5

Population and Migration

CHAPTER OUTLINE

This chapter is intended to help you better understand the dynamics, growth, and change of populations. First, we'll go over some basic math tools to help you recall many of the complicated statistics and numerical indicators. After that, we'll apply these concepts to the significant models in population geography. Then we'll review several related concepts that show up frequently on the exam, and we'll finish up with key terms.

KNOW THE MATH

In this section we're not going to drop a ton of math on you; instead, we'll give you a few helpful tips you need to know to understand how population changes occur. The concepts presented here use the math you probably learned in fourth grade. You can handle it.

BASIC POPULATION STATISTICS

Population growth is understood through the concepts of the **rate of natural increase (RNI)** and the **demographic equation**. The demographic equation uses **birth rates** and **death rates** along with **immigration** and **emigration** statistics to show **population growth** or change. Over the next few pages we walk you through the process of how population growth is calculated.

THE BIRTH RATE

The crude birth rate (CBR) or just the **birth rate**, as we will call it here, is an **annual statistic**. The total number of infants born living is counted for one calendar year and then calculated. This figure is then divided by the population divided by one thousand, or "every thousand members of the population," as it is often presented. Why? By standardizing the denominator (the lower number in the ratio), the resulting quotient will be a small integer number, such as 32 or 14. This makes the data much easier to work with.

The Birth Rate Formula

$$\frac{\text{Live Births}}{\text{Population} \div 1{,}000}$$

Estimate and Simplify

So if you have a country with 100,000 live births in a year and a population of 5,000,000, the birth rate is 20; more precisely 20 live births for every 1,000 members of the population. To make this easier, 5,000,000 divided by 1,000 is 5,000. Knock the 3 zeros off the end of 1,000 and the end of 5,000,000 and you have a simplified ration of 5,000/1 or just 5,000. Do the same with 100,000 over the 5,000. Knock off the three zeros of each and you have 100/5 or 20.

What Does the Birth Rate Tell You?

When you examine the section on demographic transition later in this chapter you'll find that high birth rates (18 to 50) are found in mostly rural agricultural Third World countries and that low birth rates (8 to 17) are more likely to be found in urbanized industrial and service-based economies. However, without knowing what's going on with mortality in that country (death rate), it's hard to know whether the population is growing and how quickly if it is. See Natality in the Know the Concepts section of this chapter to find out more.

THE DEATH RATE

OK, it sounds scary. Death is an emotional issue. What you need to do here is to think scientifically about these statistics. The crude death rate or CDR, or what we'll simply call the **death rate** is an annual statistic calculated in the same way. The number of deaths are counted for the calendar year in a country and divided by every thousand members of the population (or population/1,000).

The Death Rate Formula

$$\frac{\text{Deaths}}{\text{Population} \div 1{,}000}$$

What Does the Death Rate Tell You?

Well, not much in today's world. High death rates usually indicate a country that is experiencing war, disease, or famine. Historically, higher death rates (20 to 50) were recorded in the poorest of Third World countries where the combination of poverty, poor nutrition, epidemic disease, and a lack of medical care resulted in low **life expectancy**. However, as conditions have improved in the Third World through the **Green Revolution** (increased food and nutrition) and access to sanitation, education and health care have increased, life expectancies have gone up, and the death rate has gone down. See more on mortality in the section on stage one, starting on page 107.

The Rate of Natural Increase

By comparing the birth rate and death rate for a country, we can calculate the **rate of natural increase (RNI)**, sometimes referred to as the **natural increase rate (NIR)**. We'll call it the RNI from here on. Simply put, if you subtract the death rate from the birth rate, the difference is the amount of population change per thousand members of the population for that year. But you are not done yet. Divide the result by 10 and then you will have the RNI. The RNI is also the annual percentage of population growth of that country for that one-year period. Make sure to put a % sign after you get the answer to the equation.

Formula for The Rate of Natural Increase (RNI)

$$\frac{\text{Birth Rate} - \text{Death Rate}}{10}$$

The Simple Math

Let's take an example. If a country has a birth rate of 27 and a death rate of 12, then the RNI equals 1.5 percent. If that country had 10,000,000 people the previous year, then the population this year would total 10,150,000. The added 150,000 people are 1.5 percent of the previous 10,000,000. We can check our work to see if the birth rate and death rate concur with the math. In this country the birth rate would be calculated as such: 270,000 infants born divided by $\frac{10,000,000}{1,000}$ or $\frac{270,000}{10,000} = 27$; the death rate would be 120,000 deaths divided by $\frac{10,000,000}{1,000}$ or $\frac{120,000}{10,000} = 12$. Think about it: 270,000 - 120,000 = 150,000 new people added to the country's population.

The Negative RNI: Is It Possible?

In a couple of situations, it is possible to have a negative RNI. Mathematically, the death rate can be larger than the birth rate, resulting in a negative number that is divided by 10 to get the negative RNI. When the RNI is negative, it means the population has shrunk during the year the data was collected. One current possibility would be in a Third World location where disease, warfare, or famine has decimated the population. Swaziland, for instance, has been severely affected by the AIDS epidemic and currently has an RNI of -0.1 percent.

Shrinkage!?!

Another explanation for a negative RNI are First World countries that are highly urbanized and the roles of women in the country have become such that the traditional positions of mother and homemaker have deteriorated significantly. In these places, the status of women in society has become *increasingly* equal to that of men (not quite there, yet). When the majority of women are heavily engaged in business, political activity, and urban social networks, they are far less like to have children (reduced **fecundity**), and phenomena such as **double-income no-kid (DINK)** households and single parent–single child homes are far more common. Higher rates of divorce are another sign.

Germany is a prime example where the already low birth rates have dipped below death rates and as a result the RNI has ranged between -0.1 percent and -0.2 percent, annually. For more examples, look at the stage one and stage four parts of the Demographic Transition model in this chapter.

Why "Natural" Increase?

An important thing to keep in mind regarding the rate of natural increase is that it does not account for immigration or emigration. A country with a high rate of natural increase can have an unexpectedly low long-term population prediction if there is a large amount of emigration. Conversely, a country with a low rate of natural increase can still grow significantly over time if the amount of immigrants is high. Data shows that migrant populations also have much higher fertility rates than the general population in the country. Therefore, in places such as the United States, population growth is not necessarily from the immigrants themselves crossing the border, but the fact that they will have large numbers of children once they have settled.

Doubling Time

We can try to quickly estimate how long it would take for a country to double in size by this formula:

Formula for Doubling Time

$$\frac{70}{\text{Rate of Natural Increase}}$$

Using Bolivia as an example, an RNI of 2.1 percent would result in a doubling time of 33.3 years. That's fast, but unless something changes significantly in Bolivian society, we expect the 10 million people of today to grow to 20 million by 2050. But it won't. Why not? There is negative net migration in Bolivia. Out-migration to other countries reduces the long-term prediction to around 17 million by 2050. This is why we call the RNI an estimate.

The more accurate way would be to estimate the RNI for each year in the future by examining a country's position on the Demographic Transition Model. Then you would multiply each year's population by the RNI and add that to the next year's growth, and so on, and so on:

$$(\text{Pop.} \times \text{RNI}_1) \times \text{RNI}_2 \times \text{RNI}_3 \; .... \times \text{RNI}_n = \text{Future Population.}$$

This is the same method used to estimate the value of a currency multiplied by annual inflation rates to find the real dollar value over time.

Add Migration and Voila! The Demographic Equation

The last part of the **demographic equation** to calculate population growth is factoring in migration. Using annual birth rates and death rates to calculate the natural increase in overall population (note that we're not talking about the "rate" of natural increase here, just the total number of people) we can add the balance to the **net migration rate.** This is the number of immigrants minus the number of emigrants for every thousand members of the population. Here is the formulaic way to calculate the net migration rate:

[illegible]

Take this and add it to the birth rate minus the death rate and you will have total population growth per thousand members of the population. And, you have your demographic equation, like so:

[illegible]

Take the United States as an example. The United States has a birth rate of 14 and a death rate of 8. Add the product to a net migration rate of 3 and we find that the United States adds 9 people for every thousand in the population, annually. Divide by 10 to find that the population growth rate (including immigration) is 0.9 percent annually.

Shrinkage, Again!?!

Net migration rates can be negative. Guyana in South America has net emigration to such a degree that population is expected to fall over the long-term. Currently, Guyana's birth rate is 21 and the death rate is 9. Adding to the net migration rate of -10 (that is, by subtracting 10), we find that the population growth is only 1 per thousand or 0.1 percent. In the future, that number is expected to be -0.1 percent.

The Total Fertility Rate

By definition the **total fertility rate (TFR)** is the estimated average number of children born to each female of birthing age (15 to 45).

We can still use a basic formulaic definition to help remember TFR:

Total Fertility Rate Formula:

$$\frac{\text{Number of Children Born}}{\text{Women Aged 15 to 45}}$$

However, the TFR *is not an annual statistic* like the RNI. It is more of an estimate, taken as a snapshot of fertility for birth over the prior 30 years. Thus, TFR and RNI are not comparable. They are two different things—apples and oranges. You cannot have a negative TFR, for one thing. TFR highlights the importance of replacement in the population.

The Replacement Rate

By definition the replacement rate is a TFR of 2.1. Think about this in basic biological terms. If a mating pair has two offspring, they have replaced themselves. What about the remaining 0.1, you ask? This is what would be referred to as an error factor. We have to estimate that some small portion of the population will die before they reach adulthood—diseases and accidents do happen.

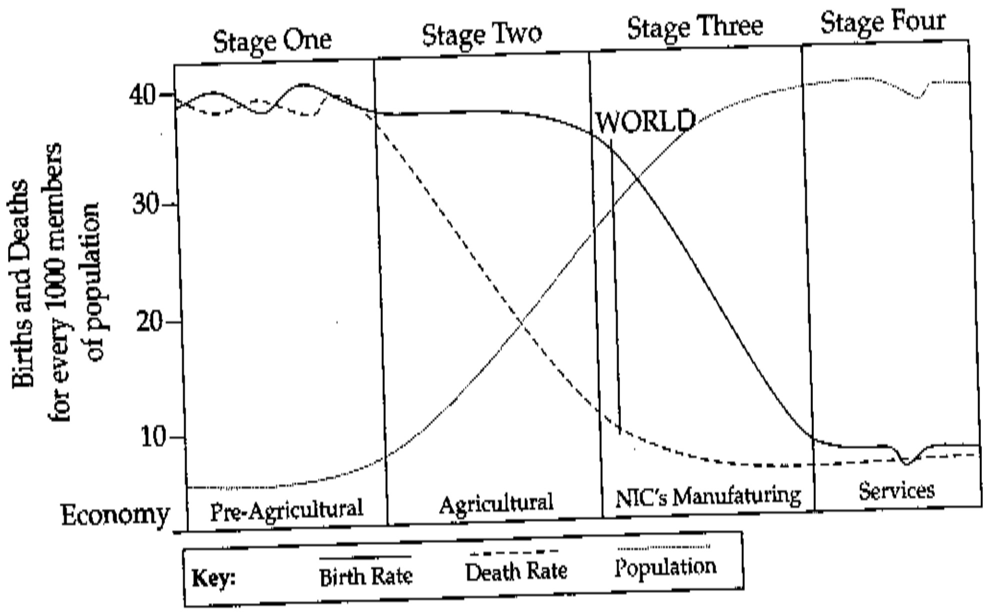
Thus, to truly replace itself, a large population must have 2.1 children per female of birthing age.

Keep Getting RNI and TFR Confused?

Remember this car analogy to remember the difference between RNI and TFR. When a country hits a TFR of 2.1 (the replacement rate) you've hit the breaks on the car and the speed population growth slows down. It's not until the RNI hits 0 that the car comes to a complete halt and population stops growing altogether. The RNI can go negative and the car rolls backward, shrinking population as you fumble to find the emergency break.

KNOW THE MODELS

THE DEMOGRAPHIC TRANSITION MODEL



The **Demographic Transition Model** has a number of uses. You should think of it as a central unifying concept in your understanding of the AP Human Geography course. Not only is it a theory of how population changes over time, but it also provides important insights into issues of migration, fertility, economic development, industrialization, urbanization, labor, politics, and the roles of women.

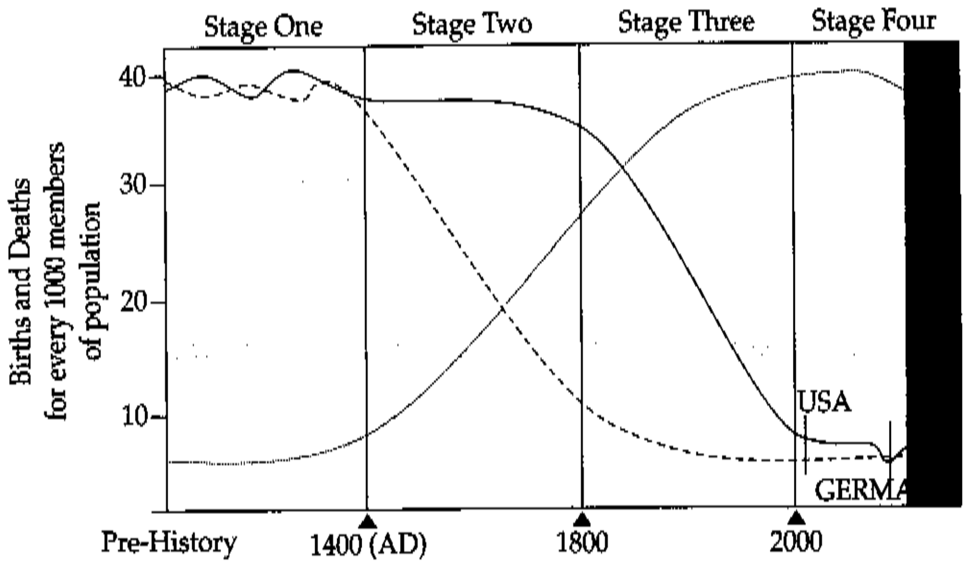
By placing a country on the model, you are defining the **population dynamics** and **economic context** of that country. Knowing where a country falls on the model lets you know what kind of economy the country has, whether or not there is significant migration going on, and, like economic indicators, this "picture" of a country's population can tell you much about its quality of life. Remember, these are theoretical estimates and averages, and not all countries fit the model perfectly. The lines shown are approximate and not always representative of every country's birth and death statistics.

The Crystal Ball

The model also has a **predictive capability**. If a country currently falls within stage two of the transition, we can use this model to predict how its population will change over time and speculate as to how much it can grow in size. Likewise, you can also look at the whole world, which falls into early stage three. Knowing this, we can estimate a **population projection** that the planet's population has only reached about two-thirds of its potential. If the planet is currently at about 6.6 billion people, then we can expect that once global populations level off in stage four, global population will be somewhere around 10 billion people. This may happen sometime around 2060—in your lifetime.

And a Look into the Past

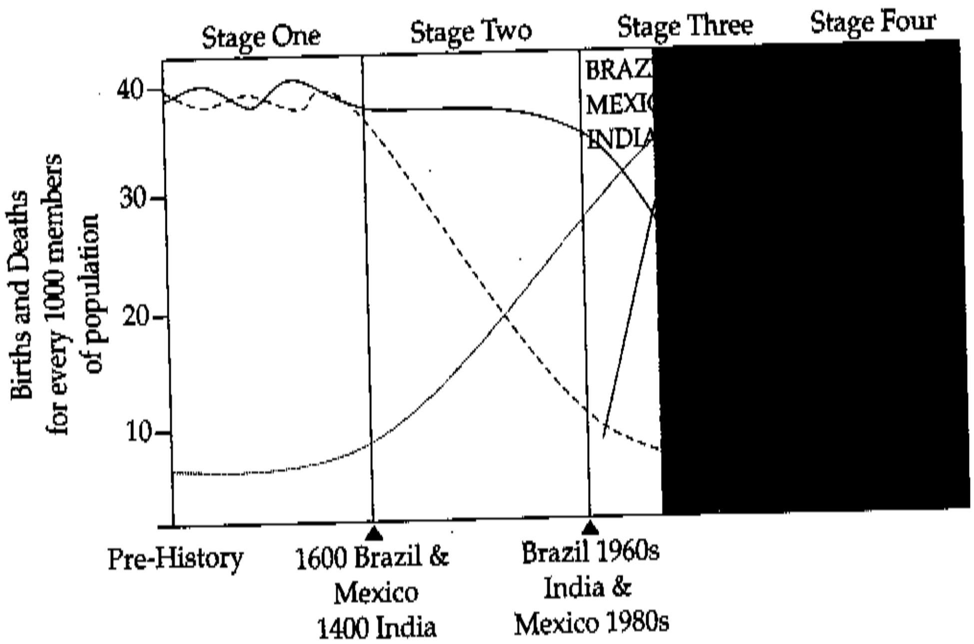
The model also provides insight into economic history. If we look at the United States, Canada, or Western Europe, we can apply dates to the bottom of the model to show how stage four countries have progressed through the system. Looking at the model below, we can see in Western Europe the beginning of the Renaissance; in Western Europe and in the United States and Canada, the **Industrial Revolution**; and likewise the recent **deindustrialization** or shift to **service-based economies.**



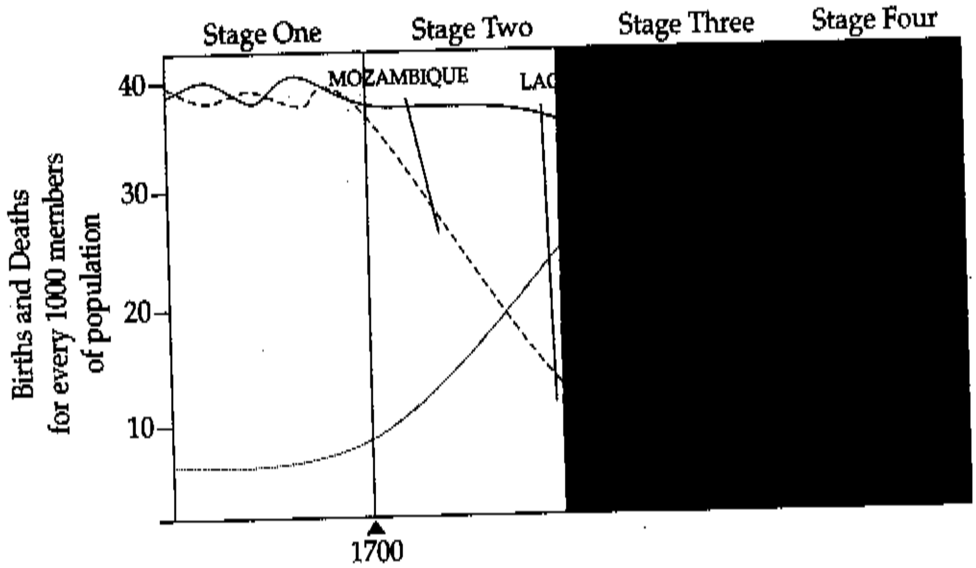
Pre-history goes all the way back to human beginnings. 1400 represents the time when there was both a cultural and economic renaissance in Europe. 1800 represents the industrial revolution, when countries like the United States and Great Britain were **newly industrialized countries (NICs).** And 2000 represents a turning point of the rise of service-based economies of **more developed countries (MDCs).** The typical MDC has a birth rate of 11 and a death rate of 10, or very little growth.

The NICs

Countries that are not as demographically or economically advanced can also be placed on the model, but you have to change the dates as to when they reach the significant turning point in their history. If we look at newly industrialized countries (NICs) such as Brazil, Mexico, and India, we can see a much more recent turning point from the **agricultural economy** of stage two to the **manufacturing-based economy** of stage three. Remember, this is a theoretical model and not all countries fit the trend. For example, China, due to its one-child policy, appears far more advanced than it should be, compared economically to other NICs. On the following page the NICs are shown in the model:



Even non-NIC stage two countries that are still agricultural-based economies can be outlined in the model. Let's take a look at Laos and Mozambique:



These stage two agricultural economies still have a lot of population growth ahead. Expect these countries to also have more rural to urban migration in the long-term.

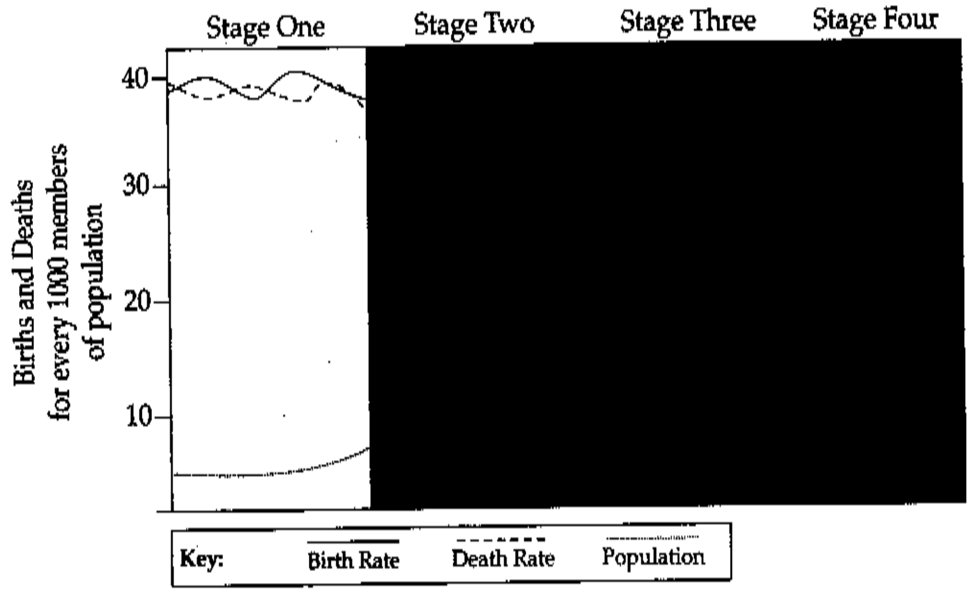
The S-Curve of Population

You've probably noticed that the population line in the model has a distinct shape to it until stage four. This is what demographers (population scientists) and population biologists call the S-curve. Humans are not the only ones whose population follows such a pattern. In fact, give any animal population a vast amount of food or remove predators from their habitat and you will see rapid population growth followed by a plateau or decline due to a population reaching or exceeding the area's **carrying capacity.** Globally, humans may be doing the same thing and, as we mentioned before, the human population may reach **equilibrium** in the global habitat. Find out more when we talk about carrying capacity in the Know the Concepts part of this chapter.

STAGE BY STAGE

The best way to learn the model is not to memorize it, but to know *why* the birth rate and death rate and, as a result, population change over time. In this next part we examine the factors that affect population in each stage of the transition.

Stage One



Historically, stage one was characterized by pre-agricultural societies engaged in **subsistence farming** and **transhumance**, that is, the seasonal migration for food and resources or owning livestock. Birth rates and death rates fluctuate as the result of factors such as climate, warfare, disease, and ecological factors, but overall both rates are high. The result is that there is little population growth until the later part of stage one when death rates begin to decline. Thus, the RNI is generally low (and can be negative in some cases), especially during disease epidemics.

Lots of Babies; Lots of Dead Folks, Too

Birth rates are high for a number of reasons. Children were an expression of a family's productivity and status. The more kids a family had, the more work that could be done raising crops, hunting, gathering, herding, or laboring in the **feudal political economy** as domestic servants or soldiers. **Child mortality** and **infant mortality** were also very high, which motivated parents to have a few extra children with the expectation that one or two would not live to adulthood.

Likewise, death rates are high for a multitude of reasons. In stage one the overall population has a very low **life expectancy.** The lack of modern medicine and health care, limited sanitation, low nutritional standards, and the effects of hazards such as famine and war all contribute to high death rates and low life expectancy. Hard physical labor and long migrations also had the effect of physically wearing down the body and thus decreasing lifespan.

Stage One Today?

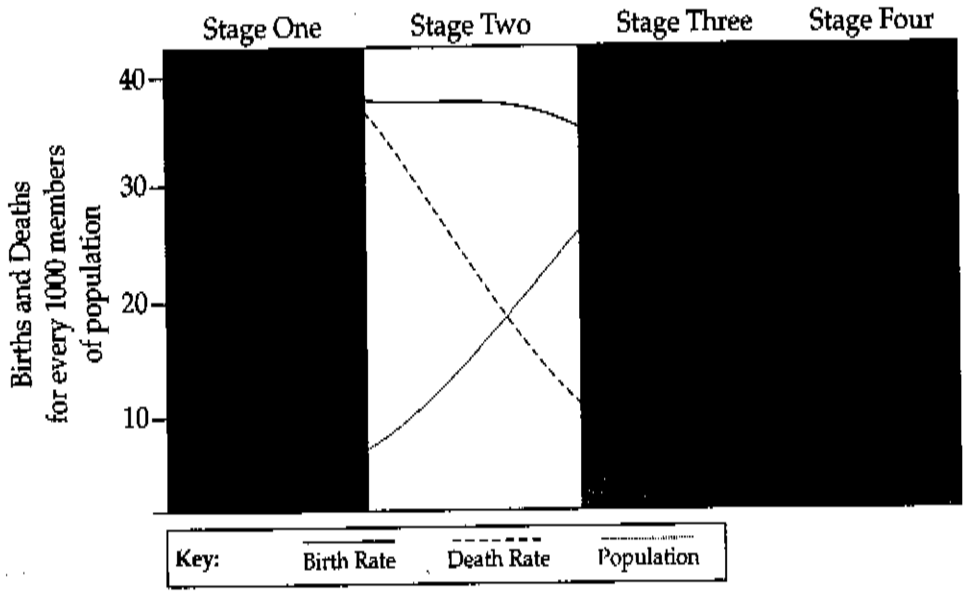
Are there any stage one countries in existence today? Occasionally, yes. Typically we see that Third World countries engaged in long periods of warfare have late stage one characteristics. When they are peaceful, Third World agricultural countries generally have stage two birth rates and death rates. During periods of war it's as if they slide backward into late stage one. The West African countries of Sierra Leone and Liberia, which have both been engaged in long civil wars, fit the model: Sierra Leone, birth rate 48, death rate 23, life expectancy 48; Liberia, birth rate 50, death rate 19, life expectancy 45.

The AIDS epidemic in Southern African countries has also created stage one demographic conditions and likewise harmed the economic development of the region. For example, Zimbabwe has a birth rate of 31, a death rate of 21, and life expectancy of 37. Botswana, the country with the highest HIV infection rate, has a birth rate of 26, a death rate of 27 (a shrinking population), and an average life expectancy of 34 (only Swaziland is lower at 33).

Let's Review

Stage One	High (25–50)	High (25–40)	Low (33–50)	Low-Moderate (-0.1–1.9%)

Stage Two



Stage two countries are typically agricultural-based economies. In this economic context, where agriculture for trade (as opposed to subsistence) is the focus of the economy, birth rates remain high while death rates decline over time. As a result, the rate of natural increase (RNI) goes up significantly as birth rates and death rates diverge. Therefore, as a country advances, population growth explodes. This is why rapid population growth has been a concern when examining the quality of life in Third World countries. Life expectancy increases as the death rate declines, but is still low compared to the First World.

Babies Are Us

Birth rates remain high as stage two countries develop in a more organized fashion around a formalized agricultural economy. Compared to stage one, children are even more important as a source of labor on farms. Infant and child mortality is still an issue due to a lack of medical care and poor nutrition for expectant mothers and infants. The vast majority of populations in stage two countries live in rural regions as a result of agriculture's economic prominence. Most cities in these countries are far from reaching their population growth potential.

Not Dead Yet!

Death rates decrease due to a number of factors. Populations engaging in the expanded agricultural economy tend to permanently settle in farming areas, and seasonal migrations become far less common. This, along with improved farming methods and the domestication of draft animals, reduces the incidence of death from excessive labor and travel by foot. Likewise, the expanded trade in agricultural goods means there is a larger and more varied food supply available to the general population. This relative increase in food volume, year-round availability, and nutrient quality means that people live longer.

The Stage Twos

Ghana in West Africa is a good example. It has a very high birth rate at 33, but in recent decades its death rate has plunged to 10. As a result, the rate of natural increase is 2.3 percent growth each year (very high), and the life expectancy has increased to 59. An example from Asia is Nepal. The birth rate is 28 and the death rate is 9, with an RNI of 1.9 percent annual percentage population growth and a life expectancy of 62.

Both of these countries focus on agriculture as their main source of economic production. Statistically, this is revealed by examining the rates of urbanization. In Ghana 56 percent of the population still lives in rural areas. Historically, much of the population has been focused on the coastal port region around the capital, Accra, a primate city. Landlocked Nepal has an even starker lack of urbanization with 86 percent of the population living in rural regions of the country.

These countries are expected to experience a population explosion over the next few decades. By 2050 Ghana, currently at 24 million, is expected to more than double in size to 48 million. Likewise, Nepal, which has 27 million, should reach 49 million in 2050.

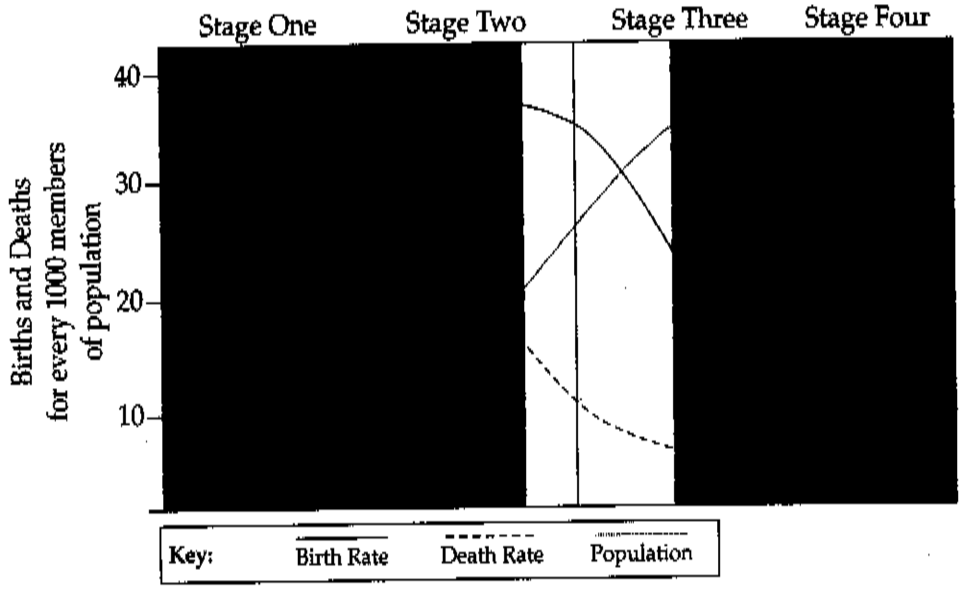
Review and Compare

	[illegible]	[illegible]	[illegible]	[illegible]
Stage One	High (25–50)	High (25–40)	Low (33–50)	Low-Moderate (-0.1–1.9%)
Stage Two	High (25–50)	Decreasing (8–25)	Increasing (<70)	Highest (1.5–3.5%)

Hey! My Textbook Uses Different Names

Different human geography textbooks use different terms to describe the stages of the model. Some call the stages "phases." Don't be concerned; they're the same thing. Also, some might refer to stage one as pre-agrarian instead of pre-agricultural, or to stages two and three as "transitional." The names we use here relate the model to economic factors far better than general terms like "transitional."

Stage Two and a Half-ish: Newly Industrialized Countries



The NIC countries are characterized by economies that are transitioning their focus away from agriculture to manufacturing as the primary form of economic production and employment. This has two distinct effects on the population. One is that there is rapid population growth in NIC countries. Looking at the model, you can see that it's in this range between stages two and three where birth and death rates are furthest apart, resulting in high RNIs.

The second effect, which is not shown on the model, is the rapidly increasing rate of urbanization. As these countries shift to manufacturing, more factories are being built in urban areas. Migrants responding to the **pull factor** of employment opportunity rapidly fill the cities to take new and better-paying jobs than those available in rural regions.

Who Has the Time Anymore?

Birth rates begin to decline with urbanization. As families move to cities they find (in comparison to the rural agricultural lifestyle) that they have less time, less need, and moreover, less space for children. Most countries forbid child labor (it still happens, even in countries where it's illegal) and thus children in cities are less likely to be seen as a source of labor.

Getting Better All the Time

Death rates continue to decline as more urban societies have greater access to food markets, increased (but limited) access to health care and sanitation, reduced physical labor (factories compared to farming and mining), and increased education.

Around the Planet

Mexico is an NIC example where death rates have plunged in recent decades due to increases in the quality of life and access to services. At present, Mexicans have a birth rate of 20 and a death rate of 5, with a resulting RNI of 1.5 percent. With just over 100 million people, the population adds over 1.6 million people per year. Mexico is mostly urban, with 76 percent in cities, and the total life expectancy has risen to 75 years old.

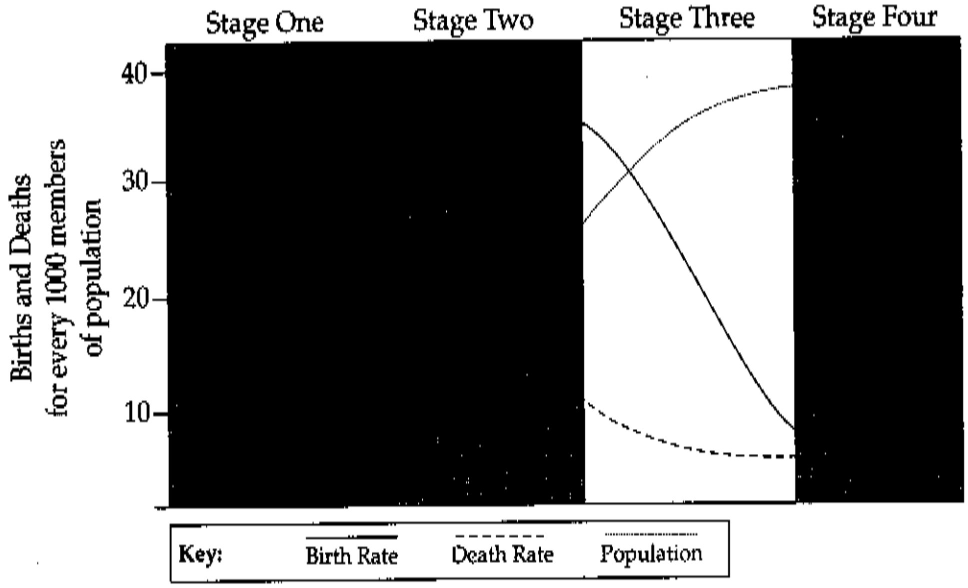
On the other side of the world, Malaysia is another NIC where industrialization and urbanization have changed the population characteristics. Malays have a birth rate of 21, a death rate of 5, and an RNI of 1.6. Life expectancy is 74, and the population is 68 percent urbanized. Mexico appears to be just slightly ahead of Malaysia in terms of demographic development.

In long-term growth, Malaysia is expected to increase 44 percent by 2050, from 28 million to 40 million. In contrast, Mexico will slow down and is expected to grow by only 22 percent in the same time period, from 107 million to 132 million.

Here's the NIC Review

Stage One	High (25–50)	High (25–40)	Low (33–50)	Low-Moderate (-0.1–1.9%)
Stage Two	High (25–50)	Decreasing (8–25)	Increasing (<70)	Highest (1.5–3.5%)
NICs	Decreasing (12–30)	Lowering (5–18)	Increasing (<75)	Higher (1.1–2.7%)

Stage Three



Stage three was historically where most "industrialized" or manufacturing-based countries were found in the transition. However, most of these First World (and many former European Communist Second World) countries have shifted their economies to a more service-based focus. During this time these same countries have completed the transition; that is, completing the S-curve and moving into stage four. Stage three is what we should expect many NICs to look like as they continue to industrialize.

Baby Please Don't Go

Birth rates continue to decrease as the effects of urbanization (less space, time, and need factors) along with increases in health care, education, and female employment have negative effects on fertility. Access to health care has an important influence on the availability of contraceptives in more urbanized and developed economies. Women's education and employment also result in fewer children due to time constraints and the empowerment that women gain from their school and job experiences.

Pushing Up the Daisies

In stage three, access to health care, nutrition, sanitation, and education continue to increase life expectancy and decrease death rates. However, death rates eventually bottom out. Why? (Here's your existential moment, folks!) We're all worm bait. Everyone is going to die, eventually, and there is a statistical floor to the death rate—or a statistical base to the death rate. At some point, you just can't stop people from dying. Life expectancies can go up even further in stage four, but the death rate stays about the same.

One Child, No Waiting

China, as an NIC, is more advanced demographically than its economic situation would predict. As a result of their one-child policy, China is more typical of a middle-to-late stage-three country, compared to other NICs like Brazil. China's birth rate is 12 and death rate 7, with an RNI of 0.5 percent. The long-term effects of population control in China will continue to slow its growth, despite policies being enforced less often. In fact, China, currently at 1.37 billion people, will likely complete the S-curve in the coming decades. The country is projected to reach 1.45 billion around 2025 and level off, maintaining population levels. Keep in mind that China is only 45 percent urbanized because of Mao's "Back to the Land" policy, and things could change in terms of population projections if the one-child policy is completely lifted.

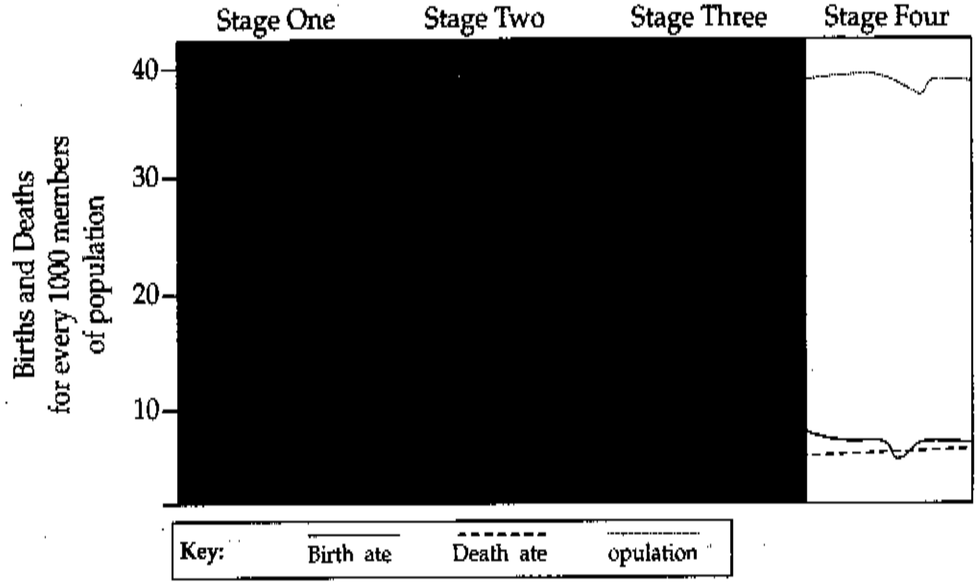
Long Ago I thought You Were "So Third World"

Uruguay also has late stage three characteristics with a birth rate of 14 and a death rate of 9, resulting in an RNI of 0.6. The country's life expectancy is 76, and it is extremely urbanized at 94 percent, as most of the country resides in and around the **primate city** of Montevideo. At present, Uruguay has about 3.3 million people and is expected to grow slowly to 3.7 million people by 2050, or about 11 percent.

The Comparisons

Stage One	High (25–50)	High (25–40)	Low (33–50)	Low-Moderate (-0.1–1.9%)
Stage Two	High (25–50)	Decreasing (8–25)	Increasing (<70)	Highest (1.5–3.5%)
NICs	Decreasing (12–30)	Lowering (5–18)	Increasing (<75)	Higher (1.1–2.7%)
Stage Three	Lowering (12–20)	Low (5–12)	Higher (<78)	Lowering (0.5–1.2%)

Stage Four



In stage four, birth and death rates converge to result in limited population growth and even population decline. Here we expect to find First World countries with service-based economies. As we discuss elsewhere, it's OK to think of them as "industrialized" countries, but keep in mind that these are service industries like finance, insurance, real estate, health care, and communications that drive the economy. Manufacturing is a dying breed in these countries. For example, in the United States, services are 80 percent of the **gross domestic product (GDP)** and manufacturing is only 17 percent. These are highly urbanized countries (over 70 percent) possessing the longest life expectancies, with some populations averaging over 80 years.

Gone, Baby, Gone

Birth rates bottom out into the lower teens. Not only is there a high degree of access to medical care, but the roles of women in society are such that most adult women are engaged in the labor force and are empowered politically and socially within the communities. The result is that fecundity is greatly reduced. When birth rates reach the same level of death rates, this is when you have a **zero population growth (ZPG)** and an RNI of 0.0 percent. Birth rates can decline to a point where they're actually lower than death rates. This results in a negative RNI and a shrinking population. Remember shrinkage?

Don't Fear the Reaper

Death rates remain low and vary slightly depending upon the age structure of the overall population. A younger average age will result in low death rates (5 to 10) and a higher average age will result in slightly higher death rates (7 to 14). Most of these countries, however, have aging populations, especially in Western Europe and in Anglo-North America. In these situations, there tends to be a large, over-65, dependent population.

Hockey Fans Wanted!

Canada, with a birth rate of 11 and death rate of 7, grows only around 0.4 percent per year. The population is 34 million, but by 2050 it should be around 42 million. Wait a minute, that's doesn't seem quite right. It's growing slowly, and population growth might hit zero, but you're telling me that it's going to add 8 million people to the population in the next few decades? We must remember that the rate of natural increase does not include migration into the country. Canada, like United States and the United Kingdom, has positive net migration, and many international migrants go to Canada, especially those from other British Commonwealth countries. Also keep in mind that migrant populations tend to have much higher fertility rates compared to the general population.

Ciao, Baby? Or Just Ciao!

Italy, like Germany, is another example of a Western European country that has experienced negative population growth in recent years. The birth rate in Italy is 9, its death rate 10, and its RNI is -0.1 percent. By 2050 Italy, which currently has 60 million people, will reach about 62 million people due to labor immigration. A number of countries that are near or below zero population growth levels offer incentives to citizens to have more children. One of the reasons for this is that with so few children being born, fewer people enter the work force over time. Many of these countries have become dependent upon foreign **guest workers**, like the ***gastarbeiter*** in Germany, many of whom have come from Turkey, North Africa, the Middle East, and more recently, the former Soviet Union.

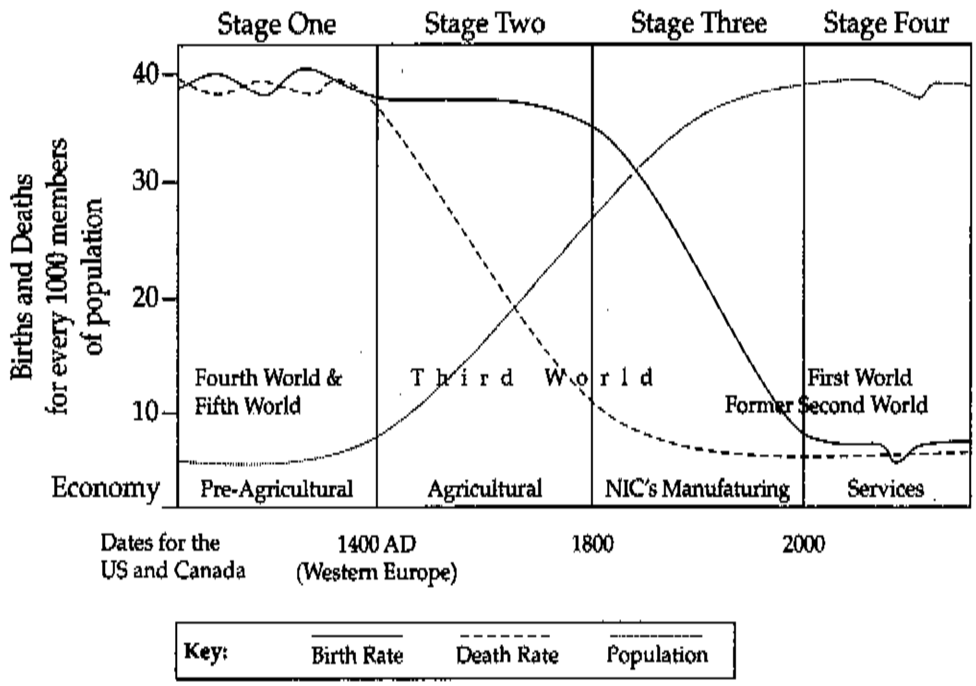
It's also important to recognize that many former Communist countries of Eastern Europe have stage four demographic characteristics. The factors behind this have recently emerged. It appears that many young workers in Eastern Europe and Russia have emigrated for better paying work opportunities in the West. Despite their recent admission to the European Union, countries like Latvia (RNI -0.4 percent), Lithuania (RNI -0.4 percent), and Hungary (RNI -0.4 percent) have shrinking populations. Some have also pointed to the lingering social effects of Communism on the population in these countries. **Economic restructuring** has brought economic, political, and social hardship to many communities. During the Communist era, people received incentives from the state to have children. With government subsidies gone, many couples don't see any motivation to have a larger family.

Got it? Good!

Well, that was hopefully not too painful. The point here is to understand *why* the model works, as opposed to just memorizing the lines on a graph. Here is a review of the numbers and the complete model one more time, just to give you a last look:

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Stage One	High (25–50)	High (25–40)	Low (33–50)	Low-Moderate (-0.1–1.9%)
Stage Two	High (25–50)	Decreasing (8–25)	Increasing (<70)	Highest (1.5–3.5%)
NICs	Decreasing (12–30)	Lowering (5–18)	Increasing (<75)	Higher (1.1–2.7%)
Stage Three	Lowering (12–20)	Low (5–12)	Higher (<78)	Lowering (0.5–1.2%)
Stage Four	Low (8–16)	Low (5–12)	Highest (<82)	Low to Negative (0.8 to -0.6%)

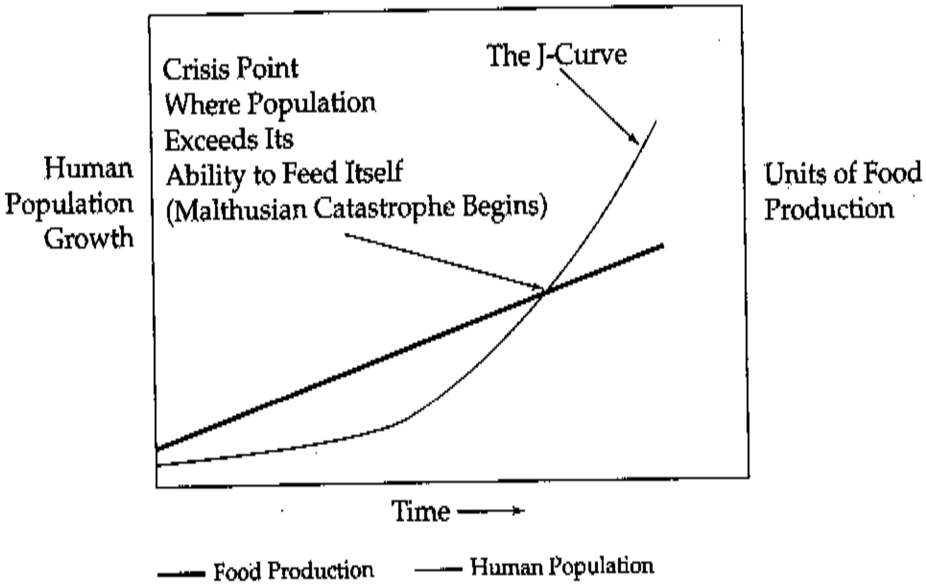
And, The Model One Last Time



MALTHUSIAN THEORY

Englishman Thomas Malthus published *An Essay on the Principle of Population* in 1798. His main idea was that the global population would one day expand to the point where it could not produce enough food to feed everyone. He predicted this would happen before 1900. The Malthusian catastrophe did not happen by 1900 or even by today, but some more recent thinkers (neo-Malthusians) think it still could in the future.

Why did he have this idea? At the time the math made sense, as the United Kingdom was engaged in the industrial revolution and people were being born at a high rate. If we look at the Demographic Transition Model timeline, Britain was moving from stage two to stage three. Like we see in NICs of today, Malthus saw rapid migration to the cities and a population explosion.

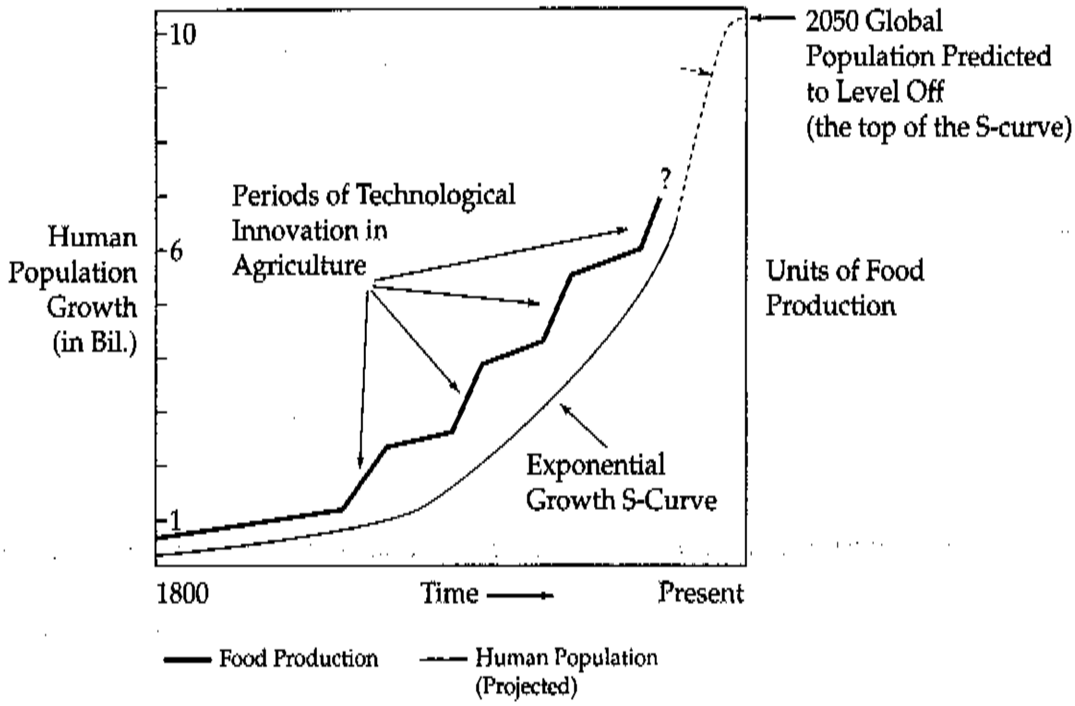


Malthus's Prediction Regarding Population and Food Production

It Was in the Numbers

Mathematically, what Malthus saw was that food production did grow over time but in a slow arithmetic manner. Arithmetic means that each year another unit of food production was added to the overall volume of agricultural products. Think of it like a volume + 1 situation. Meanwhile, human population grows in an exponential manner. Exponential means that a couple has a few children and then their children all have a few children, and so on through generations. Every few decades, you have population + the population^2, resulting in a logistic curve or **J-curve** of exponential population growth on the graph. Looking at the numbers of the time, Malthus figured population was going to catch up fast.

What Happened, Instead?



It wasn't that Malthus was wrong, but what he didn't know was that agricultural technology was soon going to boost food production several times over in the coming century. By 1900, massively important inventions such as the internal combustion engine, artificial fertilizers, pesticides, irrigation pumps, advanced plant and animal hybridization techniques, the tin can, and refrigeration were developed. As each of these new products and methods were adopted, another large volume of food would be added to global production and supply. Mathematically, this meant that food production has continued to stay ahead of population growth. For how long this will occur, we don't know. Let's hope that by 2050 or so, when the global population is predicted to level off around 10 billion (completing the top of the S-curve), that the world has food production in good working order.

What About Genetics? Avoid the Trap!

In the early 1800s, Gregor Mendel was the first to research and write about genes and plant reproduction. However, the science of genetics did not make any impact on global food production until the 1950s and genetically modified foods did not enter markets until the 1980s. If you are asked about why Malthus was wrong, talk about new technologies including plant and animal hybrids, but not genetics, since that only affects agriculture in much more recent years.

Neo-Malthusians: Be Afraid, Be Very Afraid!

Neo-Malthusians are more recent theorists who warn that a Malthusian catastrophe could still occur. You might think that things don't seem too bad now and that within a generation or two, the global population will level off. Won't we just come up with new technologies to meet future food demands? Three important points are made by the neo-Malthusians:

1. **Sustainability**. When the world does reach 10 billion people, there may be problems keeping up with food demand over the long-term. Already, many major agricultural regions have significant ecological problems like soil erosion and soil nutrient loss and, in arid regions, depletion of irrigation sources and soil salinization. If too many of the world's current growing areas are damaged, can food production keep up with the increased demand?
2. **Increasing *per capita* Demand.** Globally the amount of food consumed per person is rising. Why? The average First World citizen consumes around eight times the amount of food and resources that a person in the Third World does. As the Third World continues to develop economically, consumers there will increase their demand for food and other products several times over. Can the planet provide enough food when all 10 billion of us eat like the First World does today?
3. **Natural Resource Depletion.** Food is not the only concern of neo-Malthusians. Theorists like Paul Ehrlich have also warned about our over-consumption of other resources such as timber, minerals, energy, and other nonrenewables. Can a world with 10 billion people have enough material to house everyone, enough fuel to heat all the houses, and enough food to feed everyone? If not, we need to continue to conserve and look for alternatives so that we can stretch out supplies over time—until we have *Star Trek*-esque replicators to make food for us and fusion reactors to make energy.

THE POPULATION PYRAMID

Sounds like a game show, or a seriously geeky board game. Population pyramids are a graphical way to visualize the **population structure** of a country or place. More specifically, population pyramids reveal the **gender and age distribution** of the population. Like a country's position on the Demographic Transition Model, the shape of the pyramid can tell you a lot about that country's level of economic development.

General Principles

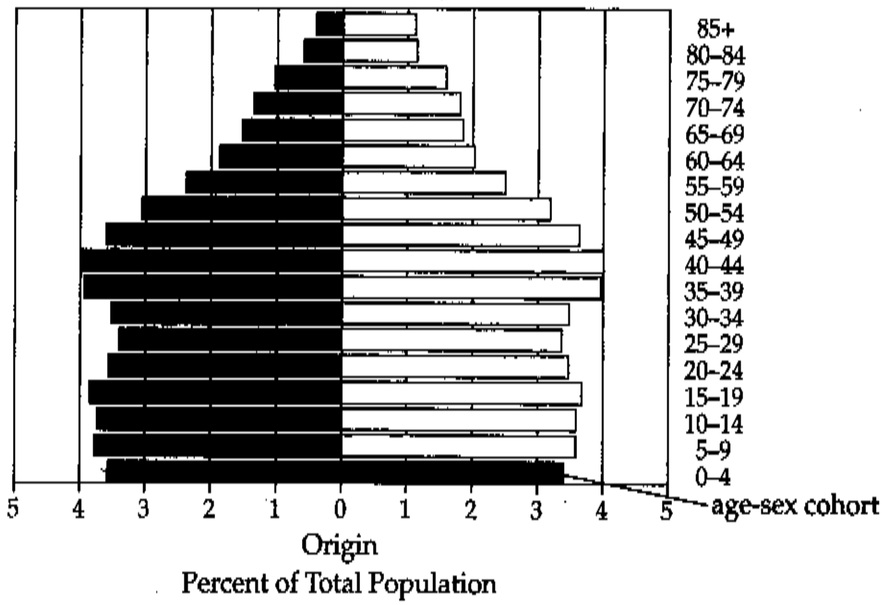
Males are always on the left of the pyramid and females are on the right. Each bar is an age **cohort,** generally made up of five-year sets: 0–4, 5–9, 10–14, etc. The origin (0-value) of each bar graph is the center and increases in value as you move left or right outward from the center. The single colored bar right or left of the origin is an **age-sex cohort,** with just one gender of that age group. (Note that age-sex cohorts may not always be colored on the exam.) Gaps, where there is an unexpectedly small bar, are important to recognize. A gap in a male cohort but not in females of the same age group is most commonly a sign of a past war that was fought outside the country. A gap in data for both males and females is likely a sign of past war inside that country, epidemic disease, or famine.

One Pyramid to Another

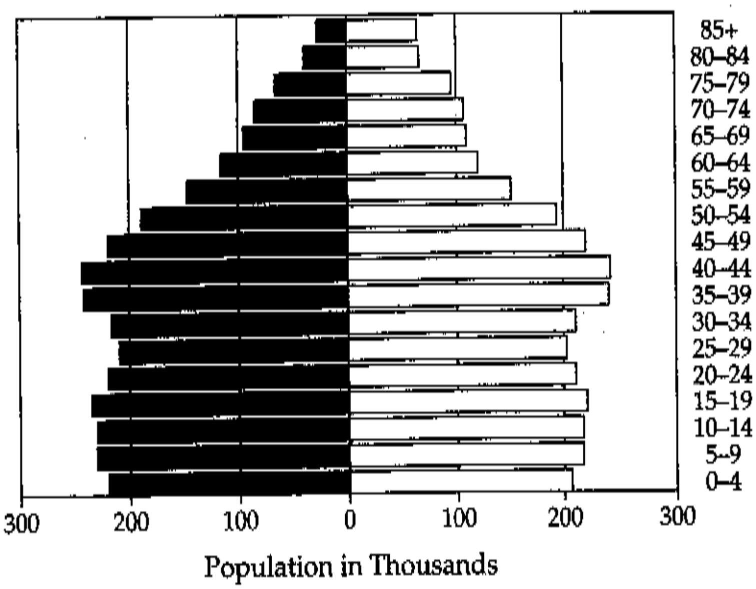
Not all population pyramids look the same. Depending upon who drew them, there may or may not be a column down the middle. Seeing the overall shape of the pyramid is what's important. We'll use both methods here so that you are used seeing it both ways. You never know what they going to put on the exam.

Check the Type of Data

Be aware of whether the bars on the graph show the *percent* of the total population or the total *number* of people in the age-sex cohort.



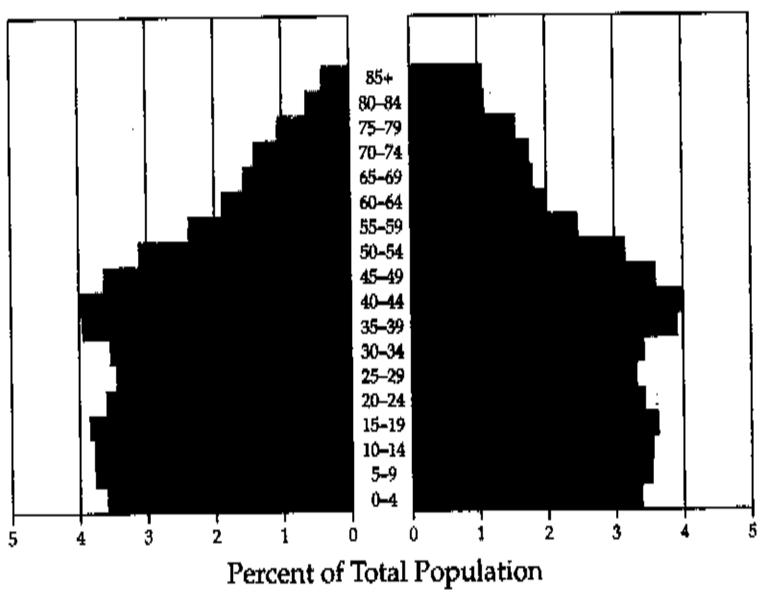
Percent Age-Sex Structure of Indiana in 2000



US Census Bureau data

Total Population Age-Sex Structure For Indiana 2000

Yes, the two pyramids look the same, but we need to be sure when referring to the data that we recognize what kind of numbers (percent versus total) we are talking about—this is especially important if asked on the essay section. What about those pyramids with the column down the middle? Here is what the percent data would look like:



US Census Bureau data

Percent Age-Sex Structure of Indiana in 2000 With Central Column

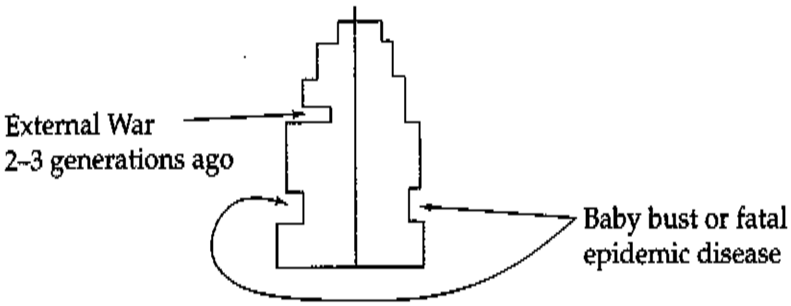
Shape Matters, Big Time

The general shape of the pyramid is what tells you about the character of the country, state, province, or city that is being diagrammed. In the case of countries, pyramid shapes are indicators of growth rates and of the level of economic development. Look at the diagram below to see the generalized differences:

Shape:	Triangular	Extended Triangle	Column	Reduced Pentagon
Growth:	Fast-Growing	Moderate Growth	Slow Growth	Shrinking
Examples:	Laos Mazambique	Mexico Brazil	USA Uruguay	Germany Hungary

The Gaps and the Busts!

What does a gap look like and what does it mean? Take a look at this generalized example. See the possible explanations for these gaps:



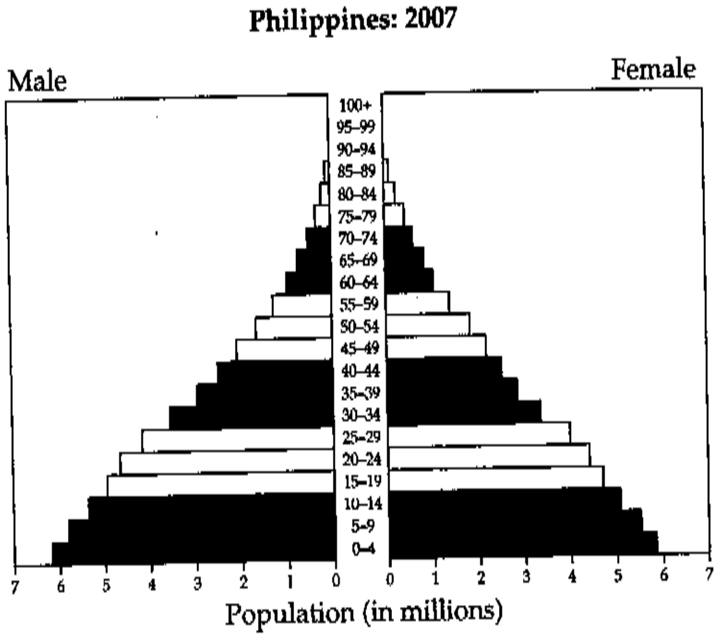
What's the difference? The war is a given event in that it affected only one age cohort significantly and only men. Had the war happened in this country, you'd see some decline in the women, as well. That's why we refer to it as external. The baby bust followed a likely post-war baby boom. At some point, booming fertility will recede after the war generation exceeds child-bearing age.

Who's on Top?

Old folks, that's who. Of course, increased mortality from disease and old age causes significant declines in the **elder population**. That's why the top shrinks so quickly. You will notice that the male side of the pyramid decline in number far more quickly that the female side. Why? Fair or not, women live 4 to 5 years longer than men on average.

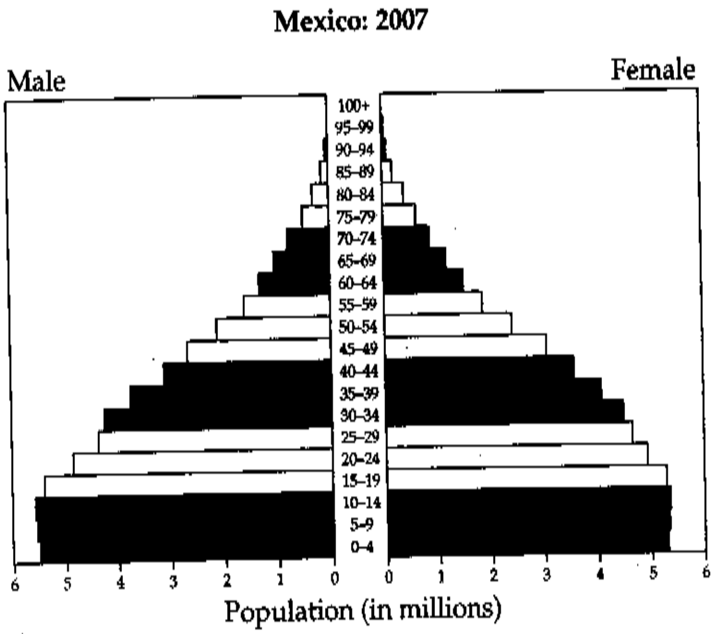
Countries, States, and Cities, Oh My!

You can have population pyramids for many different scales of population. Most commonly countries are shown, but states and cities may also show up on the exam. Let's first look at some country examples:



Source: *US Census Bureau, International Data Base*

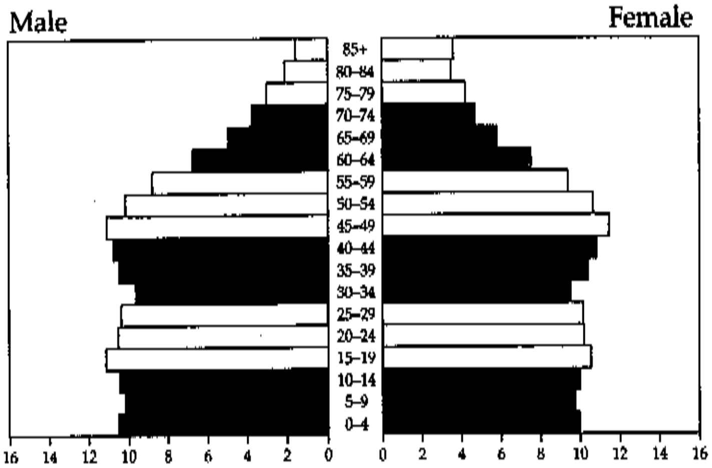
The Perfect Pyramid, a Fast-Growing Philippines (RNI = 2.1 percent)



Source: *US Census Bureau, International Data Base*

Starting to Slow, an NIC Mexico (RNI = 1.6 percent)

United States: 2007

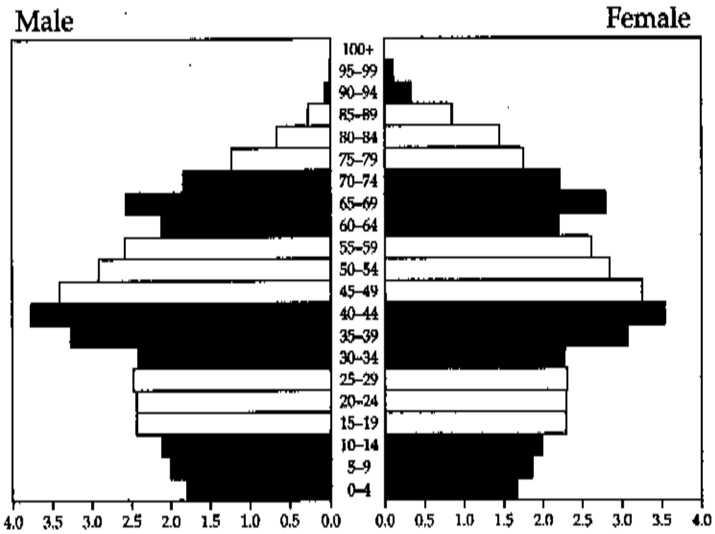


Source: *US Census Bureau, International Data Base*

The Column-Shape of the United States (RNI = 0.6 percent).

Note the "baby boom" peak for the 45 to 49 cohort of your parents Then the "baby bust" low point for the 30 to 34 cohort—the author is a bust baby. And then the "mini-boom" 15 to 19s—that's you.

Germany: 2007



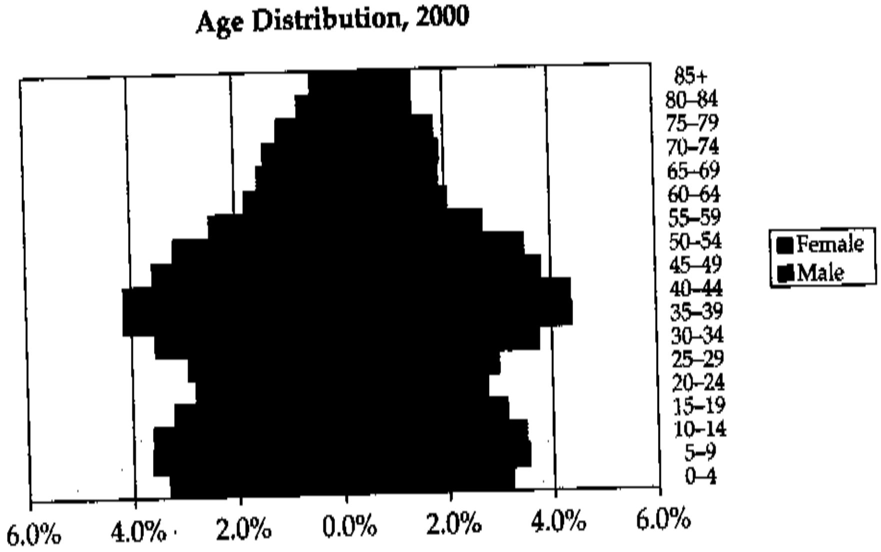
Source: *US Census Bureau, International Data Base*

The Reducing Pentagon of Germany (RNI = -0.2 percent)

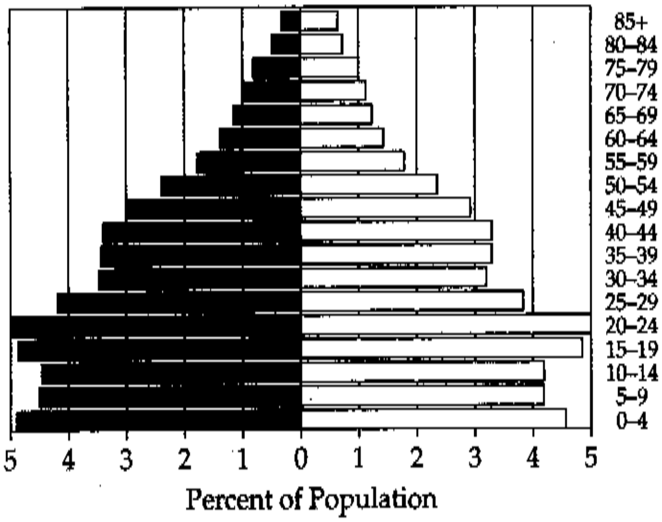
See those gaps? The 60 to 64 cohorts (both male and female) lived in Germany during World War II. Women suffered mortality in great numbers since many of the war's final years were fought on German soil. The baby boom in Germany lasted much longer than in the United States and peaked much later. This late peak is likely due to the food rationing that continued for several years after the war.

THE STATES

Let's look at two U.S. states from 2000 to see each end of the population growth spectrum:

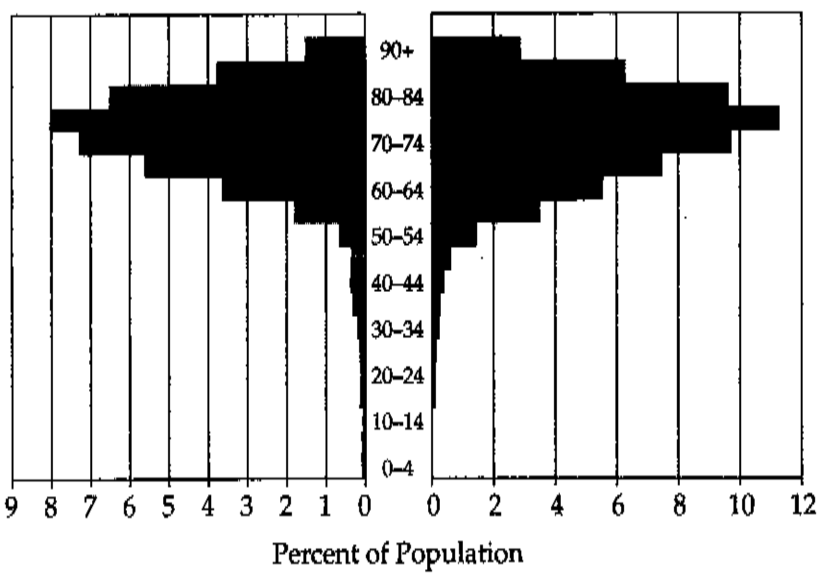


Connecticut, above, is the slowest growing state in the country. The TFR is 1.6 (0.6 children per female below the replacement rate). Despite a small mini-boom, the child-age population is declining significantly. In a decade, population structure in Connecticut could look more like Germany or Italy.

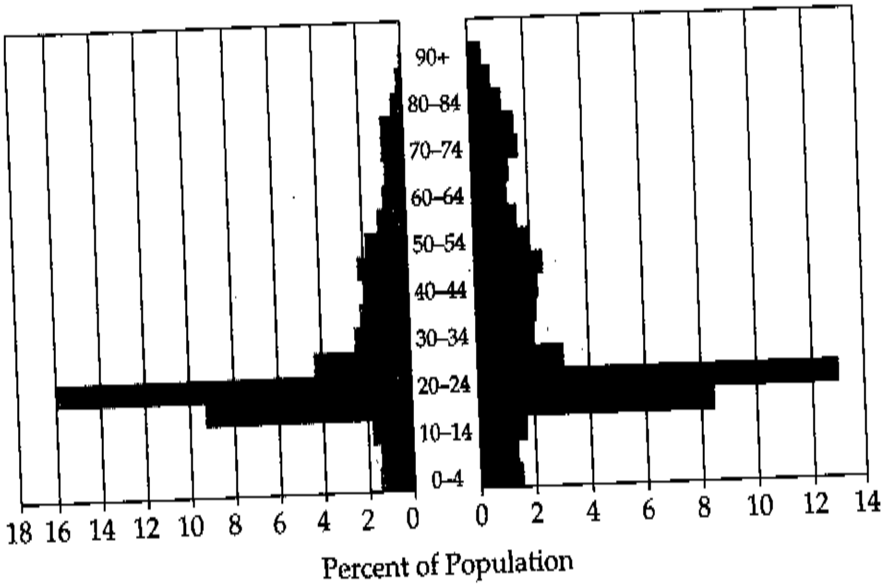


Utah, above, is the fastest growing state due to immigration and the highest fertility rate in the country (TFR of 2.6). Here, the boom and bust cycles are at different times than those in Connecticut.

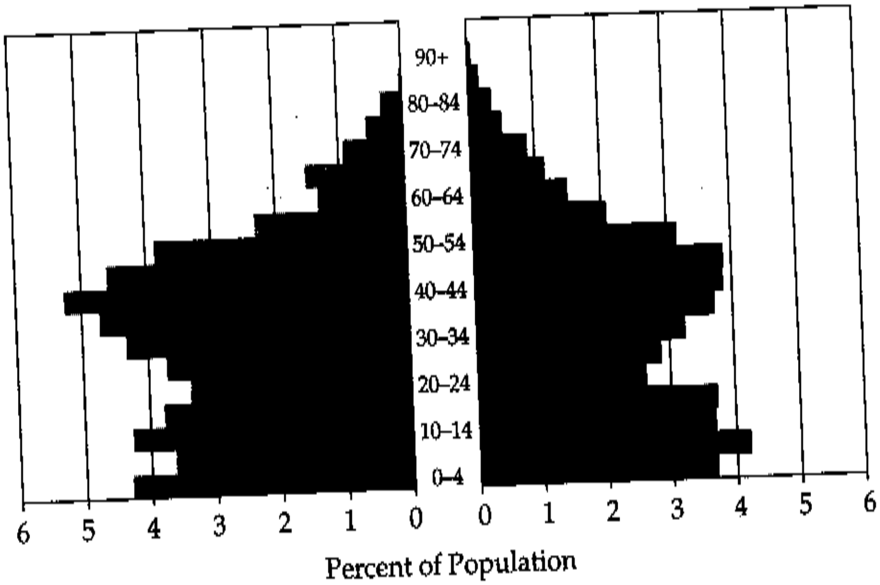
Cities also have some interesting patterns. Here are four cities from around the United States:



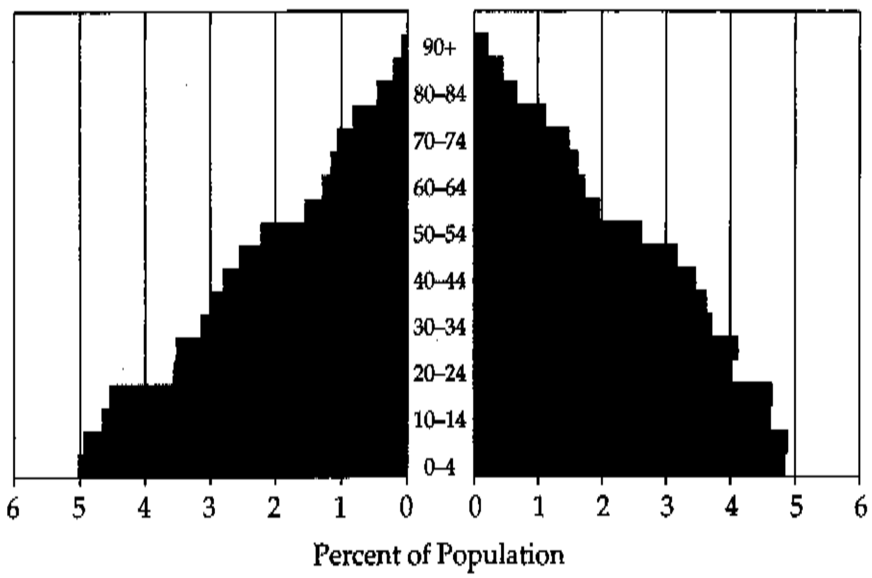
Sun City, Arizona, is a suburb of Phoenix that has long been a retirement destination for older Americans. Notice how there are almost no children.



Morgantown, West Virginia, is a university town. Home to WVU, the city's structure is cross-shaped because of the large college-age cohorts.



Prudhoe Bay, Alaska, is the main town in the northern Alaskan oil fields. As is common in remote communities in Alaska and in other resource boomtowns, there tends to be many more men than women.



Brownsville, Texas, has an age structure similar to that of Mexico (which lies just across the Rio Grande). Immigrant communities in border towns can have a great effect on population growth.

KNOW THE CONCEPTS

Population Density

There are two main ways to calculate population density. The number of people per square unit of land is known as **arithmetic density**. Most island nations and microstates have extremely high arithmetic densities. Consider also the high arithmetic densities of countries such as India, Bangladesh, Japan, and South Korea.

The number of people per square unit of *farm* land is known as the **physiologic density.** Physiologic density can be seen as a more practical tool in understanding the sustainability of a population of a certain region or country. Physiologic density is especially important in understanding the geography of countries where the amount of **arable land,** land usable for farming, is limited.

Limits to physiologic density include overcrowding on farms or a lack of abundant farming regions due to geography. For example, Iraq, Egypt, Uzbekistan, and Pakistan are all arid countries that have narrow farming regions around river systems and deltas.

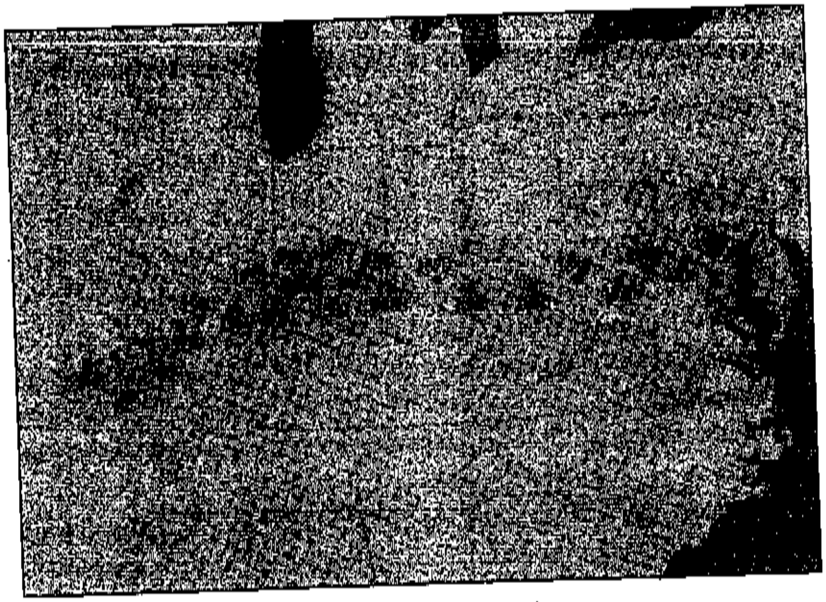
In countries like the United States and China, arable land sits in the eastern third of the country and the west is dominated by mountain and desert regions. There, high physiologic densities in farming regions have led to populations being squeezed into cities or westward into grassland and arid regions to expand agriculture to new areas.

The Center of Population

We can find the population center of a country by averaging the spatial weight of population across the country. This is different from the **geographic center** of the country, or **centroid**, which is simply the geometric center of the country's irregular polygon. To better understand the concept of "the spatial weight of population," imagine the country as a flat surface with the population standing on top in their home locations. The population center, or **population-weighted centroid**, would be the point where you could balance that weighted surface without tipping over.

In the United States, the population center has continuously moved west each decade since the first census in 1790. Originally, land in the Eastern United States was already owned and farm populations were high. Those wanting to have their own farms along with immigrants arriving in the country found no land available east of the Appalachian Mountains. Most migrated westward into the Midwest and Great Plains regions to settle and start their own farms. For this physiologic reason, the arithmetic density and population center moved westward through World War II.

After World War II, population shifted south and west due to the Sunbelt migration. See more on the Frostbelt to Sunbelt shift in a few pages.



Source: *US Census Bureau, International Data Base*

Historic Population Centers from Each Decennial Census

Note the southwestern shift from 1950 onward, toward the Sunbelt.

Population and Sustainability

The most important concept to understand about the **sustainability** of the global population is **carrying capacity**. At the global scale, we can ask: How many people can the earth sustain without triggering a **Malthusian catastrophe**? Similarly, at the regional scale we can examine the sustainability of certain **population densities**.