2017

Using the Pert Exponential Growth Model: Predicting Past and Future Chinese Populations Involving their Famous Population Control Policies

Greg Gancarz
Parkland College

Using the Pe^{rt} Exponential Growth Model

Predicting past and future Chinese populations involving their famous population control policies

Gregory Gancarz

This project serves to examine the hypothetical effects of the implementation and repeal of China's famous One Child Policy on the rate of population growth in that country through the use and applications of the basic exponential growth model. Although the various contributing factors of Chinese population growth will be largely overlooked for the purposes of the scenarios, the main trends still present themselves quite accurately through its utilization. Three hypothetical trends regarding Chinese fertility rates will be examined and computed using the exponential growth equation:

$$Pe^{rt}$$

I. Effects on the Chinese population's growth rate, had the One Child Policy and similar population control policies never been enacted and assuming all growth retardation was due to the policies' effects.

Up until the 1960's the Chinese government encouraged families to birth as many children as possible. It wasn't until the 60's and 70's that concerns regarding overpopulation began to arise and the government's position completely reversed itself. By 1979, the One Child Policy had officially been implemented, but not before the government and concern

over the cost of child rearing had already taken their toll on fertility rates. This example examines what the Chinese population would look like today had the government never switched its policy. It also assumes that all drop off in fertility rates would have been because of government interference and thus takes its population growth statistics from the years prior to when Chinese family-planning legislation took effect. This model also assumes all population growth would be able to be supported by the Chinese nation in regards to food and water and the other materials needed to prevent mass-starvation.

For this equation, we need China's population figures for 1955 and 1975, 598,574,241 and 905,580,455 respectively, to plug them into the equation. The rate of time is 20 years. The only unknown variable is the rate:

$$905{,}580{,}455 = 598{,}574{,}241e^{20r}$$

$$\frac{905{,}580{,}455}{598{,}574{,}241} = e^{20r}$$

$$\ln\left(\frac{905{,}580{,}455}{598{,}574{,}241}\right) = 20\text{r}$$

$$\ln\left(\frac{905{,}580{,}455}{598{,}574{,}241}\right) \div 20 = r$$

r = .02070 or 2.07%

Now that we have the rate of growth in this 20 year period, we can use it to predict how large the population would have grown if it were allowed to grow unfettered until recent years. For this equation, we simply plug the 1975 population in for *p*, and the rate of growth in for *r*. This growth model will take place over a period of 40 years, until 2015:

$$905{,}580443e^{(.0207)(40)}$$

=

2,072,635,182

So, assuming the growth rates prior to the change in population management policy continued unabated, China would now have a population of over two billion people, much more than the actual 2015 population: 1,376,048,943.

II. Examining what China's population level would be in 2045, assuming the repeal had never been enacted.

In late 2015, the government of China announced that it would be ending its One Child Policy. A Two Child Policy would now be the standard to help combat an aging population. But what would the nation's numbers look like if this never took place and the nation spent another 30 years with the same method of population control? This scenario examines the possible growth effects.

For this equation, we first need to calculate China's growth rate under the One Child Policy. To calculate this, the population figures from 1980 and 2010 will be used; 977,837,433 and 1,340,968,737 respectively

$$1{,}340{,}968{,}737 = 977{,}837{,}433e^{30r}$$

.

$$\frac{1{,}340{,}968{,}737}{977{,}837{,}433} = e^{30r}$$

$$ln(\frac{1{,}340{,}968{,}737}{977{,}837{,}433}) = 30\text{r}$$

$$ln(\frac{1,340,968,737}{977,837,433}) \div 30 = r$$

r = .0105 or 1.05%

Now that the rate of growth is known, about 1.05%, we can apply it to a new equation calculating the population in 2045, using the 2010 population as the principal. Now that there are no undetermined variables, we simply plug in all the numbers.

$$1,340,968,737e^{.0105(35)}$$

=

1,936,519,502

As we can see, if China never repealed their policy, the population would likely be just under two billion people in another three decades in 2045. Interestingly, even with an extra thirty years of growth, in 2045 the population under the control policies would still be less than what the unrestricted population would have been *today*, which was earlier calculated to have been just over two billion.

III. China's population in 2045 with the new Two Child Policy being implemented.

China has already seen the effects of over 30 years of one method of population control. Now how about three decades of another? This scenario examines what China's population is likely to be under the Two Child Policy in another 30 years from now, using the little data that has currently been made available since the recent policy revision.

For this equation we'll be using China's population in 2015, the year the policy was changed, and 2017, the most recently available population statistic we can use.

$$1{,}388{,}232{,}693 = 1{,}376{,}048{,}943e^{2r}$$

$$\frac{1{,}388{,}232{,}693}{1{,}376{,}048{,}943} = e^{2r}$$

$$ln(\frac{1{,}388{,}232{,}693}{1{,}376{,}048{,}943}) = 2\text{r}$$

$$ln(\frac{1{,}388{,}232{,}693}{1{,}376{,}048{,}943}) \div 2 = r$$

r = .00441 or .441%

Surprisingly, the growth rate over the time period since the policy was changed would actually seem to be *lower* than the growth rate under the One Child Policy. This is a perfect example of the flaws of using such a broad, unprecise system to take averages, especially those of only two years. The lower growth rate calculated is a reflection of only a handful of numbers. While birth rates did fall immediately after the implementation of the One Child Policy, they dropped significantly lower in recent decades, from around 1.5% in the 1990's to only about half a percent in the 2000's. The large sample size taken for calculating the One Child Policy's growth rate; from the 80's until 2010, skewed the rate positively because it also included the relatively high growth rate of the 80's and 90's. The limited sample size of the Two Child Policy's growth rate, on the other hand, only took the abysmal growth rates of 2015, 2016, and 2017 into account, all of which hovered around half a percentage point and were also below the government's own expectations.

As more time passes and more and more figures accumulate, it will likely become easier to paint a more accurate picture of what China's future population will look like, unless the growth rate continues the trend of extremely low growth, despite the relaxed birth

restrictions. Nevertheless, we will use the figures we have come up with now to estimate the 2045 population.

$$1{,}388{,}232{,}693e^{.00441(28)}$$

=

1,570,684,473

And there we have it. Unless the growth rate defies predictions and remains at the current low levels, the 1.5 billion person estimate for 2045 is somewhat flawed, but as of now, it's one of the best estimates we can glean, using this simple formula.