# THE LESLIE MODEL AND THE PEOPLE'S REPUBLIC OF CHINA

Following the revolution in 1949, China's population grew from roughly 550 million to over 1 billion by 1982. Data show that for much of this period, the average female gave birth to five or six children. At the same time, a significant decrease in infant mortality rates and improvement in health care, epidemic disease control, available food and better living conditions all contributed to a rise in the population. China's census in 1982 showed that the country included approximately one quarter of the world's population, with only 7% of the world's tillable land.

In 1978 the national government began to promote the idea of the one-child family to help lower the high rate of population growth. Initially, the goals of the policy were moderate. Leaders hoped that about a quarter of the urban families and fewer of the rural families would restrict themselves to one child. In the long-term, the policy was intended to help the population stabilize at approximately 900 million people by the middle of this century. However, the policy greatly intensified. By 1981 most governments in both urban and rural regions had developed systems to reward couples who agreed to have only one child and penalize those having more. The penalties grew over time and ranged from monetary fines to pregnancy termination and sterilization.

(*Bradley & Meek, 1986, pp. 154-172*)

## Part I

By looking at age-specific deaths in 1978, Chinese demographers calculated the probability of survival from one age class to the next. The numbers of females (in 1982) are given in millions in the table below.

| Age in years | 0-9 | 10-19 | 20-29 | 30-39 | 40-49 | 50-59 | 60-69 | 70-70 | 80+ |
|---|---|---|---|---|---|---|---|---|---|
| **Number of Females** | 102 | 129 | 85 | 64 | 49 | 37 | 24 | 11 | 3 |
| **Survival Rates** | .97 | .993 | .987 | .981 | .962 | .907 | .761 | .51 | 0 |

In view of the nature of the policy, it is difficult to predict future fertility rates. We will explore what will happen to the population for varying degrees of success of the policy.

Suppose the policy is no more successful than the level it had reached in 1981. The 1982 sample census gives age-specific birth rates for 1981, and we will suppose they will carry on into the future. These figures tell us that we could expect (approximately) a woman in age class 1 (10-19 years) to have produced an average of .45 female children in ten years' time, a woman in age class 2 to have produced .685 female children and a woman in age class 3 to have produced .135 female children. The low fertility rates of other age groups will be ignored. These figures give us a Leslie matrix on the assumption that such rates will continue.

1. Using the birth rates provided in the previous paragraph, investigate the population of China in 1992, 2002, 2012, through 2062 in steps of 10 years. Report your age distribution vectors for 1992, 2022, and 2062. For these same years, also report the total populations. What is the long-term growth rate? What is happening to the population?

2. The model above assumes an average of 2.54 children per woman in her lifetime. Briefly explain how we know this.

**Part II**

1.  Suppose *instead* that the average is 2 children/woman, where the birth rate for women 10-19 is .41 and for women 20-29 is .59 female children. Again investigate the population of the PRC in 10 year increments.
    a.  Report your age distribution vectors and total populations for 1992, 2022, and 2062.
    b.  What is the long-term growth rate; i.e. what is happening to the population?

2.  Now assume they are successful in achieving 1-child families, and the birth rates for women 10-19 is .28 and for women 20-29 is .22 female children.
    a.  Why are these birthrates reasonable for the one-child policy?
    b.  Report your age distribution vectors and total populations for 1992, 2022, and 2062.
    c.  What is the long-term growth rate; i.e. what is happening to the population?

3.  If the government continued with the one-child family indefinitely, the population would certainly decline. In actuality, the one-child family was seen as temporary.  The plan was to be implemented for one generation and then that couples who are "only children" may have two children.  Thereafter, a two-child policy was to be continued. Assume any female born between 1982 and 2002 was an only child and will be able to have two children.  Therefore the birthrates will change, and we need to change the Leslie matrix several times as we explore the female population for several decades.

    Use the rates given in #2 in this Part II from 1982 to 2002, and report the age distribution vectors for each decade from 1982-2012.  Then, as women who are only children move through the system, change the appropriate entries in the first row, and find the age distribution vectors for all decades 2022-2062.  For example the birthrates in the Leslie matrix used *to predict* the age distribution in *2012* should be [0  .28 .22  0  0  …].  The birthrates in the Leslie matrix used to predict the population from 2022 until 2062 should be [0  .41  .59  0  0…].  For all of these years, **also report the total populations**.  What is the long-term growth rate; i.e. what is happening to the population?

*Adapted from:*  Bradley, I., & Meek, R. L. (1986). *Matrices and society: Matrix algebra and its applications in the social sciences*. Princeton NJ: Princeton University Press.