

**Stages of the Demographic Transition from a Child's Perspective:  
Family Size, Cohort Size, and Children's Resources**

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**Stages of the Demographic Transition from a Child's Perspective:  
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**David Lam and Leticia Marteleto**

**Abstract:**

This paper provides a new characterization of stages of the demographic transition, describing it from a child's perspective. These stages illustrate the sequence of changes in family and cohort sizes that affect children's resources. In Stage 1, falling mortality produces increases in surviving family size and in the size of birth cohorts. In Stage 2, falling fertility overtakes falling mortality to produce declining family size, but population momentum causes continued growth in cohort size. In Stage 3, falling fertility overtakes population momentum to produce declining cohort size. We examine several countries using this framework. Many developing countries have patterns like Brazil, which entered Stage 2 before 1970, when family size began to fall, and started Stage 3 around 1982, when the largest birth cohort was born. Other countries, like Kenya, have experienced Stage 2, but will not experience the declining cohort size of Stage 3 for at least another decade. By demonstrating how the dynamics of family size and cohort size operate throughout the demographic transition in several developing countries, we shed light into how these movements can affect children's resources and well-being.

## **1. Introduction**

The demographic transition has played itself out with a great deal of regularity in developing countries over the last fifty years. Looking at a broad set of countries, a relatively simple stylized version of the demographic transition is consistent with the empirical experience of most of the developing world. The transition can be thought of as beginning with large and sustained declines in death rates, especially infant and child mortality. The immediate effect of these declines in infant and child mortality is an increase in the number of surviving children at the family level and an increase in the total number of children at the population level. These declines in mortality are eventually followed by the second key element of the transition – a decline in fertility. The timing and pace of this fertility decline has varied considerably across countries, and has provided rich research material for several generations of demographers. These changes in fertility eventually have effects on both family size and the size of cohorts. It is these changes in family size and cohort size over the course of the demographic transition that are the focus of this paper.

The major goal of this paper is to develop a new characterization of stages of the demographic transition, viewing the demographic changes from a child's perspective. We will develop a simple mathematical model of the stages of the demographic transition and demonstrate these stages empirically for six countries. As we will show empirically below, there can be dramatic changes in the numbers of siblings and the size of cohorts along the course of the demographic transition. These changes are not always in the same direction, however, as a result of the complex interaction of population momentum with falling fertility and mortality.

We focus on three stages of the demographic transition from a child's perspective, each with different implications for resource competition at the family and population level. In the first stage of the transition, falling infant and child mortality lead to increasing numbers of surviving children within families and to increases in the size of birth cohorts. This is the stage in which rapid population growth begins, as evidenced at both the family and population levels. In the second stage, falling fertility overtakes falling mortality to produce declining family size, but cohort size continues rising due to population momentum. In the third stage, falling fertility overtakes population momentum to cause declines in the absolute size of birth cohorts.

Children, especially school-age children, compete for resources at both the family and the population level. Children born in what we define as the first stage of the demographic

transition face increasing competition for resources at both the family and population levels. Children born in the second stage face increasing competition at the population level, but have decreasing numbers of siblings. Children born in the third stage experience both declining cohort size and declining family size.

The paper begins by presenting a simple model to illustrate the dynamics of cohort size and family size during the demographic transition. We then analyze the sequence of stages in several countries, documenting the fact that cohort size and family size move in opposite directions for as long as two or three decades in many countries. We look in particular detail at the case of Brazil, where we have detailed census microdata back to 1960. We use these data to look at changes in family size from the perspective of school-age children. Brazil entered Stage 2 of the transition before 1970, and entered Stage 3 around 1982, when the largest birth cohort was born. We have shown in previous work that the resulting decline in the size of the school-age population in the 1990s is associated with large improvements in schooling outcomes (Lam and Marteleto, 2005). Brazil is typical of many Asian and Latin American countries that have already entered Stage 3 of the transition. We also look in detail at Kenya, Mexico, South Africa, and Vietnam, taking advantage of large census microsamples that permit us to focus on cohort size and family size from the perspective of children in narrow age groups. We show that the number of siblings of children ages 9-12 fell in all of these countries between the two most recent censuses. This suggests that all of these countries have entered Stage 2, with children competing for resources with fewer siblings in the household.

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## **2. Previous Research on Cohort Size, Family Size, and Schooling**

Numerous researchers have considered the possible effects of family size and cohort size on resources available to children, with particular focus on their impact on schooling. The recent National Academy of Sciences' report, *Growing up Global*, provides a review of this literature (Lloyd, 2005). Without attempting to thoroughly review this large literature, we briefly discuss some of the studies that have looked at the impact of cohort size and family size on children's resources.

Negative effects of rapid growth of the school-age population on schooling outcomes have frequently been mentioned as one of the potential negative consequences of rapid population growth (Jones 1971; World Bank 1984). There has not been strong empirical evidence of a negative impact of the size of the school-age population on school outcomes, however. In one of the most comprehensive analyses of the issue, Schultz (1987) analyzed the economics of

school finance in the presence of changing size of the school-age population relative to the adult population. Using aggregate cross-national data on age structure, school enrollments, and school expenditures, Schultz found no significant effect on school enrollment rates of the proportion of the population in school age. He also found no noticeable effect of relative cohort size on the shares of GNP allocated to education, although he did find a negative association between the proportion of the population in school age and public school expenditures per child. Kelley (2001) notes that several other studies based on cross-country data also suggest that there is no impact of relative cohort size on the share of national budgets allocated to schooling. Kelley (1996) updated Schultz's analysis using data from the 1980s, and continued to find no significant effect of cohort size on the share of educational spending in GNP, although he did not look directly at the impact on enrollment.

In the case of Brazil, several studies have mentioned the potential benefits generated by lower population growth rates and decreases in the relative and absolute size of the school-age population. Birdsall and Sabot (1996) point to Brazil's rapid increase in the number of children at school ages in the 1970s and 1980s as potential cause for the poor educational performance of the 1980s. Rigotti (2001) argues that the decline in the population pressure and resulting smaller cohorts of school-aged groups may have benefited the performance of the educational system. Along the same lines, Castro (1999) has pointed to the high proportions of the population in school-age of North and Northeast Brazil as one of the potential reasons for lower enrollment rates in these regions.

In addition to the literature on cohort size, there is an even larger literature analyzing the impact of family size on schooling outcomes. As pointed out in the reviews by Lloyd (1994) and Kelley (1996), previous research in this area has produced mixed results, ranging from negative effects to statistically insignificant effects to positive effects. Most empirical studies on educational attainment in developing countries have found that children from large families attain less schooling on average than children with fewer siblings (Ahn, Knodel, Lam, and Friedman 1998; Knodel and Wongsith 1991; Marteleto 2001; Parish and Willis 1993, 1989; Patrinos and Psacharopoulos 1997). This is often attributed to a dilution of resources, with a smaller share of financial and interpersonal resources allocated to each child in larger families (Blake 1989). Some studies, however, have found a positive association between family size and education (Chernichovsky 1985; Hossain 1988; King et al 1986; Mueller 1984; Zajonc 1976), a result that Kelley (1996) argues could be theoretically plausible if there were large economies of scale in the production of human capital within families. Still other studies have found no statistically significant effect of sibship size on children's educational outcomes

(Shavit and Pierce 1991; Mason 1993). As emphasized in the review by King (1987), whatever the relationship between family size and schooling observed in the data, giving a causal interpretation to the association is difficult, since fertility and children's schooling are choices made jointly by parents. In the case of Brazil, two studies have examined the role of family size on children's education and have showed an overall negative relationship. Psacharopoulos and Arriagada (1989) found small overall negative impact of number of siblings on school enrollment and attainment, but no effect on school dropout rates. Marteleto (2001) found negative effects of number of siblings on mean years of schooling and school enrollment for cohorts of children born pre- and post- demographic transition.

While there has been considerable discussion of the impact of changes in family size and cohort size on children's resources in developing countries, there has been surprisingly little discussion of the actual dynamics of changes in family size and cohort size that typically take place during the demographic transition. One of the few papers to look directly at the patterns in cohort size in developing countries is Macunovich (2000), who adapts Easterlin's (1978) model of relative cohort size to look at the impact of cohort size on fertility. As her figures show, there have been large swings in absolute and relative cohort size in developing countries, driven by the changes in mortality and fertility that are associated with the demographic transition. Macunovich focuses on relative cohort size and its possible impact on fertility, and does not look directly at the way at changes in surviving family size. In most of the literature on the impact of cohort size and family size on children's outcomes, the discussion suggests that cohort size and family size will move together, following the path of overall population growth. As we will show below, both empirical evidence and simple models of the underlying population dynamics make it clear that family size and cohort size may move in opposite directions for as long as several decades once fertility begins to fall. Understanding these dynamics can provide a clearer picture of how the competition for resources allocated to children changes during the demographic transition, with important implications for those countries that have only recently begun to experience fertility decline.

### **3. Dynamics of Family Size and Cohort Size during the Demographic Transition**

In this section we present a stylized model of the demographic transition that demonstrates several important points about how family size and cohort size change in response to the typical changes in fertility and mortality that characterize the transition. One goal of this model is to think about how we could get some sense of how average surviving family size changes over time in a population by looking at summary measures of fertility and infant

survival. Given the strong non-stationary of vital rates, age structure, and population growth during the demographic transition, the link between vital rates in a current year and measures such as numbers of siblings of children born in that year and total number of births in that year is very complex.

It is beyond the scope of this paper to develop a complete model of these dynamics, but a simple model demonstrates a number of key points. Assume that a woman has all of her births at the mean age of childbearing  $\mu$ . This implies that all of the children born in a given year are born to women age  $\mu$ , that the cohort Total Fertility Rate (TFR) for these women is equivalent to the period TFR, which we will denote  $f$ , and that  $f$  is also the average completed family size for all children born in that year. These are clearly strong assumptions, but they can be thought of as a simple first order approximation to a more complete model that would have siblings born at ages before and after the mother was age  $\mu$ . Let  $s(t)$  represent surviving family size for children born in year  $t$ ,  $f(t)$  represent number of children born per woman who gives birth in year  $t$  (the period TFR in year  $t$  and the cohort TFR for women born in year  $t-\mu$ ), and  $p(t)$  represent the probability of survival to some age such as the age of attending school for children born in year  $t$ . Surviving family size is simply the product of the fertility rate and the survival rate is a simple multiplicative relationship

$$s(t) = f(t)p(t) \tag{1}$$

Looking at change over time, we take the natural logarithm of (1) and differentiate with respect to time to get

$$\frac{\partial \ln s(t)}{\partial t} = \frac{\partial \ln f(t)}{\partial t} + \frac{\partial \ln p(t)}{\partial t} \tag{2}$$

Equation (2) simply states that the rate of change in surviving family size is the sum of the rate of change in the fertility rate and the rate of change in the survival probability. Since during most of the demographic transition the fertility rate will be declining while the survival probability is increasing, the net change in surviving family size at any given point in the transition is ambiguous, depending on the relative magnitudes of the two changes. While a more complete model of the age profile of fertility would greatly complicate Equation (2), it would not change the basic point that declining fertility competes with increasing survival to determine the evolution of surviving family size during the transition.

We can continue with this simple model to think about the dynamics of cohort size. The actual number of births in year  $t$ , which we will denote  $N_0(t)$ , will depend on the number of women in childbearing age in year  $t$  and the number of surviving children born to each woman of childbearing age. In our model the number of women of childbearing age in year  $t$  is simply the number of women age  $\mu$  in year  $t$ , which we will denote  $N_\mu(t)$ . We can therefore express the number of surviving children born in year  $t$  as:

$$N_0(t) = N_\mu(t)s(t) = N_\mu(t)f(t)p(t). \quad (3)$$

Assuming for simplicity that all surviving births also survive to the age of childbearing, we can link current numbers of childbearing age women to past births and modify Equation (3):

$$N_0(t) = N_\mu(t)s(t) = N_0(t - \mu)f(t)p(t). \quad (4)$$

Equation (4) makes the simple but fundamentally important point that current numbers of births are the product of cohort size one generation in the past multiplied by current fertility and survival rates. As above, it is useful to take logs and differentiate with respect to time and think about the dynamics in terms of growth rates:

$$\frac{\partial \ln N_0(t)}{\partial t} = \frac{\partial \ln N_\mu(t)}{\partial t} + \frac{\partial \ln s(t)}{\partial t} \quad (5)$$

The role of population momentum is now clearly evident in Equation (5). The first term on the right-hand side can be thought of as the growth rate of the childbearing age population in year  $t$ , or equivalently (given our assumptions) as the growth rate of numbers of births  $\mu$  years in the past. While the growth rate of the childbearing age population is affected by fertility and mortality one generation back, it is not affected by current fertility and mortality, and hence does not need to move in the same direction as current surviving family size. During the course of the demographic transition the two terms on the right-hand side of Equation (5) can clearly move in opposite directions. In particular, surviving family size will start to decline if fertility falls faster than infant mortality, but the childbearing age population may continue to increase due to population momentum.

Equation (5) provides a useful framework for thinking about the dynamics of family size and cohort size during the demographic transition. Assume that before the demographic transition begins we have a stationary population, with constant numbers of surviving births in every year,  $N_0(t) = N_0(t-1) = N_0(t-\mu)$ , or equivalently,  $\partial N_\mu(t) / \partial t = 0$  in Equation (5). The most



obvious characterization of the beginning of the demographic transition is an unexpected increase in the survival probability,  $\partial p(t)/\partial t > 0$  in some year  $t_1$ , which we will think of as the onset of the transition. Since this will not cause any change in the childbearing age population for the first  $\mu$  years, all effects on numbers of surviving children work through the increase in survival probabilities. Note that this increase in child survival must increase both the average size of families,  $s$ , and the number of births born in each year,  $N_0$ , during the initial years of the transition. From the perspective of children, the generations born in some initial set of years after year  $t_1$  experience both an increase in surviving numbers of siblings and an increase in the size of their cohorts relative to previous years. This begins what we call Stage 1 of the demographic transition from a child's perspective.

Following the standard pattern of the demographic transition, we now assume that with some lag there begins a steady decline in fertility,  $\partial f(t)/\partial t < 0$  beginning in some year  $t_2$ . Recalling Equation (2), surviving family size may either continue to increase or begin to decline, depending on whether fertility falls fast enough to offset the increase in child survival. It is entirely an empirical question whether and for how long surviving family size continues to increase after fertility begins to decline. We assume that at some point, possibly quite a few years after the onset of fertility decline, fertility begins to fall fast enough to offset increased child survival, leading to decreasing family size.

Once the decline in surviving family size begins, it need not imply a decline in the numbers of surviving births in the population. As Equation (5) reminds us, population momentum resulting from the rapid growth in cohort size during the first stage of the transition will tend to cause continued growth in the size of the childbearing population for at least one generation into the future. While it is not a mathematical necessity that cohort size continues to grow after family size has begun to fall, the typical empirical pattern seems to clearly be one in which there is continued growth in total numbers of births for some period after family size has begun to decline. This is what we call Stage 2 of the demographic transition from a child's perspective. Children born during this period experience declining family size but increasing cohort size relative to previous cohorts. They compete with fewer siblings at home, but compete with more children of the same age in the overall population. This stage begins when the sum of fertility growth and survival growth in Equation (2) becomes negative.

Assuming that declines in fertility continue to be faster than increases in child survival, the stage is set for an eventual reduction in the impact of population momentum. Stage 1 of the

transition from a child's perspective was essentially a race between falling fertility and falling mortality to determine when surviving family size would begin to decline. The end of Stage occurs when falling fertility overtakes falling mortality and family size begins to fall. As Equation (5) makes clear, Stage 2 is similarly a race between falling fertility and population momentum to determine when the absolute numbers of births will begin to decline. The end of Stage 2 occurs when falling fertility overtakes population momentum to produce a decline in the absolute number of births.

It is important to add that the stages as we have defined them may not always be sharply defined. Family size might begin to decline but then rise again if the rate of decline in infant and child mortality once again overtakes the rate of decline in fertility. Similarly, the absolute number of births may reach a peak, decline for a few years, then rise again as "waves" of population momentum work their way through the childbearing population. We may therefore see some oscillations around a turning point in both family size and cohort size, rather than sharply defined peaks. We will see, however, that the basic stages as we have defined them are fairly clearly evident for countries undergoing the demographic transition during recent decades, even if the boundaries between stages are not always sharply defined.

Before we turn to microdata to observe the changes in family size at the household level, it is interesting to look at summary demographic measures for a number of countries based on United Nations Population Division estimates (United Nations Population Division 2003). Figure 1 shows the Total Fertility Rate and the probability of infant survival (calculated as one minus the infant mortality rate, where the infant mortality rate is expressed as the percentage of births who die before age one). The six countries include the five countries for which we have detailed microdata below – Brazil, Kenya, Mexico, South Africa, and Vietnam – along with Thailand, chosen because it represents an important version of the demographic transition. While the basic trends in fertility and mortality shown in Figure 1 are well known, several points are worth noting in the context of the framework just presented. Fertility in all of these countries is high and relatively stable through the 1950s and 1960s, followed by a period of rapid fertility decline and a subsequent leveling off. The probability of infant survival shows much more constant rates of change over the four decades shown, even in spite of having an upper asymptote of one. The growth rate of infant survival is steady but fairly slow, around 0.2 to 0.3 percent per year in most of the countries shown between 1955 and 2000, taking the average rate of change between the five year periods provided in the U.N. data. This compares

to growth rates of fertility that begin around zero, fall to as fast as -4 to -5 percent per year during the period of most rapid fertility decline, then level off.

Figure 2 uses the fertility and infant survival data used for Figure 1 to calculate the predicted rate of change in surviving family size, using the expression in Equation (2). In other words, the predicted rate of change in surviving family size is the annual rate of change in the TFR plus the annual rate of change in the infant survival probability.<sup>1</sup> There are several noteworthy features of Figure 2. All of the countries shown begin with positive predicted growth in surviving family size in the 1950s (these estimates are based on the 1950-55 and 1955-60 estimates of vital rates in the U.N. data). This is simply the result of the fact that infant survival was rising over this period, while fertility had not yet begun to decline. The growth rate of predicted family size becomes negative by 1970 in all countries except Kenya, where it becomes negative by 1975. In Thailand, Brazil, and Mexico, predicted family size falls fastest during the 1980s, with the rate of decline falling significantly in the 1990s. In Thailand, the fact that fertility is no longer declining as rapidly – having reached close to replacement fertility – while infant survival continues to improve, means that surviving family size, at least by this simple summary measure, has stopped falling, when viewed from the perspective of children being born today.

As the simple model above demonstrates, the evolution of cohort size need not follow the evolution of family size during the demographic transition. Figure 3 presents U.N. estimates and projections of both total numbers of births and total numbers of women age 15-49 from 1950 to 2020 for the same six countries shown in Figures 1 and 2. The top panel of Figure 3 shows the total number of births per year, using 1950=100 as a benchmark for each country. Thailand shows the earliest peak in births among the countries shown, with a peak around 1965 that is 1.4 times the number of births in 1950. Brazil shows a peak in births around 1980, a pattern that we will analyze in greater detail below. The peak number of births was around 1985 in Vietnam, 1990 in Mexico, and 1990 in South Africa. Kenya is far off the scale of the other countries, with a predicted peak around 2000 at a level that is three times the number of births in 1950. Note that with the possible exception of Thailand, where the peak birth cohort occurs close to the period in which we estimate that surviving family size started to decline, the

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<sup>1</sup> Note that while we only use infant mortality for this calculation, rather than some measure such as survival to age 5, we will still get the right answer for the rate of change of surviving family size as long as the rate of change of child survival is the same as the rate of change of infant survival. Our prediction is about the rate of change in family size, not the level, so we only need to have an accurate estimate of the rate of change of child survival, not the level.

peak in the number of births comes 10 to 30 years after the year in which we predict that surviving family size would have started to decline. The explanation for this delay is population momentum driven by growth in the size of the childbearing population. It should also be noted in Figure 2 that the total number of births does not necessarily have a single peak. In both Mexico and Kenya, for example, it appears that the number of births begins to decline, but then increases again for some period of time. This is not surprising, given the theoretical dynamics shown above. As falling fertility competes with population momentum, it is easy for the total number of births to increase even after a period in which it was decreasing, and even though fertility continues to fall. The number of women of childbearing age will grow at somewhat uneven rates due to the patterns in numbers of births lagged one generation. Even if fertility falls at a fairly steady rate, an increase in the rate of growth of the childbearing population could cause the number of births to begin increasing again after an initial period of decline.

The bottom panel of Figure 3 shows the estimated number of women age 15-49 from 1950 to 2020, using 1950=100 as a benchmark. Even in Thailand, the number of women age 15-49 was still growing in 2000, reaching a level three times the number in 1950. Most countries will experience a leveling off and subsequent decline in the number of women age 15-49 by 2020, with the notable exception of Kenya. Kenya had very rapid growth of the childbearing population in the 1990s, and this growth is projected to still be very high in 2020. Kenya represents the experience of a number of African and South Asian countries that were late in experiencing fertility decline. The projected decline in the number of women of childbearing age in South Africa beginning around 2005 represents the impact of AIDS mortality in the U.N. projections. AIDS mortality is heavily concentrated in the childbearing years, and introduces an important complication to the dynamics modeled above. The link between the number of births in the previous generation and the number of women of childbearing age is strongly affected by mortality in the childbearing years.

Like the cases of Brazil, Mexico, Thailand, South Africa, and Vietnam in Figure 3, most developing countries have already witnessed the birth of the largest cohort that has ever been born – and probably ever will be born – in the country. This is clearly the case in almost all East Asian and Latin American countries. It has probably even happened in Kenya, as Figure 3 suggests, although there are a number of African and South Asian countries where the peak is not projected to occur for another ten or twenty years. Since the absolute size of the school-age population will begin to decline roughly ten years after the largest cohort has been born, it

is clear that many developing countries, especially those in Latin America and Asia, have been in a period of declining school-age populations for a decade or more. It is more difficult to be sure when family size began to decline in all of these countries, especially when measured from the perspective of children of some particular age. Getting beyond approximations such as those presented in Figure 2 requires microdata at the household level, preferably covering a large period of the demographic transition. In the following sections we draw on large census samples from five of the countries included in Figures 1 to 3 – Brazil, Kenya, Mexico, South Africa, and Vietnam – to look in detail at how family size changes during the demographic transition, and how these changes compare to changes in cohort size.

#### **4. Data**

An important goal of our investigation is to combine macro and micro analysis of the demographic transition, looking at the simultaneous changes that occur in cohort size and family size. We therefore require micro data from censuses or surveys at multiple points during the demographic transition in a given country. Since our analysis is motivated by an interest in competition for resources from the perspective of school-age children, we need relatively large data sets in order to look at measures such as the number of siblings of children around the age of entering school. Our analysis draws on large public use samples of population censuses from several countries. We pay special attention to Brazil, where we have excellent micro-samples of the census for 1960, 1970, 1980, 1991, and 2000. We also use census data taken from the Integrated Public Use Microsamples – International (IPUMS-I) project of the University of Minnesota (Sobek et al. 2002). From the IPUMS-I web site we use census samples from Mexico (1990 and 2000), Kenya (1989 and 1999) and Vietnam (1989 and 1999). We also use the two most recent censuses from South Africa (1996 and 2001). While the census data for Mexico, Kenya, South Africa, and Vietnam do not let us go as far back in the demographic transition as we can with the Brazilian data, they do allow us to look in detail at recent changes in family size in these countries, as viewed from the perspective of school-aged children.

#### **5. The Demographic Transition, Cohort Size, and Family Size in Brazil**

It is instructive to begin with the case of Brazil, whose demographic transition is fairly typical of those observed throughout the developing world in recent decades, and where we have excellent microdata going back to 1960. Table 1 provides an overview of Brazil's demographic transition based on census data from 1940 to 2000. As shown in the first row of

Table 1, the Total Fertility Rate (TFR) for all Brazil was around 6.2 from 1940 to 1960, declining rapidly to 4.4 in 1980, 2.7 in 1991, and 2.3 in 2000. Brazil's rapid fertility decline occurred during a period of a far-reaching social change that included periods of both rapid economic growth and economic crisis (Lam and Duryea 1999; Martine 1996; Wood and Carvalho 1988). As seen in Table 1, there was considerable regional variation in the pace of fertility decline. The poorer north and northeast regions have consistently had the highest regional fertility rates and began fertility decline somewhat later than the higher income south and southeast regions. In 1970, the southeast's TFR had fallen to 4.6, while the TFR for the northeast remained at 7.5. In 1991, the regional differences persisted as the southeast showed a TFR of 2.4 and the northeast had a TFR of 4.0. By 2000 the TFR for the southeast had declined to slightly below replacement level at 2.0, with a TFR for the northeast of 2.6. This regional unevenness of demographic indicators mirror trends and patterns in socio-economic development. The TFR in the more developed southeast and south regions is similar to those of high-income countries, while the higher TFR in the north and northeast regions reflects the lower income, education, and industrialization levels of those regions.

Table 1 also shows the population size and annual growth rates for the country from 1940 to 2000. Brazil experienced rapid population growth during the second half of the 20th century, with the annual growth rate peaking at 3% in the 1950-60 period. In the 1970-1980 period the growth rate was still about 2.5% per year, but was clearly on the decline. The annual growth rate fell to 1.9% in the 1980-91 intercensal period, and to 1.6% in the 1991-2000 period. As seen in the last row of Table 1, Brazil more than quadrupled its total population over this period, from 41 million in 1940 to 169 million in 2000.

The dramatic changes in fertility rates and population growth rates shown in Table 1 are associated with large changes in the size of birth cohorts. These are shown graphically in Figure 1, which combines the overlapping single-year age distributions from the censuses of 1960, 1970, 1980, 1991, and 2000. The figure shows the size of the birth cohort as reported in two overlapping censuses (when possible), without any adjustment for mortality, using the age distributions from age 0 to age 20 in each census. For example, the two numbers shown for the 1975 cohort are the number of 5 year-olds in the 1980 census and the number of 16 year-olds in the 1991 census.<sup>2</sup> Since our interest is in estimating the size of cohorts at the time those

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<sup>2</sup> The census is taken in October of each census year. For simplicity we assume that those reported at age zero were born in the same year as the census, those age one were born in the previous calendar year, etc.

cohorts were in school, rather than the actual number of births that originally occurred for each cohort, adjustments for mortality are relatively unimportant to our calculations.

Figure 1 shows an increase in cohort size throughout the 1950s, 1960s, and 1970s, peaking around 1982-1983. The rate of increase varies over time, with much slower growth in the 1960s than in the 1970s. These changes in the pace of the increase in cohort size are the result of the complex interaction between falling fertility rates and increasing numbers of women in childbearing age. The decline in cohort size after the peak in the early 1980s is also uneven, with cohort size actually increasing again during the early 1990s. This is not due to an increase in fertility, which falls rapidly throughout the period, but to an increase in women of childbearing age as an “echo” of the rapid cohort growth of the 1970s.

### **Declining Family Size in Brazil**

The changes in fertility and mortality that caused the changes in cohort size shown above also caused large changes in family size. The changes in family size do not simply track changes in cohort size, however. Family size begins to decline well before the largest birth cohort is born, a pattern that can be expected in all countries during the demographic transition. We can use micro data from the Brazilian censuses to track changes in family size from a child’s perspective over the course of the demographic transition. Table 2 presents estimates of the number of children ever born and the number of children surviving as reported by mothers of children ages 9-12 in the five Brazilian censuses from 1960 to 2000. The three-year age group centered on age 10 is used to reduce the impact of age misreporting and capture an age group that would be expected to be in school. The children ever born columns indicate that fertility decline was already underway in Brazil between the 1960 and 1970 censuses. Looking at the row for all Brazil, the mothers of 9-12 year-olds reported 0.35 fewer children ever born in 1970 than did their counterparts in 1960. The children surviving columns show a different pattern however, with an increase of 0.03 in the number of children surviving to the mothers of 9-12 year-olds. While this increase in surviving siblings is very small, it suggests that Brazil was still in what we would call Stage 1 of the demographic transition in 1970 – falling infant and child survival was leading to increasing family size, even though fertility had already begun to decline.

Looking at changes from 1970 to 1980, the declines in children ever born are substantially larger than the 1960-70 declines. Children aged 9-12 in 1980 had almost one fewer sibling ever born than their counterparts in 1970. These declines were large enough to cause a 0.5

decline in the number of surviving siblings. The fact that the number of siblings ever born declined by about 0.86, while the number of surviving children declined by only 0.55, indicates that falling infant and child mortality continued to have an important impact on family size in the 1970s. The number of siblings ever born to 9-12 year-olds continues to decline rapidly over the next two decades, with a decline of 1.3 between 1980 and 1991 and 0.8 between 1991 and 2000. Children aged 9-12 in 1991 had one full sibling less than their counterparts in 1980, with a further decline of 0.6 siblings between 1991 and 2000. The net impact of declining fertility over these four decades was to cause 9-12 year-olds in 2000 to have more than two fewer surviving siblings than their counterparts in 1960, a decline of over 40%.

The next two rows of Table 2 present separate estimates for two large regions of Brazil, the less developed northeast and the highly industrialized and higher income southeast. Fertility is considerably higher in the northeast in all periods, although fertility decline was already evident in the northeast in the 1960-70 period. The northeast demonstrates an even more pronounced increase in surviving family size between the 1960 and 1970 censuses, with an increase of 0.16 in the number of surviving siblings to 9-12 year-olds. The southeast, on the other hand, had already move out of Stage 1 of the demographic transition by 1970, with decreasing numbers of surviving siblings. In the 1970-80 period we also see a decline in surviving family size in the northeast, indicating that the northeast moved into Stage 2 of the transition sometime between 1970 and 1980. Children aged 9-12 in the northeast had about 0.5 fewer surviving siblings in 1980 than they did in 1970.

In Table 2 we also break down the 9-12 population by mother's education, using four years as a cutoff between low and high education. As with the regional breakdown, we observe an increase between 1960 and 1970 in the number of surviving siblings for children with low mother's education, but an decrease for those with high mother's education.

Figure 2 shows the distribution of family size in detail in each of the five Brazilian censuses. The top panel shows the histogram of numbers of siblings of children ages 9-12. The bottom panel shows the inverse cumulative distribution, showing the percentage of children with at least a given number of siblings. The figure provides a clear picture of the evolution of small families in Brazil. In 1960 and 1970 over 50% of 9-12 year-old had five or more siblings, while only about 20% had less than three siblings, with almost no change over the decade. By 2000 these proportions had reversed, with only about 20% having five or more siblings while over 50% had less than three. Over 25% of 9-12 year-olds had only one sibling



in 2000, compared to 7% in 1960. Looking across the five census years, some of the largest changes in family size of 9-12 year-olds take place between the 1980 and 1991 censuses. These reflect the rapid declines in fertility in Brazil between 1970 and 1981, declines that far offset the improvements in infant and child survival during that period,

Figure 3 combines the census estimates of cohort size and family size for children ages 9-12 in the five censuses from 1960 to 2000. The figure presents a concise summary of our interpretation of the stages of the demographic transition from a child's perspective. As noted above, the number of surviving siblings (as measured by the mother's report of surviving births) rises slightly between the 1960 and 1970 censuses. The total number of 9-12 year-olds in the population increases by about 30% between 1960 and 1970. From the perspective of 10 year-olds, Brazil was still in Stage 1 of the demographic transition between 1960 and 1970, with both family size and cohort size increasing. Between 1970 and 1980 the surviving number of siblings declined, while the total number of 9-12 year-olds in the population continued to grow, increasing by 19% during the decade. Although we cannot pinpoint the turning point, which could have occurred either during the 1960s or 1970s, Brazil is clearly well into Stage 2 of the demographic transition from the perspective of 10 year-olds by 1980, with falling numbers of siblings and rising cohort size. These trends continue between the 1980 and 1991 censuses. Ten year-olds in 1991 have one fewer sibling than ten year-olds in 1980, but the total number of ten year-olds in the population increases by 30%, almost as large as the increase of the 1960s. With the largest cohort born in 1982, the number of 9-12 year-olds obviously declines between the 1991 and 2001 census, a decline of about 10%. The timing of the entry into our Stage 3 of the demographic transition is much easier to see than the boundary between Stage 1 and Stage 2, since it only requires identification of the year in which the largest cohort is born. From the perspective of a 10 year-old, 1992 marks the year in which there is both a decline in the absolute number in the population as well as a (continuing) decline in the average number of siblings.

## **6. Changing Family Size in Kenya, Mexico, South Africa, and Vietnam**

Table 3 presents our estimates of the number of siblings of 9-12 year-olds in the two most recent censuses for Kenya, Mexico, South Africa, and Vietnam. In each country we present estimates for the total population followed by breakdowns between rural and urban populations and breakdowns by whether the mother has four or more years of schooling. We present total population figures by mother's education and rural residence because these are two classic variables associated with different fertility and mortality levels. As in our Brazil results, we

present both the number of siblings ever born and the number of siblings surviving at the time of the census, based on the information provided by mothers about children ever born and children surviving.

Results for Kenya show that in spite of the late onset of fertility decline in this country, falling number of siblings was clearly evident for children ages 9-12 between the 1989 and 1999 censuses. This is true both for numbers of siblings ever born and numbers surviving, with declines of around 0.75 in both measures for the country as a whole. While family size is higher in rural areas, the number of surviving siblings declined by 0.66 for 9-12 year-olds in rural areas between 1989 and 1999. The smallest declines are observed when we focus on those whose mothers have less than four years of schooling. In this group the number of surviving children declines by 0.3 over the decade, compared to a decline of 0.75 for children with better-educated mothers. As shown in Figure 3, cohort size was still increasing in Kenya during the period when these 9-12 year-olds were born. Census estimates indicate that the absolute number of 9-12 year-olds in 1999 was 33% higher than the number in 1989, an annual growth rate of 2.9%. According to our typology, then, Kenya was clearly in Stage 2 of the demographic transition in the 1990s, with cohort size still increasing while family size was clearly on the decline.

Family size was also declining in Mexico, South Africa, and Vietnam in the 1990s. As shown in Table 3, the number of surviving siblings of 9-12 year olds fell by 0.4 in Mexico between 1990 and 2000, a decline of a little over 10%. Declines are observed in both rural and urban areas in Mexico, and among for children of both high education and low education mothers. Note that the smaller declines in family size within educational groups demonstrates that rising women's education contributes substantially to the decline in fertility over the period in which these children were born. As shown in Figure 3, cohort size was increasing slightly between 1980 and 1990, reaching a peak around 1990. The number of 9-12 year olds in 2000 was therefore about 5% higher than it was in 1990. Mexico, then, represents a case where it moved from Stage 2 to Stage 3 around 1990, with both family size and cohort size beginning to fall. The decline in cohort size had not yet reached the population aged 9-12 in 2000, but the school-age population should have just started to decline around that time.

The South African censuses are only five years apart, but nonetheless show clear declines in the numbers of siblings of children aged 9-12. The overall decline is 0.2 surviving siblings, with a larger decline in urban areas. Children whose mothers have low schooling have about 1.2 more surviving siblings than children with better educated mothers, but the absolute

decline between censuses is roughly similar for the two groups. The average number of siblings in South Africa in 2001 of 3.86 is fairly close to the Mexico average of 3.7, with very similar annual rates of decline in the intercensal periods in both countries.

In Vietnam the number of surviving siblings falls by more than one sibling between 1989 and 1999, a decline of 30% in one decade. This is one of the largest percentage declines in family size observed in our sample of countries. Similar declines are observed in rural and urban areas, and by education group. Vietnam experienced its largest cohort around 1985, with the 1980 cohort being about 5% larger than the 1990 cohort, similar to the experience of Brazil. For Mexico and Vietnam, then, the 9-12 year-olds in the 2000 census were still experiencing small increases in cohort size, but were experiencing fairly significant declines in family size compared to their counterparts in 1990.

Figure 7 shows the detailed distribution of numbers of siblings of children ages 9-12 in Kenya, Mexico, South Africa, and Vietnam. We show the cumulative distributions for these comparisons, showing the percentage of children who have  $x$  or more siblings. These cumulative distributions clearly demonstrate the decline in family size over time in each country, and the large differences between countries. Looking at the distribution for Kenya in the top panel, 56% of 9-12 year-olds had five or more siblings in 1989. This fell to 45% in 1999. The percentage with seven or more siblings fell from 28% to 21% over the decade, while the percentage with less than four siblings increased from 28% to 40%.

Mexico already had significantly smaller family sizes than Kenya in 1989, and the declines in Mexico in the 1990s were smaller than those observed in Kenya. The percentage of 9-12 year-olds with five or more siblings in Mexico fell from 38% to 33% over the decade, while the percentage with less than three siblings grew from 30% to 37%. South Africa shows somewhat smaller changes in the distribution, due partly to the fact that the censuses are only five years apart. Declines in the proportions of children in large families are nonetheless clearly evident in South Africa. The percentage of 9-12 year-olds with five or more siblings fell from 36% to 30% between 1996 and 2001.

Vietnam had by far the smallest families of the three countries shown in 1989, with only 26% of 9-12 year-olds having five or more siblings in 1989. Vietnam also shows some of the largest declines in family size over the decade, however, with the percentage of 9-12 year-olds having five or more siblings falling to 12% in 1999, about 1/4 of the percentage with five or more siblings in Kenya. The percentage with less than three siblings in Vietnam increased

from 34% to almost 60% between 1989 and 1999, a dramatic emergence of small families. The distribution of family size in Vietnam in 1999 is similar to that observed in Brazil in 2000, with the percentage having one sibling or less at 32% in Brazil and 34% in Vietnam.

The overall picture shown in Figure 7 is a clear shift toward smaller families in each of the quite diverse countries shown, viewed from the perspective of school-age children. While this should perhaps not be surprising, given the fertility decline underway in each country, several points should be noted. First, fertility decline must compete with declines in infant and child mortality to determine the number of surviving siblings. Only by looking directly at numbers of siblings for children of a given age can we see the net effect of these two offsetting demographic trends. The second point is that there is a quite complex relationship between the Total Fertility Rate estimated in a given year and the number of siblings that will be experienced by a child born in that year. Our simple model abstracts from these complexities in a number of ways, providing a rough approximation to trends in family size and cohort size but leaving considerable uncertainty about the actual experience we will observe in a given population. Only direct analysis of micro data can answer the question of whether the number of siblings of school-age children is increasing or decreasing. A third point is that it is important to look at the change in the complete distribution of numbers of siblings, changes that are difficult to predict based on fertility rates alone. One of the patterns evident in Figure 7 is that the biggest changes in numbers of siblings are taking place at the largest family sizes. This means that children in these countries are significantly less likely to have large numbers of siblings, with these declines well underway in all of the countries for which we have the necessary micro data.

## **7. Stages of the Demographic Transition**

Returning to our stylized characterization of stages of the demographic transition from a child's perspective, the previous section documents that the five countries for which we have micro data – Brazil, Kenya, Mexico, South Africa, and Vietnam – all moved into Stage 2 of the transition long enough ago that we see a clear decline in the number of surviving siblings for children age 9-12 when we compare the two most recent censuses. In Brazil, where we have census data back to 1960, we can see a movement from Stage 1, with rising family size and rising cohort size, into Stage 2, with falling family size and rising cohort size, some time in the 1960s or 1970s. For the other countries it is impossible to tell when they moved from Stage 1 to Stage 2 in the absence of comparable micro data for earlier years. In all cases we know that there had to be a Stage 1, since there had to be a period in which net family size increased in

order to create the rapid population growth and resulting population momentum that is typical of the demographic transition in these countries. We also know that all five countries moved from Stage 1 into Stage 2 by at least the 1990s, and perhaps some time before that.

Declines in the absolute numbers of births seem clearly to have come later than the decline in surviving family size in all five countries, as suggested by our model and our typology of stages of the demographic transition. It is important to keep in mind that this sequence of changes is not a mathematical necessity, though we believe the typical pattern of the demographic transition is likely to always produce continued increases in cohort size for one or two decades after family size begins to fall. Age pyramids provide a useful summary measure to analyze the trends in the size of surviving birth cohorts in each country, especially at younger ages where there is limited impact of mortality beyond initial infant survival. These age pyramids can be used to make a few final points about the dynamics of cohort size. Figure 8 shows age pyramids for Brazil, South Africa, and Kenya. These three pyramids capture three typical age patterns observed in developing countries today. Brazil's trends in cohort size have been discussed above, and can be seen clearly in the 2000 age pyramid. The largest age group is 15-19 year-olds, corresponding to the peak in births in the early 1980s. Cohort size dropped sharply over the next decade, then leveled off in the late 1990s. With fertility having already declined to near replacement levels, the entry of the early 1980s birth cohort into childbearing years is likely to cause the number of births to increase again, although it is unlikely to return to the early 1980s level.

South Africa is typical of a country with a more recent fertility decline. The absolute number of births leveled off in the 1980s and 1990s, leading to a relatively vertical age pyramid between ages 5 and 19. The number of births increased in the late 1990s according to these U.N. figures, a reflection of the steepness of the age pyramid in the childbearing years. This suggests that South Africa is still in Stage 2 of the demographic transition using our typology, with cohort size continuing to grow while family size is declining.

Kenya is typical of a country with even later fertility decline. Kenya had an extremely steep age pyramid twenty years ago, but the pyramid leveled off to produce relatively similar numbers of 5-9 year olds and 10-14 year-olds in 2000. The number of births increased again in the late 1990s. As in South Africa, this reflects the steepness of the age pyramid in the 20-35 age range, with population momentum continuing to overtake falling fertility. The U.N. projects that Kenya will experience a peak in births, and thus enter our Stage 3 of the demographic transition around 2005-2010. This implies that the school-age population would

continue to grow until well beyond 2010, after which it is likely to decline quite rapidly for one or two decades.

## **8. Conclusion**

While the demographic transition has been heavily analyzed and discussed, researchers have failed to recognize one of the most interesting and important features of the population dynamics that drive the transition. While the basic empirical regularities of falling mortality, falling fertility, and resulting patterns in population growth rates are well known, little attention has been paid to the implications of these changes on the dynamics of family size and cohort size. Indeed, most of the literature on the impact of cohort size and family size on children's outcomes suggests that cohort size and family size will move together, following the path of overall population growth. In this paper we show that these dynamics turn out to have a number of intriguing features, the most important of which being the tendency for family size and cohort size to move in opposite directions during a significant part of the demographic transition. We have demonstrated through both empirical evidence and simple models of the underlying population dynamics that family size and cohort size may indeed move in opposite directions for as long as several decades once fertility begins to fall. The understanding of these dynamics can provide a clearer picture of how the competition for resources allocated to children changes during the demographic transition, with important implications for those countries that have only recently begun to experience fertility decline.

Past research has extensively demonstrated the consequences of the demographic transition at the societal levels. Yet, little is known about how the dynamics of family size and cohort size operate from a child's perspective. We have proposed a characterization of the demographic transition from a child's perspective that has three stages. Children born in Stage 1 face increases in both family size and cohort size, the result of falling infant and child mortality. Children born in Stage 2 experience declining family size, as falling fertility overtakes falling mortality, but face continued increases in cohort size as the result of population momentum. Children born in Stage 3 experience declines in both cohort size and family size. Using a simple model of the demographic transition, we demonstrate the key components of these stages – a race between falling fertility and falling mortality in Stage 1, and a race between falling fertility and population momentum in Stage 2. This model suggests that Stage 2 is likely to be a typical feature of the demographic transition, potentially lasting for one or two decades.

Using unusually rich census data for Brazil, we have shown that Brazil was still in Stage 1 during the 1960s, was in Stage 2 from roughly 1970 until about 1982, and has been in Stage 3 since 1982, the year in which the largest birth cohort was born. Using data for the most recent two censuses from Kenya, Mexico, South Africa, and Vietnam, we show that the average number of siblings of 9-12 year-olds declined in all four countries. Analysis of the distribution of number of siblings shows that these declines are driven in large part by substantial declines in the number of 9-12 year-olds with large numbers of siblings. For Mexico and Vietnam, these declines in family size occurred during a period in which cohort size was also decreasing. These countries therefore seem to have entered our Stage 3 of the demographic transition. South Africa's age pyramid suggests that the peak number of births has not yet occurred in the country, although it is likely to be reached soon. South Africa thus appears to be near the transition into Stage 3 of the transition, with declines in the size of the school-age population during the coming decade. Kenya seems to be clearly still in Stage 2, with rising cohort size combining with falling family size.

The implications of these changes in family size and cohort size obviously depend on the interaction between these variables and outcomes such as schooling, health, and eventually labor market experience. As noted above, an extensive literature has explored these relationships, and it is beyond the scope of this paper to provide new evidence on those links. The goal of this paper has been to provide new insights into the underlying population dynamics affecting the competition for resources at the family and population levels. By demonstrating how the dynamics of family size and cohort size operate throughout the demographic transition in several developing countries, we shed light into how these movements can affect children's resources and well-being. We believe this framework will help increase our understanding of the changes that have taken place in many developing countries during recent decades and in planning for the needs of young people in the decades to come.

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**Table 1. Total Fertility Rates by Regions, Total Population and Annual Growth Rates, Brazil, 1940-2000**

	<b>1940</b>	<b>1950</b>	<b>1960</b>	<b>Year</b> <b>1970</b>	<b>1980</b>	<b>1991</b>	<b>2000</b>
Total Fertility Rates							
Brazil	6.16	6.21	6.28	5.76	4.35	2.70	2.31
North	7.17	7.97	8.56	8.15	6.45	4.00	3.05
Northeast	7.15	7.5	7.39	7.53	6.13	4.00	2.60
Southeast	5.69	5.45	6.34	4.56	3.45	2.40	2.00
South	5.65	5.7	5.89	5.42	3.63	2.30	2.25
Center-West	6.36	6.86	6.74	6.42	4.51	2.90	2.34
Total Population (millions)	41.23	51.94	70.07	93.14	119.00	146.83	169.54
Annual Intercensal Growth Rate		2.31	2.99	2.85	2.45	1.91	1.60

Source: IBGE (1996; 2002), Wong (2000).

**Table 2. Number of siblings ever born and siblings surviving to 9-12 year olds, Brazil 1960 to 2000**

	<b>Siblings ever born</b>					<b>Siblings Surviving</b>				
	<b>1960</b>	<b>1970</b>	<b>1980</b>	<b>1991</b>	<b>2000</b>	<b>1960</b>	<b>1970</b>	<b>1980</b>	<b>1991</b>	<b>2000</b>
<b>All Brazil</b>	6.41	6.06	5.19	3.91	3.13	4.93	4.96	4.41	3.43	2.84
<b>Northeast Brazil</b>	7.57	7.21	6.49	5.38	4.09	5.35	5.51	5.18	4.51	3.58
<b>Southeast Brazil</b>	5.72	5.36	4.40	3.07	2.50	4.56	4.50	3.86	2.80	2.35
<b>Low Mother's Schooling</b>	6.82	6.57	5.95	5.38	4.71	5.17	5.29	4.96	4.59	4.14
<b>High Mother's Schooling</b>	4.95	4.57	3.67	2.63	2.18	4.10	3.97	3.29	2.41	2.05

*Note: Low Mother's Schooling = < 4 years; High Mother's Schooling = 4+ years*

**Table 3. Number of siblings ever born and siblings surviving to 9-12 year olds, Kenya, Mexico, South Africa, and Vietnam**

	<b>Siblings ever born</b>			<b>Siblings surviving</b>		
	<b>1989</b>	<b>1999</b>	<b>Change</b>	<b>1989</b>	<b>1999</b>	<b>Change</b>
<b>Kenya</b>						
<b>Total</b>	5.88	5.14	-0.75	5.27	4.55	-0.72
<b>Rural</b>	6.03	5.35	-0.68	5.39	4.74	-0.66
<b>Urban</b>	4.64	4.20	-0.44	4.25	3.73	-0.51
<b>Low Mother's Schooling</b>	6.38	6.10	-0.29	5.58	5.29	-0.29
<b>High Mother's Schooling</b>	5.20	4.55	-0.65	4.85	4.10	-0.75
<b>Mexico</b>						
<b>Total</b>	4.49	4.04	-0.45	4.12	3.70	-0.43
<b>Rural</b>	5.57	4.89	-0.68	5.01	4.44	-0.56
<b>Urban</b>	3.94	3.32	-0.62	3.67	3.07	-0.60
<b>Low Mother's Schooling</b>	5.64	5.47	-0.17	5.08	4.92	-0.15
<b>High Mother's Schooling</b>	3.47	3.20	-0.27	3.27	2.98	-0.29
<b>South Africa</b>						
<b>Total</b>	4.58	4.05	-0.53	4.06	3.86	-0.20
<b>Rural</b>	5.38	4.88	-0.50	4.64	4.57	-0.08
<b>Urban</b>	3.70	3.34	-0.36	3.42	3.25	-0.17
<b>Low Mother's Schooling</b>	5.86	5.12	-0.74	4.95	4.78	-0.18
<b>High Mother's Schooling</b>	4.07	3.67	-0.40	3.70	3.53	-0.17
<b>Vietnam</b>						
<b>Total</b>	3.81	2.62	-1.19	3.52	2.48	-1.04
<b>Rural</b>	4.12	3.01	-1.11	3.78	2.84	-0.94
<b>Urban</b>	3.26	2.09	-1.17	3.06	2.00	-1.06
<b>Low Mother's Schooling</b>	4.88	3.92	-0.96	4.40	3.61	-0.78
<b>High Mother's Schooling</b>	3.27	2.31	-0.96	3.08	2.22	-0.86

*Note: Low Mother's Schooling = < 4 years; High Mother's Schooling = 4+ years*

Figure 1. Total Fertility Rate and Probability of Infant Survival for 6 countries, U.N. Population Data

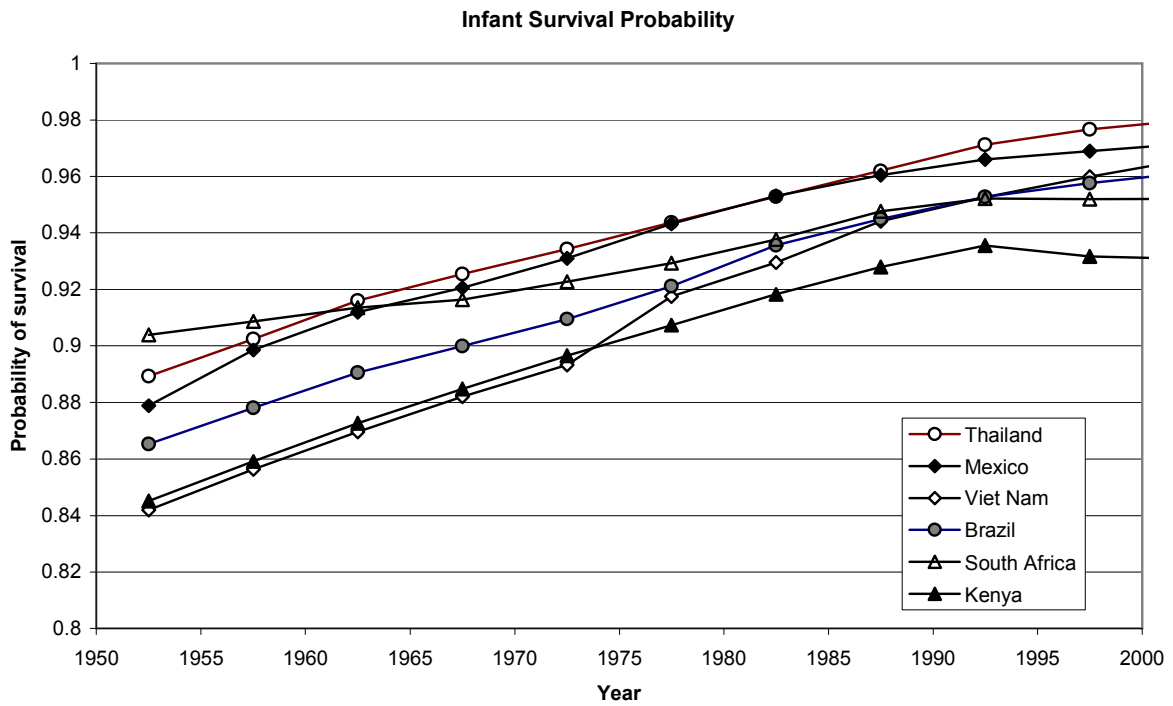
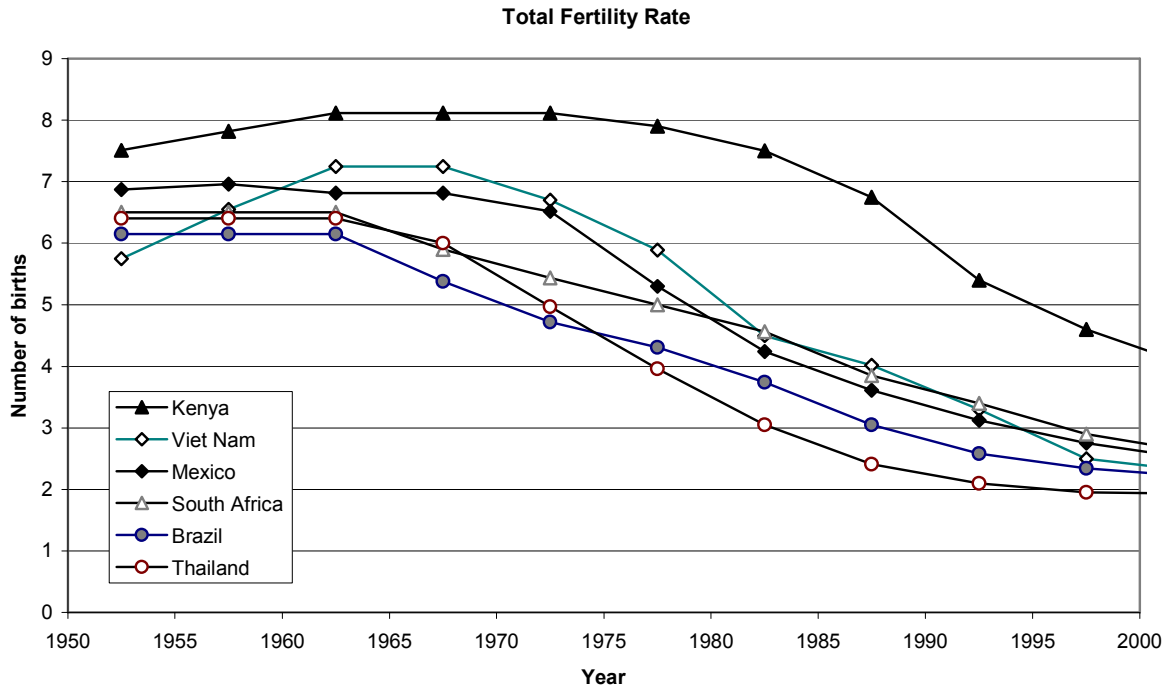


Figure 2. Predicted annual change in surviving family size by year of birth of child

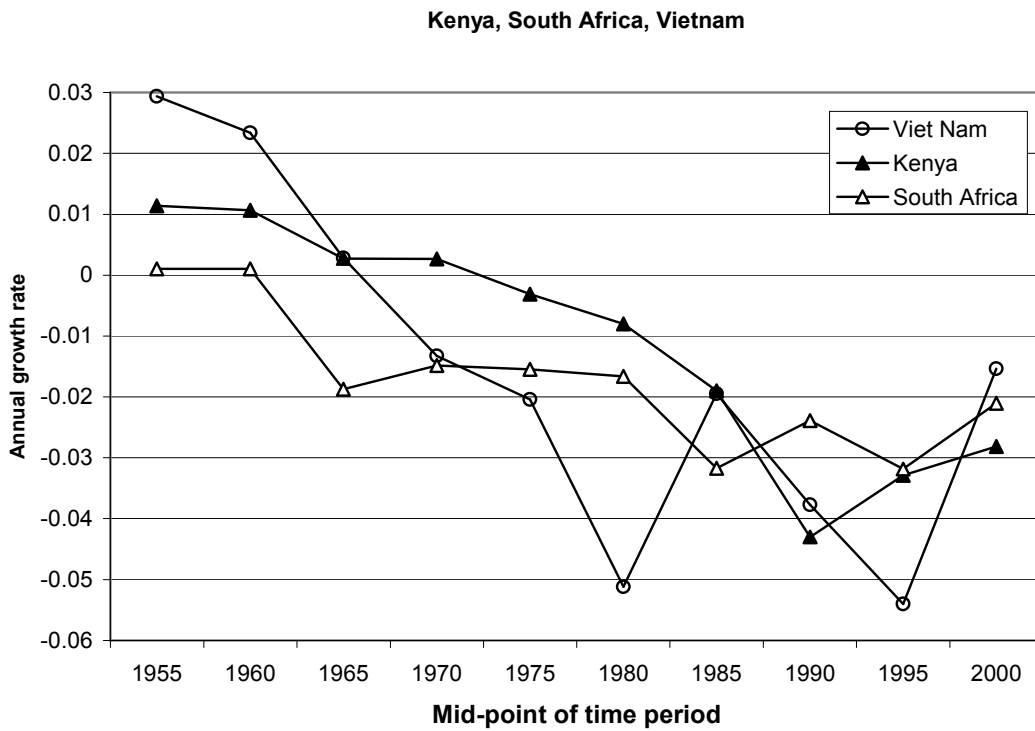
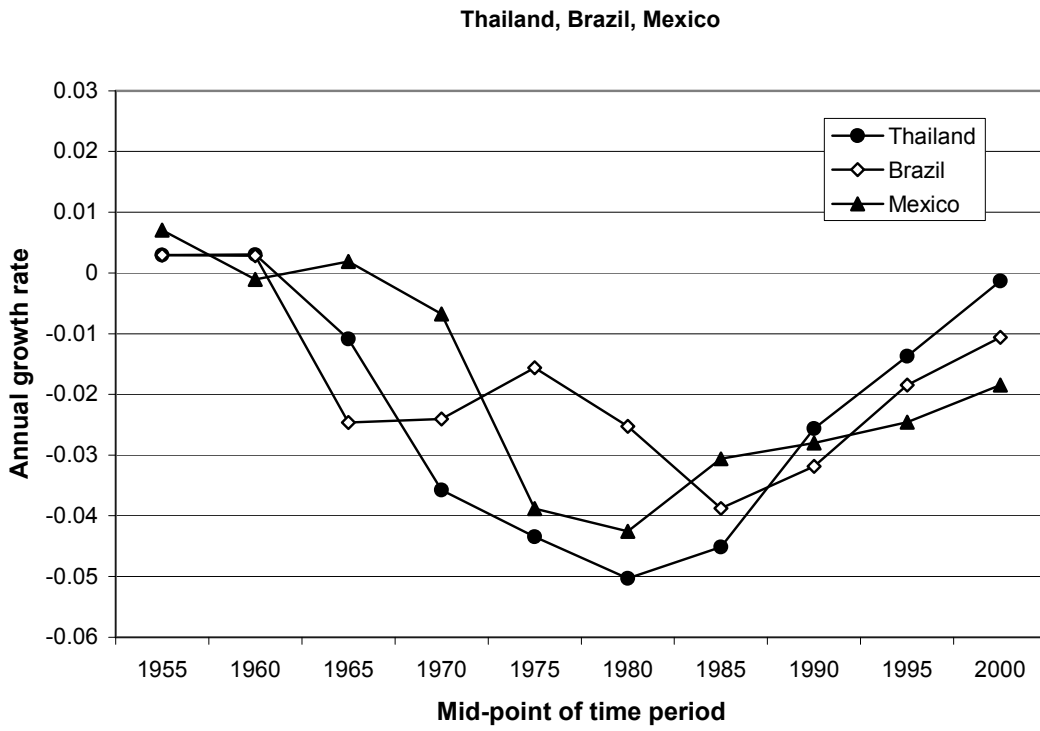


Figure 3. Number of Births and Number of Women Age 15-49 for 6 countries, U.N. Population Data

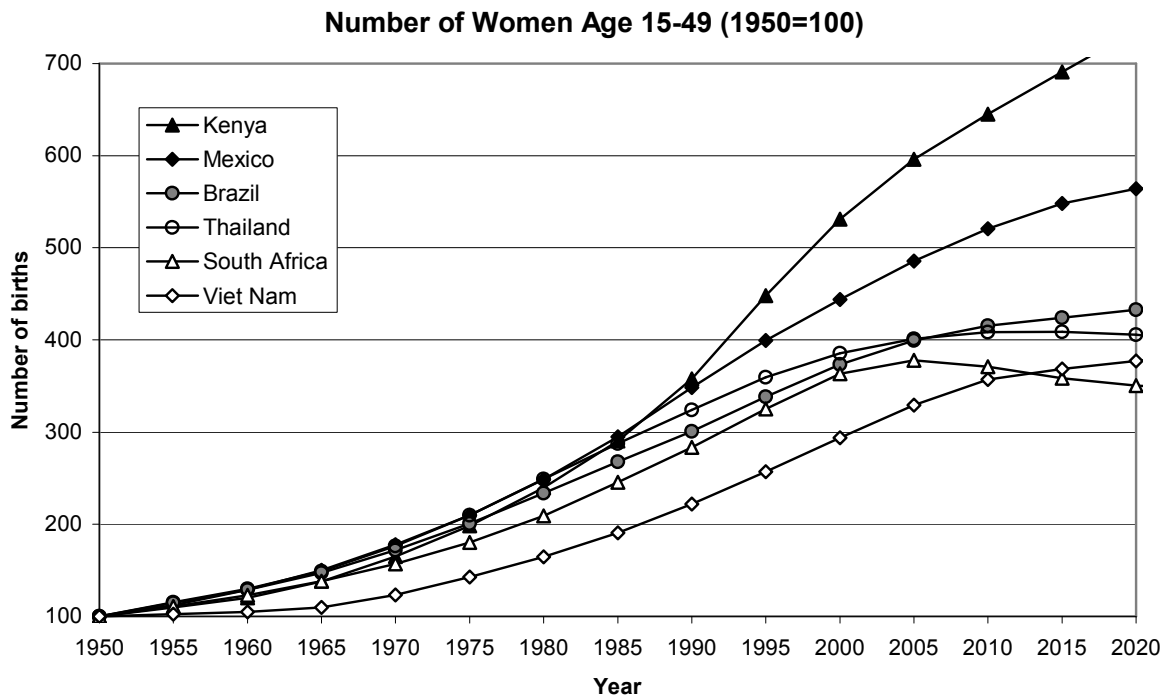
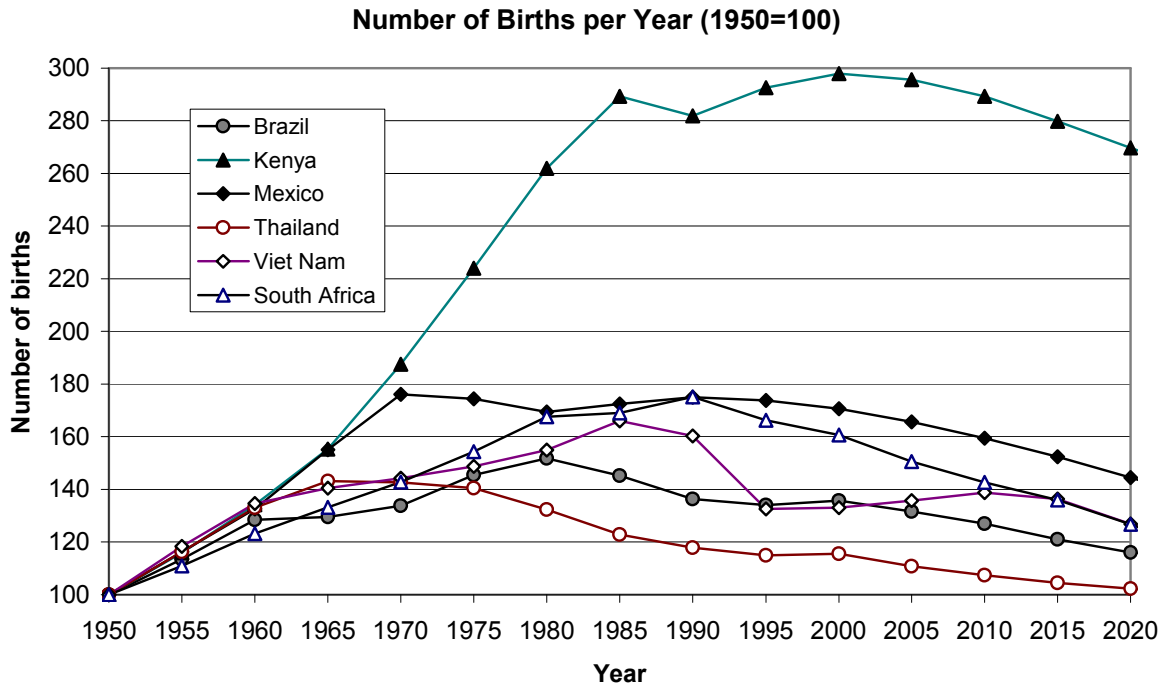




Figure 4. Size of Birth Cohorts in Brazilian Censuses of 1970, 1980, 1991, and 2000

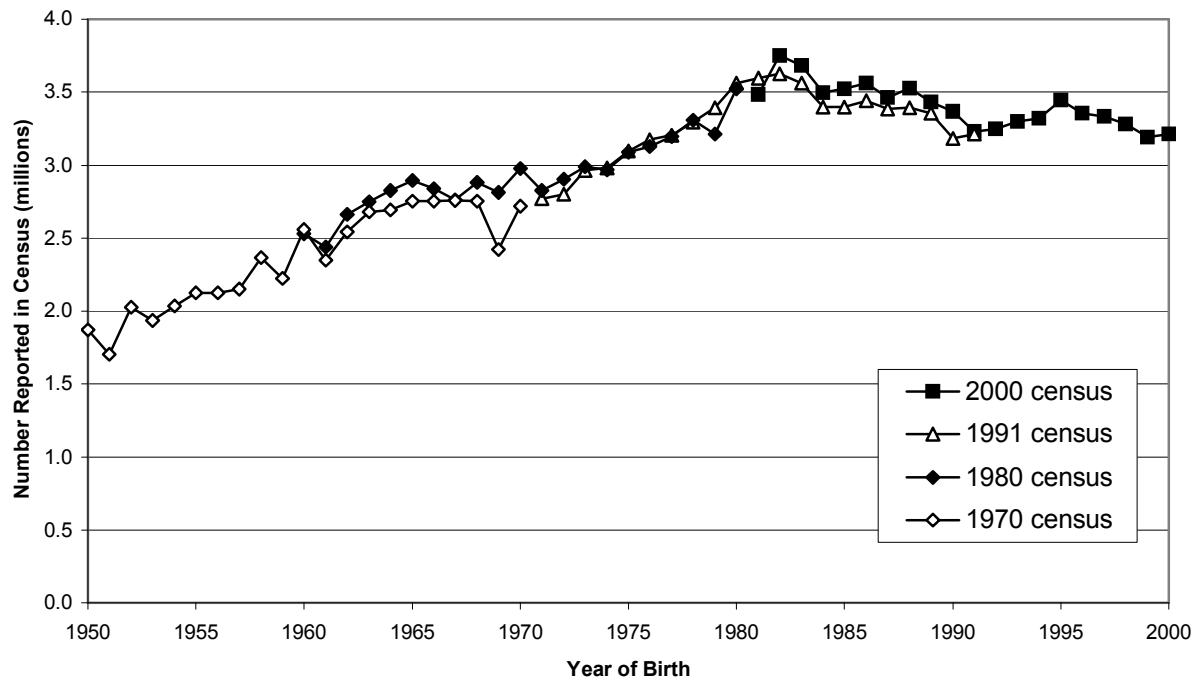
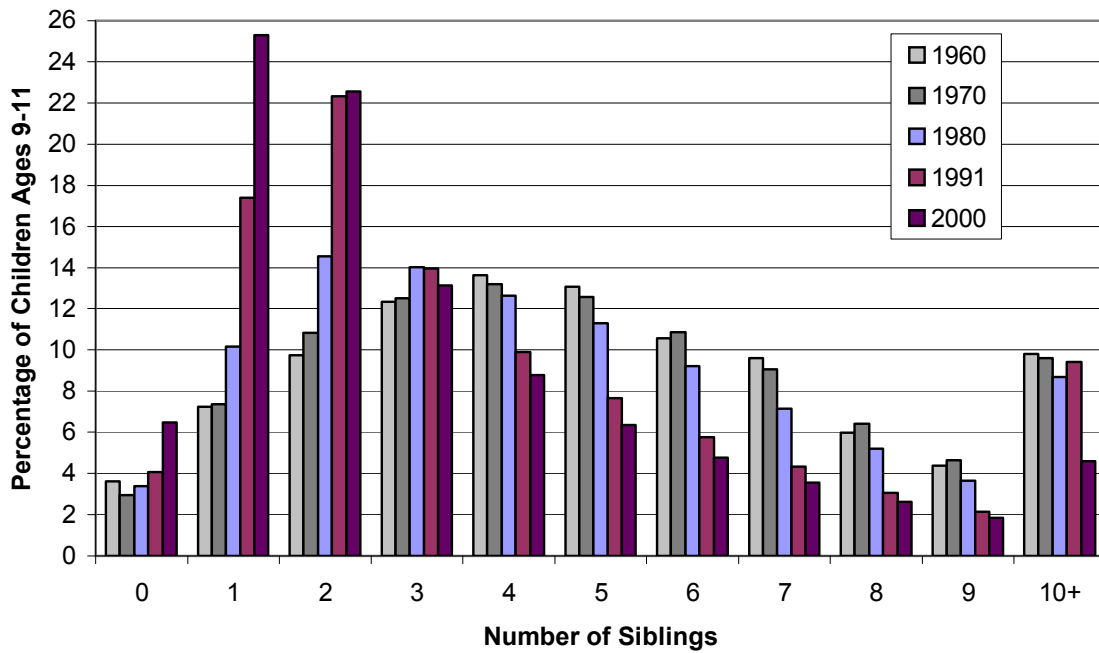
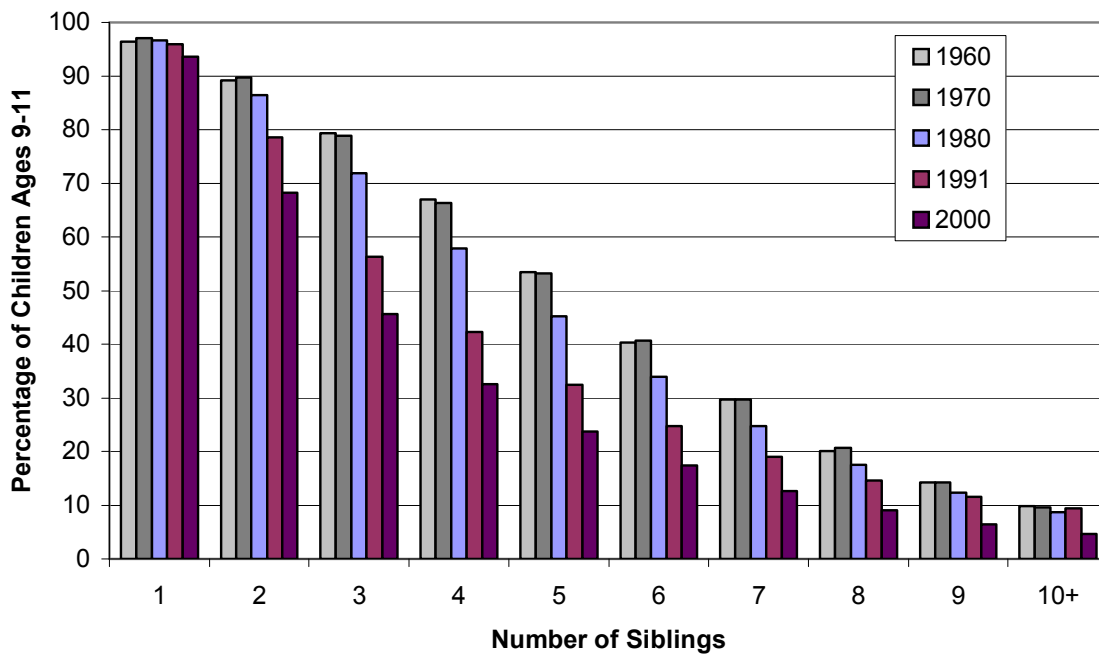


Figure 5. Distribution of Numbers of Siblings of Children Ages 9-12, Brazil 1960-2000

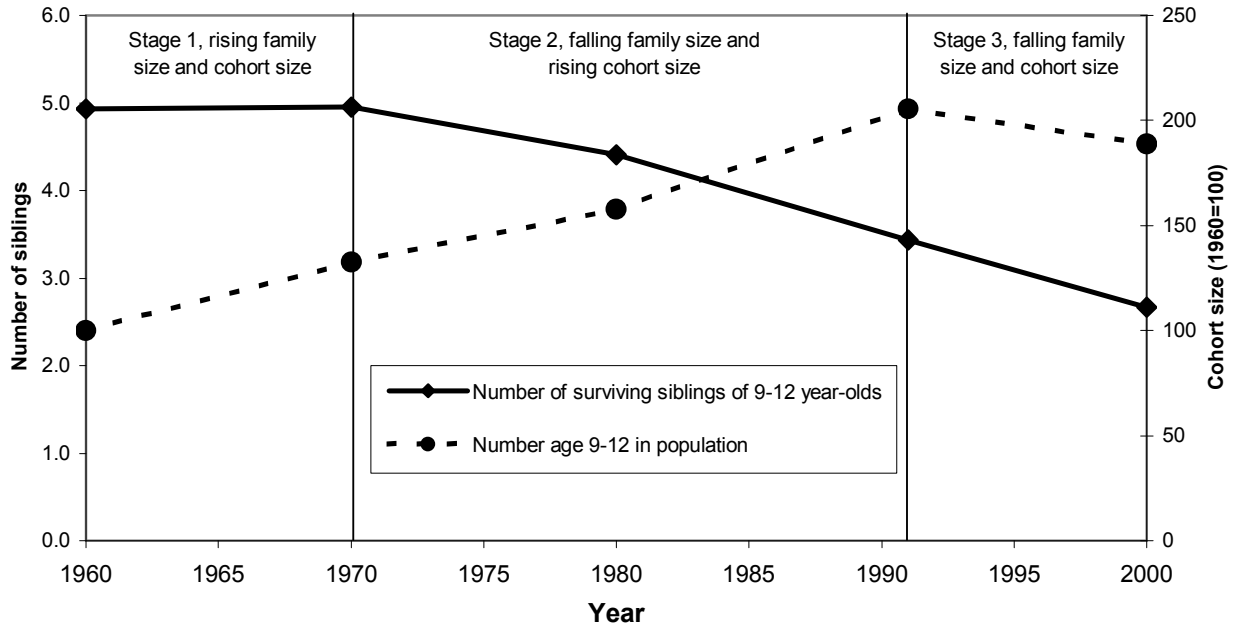
Percentage with x siblings



Percentage with x or more siblings



**Figure 6. Number of living siblings and total number in population of 9-12 year-olds, Brazilian censuses 1960-2000**



**Figure 7. Percentage with x or more siblings, Children Ages 9-12, Kenya, Mexico, South Africa, and Vietnam**

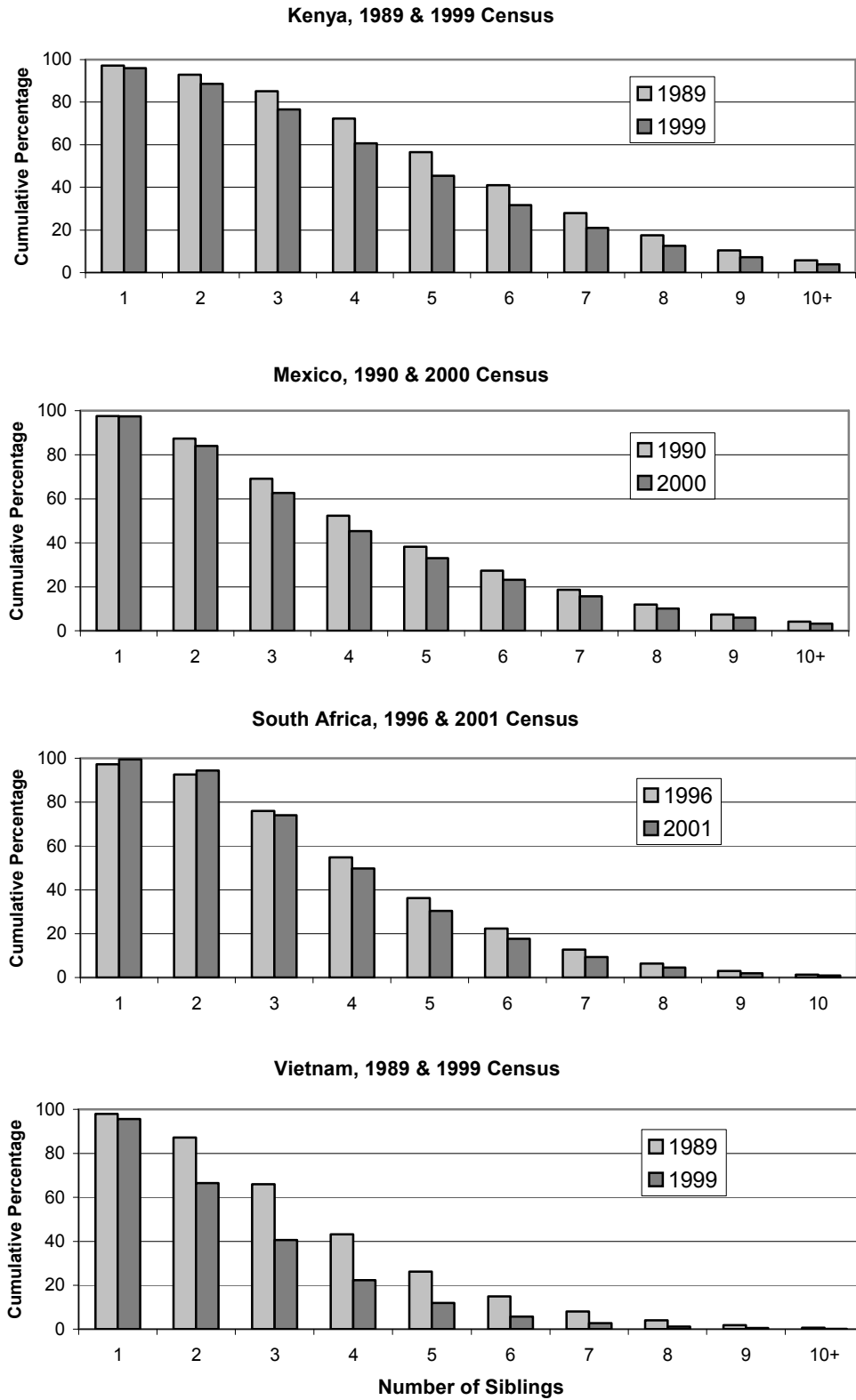


Figure 8. Age Pyramids for Brazil, Kenya, and South Africa

