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

David Lam
University of Michigan
davidl@umich.edu

and

Letícia Marteleto
Universidade Federal de Minas Gerais
leticia@cedeplar.ufmg.br

Prepared for submission to the 2004 meetings of the
Population Association of America

September 2003

David Lam is Professor of Economics and Director of the Population Studies Center at the University of Michigan. Leticia Marteleto is a researcher in the Demography Department and CEDEPLAR at the Federal University of Minas Gerais in Brazil. Support for this research was provided by the U.S. National Institutes of Health (NICHD Grant Number R01HD031214), the Mellon Foundation and the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq), Brazil.

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

David Lam and Letícia Marteleto

Abstract:

The demographic transition, as typically experienced in developing countries over recent decades, generates a sequence of changes in family size and cohort size that may have important implications for resources available to children. In this paper we provide a new characterization of stages of the demographic transition from a child's perspective. In the first stage, falling infant and child mortality lead to increasing numbers of surviving children within families and to increases in the size of birth cohorts. 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 born in the first stage 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.

We analyze the sequence of stages in a number of countries, with particular emphasis on Brazil, where we have detailed census microdata back to 1960. Brazil entered Stage 2 of the transition before 1970, and entered Stage 3 around 1982, when the largest birth cohort was born. The resulting decline in the size of the school-age population in the 1990s is associated with large improvements in schooling outcomes. Brazil is typical of many Asian and Latin American countries that have already entered Stage 3 of the transition. Kenya has clearly entered Stage 2, with declines in the number of siblings for school-age children observed between 1990 and 2001, but will probably not enter Stage 3 for at least another decade.

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 every age at the population level. These declines in moratlity 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. Children, especially school-age children, compete for resources at both the family and the population level. 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 born in the first stage 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.

We analyze the sequence of stages in several 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 show that the resulting decline in the size of the school-age population in the 1990s is associated with large improvements in schooling outcomes. Brazil is typical of many Asian and Latin American countries that have already entered Stage 3 of the transition. Kenya has clearly entered Stage 2, with declines in the number of siblings for school-age children observed between 1990 and 2001, but will probably not enter Stage 3 for at least another decade.

DATA

An important goal of our analysis 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 we want to look at 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 supplement these census data with the large household surveys collected by the *Instituto Brasileiro de Geografia e Estatística* (IBGE), the Brazilian statistical bureau. The *Pesquisa Nacional de Amostra de Domicílios* (PNAD) is a nationally representative sample of 80,000 to 100,000 households collected annually to provide data on employment and earnings. The PNAD contains standard demographic and economic variables such as employment status, occupation, income, and schooling for all members of the household. In this paper we use the PNAD from 1977 to 2001.[1]

[1] There was no survey in 1980, 1991, or 2000 because of the censuses conducted in those years, and there was no survey in 1994.

We also use census data taken from the Integrated Public Use Microsamples – International (IPUMS-I) project of the University of Minnesota. From the IMPUS-I web site we use census samples from Mexico (1990 and 2000), Kenya (1989 and 1999) and Vietnam (1989 and 1999). While these data do not let us go as far back in the demographic transition as we can with the Brazilian data, the two censuses taken a decade apart allow us to look at how family size is changing in these countries.

DYNAMICS OF FAMILY SIZE AND COHORT SIZE DURING THE DEMOGRAPHIC TRANSITION

This section will present a simple model of the dynamics of family size and cohort size during the demographic transition. The model begins with a stable population in equilibrium. An initial sustained decline in infant mortality is followed with some delay by a sustained decline in fertility. We show that family size and cohort size must increase together in the initial stage, but that family size declines well before cohort size begins to decline. Our stages of the demographic transition can be clearly defined using this representation.

THE DEMOGRAPHIC TRANSITION AND COHORT 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. 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 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.[2] Since our interest is in estimating the size of cohorts at the time those cohorts were 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

[2] 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.

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.

The changes in cohort size shown in Figure 1 translate into large changes in the absolute size and growth of the school-age population. We use the cohort size numbers in Figure 1 to generate the number of children age 7-14 and their growth rate for each calendar year. Figure 2 shows the absolute size of the population ages 7-14 in each year, using 1965 as a reference year, along with the annual percentage growth rate for the population age 7-14. As seen in Figure 2, the 7-14 age group grew very rapidly in the 1965-1975 period, reaching growth rates exceeding 3% per year. The age group grew at a much slower rate in the 1975-1980 period, falling to an annual growth rate of around 0.5% around 1978. The growth rate increased rapidly again in the 1980s, peaking at a growth rate of around 2.5% around 1988, followed by a rapid decline in the 1990s. The population age 7-14 actually begins to decline in absolute numbers around 1995. These rapid changes in the size of the population age 7 to 14 during the 1980s and 1990s are the result of a complex combination of the pace of fertility decline and the numbers of women entering childbearing age, reflecting past population dynamics. Figures 1 and 2 demonstrate that not only the relative, but also the absolute size of the school age population are declining by mid-1990s.

CHANGING FAMILY SIZE

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 6-8, 9-11, and 12-14 in the 1960, 1970, and 1980 Brazilian censuses. The three-year age groups are used to reduce the impact of age misreporting and cover the range of ages from school entry to the highest legal (though poorly enforced) age of compulsory school attendance. The children ever born columns indicate that fertility decline was already underway in Brazil between the 1960 and 1970 censuses. The mothers of children in all three age groups reported fewer children ever born in 1970 than did their counterparts in 1960, with declines of 0.25 to 0.46 births. The children

surviving columns show a different pattern however, with slight increases in the number of children surviving to the mothers of children in all three age groups. While the mothers of children age 9-11 had given birth to 0.36 fewer children in 1970 than in 1960, the 1970 children actually had 0.4 more surviving siblings than did their 1960 counterparts. 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. From the standpoint of children ages 6-8, the mothers of 1980 had given birth to about one child fewer than the mothers of 1970. These declines were large enough to cause declines in the numbers of surviving children. For children ages 6-8 the number of children surviving to their mothers declined from 5.52 to 4.86. The fact that children ever born declined by almost a full birth, while the number of surviving children declined by only 0.7 births, indicates that falling infant and child mortality continued to have an important impact on family size in the 1970s.

Table 2 also presents 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 increases of 0.14 to 0.18 surviving siblings to children in the three age groups. The southeast, on the other hand, had already move out of Stage 1 of the demographic transition by 1970, with decreasing numbers of surviving children to the mothers of all three age groups. 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 in the northeast had about 0.3 fewer siblings in 1980 than they did in 1970.

OUTLINE OF REMAINDER OF PAPER

The paper will continue this analysis with the 1991 and 2000 Brazilian censuses, supplemented with the rich detail of the annual PNAD surveys. In addition to looking at changes in family size and cohort size, we will look at changes in school enrollment and schooling

attainment over the four decades. We have shown in an earlier paper that the declines in the size of the school-age population beginning around 1990 coincide with large improvements in schooling. We will extend this analysis back to earlier periods.

We have also begun conducting similar analysis using the Kenya, Mexico, and Vietnam census samples. Patterns in both cohort size and family size differ significantly across these countries, but all appear to fit well into our overall framework.

.

REFERENCES

Anh, T., J. Knodel, D. Lam and J. Friedman. 1998. "Family Size and Children's Education in Vietnam." *Demography* 35:57-70.

Barros, R. and D. Lam. 1996. "Income and Education Inequality and Children's Schooling Attainment in Brazil." Pp. 337-366 in *Opportunity Foregone: Education in Brazil,* edited by N. Birdsall and R. Sabot . Washington: Inter-American Development Bank.

Bercovich, A. and F. Madeira. 2000. "Demographic Discontinuities in Brazil and in the State of São Paulo." *Brazilian Journal of Population Studies* 2:5-26.

Birdsall, N. 1988. "Economic Approaches to Population Growth." Pp. 477-542 in *Handbook of Development Economics*, *V. 1*, edited by H. Chenery and T. N. Srinivasan. Amsterdam: North Holland.

Carvalho, J. A. and L. Wong. 1995. "A window of opportunity: Some demographic and socioeconomic implications of the rapid fertility decline in Brazil." Discussion Paper 91. CEDEPLAR, Universidade Federal de Minas Gerais.

Chernichovsky D. 1995. "Socioeconomic and demographic aspects of school enrollment and attendance in rural Botswana." *Economic Development and Cultural Change* 33: 319-32.

Anuário Estatístico do Brasil. 1980. Rio de Janeiro: IBGE.

Anuário Estatístico do Brasil. 1996. Rio de Janeiro: IBGE.

Jones, G. 1971. "Effects of Population Growth on the Attainment of Educational Goals in Developing Countries." Pp. 315-367 in *Rapid Population Growth*, National Academy of Sciences. Baltimore: Johns Hopkins University Press.

Knodel, J. and M. Wongsith. 1991. "Family Size and Children's Education in Thailand: Evidence From a National Sample." *Demography* 28:119-31.

Knodel, J. 1992. "Fertility Decline and Children's Education in Thailand: Some Macro and Micro Effects." In *Fertility, Family Size, and Structure: Consequences for Families and Children* edited by *C.* Lloyd. New York: The Population Council Research Division.

Lam, D. 2001. "Generating Extreme Inequality: Schooling, Earnings, and Intergenerational Transmission of Human Capital in South Africa and Brazil," Paper presented at the Population Association of America Annual Meeting, Washington, March.

Lam, D. and S. Duryea. 1999. "Effects of Schooling on Fertility, Labor Supply, and Investments in Children, With Evidence From Brazil." *Journal of Human Resources* 341:160-192.

Lam, D. and L. Marteleto. 2000. “Grade repetition, school enrollment, and economic shocks in Brazil.” Paper presented at the 2000 Population Association of America Meeting, Los Angeles, March.

Marteleto, L. 2001. “A Cohort Analysis of Children’s Schooling in Brazil: Do Number and Composition of Siblings Matter?” Paper presented at the 2001 Population Association of America Annual Meeting, Washington, March.

Martine, G. 1996. “Brazil's fertility decline, 1965-95: A fresh look at key factors.” *Population and Development Review* 22:47-75.

Parish, W. and R. Willis. 1993. “Daughters, education, and family budgets: Taiwan experience.” *The Journal of Human Resources* 28:863-98.

Patrinos, H. and G. Psacharopoulos. 1997. “Family size, schooling and child labor in Peru: An empirical analysis**.”** *Journal of Population Economics* 10:387-405.

Psacharopoulos, G. and A. M. Arriagada. 1989. “The determinants of early age human capital formation: Evidence from Brazil.” *Economic Development and Cultural Change* 37:683-708.

Rigotti, I. 2001. “A Transição da Escolaridade no Brasil e as Desigualdades Regionais.” Paper presented at the IUSSP Conference. Salvador, Brazil.

Schultz, T. P. 1987. “School Expenditures and Enrollments, 1960-80: The Effects of Income, Prices, and Population Growth.” Pp. 413-476 in *Population Growth and Economic Development: Issues and Evidence,* edited by D. G. Johnson and R. Lee. Madison: University of Wisconsin Press.

Wong, L. 2000. “ A Projeção da Fecundidade: Um Exercício Aplicado ao Brasil para o Período 1991-2000.” *Annais of the XII Meeting of the Brazilian Association of Population Studies.* Caxambu: ABEP.

Wood, C. and J. A. M. de Carvalho. 1988. *The Demography of Inequality in Brazil*. Cambridge: Cambridge University Press.

Population Change and Economic Development: World Bank World Development Report. 1984. New York: Oxford University Press.

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

	Year						
	1940	**1950**	**1960**	**1970**	**1980**	**1991**	**2000**
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 children ever born and children surviving to mothers of school-age children, Brazil 1960, 1970, and 1980 Censuses

	Children ever born			*Children Surviving*		
	1960	**1970**	**1980**	**1960**	**1970**	**1980**
All Brazil						
Age 6-8	6.75	6.50	5.53	5.47	5.52	4.86
Age 9-11	7.41	7.06	6.19	5.93	5.96	5.41
Age 12-14	7.97	7.51	6.70	6.28	6.28	5.80
Northeast						
Age 6-8	7.79	7.48	6.76	5.86	6.00	5.65
Age 9-11	8.57	8.21	7.49	6.35	6.51	6.18
Age 12-14	9.21	8.77	8.10	6.69	6.87	6.58
Southeast						
Age 6-8	6.11	5.84	4.74	5.13	5.10	4.30
Age 9-11	6.72	6.36	5.40	5.56	5.50	4.86
Age 12-14	7.22	6.75	5.87	5.90	5.79	5.25

Figure 1. Size of Birth Cohorts in Brazilian Censuses of 1970, 1980, 1991, and 2000

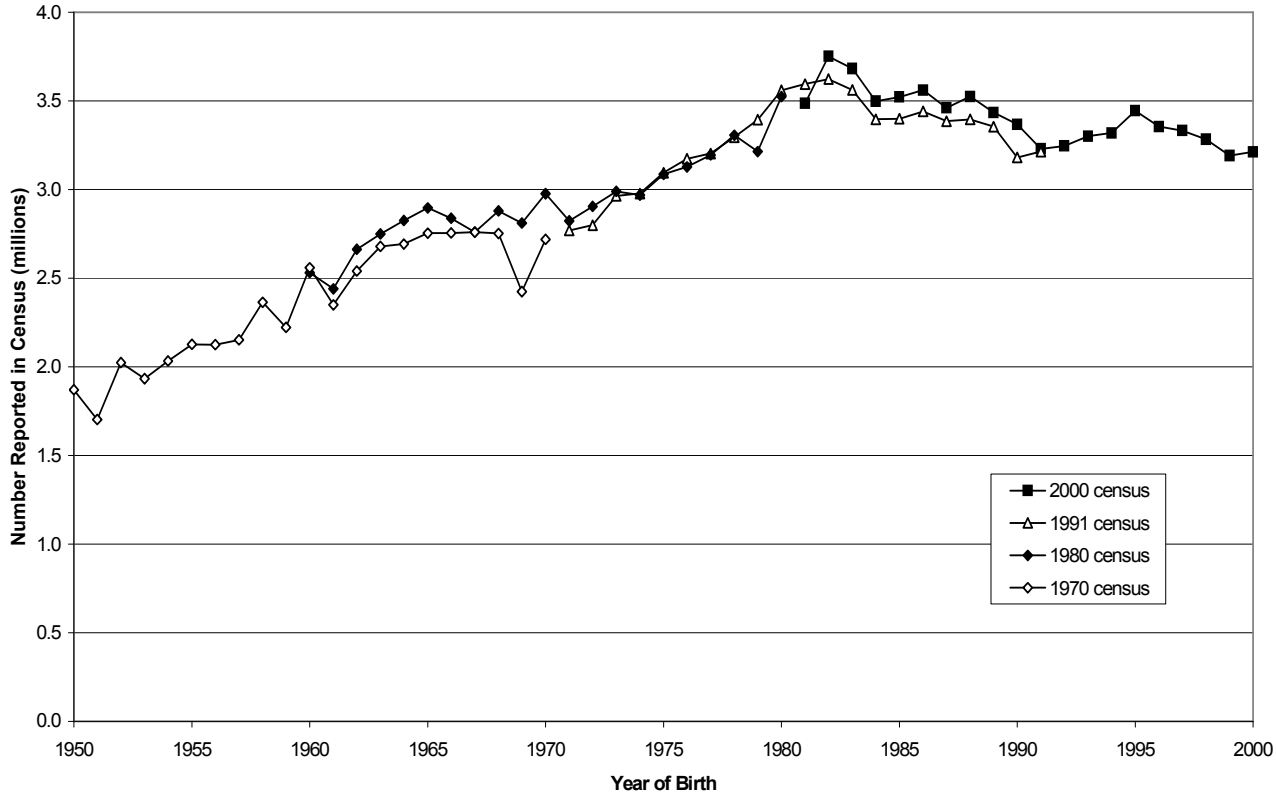

Figure 2. Number and growth rate of population age 7-14, Brazil, 1965-2000 (number relative to 1965=100)