version of the results of this type of regression analysis, with a more complete set of results in Appendix Table A1. The results in Table 2 are the estimated effects of RCS and infant mortality on the TFR when we include *all* of the 189 countries in the United Nations data—the forty members of the "early transition" group like the United States together with Third World countries. Even though the lagged TFR exerts a very strong effect, RCS maintains a very significant estimated coefficient which is more than *twice* the absolute magnitude of the estimated (standardized) coefficient on infant mortality (-0.189 and 0.090, respectively).

Appendix Table A2 presents similar results for various subsets of the United Nations data: four groups of countries based on their fertility levels in 1950 to 55—from high (greater than 6.5 births per woman) to low (3.5 births per woman or less)—and nine groups of countries by geographical region. It can be seen in Table A2 that, in all cases except two "outlier" countries—Niger and Cape Verde in Western Africa—RCS exhibits the expected significant negative effect on TFR. Infant mortality, on the other hand, retains its positive statistical significance in only *4* of the 13 regressions presented in Table A2.

Probably the most significant aspect of relative cohort size with respect to fertility, however, is its apparently unique identification of the *turning point* when the transition is initiated, which is so evident throughout the graphs presented here and in Macunovich (1999c).

Asymmetric Effects of Relative Cohort Size on Fertility

But many readers will have noted the fact that the TFR in all countries continues to decline, once it has started the transition, despite a subsequent *decrease* in RCS. Aren't the effects of RCS on fertility supposed to be symmetrical, with an increase causing the TFR to decline and a decrease causing it to rise? That has been the expectation among academics who have tested for cohort size effects on fertility in the more-developed nations (as reported in Macunovich 1997).

This is a very important point, because it bears directly upon Neo-Malthusian arguments such as those of Abernethy (1996), who maintain that the United States and other developed countries should close their doors to migrants from, and restrict financial aid to, developing nations in order to avoid opening an "escape hatch" which only encourages higher fertility among those remaining in the developing countries. Emigrants are drawn preponderantly from the younger adult age group, so that their exit must surely reduce relative cohort size in the originating country. Why don't we observe fertility *increasing again* in countries, once relative cohort size begins to abate?

But as emphasized in Macunovich (1999a), relative cohort size effects on *relative income* are not symmetrical, because of differential aggregate demand effects on the leading and lagging edges of a baby boom—thus we should not expect them to be symmetrical in terms of fertility. Even if decreasing relative cohort size exerts a positive effect on fertility, that positive force is counteracted to some extent by the depressing effect of the economic slowdown induced by declining cohort size. In addition, it seems likely that the awareness of fertility control brought about in the fertility transition by increasing relative cohort size has a cumulative "snowball" or "cascade" effect, as declining average family size reinforces a society's acceptance of smaller numbers of children. That strong negative "cascade" effect would also counteract any positive effect on fertility, of declining relative cohort size.

We can test for this type of asymmetry econometrically using the 1998 United Nation population and fertility data, with an approach similar to the one adopted for relative income in Macunovich (1998a, 1999a, 1999b): we can look at the effect of the *rate of change* in relative cohort size, as well as the effect of relative cohort size itself. The hypothesis is that a positive rate of change will tend to slow the decline in fertility when cohort size is rising, while a negative rate of change will tend to dampen fertility increases when cohort size is declining.

Our measure of the rate of change in RCS is very crude, however, since we have only quinquennial observations between 1950 and 1995, and we hypothesize that any economic slowdown results not so much from *declining relative cohort size*, as from the *transition to decline* and its effect on expectations and business investment. Five yearly observations give us only a very weak identification of that point of transition.

Despite the weakness in our measure of change in cohort size, however, we find fairly strong and significant effects of a change variable, with the expected positive sign, as demonstrated in Table 3. Table 3 repeats the results which were presented in Table 2, and adds in the second column a set of results in which the basic model is supplemented with an RCS change variable. The second column in Table 3 is, once again, an abbreviated version of regression results which are presented in full in the Appendix—this time in Table A3.

RCS	**-1.355**	**-2.038**
	-0.189	*-0.285*
	(-8.0)	*(- 8.3)*
RCS change		**1.100**
		0.176
		(4.5)
infant mortality	**0.276**	**0.291**
	0.090	*0.095*
	(3.1)	*(3.3)*
lagged TFR	**0.371**	**0.311**
	0.374	*0.314*
	(7.0)	*(6.6)*
No. of obs	**1316**	**1316**
adj R-sq	**0.3385**	**0.3464**

The dependent variable is the first difference of the Total Fertility Rate (TFR).
All independent variables are expressed as first differences.
t-statistics are italicized in parentheses, and normalized coefficient estimates are in italics.

Table 3: Estimation of asymmetric effects of relative cohort size and infant mortality on the Total Fertility Rate in 189 countries between 1950 and 1995, using OLS regression.

In this extended model, the positive effect of the lagged TFR supports the idea of a "cascade" effect on social norms regarding fertility during the transition, with the declining fertility rate in past years exerting a strong influence on fertility in subsequent years. This cascade effect together with the asymmetry of the relative cohort size effect accounts for the continuing decline of the TFR even once RCS has begun to decline in these developing nations.

This highlights a point which should be emphasized: as indicated in the graphs presented here and in Macunovich (1999c), countries do not reverse direction once the RCS-induced fertility transition has begun. Apart from Cambodia and East Timor, where mass killings rather than an actual fertility transition produced substantial changes in TFR and RCS in the late 1970s, there is not a single case in the 136 countries presented in Macunovich (1999c) in which the TFR *increases again* once a country has embarked on the fertility transition, at least until that country's TFR has dipped below 2.0.

It appears that there are two completely separate regimes, pre- and post-transition, with fluctuations occurring *within* each of those regimes—but never leading to switching from the low back toward the high regime. Thus the instances often cited by Abernethy (1993, 1994a, 1994b, 1996), in which increasing income leads to increases in fertility, are simply cases of fluctuations *within the pre-transition regime*, rather than the implied reversals of the fertility transition.

What Are the Effects of Migration on Fertility?

To what extent does emigration act as a "release valve" for "excess population pressure" in developing countries, thereby leading to increased world population growth, as maintained by Abernethy (1996)? We have seen that increasing relative cohort size apparently creates the motivation for fertility control which initiates fertility transition. And country after country since 1950 provide historical evidence that the fertility transition, once initiated in a country, has never been reversed. However, it seems sensible to assume that emigration, drawn primarily from the younger age groups, will lower relative cohort size and thus reduce the motivation for fertility control—thus perhaps slowing the fertility transition, even if not reversing it.

However, the regression results presented in Appendix Table A1 indicate that there are strong relative cohort size effects on fertility *in all countries* regardless of initial fertility levels—even in the industrialized countries which receive the majority of immigrants from the Third World. Thus, there must be some fertility *decline* in the receiving nations which will to some extent counterbalance the fertility *increase* in the sending nations. This effect on fertility in the destination country has been postulated by economists such as Kuznets (1958), Easterlin (1968) and Berry (1996) to have occurred during the period of heavy migration to the United States at the turn of the century. We can use our regression results to estimate the relative size of these effects.

Table 4 presents the results of simulations, based on the regression model presented in column 2 of Table 3 and columns 6 to 10 of Appendix Table A3, in which it is assumed that one percent of the young adults in a given Third World nation emigrate to the United States. This migration has the effect of reducing relative cohort size in the sending country—thus raising the

(1) Year	(2) number of 15-24 year olds who migrate	(3) number of births removed from LDC	(4) number of new births generated in LDC	(5) number of births foregone in US	(6) net change in total births	(7) additional births lost if migrants reduce fertility	(8) migrants' TFR in LDC
			(all numbers in thousands)				
Bangladesh:							
1965	90	302	76	-89	**-13**	**-152**	6.68
1975	113	397	98	-113	**-14**	**-283**	7.02
1985	169	520	147	-170	**-22**	**-366**	6.15
1995	204	347	183	-206	**-22**	**-137**	3.40
Egypt:							
1965	44	158	21	-44	**-22**	**-84**	7.07
1975	64	179	31	-64	**-32**	**-113**	5.53
1985	83	210	42	-83	**-40**	**-134**	5.06
1995	103	195	56	-103	**-47**	**-90**	3.80
Ethiopia:							
1965	46	159	37	-45	**-8**	**-82**	6.90
1975	58	197	48	-57	**-9**	**-138**	6.80
1985	74	257	63	-74	**-10**	**-189**	6.91
1995	90	316	79	-91	**-12**	**-223**	7.00
Indonesia:							
1965	185	503	160	-184	**-24**	**-195**	5.42
1975	212	542	188	-212	**-24**	**-327**	5.10
1985	297	603	268	-298	**-30**	**-333**	4.06
1995	382	553	356	-385	**-28**	**-162**	2.90
India:							
1965	804	2338	671	-798	**-127**	**-1006**	5.81
1975	1004	2726	866	-1000	**-134**	**-1712**	5.43
1985	1336	2987	1174	-1342	**-168**	**-1770**	4.47
1995	1650	2797	1510	-1665	**-154**	**-1105**	3.39
Iran:							
1965	36	130	30	-35	**-5**	**-71**	7.26
1975	55	180	47	-54	**-7**	**-124**	6.54
1985	77	261	69	-77	**-7**	**-191**	6.80
1995	111	296	107	-112	**-5**	**-181**	5.30
Mexico:							
1965	68	231	61	-67	**-5**	**-119**	6.82
1975	98	320	91	-97	**-6**	**-220**	6.52
1985	139	295	132	-140	**-7**	**-168**	4.24
1995	183	285	177	-184	**-7**	**-97**	3.12
Pakistan:							
1965	85	297	71	-84	**-13**	**-156**	7.00
1975	120	423	104	-120	**-16**	**-301**	7.00
1985	174	612	153	-175	**-22**	**-452**	7.00
1995	235	707	214	-237	**-23**	**-465**	6.00

One percent of a nation's 15 to 24 year olds are assumed to migrate to the US. This exercise demonstrates

- *(column 4) how many births would be gained among women remaining in the LDC, and*
- *(column 5) how many would be lost among women in the U.S.,*

as a result of relative cohort size change effects on fertility rates in each country.

Column 6 indicates the world's net gain or loss in births as a result of the migration, and column 7 indicates the number of additional births which would be lost if the migrants reduce their fertility to the current United States level.

Calculations are based on the regression results in columns 5 to 10 of Appendix Table A2.

Table 4: Net loss in births resulting from migration between various Third World countries and the U.S., due to relative cohort size effects on fertility levels.

fertility of the young adults who remain behind—and increasing relative cohort size in the United States which in turn lowers fertility there. Table 4 allows us to trace through and estimate the net effect of these movements in a variety of countries with a range of population sizes and fertility rates, in the years 1965, 1975, 1985 and 1995.

As an example, let's look at the case of Bangladesh in 1965 (the top row in Table 4). One percent of the population aged 15 to 24 produces a total of 90,000 migrants (column 2), who at the 1960 to 65 TFR of 6.68 (column 8) would have produced a total of 302,000 children in Bangladesh (column 3), had they remained there.[6] Because the Bangladeshi relative cohort size is reduced by this out-migration, downward pressure on young men's relative wages is relieved and fertility increases, producing 76,000 more surviving births among the young women remaining in Bangladesh, than would otherwise have occurred (column 4).[7]

But in the United States relative cohort size would be increased, reducing young men's relative wages and fertility there by about 89,000 surviving births (column 5). Thus overall—contrary to Dr. Abernethy's fears—in a global sense the number of surviving births would have been *reduced by about 13,000* (column 6) as a result of this migration to the United States In addition, since her stated concern is with overcrowding in Bangladesh as a result of high rates of population growth, it should be noted that there is a *net reduction in Bangladesh's total population as a result of this out-migration, of about 316,000 persons* (adding together columns 2 and 3 and subtracting column 4).

And those who might be concerned about a welfare reduction among young adults in the United States, caused by the decline in relative income, may be reassured to note that the reduction is almost certainly only in *relative* terms. Economists such as Simon Kuznets (1958) have identified

(1) Scenario	(2) number of 15-24 year olds who migrate	(3) number of births removed from LDC	(4) number of new births generated in LDC	(5) number of births foregone in US	(6) net change in total births	(7) additional births lost if migrants reduce fertility	(8) migrants' TFR in LDC	(9) migrants' TFR needed for balance
			(all numbers in thousands)					
Bangladesh:								
1	204	347	153	-172	**-18**	**-137**	3.40	.
2			213	-239	**-26**			.
3			183	-206	**-22**			.
4			153	-239	**-85**			.
5			213	-172	**40**			**3.00**
Egypt:								
1	103	195	52	-87	**-34**	**-90**	3.80	.
2			59	-120	**-61**			.
3			56	-103	**-47**			.
4			52	-120	**-68**			.
5			59	-87	**-27**			.
Ethiopia:								
1	90	316	66	-76	**-10**	**-223**	7.00	.
2			92	-105	**-13**			.
3			79	-91	**-12**			.
4			66	-105	**-39**			.
5			92	-76	**15**			**6.66**
Indonesia:								
1	382	553	298	-323	**-24**	**-162**	2.90	.
2			414	-447	**-33**			.
3			356	-385	**-28**			.
4			298	-447	**-149**			.
5			414	-323	**91**			**2.42**
India:								
1	1650	2797	1265	-1395	**-129**	**-1105**	3.39	.
2			1754	-1934	**-179**			.
3			1510	-1665	**-154**			.
4			1265	-1934	**-669**			.
5			1754	-1395	**359**			**2.95**
Iran:								
1	111	296	89	-94	**-4**	**-181**	5.30	.
2			124	-131	**-6**			.
3			107	-112	**-5**			.
4			89	-131	**-41**			.
5			124	-94	**29**			**4.77**
Mexico:								
1	183	285	177	-154	**22**	**-97**	3.12	**2.88**
2			177	-214	**-37**			.
3			177	-184	**-7**			.
4			177	-214	**-37**			.
5			177	-154	**22**			**2.87**
Pakistan:								
1	235	707	179	-199	**-19**	**-465**	6.00	.
2			248	-276	**-27**			.
3			214	-237	**-23**			.
4			179	-276	**-96**			.
5			248	-199	**49**			**5.58**

This Table presents the same type of information as in Table 4, but here we have results in 1995 under five scenarios regarding the rate of change in the flow of migration between the LDC and the United States (actually the rate of change of the change in relative cohort size).

- *Scenario 1 assumes that the flow is* ***increasing*** *both for the LDC and the U.S.*
- *Scenario 2 assumes that the flow is* ***decreasing*** *both for the LDC and the U.S.*
- ***Scenario 3*** *assumes a* ***steady state*** *in the flow of migrants (so that the rate of change in the flow is zero).* ***This is the scenario presented in full in Table 4.***
- *Scenario 4 assumes that the flow is* ***increasing*** *in the LDC and* ***decreasing*** *in the U.S.*
- *Scenario 5 assumes that the flow is* ***decreasing*** *in the LDC and* ***increasing*** *in the U.S.*

Column 9 indicates, where appropriate, the TFR which the migrants would have to achieve in the United States in order to balance any overall net gain in births resulting from the migration.

Table 5: A comparison of net births which would have occurred as a result of changing relative cohort size in 1995 in a range of migration scenarios.

strong positive aggregate demand effects of immigration which overall would act as a spur to economic growth and thus tend to *increase* average wages among United States residents as a whole.

But what of the fertility of the migrants themselves? If they had remained in Bangladesh they would have produced about 302,000 births. If, on the other hand, their fertility were to fall to the 1965 United States level, 152,000 of those births would be averted (column 7)—thus as many as *165,000 births might have been averted in total as a result of the migration (adding columns 6 and 7).*

There is considerable evidence in the literature that immigrants do reduce their fertility once in the United States For example, Blau (1992) analyzed fertility among immigrant women from 35 high fertility countries in 1970 and 1980 and found that

> "immigrants from these on average high-fertility source countries [average TFRs in excess of 5.5] were found to have very similar unadjusted fertility to native-born [United States]women. The number ever born was 0.07 lower for immigrants than natives in 1970 and only 0.18 higher in 1980."

She found that immigrant women have 0.2 to 0.5 *fewer children* than native women with similar characteristics, and suggests that a primary reason for their dramatic fertility reduction was the *strong price effect of women's wages among immigrants*, which was about 50 percent higher than among native-born women. [8]

However, the results in Table 4 assume a steady state in terms of the flow of migrants between these countries and the United States; that is, it is assumed that our RCS change variable in Table 3 is equal to zero. How would these results be altered under different assumptions? If the RCS change variable were positive in the United States, for example, economic conditions would be somewhat improved, so that fertility would not be reduced as greatly as estimated in Table 4.

Table 5 presents a comparison of results under five different assumptions regarding the rate of change in the immigration flow (and hence in the increase or decrease in relative cohort size in each country).

- Scenario 1 assumes that the flow is **increasing** both for the LDC and the United States.
- Scenario 2 assumes that the flow is **decreasing** both for the LDC and the United States.
- Scenario 3 assumes a **steady state** in the flow of migrants (so that the rate of change in the flow is zero). **This is the scenario presented in full in Table 4.**
- Scenario 4 assumes that the flow is **increasing** in the LDC and **decreasing** in the United States.
- Scenario 5 assumes that the flow is **decreasing** in the LDC and **increasing** in the United States.

The last is the "worst case" scenario, since it produces the lowest tendency for fertility reduction in the United States, and the strongest increase in fertility among women remaining in the source country. Thus in this one scenario we see in many instances an overall *net gain* in births as a result of the migration. In the case of Bangladesh, for example, there would be a net gain of 40,000 births in 1995. But remember that this is a net gain *under the assumption that the migrants do not reduce their fertility at all* when they come to the United States We know that this is a highly unlikely situation, and columns 8 and 9 in Table 5 indicate that the Bangladeshi immigrants would only need to reduce their fertility from the 3.40 level in Bangladesh in 1995, to about 3.00 when they are in the United States, in order to cancel out the 40,000 net gain in births resulting from their migration. None of the required reductions indicated in Table 5 seem unreasonable, and in many cases they are almost negligible.

In addition, we must take into consideration the low probability associated with scenario five. In order for the flow to be increasing in the United States but decreasing in Bangladesh, for example, immigration to the United States from some other country would have to be on the increase, so that a more complete analysis would reveal a *net loss* of births due to the flow between the United States and the second LDC, which would probably counterbalance the net gain observed between the United States and Bangladesh.

As a result, the most likely scenarios in Table 5 are numbers 1 through 3, which in almost all cases produce unequivocal net reductions in global births. In results not presented here, this type of simulation has been conducted using all of the alternative regression results presented in Tables A1 to A3, and under varying assumptions regarding the level of migration—assuming, for example, a fixed migration of 100,000 from each country to the United States Although the magnitude of the loss of births varies with these assumptions and models, the end result remains unchanged in that there is a *net loss of births* in virtually all cases, even if the migrant women maintain their native Total Fertility Rates once they arrive in the United States.

One final issue raised by Neo-Malthusians should be addressed with regard to the relative income effect on fertility in developing countries. It has been suggested that immigrant remittances from the United States—money sent back to relatives in source countries—will tend to increase fertility in these countries. Here again, however, one must consider the counterbalancing *reduction* in fertility among the immigrants themselves in the United States, which would occur if they were to send remittances out of their own income.

Thus, we appear to get the best of all possible outcomes with migration: population is reduced in "overcrowded" Bangladesh, total world population growth is substantially reduced, and upwards of 150,000 children (adding columns 3 and 7 in Table 4) are given the opportunity of growing up with all the educational and health advantages of United States residents.

There are, of course distributional issues involved here, in that some 89,000 births which would have occurred to United States residents in 1965 in the first row of Table 4 have been "replaced" by migration. But this is more an ethical than an economic question—one which requires soul-searching on our part, if we feel that a birth to a current United States resident should be preferred over a birth to a new resident. For those whose concern is with reducing total world population growth and alleviating the pressures of rapid population growth in the Third World, migration appears to offer a very effective solution.

Conclusions

We have seen in this analysis that changes in relative cohort size are important in determining the pattern of fertility—not just in developed countries, as demonstrated in Macunovich (1996, 1998), but perhaps even more importantly in countries as they pass through the demographic transition. The increase in relative cohort size which occurs as a result of declining mortality rates during the demographic transition, acts as the mechanism of transmission which determines *when* the fertility portion of the transition begins. The increasing proportion of young adults generates a downward pressure on young men's relative wages, which in turn causes young adults to accept a trade-off between family size and material well-being, setting in motion a "cascade" or "snowball" effect in which total fertility rates tumble as social norms regarding acceptable family sizes begin to change.

Paradoxically, however, despite the importance of relative cohort size in determining fertility levels, out-migration from currently developing countries experiencing the fertility transition does not increase the overall level of births, even though it does relieve population pressure there. This is due to the fact that the relative cohort size mechanism operates in countries *receiving* migrants, as well, so that an influx of migrants increases cohort size and reduces fertility among the residents there.

Simulations based on regression results for 189 nations over a 45 year period indicate that the net result of such migration is a *reduction* in the global number of births. This overall reduction in births occurs even if new migrants maintain the fertility rate typical of their source countries.

Thus, relative cohort size can be thought of as the mechanism which prevents excessive rates of population change—reducing fertility when previous high rates, in combination with low mortality rates, have caused relative cohort size to increase, and increasing fertility when previous low rates have caused relative cohort size to decline. The only “spanner in the works” is the possibility of institutions which prevent the transmission of relative cohort size effects to male relative income, and thus to fertility.

KEY TO REGIONAL GROUPINGS OF COUNTRIES:

FIRST WORLD:

North America:
- USA
- Canada

Oceania:
- Australia
- New Zealand

Western Europe:
- Austria
- Belgium
- France
- United Germany
- former West Germany
- Luxembourg
- Netherlands
- Switzerland

Northern Europe:
- Denmark
- Finland
- Iceland
- Ireland
- Norway
- Sweden
- UK

Southern Europe:
- Albania
- Greece
- Spain
- Portugal
- Malta
- Italy

SECOND WORLD:
- Belarus
- Bosnia Herzegovina
- Bulgaria
- Croatia
- Czechoslovakian Republic
- Estonia
- Georgia
- German Democratic Republic
- Hungary
- Latvia
- Lithuania
- Moldova
- Poland
- Romania
- Russian Federation
- Slovakia
- Slovenia
- Ukraine
- former Czechoslovakia
- former USSR
- former Yugoslavia
- former Yugoslav Rep.of Macedonia

South America:
- Argentina
- Bolivia
- Brazil
- Chile
- Colombia
- Ecuador
- Guyana
- Paraguay
- Peru
- Suriname
- Uruguay
- Venezuela

Central America & the Caribbean:
- Belize
- Costa Rica
- El Salvador
- Guatemala
- Honduras
- Mexico
- Nicaragua
- Panama

Caribbean:
- Bahamas
- Barbados
- Cuba
- Dominican Republic
- Guadeloupe
- Haiti
- Jamaica
- Martinique
- Netherlands Antilles
- Puerto Rico
- Trinidad and Tobago

East, SE and South-Central Asia:

East Asia:

China
Dem.Peoples' Rep.of Korea
Hong Kong
Japan
Macau
Mongolia
Rep. Of Korea

SE Asia:

Brunei
Cambodia
East Timor
Indonesia
Lao
Malaysia
Myanmar
Philippines
Singapore
Thailand
Viet Nam

Pacific Islands:

Fiji
New Caledonia
Papua New Guinea
Solomon Islands
Vanuatu
Guam
French Polynesia
Samoa

South-Central Asia

Afghanistan
Bangladesh
Bhutan
India
Iran
Kazakstan
Kyrgyzstan
Maldives
Nepal
Pakistan
Sri Lanka
Tajikistan
Turkmenistan
Uzbekistan

West Asia & North Africa:

West Asia:

Armenia
Azerbaijan
Bahrain
Cyprus
Gaza Strip
Iraq
Israel
Jordan
Kuwait
Lebanon
Oman
Qatar
Saudi Arabia
Syrian Arab Republic
Turkey
United Arab Emirates
Yemen

North Africa:

Algeria
Egypt
Libyan Arab Republic
Morocco
Sudan
Tunisia
Western Sahara

Middle, West & Southern Africa

Middle Africa:

Angola
Cameroon
Central African Republic
Chad
Congo
Dem. Rep. Of the Congo
Equatorial Guinea
Gabon

Western Africa:

Benin
Burkina Faso
Cape Verde
Cote d'Ivoire
Gambia
Ghana
Guinea
Guinea-Bissau
Liberia
Mali
Mauritania
Niger
Nigeria
Senegal
Sierra Leone

Togo

Southern Africa:

Botswana
Lesotho
Namibia
South Africa
Swaziland

<u>Eastern Africa</u>

Burudi
Comoros
Djibouti
Eritrea
Ethiopia
Kenya
Madagascar
Malawi
Mauritius
Mozambique
Reunion
Rwanda
Somalia
Uganda
United rep. Of Tanzania
Zambia
Zimbabwe

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Full Model with All Interactions				Parsimonious Model			
	Relative Cohort Size	*Lagged TFR*	*Infant Mortality*	*Intercept*	*Relative Cohort Size*	*Lagged TFR*	*Infant Mortality*	*Intercept*
Basic model	**-1.884**	0.373	0.132	-0.071	**-1.355**	**0.371**	**0.276**	**-0.057**
(First World)	***-0.263***	*0.376*	*0.043*		***-0.189***	*0.374*	*0.090*	
	(-2.7)	*(3.9)*	*(0.6)*	*(-1.3)*	***(-8.0)***	*(7.0)*	*(3.1)*	*(-2.2)*
regional interactions:								
South America	-0.177	-0.265	0.254	0.006		**-0.170**		
	-0.006	*-0.089*	*0.029*	*0.004*		*-0.057*		
	(-0.2)	*(-1.7)*	*(0.5)*	*(0.1)*		*(-2.2)*		
Central America & Caribbean	0.828	-0.226	0.445	0.055		**-0.113**		
	0.041	*-0.104*	*0.082*	*0.044*		*-0.052*		
	(0.9)	*(-1.6)*	*(1.0)*	*(0.6)*		*(-1.8)*		
East, SE & South-Central Asia	1.083	-0.392	0.449	0.032		**-0.270**		
	0.089	*-0.267*	*0.108*	*0.034*		*-0.184*		
	(1.3)	*(-3.1)*	*(1.2)*	*(0.4)*		*(-5.3)*		
West Asia & North Africa	1.048	-0.030	0.240	0.134				
	0.068	*-0.012*	*0.048*	*0.118*				
	(1.1)	*(-0.2)*	*(0.6)*	*(1.4)*				
East Africa	0.566	0.068	0.051	0.176				**0.121**
	0.013	*0.015*	*0.004*	*0.129*				*0.089*
	(0.4)	*(0.4)*	*(0.1)*	*(1.8)*				*(3.5)*
Middle, West & Southern Africa	1.255	0.101	0.794	0.601			**0.565**	**0.532**
	0.029	*0.021*	*0.102*	*0.163*			*0.073*	*0.144*
	(0.9)	*(0.6)*	*(1.7)*	*(2.2)*			*(2.0)*	*(2.1)*
Niger & Cape Verde	4.407	-0.681	6.646	0.280	**4.033**	**-0.655**	**6.432**	**0.240**
	0.128	*-0.091*	*0.178*	*0.263*	*0.117*	*-0.088*	*0.172*	*0.225*
	(3.3)	*(-2.4)*	*(2.3)*	*(3.1)*	*(4.0)*	*(-2.6)*	*(2.3)*	*(6.2)*
Second World	0.969	-0.494	-0.009	-0.034		**-0.424**		
	0.042	*-0.135*	*-0.002*	*-0.029*		*-0.116*		
	(1.2)	*(-3.8)*	*(0.0)*	*(-0.5)*		*(-4.5)*		
fertility-level interactions:								
3.51 - 5.5	-0.815	0.107	-0.038	-0.167				**-0.163**
	-0.063	*0.061*	*-0.009*	*-0.161*				*-0.157*
	(-1.0)	*(0.8)*	*(-0.1)*	*(-2.1)*				*(-5.6)*
5.51 - 6.5	-0.573	0.343	-0.947	-0.248		**0.261**	**-0.696**	**-0.213**
	-0.038	*0.207*	*-0.217*	*-0.291*		*0.158*	*-0.159*	*-0.250*
	(-0.6)	*(2.5)*	*(-2.5)*	*(-2.9)*		*(4.4)*	*(-3.8)*	*(-5.7)*
>6.5	0.155	0.407	-0.071	-0.152		**0.384**		**-0.097**
	0.013	*0.264*	*-0.017*	*-0.192*		*0.249*		*-0.123*
	(0.2)	*(2.9)*	*(-0.2)*	*(-1.8)*		*(6.5)*		*(-3.5)*
Number of obs				1316				1316
F-Statistic				15.55				34.65
Adjusted R-square				0.3422				0.3385

[*]excluding Niger and Cape Verde
Dependent variable is the year-to-year change in the Total Fertility Rate (TFR).
Relative Cohort Size is the ratio of population aged 15-24 to those aged 25-59.
All variables expressed as first differences.
t-statistics in italics and parentheses, standardized coefficients in italics below estimated coefficients.

Appendix Table A1: Estimated effects of a change in Relative Cohort Size (RCS) on the Total Fertility Rate (TFR) in 189 countries between 1950-1995, using an aggregate time-series cross-section model with full interaction terms for eight regions and three 1950-55 fertility levels.

	(1) Relative Cohort Size	(2) Lagged TFR	(3) Infant Mortality	(4) Intercept	(5) No.of obs (Adj.R-sq)
By Region:					
South America	**-2.041** ***(-2.9)*** -0.286	0.526 *(5.5)* 0.570	-0.043 *(-0.1)* -0.012	-0.221 *(-3.5)*	84 (0.2668)
Central America & Caribbean	**-1.531** ***(-3.0)*** *-0.233*	0.408 *(5.4)* *0.448*	0.262 *(1.0)* *0.079*	-0.213 *(-3.6)*	133 (0.2335)
East, SE & South-Central Asia	**-1.352** ***(-3.1)*** *-0.185*	0.258 *(4.5)* *0.264*	0.077 *(0.4)* *0.021*	-0.259 *(-5.6)*	280 (0.0799)
West Asia & North Africa	**-0.947** ***(-2.7)*** *-0.162*	0.728 *(11.3)* *0.669*	0.379 *(2.1)* *0.126*	-0.070 *(-1.7)*	168 (0.4335)
East Africa	**-1.298** ***(-1.6)*** *-0.121*	0.772 *(9.4)* *0.696*	-0.256 *(-0.9)* *-0.064*	-0.072 *(-2.2)*	112 (0.4352)
Middle, West & Southern Africa*	**-1.136** ***(-2.1)*** -0.106	0.796 *(13.5)* 0.727	0.070 *(0.5)* 0.028	-0.026 *(-1.5)*	196 (0.5245)
Niger & Cape Verde	**2.679** ***(2.4)*** *0.555*	0.099 *(0.4)* *0.095*	6.708 *(2.2)* *0.479*	0.378 *(1.3)*	14 (0.5779)
Second World	**-0.978** ***(-2.6)*** *-0.208*	0.033 *(0.5)* *0.039*	0.183 *(1.3)* *0.107*	-0.113 *(-3.6)*	156 (0.0407)
First World	**-2.044** ***(-4.5)*** *-0.294*	0.473 *(7.9)* *0.518*	-0.024 *(-0.1)* *-0.010*	-0.125 *(-3.3)*	173 (0.2963)
By fertility level in 1950-55:					
<= 3.5	**-0.965** ***(-2.7)*** *-0.158*	0.187 *(3.2)* *0.191*	0.137 *(1.2)* *0.073*	-0.085 *(-3.4)*	280 (0.0641)
3.51 - 5.5	**-1.725** ***(-4.5)*** *-0.291*	0.198 *(3.3)* *0.219*	0.567 *(2.6)* *0.170*	-0.137 *(-2.7)*	210 (0.1460)
5.51 - 6.5	**-1.492** ***(-3.6)*** *-0.174*	0.498 *(10.0)* *0.499*	-0.125 *(-0.7)* *-0.037*	-0.156 *(-5.5)*	357 (0.2317)
> 6.5	**-0.668** ***(-2.5)*** *-0.093*	0.661 *(17.2)* *0.637*	0.439 *(3.5)* *0.128*	-0.078 *(-3.5)*	469 (0.4272)

excluding Niger and Cape Verde

Dependent variable is the year-to-year change in the Total Fertility Rate (TFR).

Relative Cohort Size is the ratio of population aged 15-24 to those aged 25-59.

All variables expressed as first differences.

t-statistics in italics and parentheses, standardized coefficients in italics below estimated coefficients.

Appendix Table A2: Estimates for 1950-1995 of the effects of a change in Relative Cohort Size (RCS) on the Total Fertility Rate (TFR) in 189 countries grouped by region and by fertility level in 1950-55.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Full Model with All Interactions					Parsimonious Model				
	Relative Cohort Size	*Change in RCS*	*Lagged TFR*	*Infant Mortality*	*Inter-cept*	*Relative Cohort Size*	*Change in RCS*	*Lagged TFR*	*Infant Mortality*	*Inter-cept*
Basic model (First World)	**-2.805**	**1.806**	0.350	0.162	-0.064	**-2.038**	**1.100**	**0.311**	**0.291**	**-0.057**
	-0.392	*0.289*	*0.353*	*0.053*	.	*-0.285*	*0.176*	*0.314*	*0.095*	.
	(-3.4)	*(2.3)*	*(3.7)*	*(0.7)*	*(-1.2)*	*(-8.3)*	*(4.5)*	*(6.6)*	*(3.3)*	*(-2.2)*
regional interactions:										
South America	0.168	0.277	-0.272	0.194	-0.010			**-0.147**		
	0.005	*0.007*	*-0.091*	*0.022*	*-0.007*			*-0.049*		
	(0.1)	*(0.2)*	*(-1.7)*	*(0.4)*	*(-0.1)*			*(-2.0)*		
Central America & Caribbean	2.024	-2.041	-0.130	0.271	0.044		**-1.096**			
	0.101	*-0.106*	*-0.060*	*0.050*	*0.035*		*-0.057*			
	(1.8)	*(-1.9)*	*(-0.9)*	*(0.6)*	*(0.5)*		*(-2.3)*			
East, SE & South-Central Asia	1.617	-0.976	-0.342	0.408	0.030			**-0.247**		
	0.133	*-0.092*	*-0.233*	*0.098*	*0.032*			*-0.169*		
	(1.5)	*(-1.0)*	*(-2.6)*	*(1.0)*	*(0.3)*			*(-5.5)*		
West Asia & North Africa	2.207	-1.837	0.039	0.129	0.123	**0.840**	**-0.843**			
	0.143	*-0.152*	*0.016*	*0.026*	*0.108*	*0.054*	*-0.070*			
	(2.0)	*(-1.8)*	*(0.3)*	*(0.3)*	*(1.3)*	*(1.7)*	*(-2.0)*			
East Africa	0.728	0.059	0.118	0.002	0.177				**0.120**	
	0.017	*0.001*	*0.026*	*0.000*	*0.130*				*0.088*	
	(0.4)	*(0.0)*	*(0.7)*	*(0.0)*	*(1.8)*				*(3.5)*	
Middle, West & Southern Africa	1.870	-1.049	0.165	0.721	0.562			**0.598**	**0.247**	
	0.043	*-0.025*	*0.035*	*0.093*	*0.152*			*0.077*	*0.232*	
	(1.1)	*(-0.7)*	*(0.9)*	*(1.5)*	*(2.1)*			*(2.2)*	*(6.4)*	
Niger & Cape Verde	3.786	0.814	-0.452	5.576	0.279	**3.966**	**-0.550**	**6.008**	**0.516**	
	0.110	*0.023*	*-0.061*	*0.150*	*0.262*	*0.115*	*-0.074*	*0.161*	*0.140*	
	(2.3)	*(0.6)*	*(-1.6)*	*(2.0)*	*(3.1)*	*(3.9)*	*(-2.2)*	*(2.1)*	*(2.0)*	
Second World	2.412	-2.377	-0.422	-0.144	-0.047	**1.090**	**-1.355**	**-0.375**		
	0.104	*-0.135*	*-0.116*	*-0.029*	*-0.040*	*0.047*	*-0.077*	*-0.103*		
	(2.4)	*(-2.7)*	*(-3.2)*	*(-0.5)*	*(-0.7)*	*(1.6)*	*(-2.5)*	*(-4.1)*		
fertility-level interactions:										
3.51 - 5.5	-1.197	0.445	0.021	0.126	-0.161				**-0.166**	
	-0.093	*0.039*	*0.012*	*0.030*	*-0.156*				*-0.161*	
	(-1.2)	*(0.5)*	*(0.2)*	*(0.4)*	*(-2.1)*				*(-5.7)*	
5.51 - 6.5	-0.468	-0.413	0.304	-0.915	-0.253		**0.266**	**-0.715**	**-0.215**	
	-0.031	*-0.029*	*0.184*	*-0.209*	*-0.297*		*0.161*	*-0.164*	*-0.252*	
	(-0.4)	*(-0.4)*	*(2.2)*	*(-2.3)*	*(-3.0)*		*(4.5)*	*(-3.9)*	*(-5.8)*	
>6.5	-0.086	-0.008	0.363	-0.002	-0.150		**0.407**		**-0.094**	
	-0.007	*-0.001*	*0.236*	*-0.001*	*-0.189*		*0.264*		*-0.118*	
	(-0.1)	*(0.0)*	*(2.5)*	*(0.0)*	*(-1.7)*		*(6.9)*		*(-3.4)*	
Number of obs			1316					1316		
F-Statistic			13.06					28.87		
Adjusted R-square			0.3512					0.3464		

[*]excluding Niger and Cape Verde
Dependent variable is the year-to-year change in the Total Fertility Rate (TFR).
Relative Cohort Size is the ratio of population aged 15-24 to those aged 25-59.
All variables expressed as first differences.
t-statistics in italics and parentheses, standardized coefficients in italics below estimated coefficients.

Appendix Table A3: Estimated effects, allowing for asymmetry, of a change in Relative Cohort Size (RCS) on the Total Fertility Rate (TFR) in 189 countries between 1950-1995, using an aggregate time-series cross-section model with full interaction terms for eight regions and three 1950-55 fertility levels.

Endnotes

1. The precise definition of this important age group remains to be determined by future research. The use of the 15 to 24 age group is dictated here by its availability in historical and international data.

2. There is also an effect of relative cohort size on female wages, as analyzed in Macunovich (1998e) but this is more complex and not as immediately relevant to the present analysis.

3. Male relative income is calculated here as the average annual earnings of young men in their first five years of work experience (no longer enrolled in school), in year *t*, relative to the average annual income of families with head of either sex aged 45 to 54 in year *t-5*.

4. This is unfortunately a fairly crude measure of relative cohort size, since the younger and older members of the 25 to 59 age group are fairly good substitutes for those aged 15 to 24, but it is the only measure permitted by the available data.

5. See, for example, Lavely and Freedman (1990)

6. It's assumed here that there are equal numbers of men and women among the migrants. Even if there were more males than females, fertility would be reduced proportionally among the women remaining behind, by the shortage of male partners.

7. We apply Bangladesh's 1960 to 1965 infant mortality rate of 155 per 1,000 to estimate potential surviving infants.

8. These results correspond with those of other researchers such as Kahn (1988). One must look critically at claims such as the following by Linden (1994): ". . .peasant families tend to have two or three children in Mexico City, while those who immigrate to the U. S. average four or five children." Statements like these often compare apples (average family size of women *of all ages*) and oranges (family size of recent immigrants, who tend to be women *in their peak reproductive years*).

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