Population Economics and Malthusian Theory

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Population economics is a field where economists study the relationship between population and economic situation. This relationship can be two-way: economic development or fluctuation can have an impact on population, and population growth and quality can have economic consequences. In this paper I would like to give a brief introduction to population economics and discussion Malthusian theory based on the broader background.

1 Dynamics of population

To discuss the dynamics of population of an economy, we need to talk about both the inflow side and the outflow side.

On the outflow side, the first concept that comes to our mind is mortality. Given the number of people living in the economy, the number of survivals is what we care most about, since this is the group of people on whom we base our welfare analysis.

We can calculate the mortality rate for the entire population, or the mortality rate of for each age category. The age-specific mortality rate is often a U-shaped curve: mortality is high at young ages and old ages, and is usually quite low in the prime of life.

By analyzing the mortality pattern of the population, we would be able to calculate the life expectancy: in expectation, how long would one individual live? One way is to use the age-specific mortality rate of the current population, and the underlying assumption is that the mortality rate of the people in the future is the same as the one of the people living today. Since overtime we usually observe decrease in mortality rate, the life expectancy calculated this way (called period life expectancy) is usually lower than the cohort based one. For cohort based life expectancy, we need to observe the age-specific mortality rate for a cohort (usually retrospectively).

Life expectancy is a very important characteristic of the population. Without being alive, the good things that a growing economy has to offer are just vacant. In later sections we would discuss the determinants of mortality and connect them to the Malthusian theory.

On the inflow side, fertility is the most important concept. The first thing related is fecundity, which is the physical ability of having a baby for a woman. In addition to the physical ability, having a child is usually a decision of a family taking all cost-benefit analysis into account. We have both crude birth rate and fertility rate. Crude birth rate is the number of children born in a certain period divided by the total population living in the same period, while fertility rate
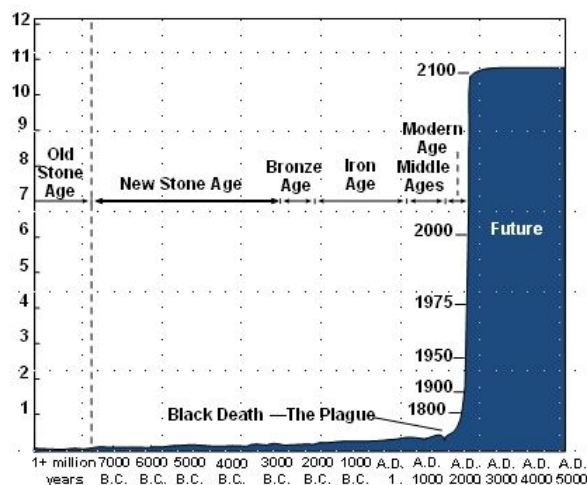
Figure 1: World Population Growth through History (in billions)
Source: US Population Reference Bureau; and United Nations, World
Population Projections to 2100 (1998)

is divided by the number of women at the fertile age. So we can see that in order to determine the number of newborns, we need to consider the number of women at the fertile age, their physical ability of having a baby, and also their decision of whether to have one or not. Malthusian theory talks about fertility, but does not go into details of each of these factors.

Number of in-migrants and out-migrants is also an ingredient for population dynamics, but we would not say much of them here, but focus on the dynamics within the economy.

2   Stylized facts over the long-run

We can see that for a very long period of human history, world population was stagnant, or had very little growth. But after 1700, there was an explosion of population. Also, during the period of 17-18th century, mortality declined, life expectancy increased and fertility decreased.

Another key feature is that per capita GDP increased tremendously since then. During this period, it seems that human being not only escaped from the curse of mortality but also the curse of low living standard. These stylized facts motived the research in many aspects. General demographic theory describes the demographic transition by the following five stages: In the first stage, both birth rate and death rate are high, so the total population is small; in the second stage, birth rate stays constant, while death rate decreases, so the total population starts to increase; in the third stage, birth rate also starts to decrease, but population still increases since the decrease in death rate dominates; in the fourth stage, both birth rate and death rate are low, and total population just increases a little bit; in the fifth stage, things are very uncertain, especially for the birth rate.

Regarding this general demonstration, there are several questions to be an-
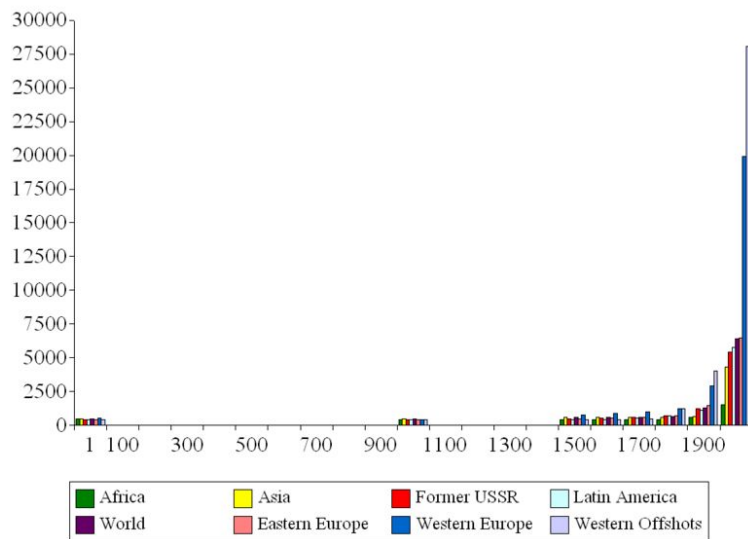
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World GDP/capita 1-2003 A.D.

Figure 2: World per capita GDP 1-2003 A.D
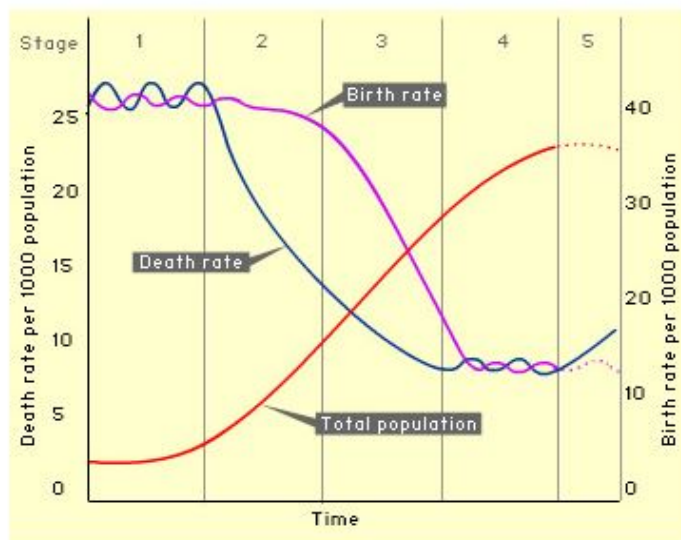Data Source: Angus Maddison's "World Population, GDP and Per Capita
GDP, 1-2003 AD

Figure 3: Five stages of demographic transition
Source: WikimediaD

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swered: 1) Does death rate decrease before the decrease in birth rate empirically for different countries? 2) How do we determine the timing of the decline? 3) Does decrease in death rate cause the decrease of fertility rate? 4) What role does economic development play in the process?

In the following section, we would discuss different theories trying to establish the relationship between mortality, fertility and economic conditions. For Question One, the evidence is mixed. Sweden and Mauritius had historical patterns confirming the theory, but other countries (like United States, UK and France) did not. For the second question, there is no theory that provides a rule for determining the timing. Most theories focus on the decision of childbirth and discuss the relationship between demographic transition and economic growth.

3 Theories of demographic transition: Malthusian and beyond

The first kind of theory is dominant theory. Its main argument is that lower infant mortality lead to lower fertility, through both biological channel and behavioral channel, but does not talk about economic development. On the biological mechanism side, lactation interruption because of the living child will postpone the birth of the next child. On the behavioral mechanism, this theory assumes that parents have a target number of children, and more surviving children mean that there is no need for extra birth. But the basic prediction of the model says that birth rate will decrease while fertility does not. Also, the calibrated model of Doepke (2005) suggests that infant mortality decline only accounts for a small proportion of fertility decline. In addition, this theory assume that individuals understand infant mortality rate very well and it is not very clear empirically how people get this knowledge (not only about themselves, but about the overall probability). The second kind of theory tries to explain the decline in fertility. Malthusian theory links population with economic growth and the basic prediction is that despite economic development, population growth and per capita income are always stable. The model focuses on agricultural activities with land as a fixed factor. The determinants of mortality include nutrition, housing and so on, which all depend on income. While income increases, fertility increases, and more people will be populated on the fixed area of land, suppressing the rise of income. With low income, there are both "positive check" and "preventive check": positive check refers to increase in mortality while preventive check refers to decrease in fertility. With these two forces, population and wages always stay at the equilibrium level.

The basic argument of Malthusian theory makes a lot of sense. First, empirically, before 1800, the world acted exactly the way described by Malthus, with low population, low income, and little technological progress. Theoretically, in macroeconomics, we usually talk about "steady-state", where per capita income does not change even if the population increases. Malthusian equilibrium is like such a steady state. However, in the macro model, there are shocks or innovations in technology such that we are able to move to a better steady state, where per capita income is higher. We are able to do this because there are no fixed factors that will constraint the total production while in Malthusian world
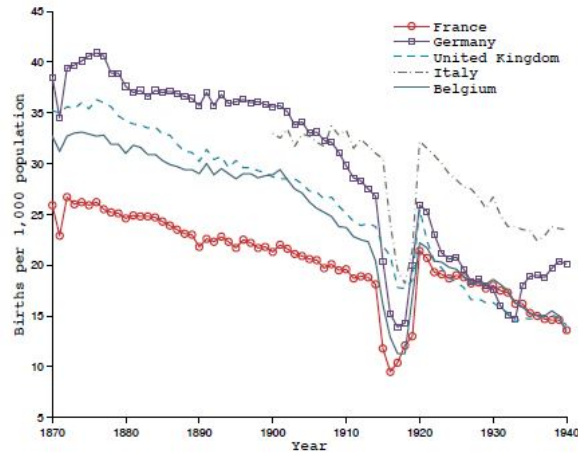
Figure 4: Crude Birth Rates in Some European Countries
Source: Mitchell (1998)

we are tied to only agricultural production. After industrial revolution, capital becomes a more important production input, and capital can be accumulated over time through investment.

The second major argument of Malthusian theory is about the relationship between fertility and income. I would say that this argument is still valid in some cases, as what we will see in Section 6 in a period of China. However, over a longer horizon or with cross-sectional comparisons of different countries, the prediction of Malthus is not true. From Figure 4 we can see that for these developed countries, during the period of 1970-1940, birth rate declined over time, except for the years with the interruption of wars. Malthusian theory views the decision of human child bearing the same as that of animals, and infers that human nature would result in increase in child births with the increase of resources available. However, although continuing the family line or "genes" is a very important task for human being, the options in human life are much more affluent than animal life. The direct cost of children, such as providing education, housing and even getting them married, increases, and also the opportunity cost increases if people value individual life more than family life. I will talk more about this in Section 7 taking Japan as an example.

After Malthus, there are several new research papers working on reconciling the predictions of Malthusian theory and the observed "escape" in human history. Among them, one important work is Hansen and Prescott (2002). In their paper, we are no longer in a pure Malthusian world with only agricultural technology. Instead, we have two kinds of technologies to produce a good, one using land as a fixed factor, and another without land requirement. Both productions depend on exogenously growing knowledge. Firms would choose the technology to adopt: when knowledge level is low, we would use the first Malthusian technology, while when knowledge reaches a certain point, we would switch to the second Solow technology. Empirically, the transition is the industrial revolution. This model explains the transition from the perspective of optimality in choosing
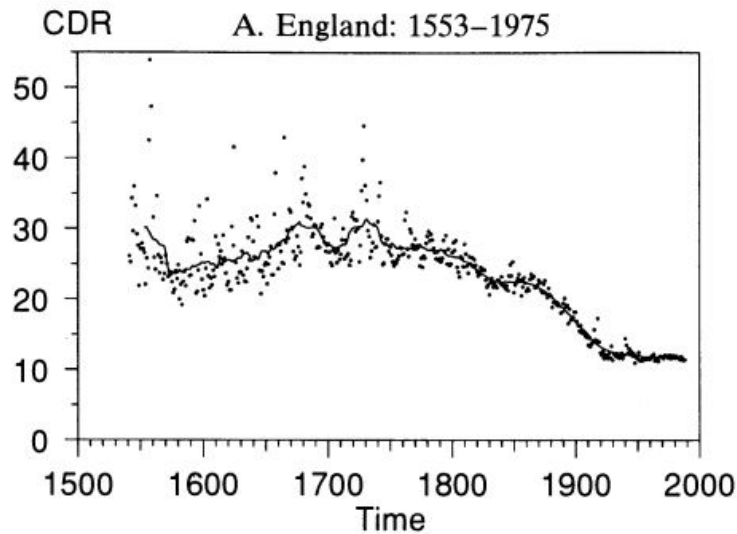
Figure 5: Secular trends in mortality in England
Source: Fogel (1994)

the technology, but the transition depends on exogenously growing innovation; say, it does not say about why the industrial revolution happened. Another work by Galor and Weil (2000) deals with the innovation part. In their model, technical changes are powered by human capital accumulation, and skill-biased technological progress will encourage the increase of human capital. Facing the trade-off of quality and quantity of children, fertility might decrease due to higher returns to human capital. In addition, with a larger population size, the speed of technology diffusion will be higher, promoting economic growth as well. However, this model does not say about the timing of transition either.

4 Determinants of mortality

In Malthusian theory, mortality acts as a "positive check". How does mortality act in reality? There are several empirical facts about mortality. The first fact is that across developed countries, mortality rates fall and converge. The second fact is that cross-sectional comparison shows that countries with higher income have lower mortality rate. Also, when we do within country comparison, we observe that people with higher income or other socio-economic status usually have better health conditions and lower mortality rate.

It seems that income and mortality are closely related as pointed out by Malthus. However, there are also counter examples: in England during 1553 to 1800, the crude death rate did not decrease with increase in income. This pattern motivates us to look into the determinants of mortality more closely.

Nutrition is one important factor. Nutrition has a direct effect on birth weight and body-mass index, while there is evidence showing that these two variables are good predictors for general health conditions, including mortality. Nutrition is clearly very closely related with individual income, and its effect is
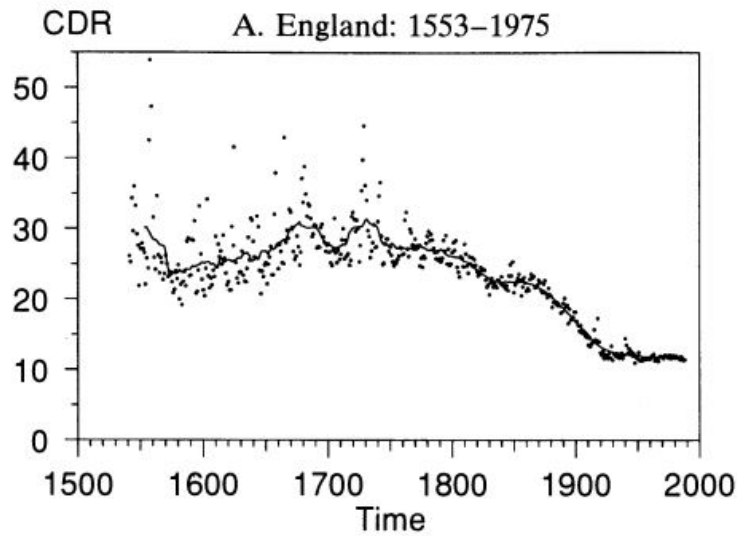
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Figure 6: Life expectancy versus GDP per capita
Source: Cutler, Deaton, and Lleras-Muney (2006)

also emphasized by Malthus. However, there is one very important factor that is overlooked by Malthus, which is public health. Nowadays the most important cause of death for human being is cardiovascular disease, while in older ages, epidemic diseases were the most fatal ones. Culter and Miller (2005) shows that half of the reduction in mortality in the first third of 20th century could be explained by clean water. Sanitation is an important aspect of public health, and an effective way of prevention method for the spread of epidemic diseases. Also, invention of vaccines greatly improved the efficiency of disease prevention. All these factors can be broadly viewed as "innovations" in knowledge, and although we are not sure how these innovations happened in the very beginning, but as time passes, people find ways to decrease mortality in a more cost-efficient way. These innovations will improve people's health status even the per capita income remains constant, but they are not included in Malthusian theory.

From Figure 6 we can also see that the relationship between per capita GDP and life expectancy is not linear. One important factor here is the spill-over of public health knowledge from developed countries to developing countries. Also, we need to pay attention to the slow-down of increase in life expectancy in developing countries. Although per capita income of countries like U.S. and Germany is far higher than that of Mexico and Brazil, but the difference in life expectancy is small. One possibility is that in developed countries we are already approaching the limit of human life expectancy, so it is very difficult to make further progress. Another possibility is that when income reaches a certain point, there are other factors that are more important for increase in life expectancy, for example, healthy lifestyle. But still, there is much to learn about this graph and determinants of mortality and in general human health.

5 Malthusian theory and U.S.

All the above discussions are very general. From this section on I would like to discuss specific countries and their own challenges in health.

For the U.S., one important problem is what we have seen in Figure 6: it is a little bit below the curve, meaning that when its per capita GDP is among the highest, it is not doing so well in terms of life expectancy. U.S. is one of the countries that spend a large share of public expenditure on health system. Clearly this stagnancy in life expectancy in U.S. is not due to income reasons, but due to how people spend the income. Providing medical care when people are already sick is very important, but preventing the occurrence of diseases is even more important, and possibly less economic costly.

Another problem is about inequality. According to Kearney and Levine (2012), "U.S. teens are two and a half times as likely to give birth as compared to teens in Canada, around four times as likely as teens in Germany or Norway, and almost ten times as likely as teens in Switzerland. A teenage girl in Mississippi is four times more likely to give birth than a teenage girl in New Hampshire—and 15 times more likely to give birth as a teen compared to a teenage girl in Switzerland." This creates social problems because for fertility or birth rate, it is not only important that how many children are born, but also who are giving birth to children at what time. Teenage girls are usually not ready in many aspects for being a parent, and teenage parents are usually coming from disadvantaged households. This problem can enlarge the inequality of people from different socio-economic background, and can also have negative externality on the society.

From the example of the U.S., we can see that although income and fertility are simple concepts in Malthusian theory, but when we look into the real world, one dollar today and one dollar three hundred years ago can have different impact on health, and one dollar in the U.S. and one dollar in Nigeria are also different; one birth in a rich well-educated family and one birth by a low-income teenage girl are not the same. We need to decompose these concepts and map them to the reality to see how the population evolves and what welfare impact it has.

6 Malthusian theory and China

China is an interesting country to talk about population issues and Malthusian theory. When the People's Republic of China was established in 1949, the population in mainland China was 541,670,000; due to economic and health system development, in 1969, the population reached 806,710,000. After that, the Chinese government realized that the rapid growth of population would have adverse effect on the society, and started birth control; from 1978 onwards, birth control has become one of the most important national policies. There is one key person to mention in the history of Chinese population policy reform: a Chinese economist named Yinchu Ma. In 1953, mainland China conducted the first population census, and the result showed that the population up to June, 30, 1953 was 601,938,035, and population growth rate was 20‰. This fact caught Ma's attention and he thought that the growth rate was even underestimated. In his book New Population Theory, he stated that there were many reasons

that we should control the population size. The first one was about capital accumulation. He thought that a large population would need to consume a lot of output, thus the investment in capital would be reduced. The second one was about technological innovation. He said that in order to promote productivity, we needed to develop large industrial firms, while with a large population, we had to arrange employment for all of them and could induce inefficiency. The third point was about the tradeoff between manufacturing input and food consumption. He claimed that the raw material for light industries is from agriculture, and if too much of the crops are spent in food consumption, we were not able to boost light industry production. The last one was about scarcity of land resources. The per capita arable land resource of China was very small and even simply from the point of view of getting everyone fed, we could not afford a too large population.

His point makes much sense if we look retrospectively. However, starting from 1957, the entire mainland China was involved in the Great Leap Forward Movement initiated by Chairman Mao, and the slogan of that time was "the more people we have, the more powerful we would be". Due to the irrational political fanaticism, and due to improved living conditions, the population in China exploded. Ma's voice was criticism and suppressed, and Ma himself was recalled from the position of president of Peking University.

It was not until 1969 did Chinese government finally realize its mistake and follow the claim of Ma. Still, due to the huge base of population, although the growth rate was greatly reduced after the "one-child" policy, China is still the most populated country in the world now.

We can see that although Ma emphasizes a lot on technology innovation and capital accumulation, his idea about fixed land resources and adverse effect of population growth is very similar to Malthus. And it is true that during that specific period of China, Malthus's prediction of population growth and stagnant income level held. In addition to the choice of the people themselves, extra births were caused by political propaganda. "One-child" policy is criticized worldwide for its inhumanity; however, if we didn't do anything about the fast growing population, China would really be living in a Malthusian world. The problem of China was that the transition happened so fast: industry was so undeveloped before the establishment of the Republic, and people were so poor. Once people were able to get enough food and other resources, without realizing the general equilibrium effect, fertility was very high. Also, the medical conditions in the old ages were very bad and great progresses were made in terms of public health afterwards. People needed time to adjust their way of life and the way of thinking, while they actually did not have. This information problem was also mentioned in dominant theory: people need to understand what mortality rate means.

Nowadays, China seems to go to another kind of dilemma: do we want to relax the "one-child" policy or do we want an ageing society? I will put the discussion of this problem in the next section.

7   Malthusian theory and Japan

According to a journal article on the Economist, "Japan's population began falling in 2004 and is now ageing faster than any other on the planet. More

than 22% of Japanese are already 65 or older. A report compiled with the government's co-operation two years ago warned that by 2060 the number of Japanese will have fallen from 127m to about 87m, of whom almost 40% will be 65 or older."

With more and more people retiring and getting old, the fertility rate of Japan is very low. The Japanese government tried many policies to boost birth rate, but none of them was really effective.

Going back to the problem of fertility, Malthusian assumes that people always want more offspring just because of animal nature. However, as a social animal and economic animal, humans have more decisions to make. Once I watched a documentary film about Japan, and felt that there were such severe problems in the culture and in the modern society. If the burden or cost of getting married and bearing a child become so high (both economically and mentally), men and women simply no longer want a family or a child. People seem to be exhausted from daily work, and after work a lot of them just go to bars. Also, some married men would keep an "electronic pet girlfriend" in addition to normal family life and get true affection over the girlfriend, and he himself couldn't tell whom he loved more: the electronic girlfriend or the real wife.

Modern society has changed people's way of living and perception about life. Population is an aggregate measure but it is formed by numerous individual choices. I would say that we face more challenges today even if we escaped from the Malthusian world. We surely need to understand more about the population and see what is truly happening now, before we develop new theories to solve new problems.

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