

Malthus and Population Growth

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1 Malthus and the Dismal Science

Do you know why economics is known as "the dismal science"? It's all the fault of T. Robert Malthus. In the 1700's Malthus noticed that population grows geometrically (exponentially) while food resources would grow arithmetically (linearly), thus it was only natural that the poor would starve, or there would be widespread famine. At the time his writing was taken to mean that the poor would always be with us, always on the brink of starvation, and therefore society should accept this and focus on other goals. Sounds pretty dismal to you, doesn't it? And thus the body of science he was one progenitor of—economics—was the "dismal science."

The basic economics of his argument is an implication of diminishing marginal product and exponential population growth. If each couple has four children then in the next generation the population will be four, in the following eight, and so on. Within 20 generations these two people will have had over a million descendants. Even if they have three children within 35 generations they will have over a million descendants. Now let us examine the production function for food. In the short run it is clearly a function of A —arable land¹—and L —labor, or in this case the population.

$$F = g(A, L) .$$

The amount of arable land is clearly fixed, and based on diminishing marginal product we can assume that $\frac{\partial^2 F}{\partial L^2} < 0$. This means that as the population rate grows at an exponential rate the marginal productiveness of workers will decrease. But it's worse than that because what we really care about is $\frac{F}{L}$, which is the amount of food per-capita, if this is decreasing then each person is getting less and less food. Thus we want the margin to be positive:

$$\partial \left(\frac{F}{L} \right) / \partial L = \frac{1}{L} \left(\frac{\partial F}{\partial L} - \frac{F}{L} \right) > 0$$

but if one looks at the change in the margin:

$$\frac{\partial^2 \left(\frac{F}{L} \right)}{\partial L^2} = - \left(\frac{2}{L} \right) \partial \left(\frac{F}{L} \right) / \partial L + \frac{1}{L} \frac{\partial^2 F}{\partial L^2}$$

one realizes that this will be strictly negative unless $\partial \left(\frac{F}{L} \right) / \partial L$ is negative, this locks us in a conundrum. Basically unless the quantity of food per-capita is falling the marginal impact of a worker will be falling. The result, Malthus

¹Arable land is land appropriate for growing food. Currently, Antarctica is not arable.

says, will be starvation and death. Specifically for the poor, who will always be with us.

However I think most modern economists would disagree with him, there are three parts to this argument.

2 The Cause of Famine:

In 1998 Amartya Sen was given the Nobel prize for radically changing the way we thought about famine. He realized that famine was not caused by a shortage of food, but by markets. Free markets do not take care whether people starve, this is the job of the government. To be clear, a famine is the government's fault.

His seminal work was based on the Bengali famine of 1943.² He carefully presented data showing that the death of over three million people was caused not by a food shortage but by markets. This was during World War II and the English (who ruled India) desperately needed food for the troops. This caused the price of food to rise dramatically. Then there was a bad year for agriculture, and this caused the price of food to climb even higher while farmers' incomes fell sharply. This sudden shock is what caused the deaths. The farmers could not afford to feed their families because their income fell and prices rose at the same time.

Proof that it's the government's fault is shown by what has happened since the independence of India. Agriculture routinely fails in India. It depends on the Monsoons, and these fail fairly regularly. However since independence (1947) there has not been a single famine in India. It's a democratic government, and famines tend to make people vote for a different government. (Those that survive the famine, obviously.)

The Irish potato famine (1845-1849)? It was caused by a virus affecting the potato crop, right? Yes, that caused the drop in potato output, but not the famine. Rather, just like India, the problem was caused by free markets. The potato farmers would sell their crops to the landlords, the landlords (who happened to be English) sold their potatoes where they could get the most money for them—in England, where incomes had not fallen drastically. The terrible thing is that since the English kept such careful records it is easy to show that there were enough potatoes to feed the Irish, but they were shipped to England.³

Thus Malthus was wrong about the cause of famine, and indirectly his thesis contributed to the problem. It was not "the poor are always with us and sometimes they starve" but rather "during an agricultural failure the government

²Bengal is a state in the north east corner of India, about one tenth of the size of Turkey.

³As an aside, I don't want you to conclude that English are terrible people. Instead you should conclude that they are great record keepers.

At the time no one was aware of these atrocities. People thought "well a Potato blight is causing the famine," or "well, the Monsoons failed." If the English had been aware of this they would have fixed the problem. The fault, if fault must be found, is at the feet of Economists before Amartya Sen. It is our responsibility to make sure this sort of thing does not happen.

must intervene so people do not starve." The poor (farmers) are at greatest exposure to the whimsy of the market but they do not need to die.⁴

One could counter that at some point Malthus will be proven right. I don't believe that but it will take two more steps to the argument.

3 The Direct Impact of Technology:

The standard response to Malthus is to merely point out that there is a third important input into food production, technology, T .

$$F = g(L, A, T)$$

and technology has been increasing dramatically. This is obviously true, while it does have its downsides improvements in food production technology is the primary reason that we do not have much higher food prices. For example the "green revolution" in the 1950's and 1960's caused a six-fold increase in the agricultural output of Mexico.

But still, hard-core Malthusians might say, the end days are coming. The amount of arable land is finite... and when we hit that bound...

4 Children as Consumption goods—the indirect impact of technology.

The final nail in the coffin for Malthus's argument goes to the heart of the fertility rate. The fertility rate is the number of children a woman will give birth to over her life time. If it is two or fewer the population is shrinking—or will in the future. In fact the experts in this field include a fudge factor because the statistic assumes every woman will live through their fertile years. Some women will die before giving birth thus experts say that 2.1 is zero population growth. Do you know Turkey's fertility rate?

My hypothesis (which is not universally accepted) is that the final nail in the coffin of Malthus's hypothesis is that the world fertility rate will fall below 2.1 within your lifetimes. In other words before you die it is possible that a shrinking population will be the worldwide norm.

The reason for this is because of a change in the role of children in a family. In the twentieth century children changed from a significant investment good to being primarily a consumption good. In other words I and most parents these days do not expect to rely on our children when we are old, and even if we did the idea of them transferring back the amount of money we spend on them is ridiculous. The reasons for this are two indirect impacts of technology.

⁴From the most cynical point of view, having the labor force die unnecessarily will decrease future GDP. Thus this is clearly the government's responsibility.

4.1 The Impact of Technology on the Wage Rate.

When I retire I am going to have income from four sources. First both of my major employers have retirement accounts for me—Rice University and Bilkent, secondly since I have worked in two countries both the United States and Turkish government will give me a monthly salary (social security). This monthly salary works as a transfer from the young (currently working) to the old. The bottom line of all these forms of income is that I am earning so far in excess of what I need to survive that I can afford to save enough money for retirement.

To understand how much this has changed we need to take a long view. For this reason I refer you to the books of Jane Austin—an English writer who lived from 1775 to 1817. My leading example is *Persuasion*. In that book Anne Elliot—the daughter of an English landlord—wants to marry Frederick Wentworth—the son of a clergyman (equivalent to a priest or imam.) She is told she cannot because there is no way that the son of a clergyman can support her properly. Simply put there is no way for him to become wealthy. His only chance is to join the navy. Now a little publicized fact about the English navy of the day was that they were basically pirates who would not raid ships flying the English flag. In other words the only ways to become wealthy were either to be a landlord or a pirate.

At this point you should think about Bill Gates, Steve Jobs, and Mark Zuckerberg. OK, those examples are a little extreme but I would also suggest people like Enis Erkel—my bacanak (brother-in-law who is married to my ex-wife's sister.) He came from a small Black Sea town that didn't even have a high school and worked his way to being a millionaire.

What changed? Technology, the rise of technology has led to a world where wages are so high that people can become rich based on their labor alone. The modern equivalent of being a landlord is to make your fortune on the stock market. This is possible but investors in the stock market are investing in other people's labor. Their money goes to businesses and often the biggest single category of expenditures for businesses is labor.⁵

This is relevant to our discussion because back in Jane Austin's day one could either inherit a fortune or steal it. In the modern day it is the rare person who's wealth is due to inheritance. Donald Trump is the only example I can be sure of all of you knowing, and he claims to have significantly increased his inheritance. Even lowly workers like your's truly can save enough to be sure of an income in his old age. Heck, even the people working at grocery stores expect to have a sufficient government pension.

Back in Jane Austin's day the only recourse the poor/middle classes would have for old age was to live off of their children, often moving in with them if times were rough. This made children a significant investment good. Indeed child mortality rates would cause risk averse mother's to have even more children

⁵I should also mention that Beyonce, Michael Jordan, Pele (Edson Arantes do Nascimento), etceteras also are rich due to technology. A hundred years ago even the idea of making a living from soccer/football was ridiculous. Television changed that, and without records musicians at best could make a comfortable living.

because some would die before reaching adulthood. This still a part of Turkish traditional culture, but even there the way it has changed shows it is not as important. For example my ex-wife's family bought her parents an apartment. But they did it in order for her parents to have a classy place to live. They were not providing housing but luxury housing.

In short, the rise of technology has resulted in a world where the wages of labor are sufficient to take care of oneself in old age. Children are no longer needed to provide for you when you are old.

4.2 The Impact of Technology on training.

In a biography, Jiro Ono (a famous sushi chef in Japan, born 1925) talked about how he had to start working when he was seven years old (1932-1933) and two years later left home for an apprenticeship in Tokyo. This was extreme but it wasn't unheard of. Nowadays it would not even be legal. Like Turkey, Japan does not allow people to work until they are fifteen. Indeed in both countries you have to go to school until you are at least fifteen—in Turkey a 2012 law requires you to complete twelve years of school (seventeen or eighteen years old). In the United States it is decided on a state level. In Indiana (where I am from) you have to go until you are 18 years old and can begin working at 16.

What caused the shift? Why, in the last century, have so many countries made child labor illegal and replaced it with required schooling? Technology, all of the examples I gave above of the fabulously rich are people who worked on the cutting edge of technology. For the everyday person if you can't operate a computer you are locked out of a lot of jobs—like being a car mechanic. In order to be productive in the modern economy you need extensive training in how to operate the everyday technologies we see around us.

And this training is expensive. For example in Turkey many children go to private school. My recent estimate of the cost of having a child graduate from BLIS was approximately a million TL (2018). Some friends of mine decided not to move to Istanbul because the cost would be three million per child. In the United States the situation is more complicated because public schools are paid for with local taxes. The result of this is that people move to suburbs with high tax rates and then send their kids to the local school. Some friends of mine were quite clear that they moved to Zionsville (Indiana) because the cost of private school tuition was higher than the tax rate. In the US, however, parents must pay for college. The average tuition is currently \$10,000 for public schools in the same state and \$25,000 for out-of-state students.⁶ This does not include the cost of living expenses, books, and etceteras.

Thus children have gone from people whom (if necessary) could begin working at the age of ten to people who realistically need as much as sixteen years of expensive training in order to enter the workforce. In some countries the government pays a significant part of these expenses, but that does not mean the

⁶I would like to mention that this is the list price. Schools usually give a discount to students from "less advantaged" backgrounds. Many to most students pay less than these prices.

expenses disappear. Universally, at the minimum, the child is now not allowed to work until she or he is fifteen or sixteen and the parents have to pay expenses for schooling during that period.

4.3 The overall implication and statistical evidence.

In 1800 I would be already considering an apprenticeship for my son, if my family had enough land perhaps I could delay that for a few years but that would be a luxury. I would expect my daughter to already be learning household production skills so that she could become productive in at most two years. I would know that my children's entire life prospects would be set out by my family's wealth—with the outside option of becoming a pirate. In 2018 I expect them to go to school for at least sixteen years—with the option of going for a further five to six years to get a PhD. I expect that my income when I am old will be essentially unconnected to their success in business or piracy. The upshot is that when you look at my decision from the framework of history you see that what used to be an investment good—to provide income in my old age—has now become a consumption good—I had my children because I love them.

What would be the best statistic to capture the change in the nature of children? I suggest it would be the fertility rate—the average number of children a woman will give birth to in her lifetime. I expect that a higher income has two effects. First the higher my personal and social savings. Second, I am more likely to expect that my children will need good education to be successful. On a national level Gross Domestic Product per capita (GDP/capita) captures average income.

Do the statistics support this hypothesis? Examples certainly abound. The average fertility rate for the European Union is 1.6, for the United States it is 1.84, and for Japan is 1.46. Turkey—a middle income country—has a fertility rate of 2.05. On the other extreme, Niger has a fertility rate of 7.6 and a GDP/capita of \$363 per year—about one thirtieth of Turkey's.⁷ The simple interpretation of this is that children are an inferior good—the rich have better things to spend their money on. Personally I find that ridiculous, I know that if I could afford another child I would probably have one. Thus I suggest another hypothesis. A country like Turkey pays a high cost per child (both social and private) because children aren't needed when parents are old and they must be trained for the modern, technological, world.

This theory suggests that in a regression like:

$$\ln(\text{Fertility rate}) = \alpha + \beta \ln(\text{GDP/capita}) + \varepsilon$$

the estimate of β should be negative and significant. One can find different data sets for fertility rate and GDP/capita, looking at data from the World Bank (both statistics), Population Report (fertility rate), CIA (fertility rate), IMF (GDP/capita), and UN (GDP/capita) one arrives at estimates ranging from -.21 to -.25 for β and always highly significant. In short if world GDP/capita

⁷This data is from the World Bank (2016).

doubles the fertility rate will fall by at least 21%. World GDP/capita doubles approximately every twenty years, and the worldwide fertility rate is currently at 2.439. Thus a simple application of this ridiculously simple theory says that in twenty years—when GDP/capita doubles—the worldwide fertility rate will be below 2.1.

You should not take this model seriously, but it suggests that within your lifetime the fertility rate will drop below the zero population growth level. Will the population growth rate? That, of course, depends on life expectancy. Population growth will probably follow this statistic with a lag, possibly still growing throughout your lifetime but at a significantly reduced rate.

Let me emphasize that I am not a population economist, and that a ridiculous cross-country regression should not be applied to a time series analysis.⁸ However my theory does explain why children appear to be an inferior good. The fact that the theory and data say the same thing is evidence in support of my hypothesis.

As Turks you do not need to concern yourself with the worldwide statistic. Of more relevance is that currently the fertility rate in Turkey is below 2.1—and likely to fall. This means that Turkey—like the United States and the European Union—will need to change from a land of emigration to a land of immigration or the population growth rate will become negative.⁹ Why should you care about the population growth rate? Because—like all modern societies—social security (government income for the old) is paid for by a transfer from the working age population to the retired. In many ways all of our economies are based on the hypothesis that the population is growing. Is Erdogan concerned about this? A while ago he suggested that families should have three or more children.

How do I feel about this on a global level? Woo hoo! We're probably not going to fall into Malthus's trap! That makes me very, very happy. Personally I think it would be great if the world's population fell by a few billion—without anyone dying. (I do not endorse Thanos. I think his "solution" is rather childish.)¹⁰ But on the other hand I recognize there will be a significant downside of this change. How will it change our economy if one of the most basic inputs—labor—begins decreasing? On the other hand those who are waiting for the robot apocalypse should be happy. We might be running low on people when it happens.

⁸I am basing my analysis on variation between countries **today** and then applying it to analyzing what will happen in the **future**. This is bad statistics.

⁹Net migration in Turkey was negative until 2010. The latest data (2015) has it at a peak of 4.32 per 1000. This is insufficient, if it wasn't for increased life expectancy the population growth rate of Turkey (1.6%) would be negative.

¹⁰For those who have been living under a rock, in the movie "Avengers: Infinity War" Thanos wants to wipe out half of all intelligent life in the universe. His hypothesis is that then there will be enough resources for the rest.

I say, hah, a minor drop in population like that can be replaced in a few generations. (I am discounting the massive economic depression that this will cause.)

Now the Film Theorist makes an argument about the fertility rate that is almost the same as mine and concludes that because of the low fertility rate the dip might be permanent:

<https://www.youtube.com/watch?v=3eQP6JoxTKk>

But everyone knows he's a flaming idiot—you can tell MatPat I said that.