

Population Catastrophe: Explosion, Implosion, and Replacement

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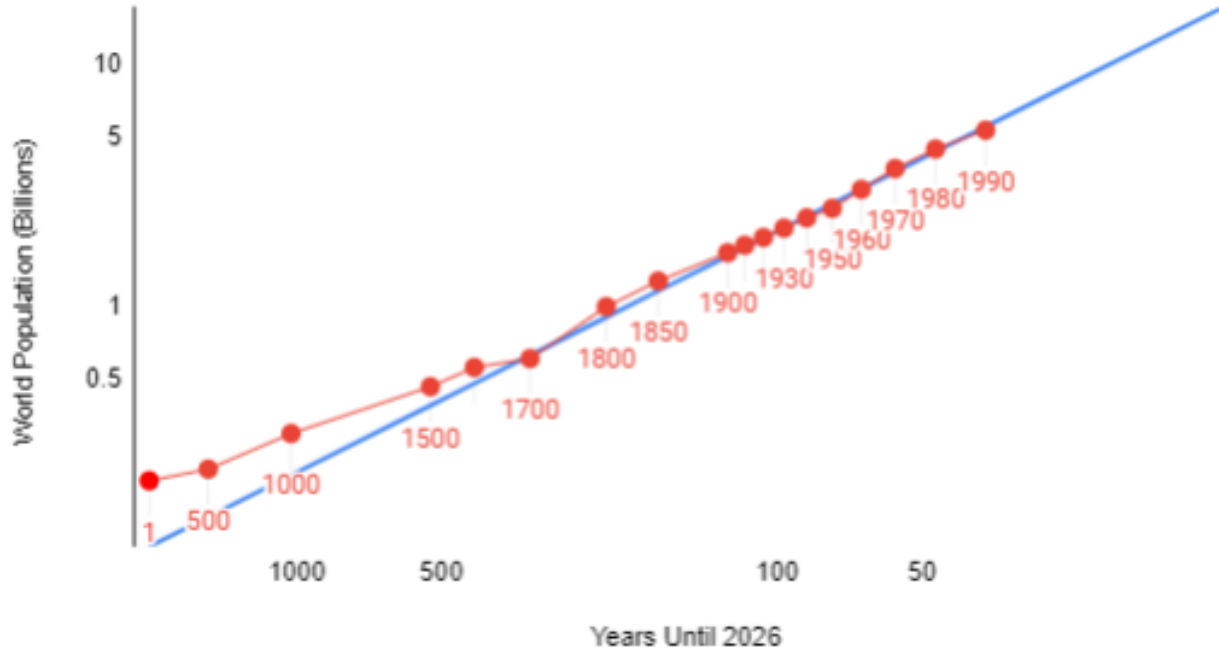
Lecture/Book Overview

- What happened to population over the last 250 years.
- How people thought about it (scholars, broader society, governments) and what they did about it.
- What happens in the future.

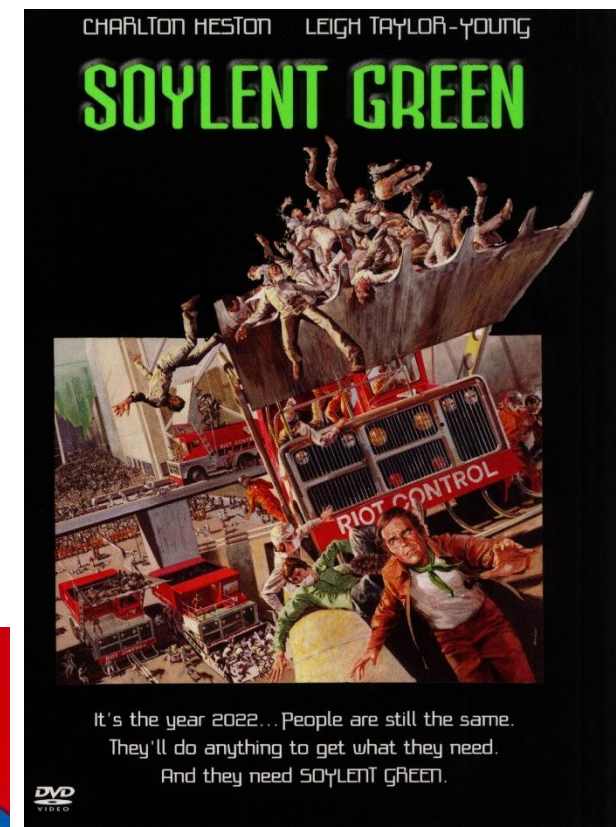
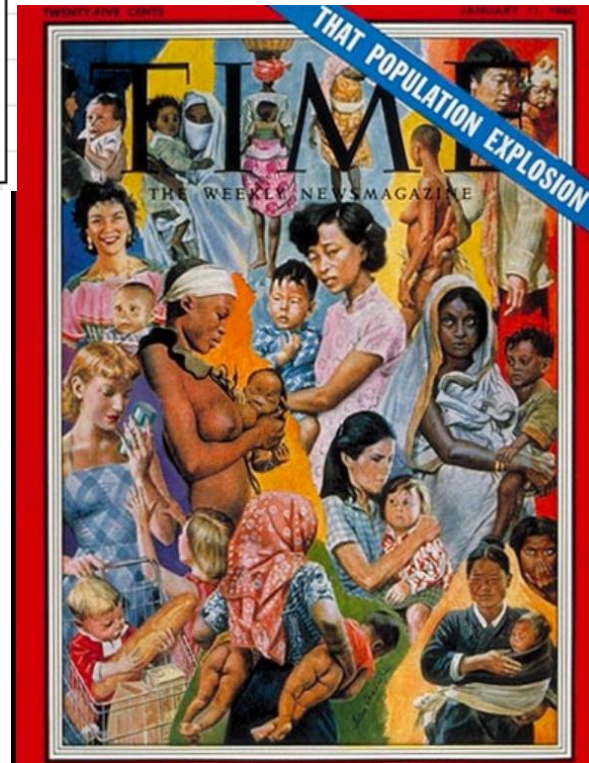
Three Population Problems

- What people have worried about:
 - Too much breeding (population explosion).
 - Not enough breeding (birth dearth, population aging).
 - The “wrong” kind of people breeding.
-
- These are all old ideas, but they surged in prominence in the last two centuries.

The Doomsday Equation for World Population



Science, November 4, 1960



Soylent Green (1973)

Time Magazine
January 11, 1960

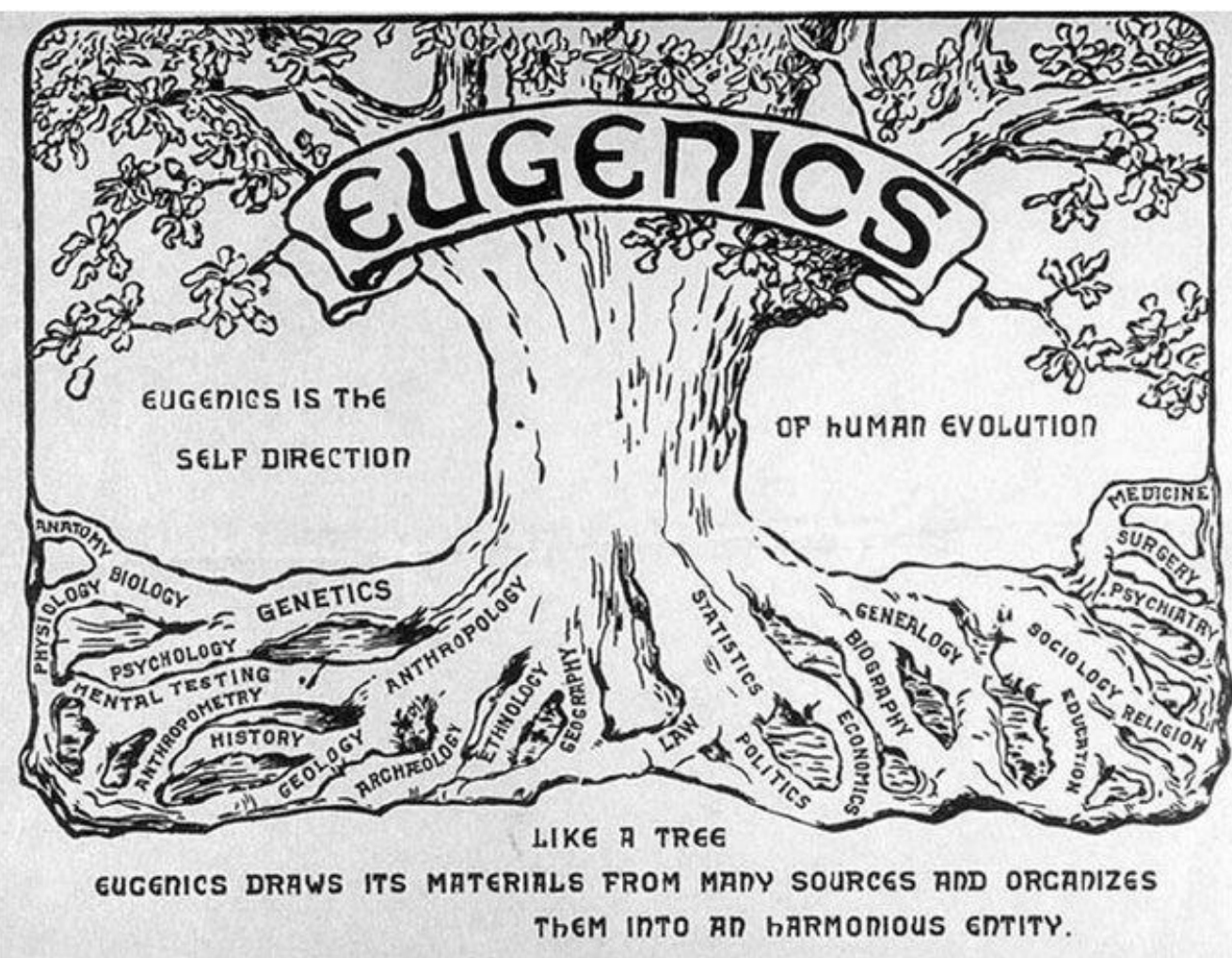
**Europe needs many more babies to
avert a population disaster**

**Elon Musk Tweets on 'Population Collapse' After
China's Birth Rate Plummets**

South Korea in demographic crisis as many stop having babies

*Pope Scolds Couples Who Choose Pets
Over Kids*

**Can Any Amount of Money Turn the Tide
on Global Fertility?**



- “Race suicide” (E.A. Ross, 1901)

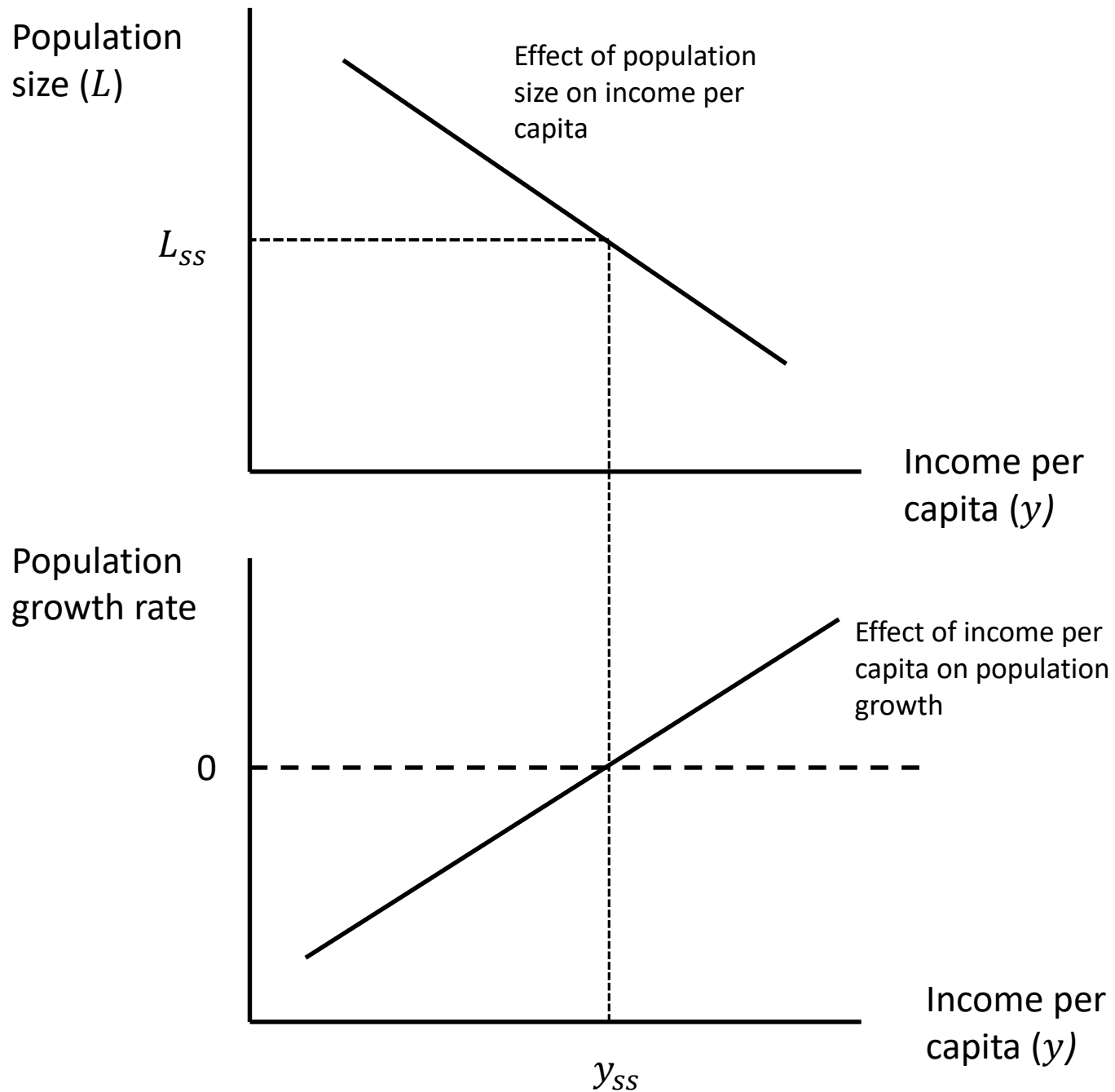
“There is no bloodshed, no violence, no assault of the race that waxes upon the race that wanes. The higher race quietly and unobtrusively eliminates itself rather than endure individually the bitter competition it has failed to ward off from itself by collective action.”

Poster from the International Eugenics Congress of 1921

How Did We Get Here?

- Two models of population dynamics:
 - Malthusian
 - Demographic Transition Theory

The Malthusian Model



The Malthusian Model

- Stable Malthusian equilibrium characterized most of human history
 - Little long run change in standard of living.
 - Slow population growth matched slow technological progress.
 - Homeostatic response of population growth to shocks, e.g. Black Death.
 - Variation in social arrangements that influenced fertility (age of marriage, frequency of non-marriage, abstinence following births, etc.) was reflected in standards of living.
 - Positive correlation of income and reproductive success.

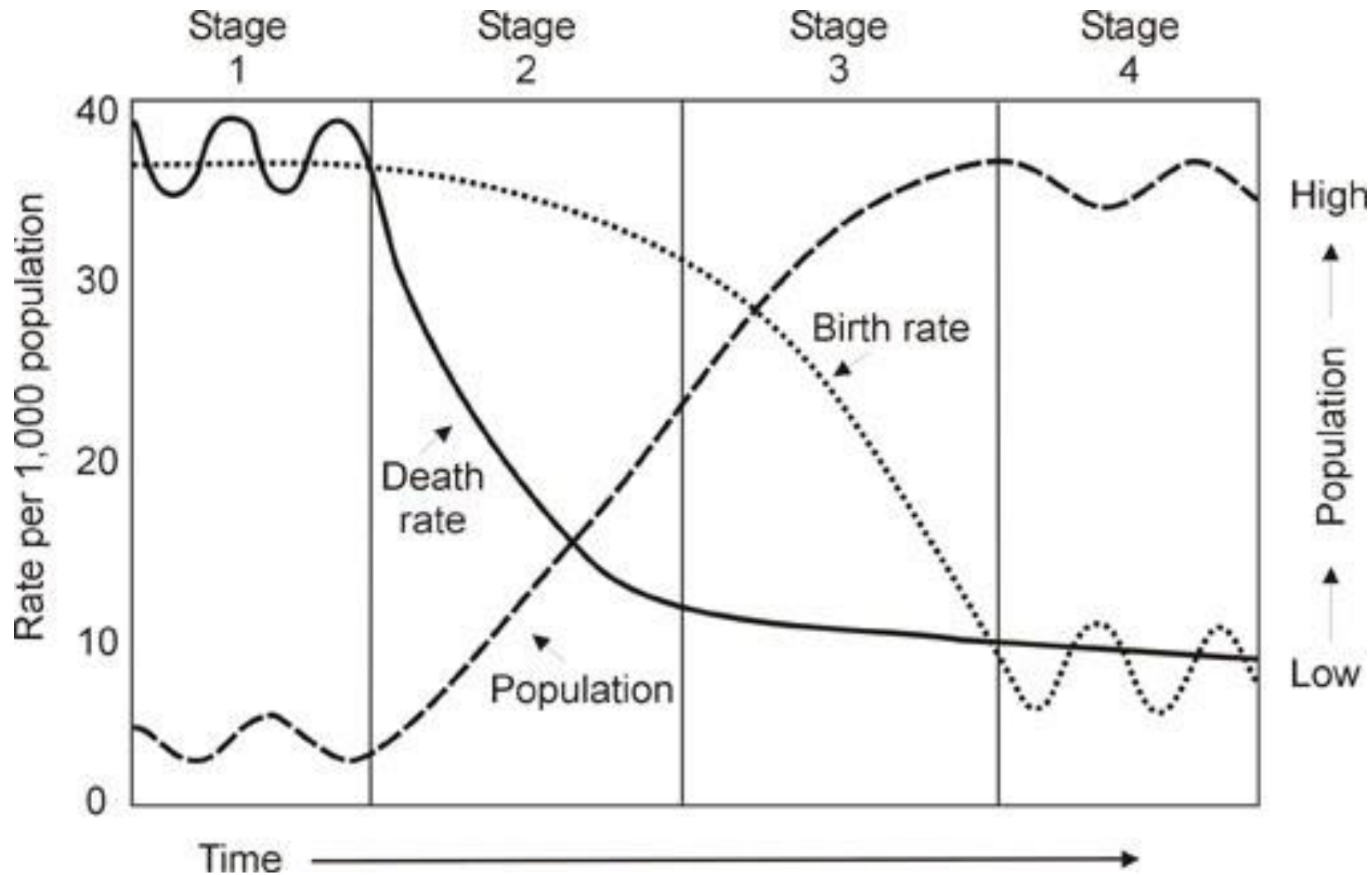
Why Did the Malthusian Era End?

- Malthus thought that more income would always increase population.
- He didn't take into account other changes that accompanied income growth:
 - Economic change: child quality (human capital) valued over quantity.
 - Cultural change: secularization, elevation of women's role in society
 - Improved contraception technology
 - Modern states replace the family as a source of insurance and protection
- These changes
 - reduce the desired number of children.
 - make it easier to hit that target number.
 - break the link from higher income to more children.

Demographic Transition Theory

- Stresses a key driver of reduced fertility: reduced mortality.
- When mortality falls (especially child mortality), people will desire fewer births.
- With some lag, social arrangements (such as age of marriage and contraceptive practices) will change to lower fertility.
- During this lag, population will grow.

The Demographic Transition



The Demographic Transition and the End of the Malthusian Regime

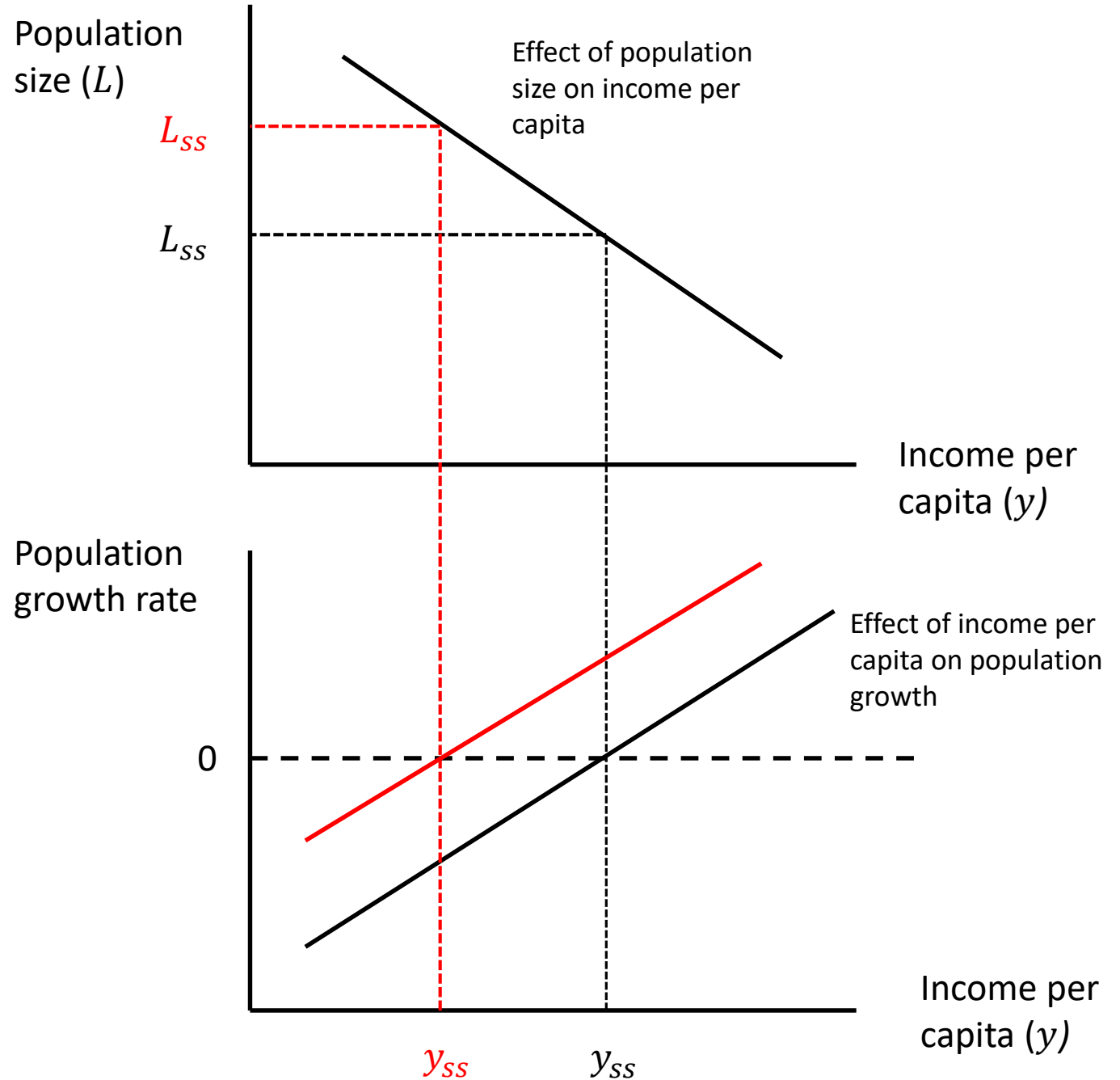
- Are these two different things (or two models of the same thing)?

The Demographic Transition and the End of the Malthusian Regime

- Are these two different things (or two models of the same thing)?
- My answer: These are two separate things that happened at about the same time.

		Mortality Environment	
		High mortality (especially infant / children)	Low mortality
Is the Malthusian Model Operative?	Homeostatic population	The whole world most of the time before 1750 or so.	Denser and poorer pre-industrial world – this is what population pessimists feared
	Non-homeostatic population	Not so different from our current world	Modern demographic regime.

Improvement in Health Within the Malthusian Model



The Reaction to Falling Fertility (early countries)

- By the late 19th century, falling fertility was well recognized and discussed in developing countries.
 - Demographic Transition Theory, which makes falling fertility look natural, did not arrive until the 1929.
- Clashing perspectives:
 - Neo Malthusians (conservative in UK, socialist on Continent)
 - Pro Natalists (Theodore Roosevelt, Emile Zola)
 - Feminists / birth controllers (Margaret Sanger, Marie Stopes)
 - Eugenacists

The Origins of Eugenics in Europe & USA

- Early adopters of fertility limitation were elite and educated women.
- Public health improvement in 2nd half of 19th century greatly flattened the income-mortality gradient.
- Together, these reversed the historical pattern in which elites outbred lower orders of society.
- I think that these changes, rather than scientific development of genetics, were the primary drivers of eugenic thinking.
- The idea of breeding better humans long pre-dated Galton!

Charles Darwin, *The Descent of Man* (1871)

- “With savages, the weak in body or mind are soon eliminated; and those that survive commonly exhibit a vigorous state of health. We civilised men, on the other hand, do our utmost to check the process of elimination.... Thus the weak members of civilised societies propagate their kind. No one who has attended to the breeding of domestic animals will doubt that this must be highly injurious to the race of man.”

Marie Stopes (1923)

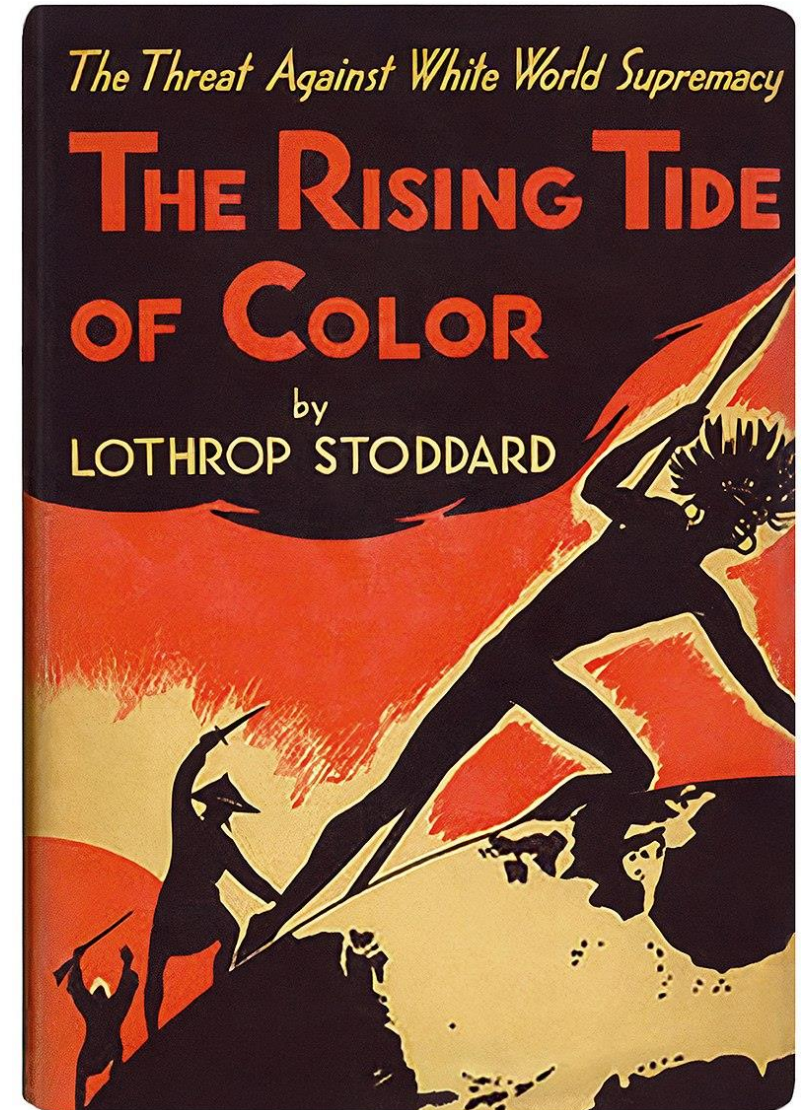
- “The object of the Society [for Constructive Birth Control and Racial Progress] is, if possible, to counteract the steady evil which has been growing for a good many years of the reduction of the birth rate just on the part of the thrifty, wise, well-contented, and the generally sound members of our community, and the reckless breeding from the C.3 end.” [C.3 was the lowest level of military fitness classification]

Eugenics and Fertility Limitation

- Eugenecists initially opposed fertility limitation because they saw that it was social elites that were doing the most limitation.
- Sometime around World War I, they changed tacks
 - Gave up on persuading elite women to stop reducing fertility
 - Allied with birth control advocates in agitating to get contraceptives into the hands of the poor.
 - This pre-figured the post World War 2 push of contraceptives to developing countries.

Eugenicists and the Population Explosion

- American eugenicists opposed immigration of the people other than northern Europeans.
 - e. g. Lothrop Stoddard's bestselling book, *The Rising Tide of Color Against White World Supremacy* (1920)
- That drove them to think about population growth elsewhere as a push factor.
- They figured out that the Population Explosion was coming before anyone else.



E. A. Ross, *Standing Room Only* (1927)

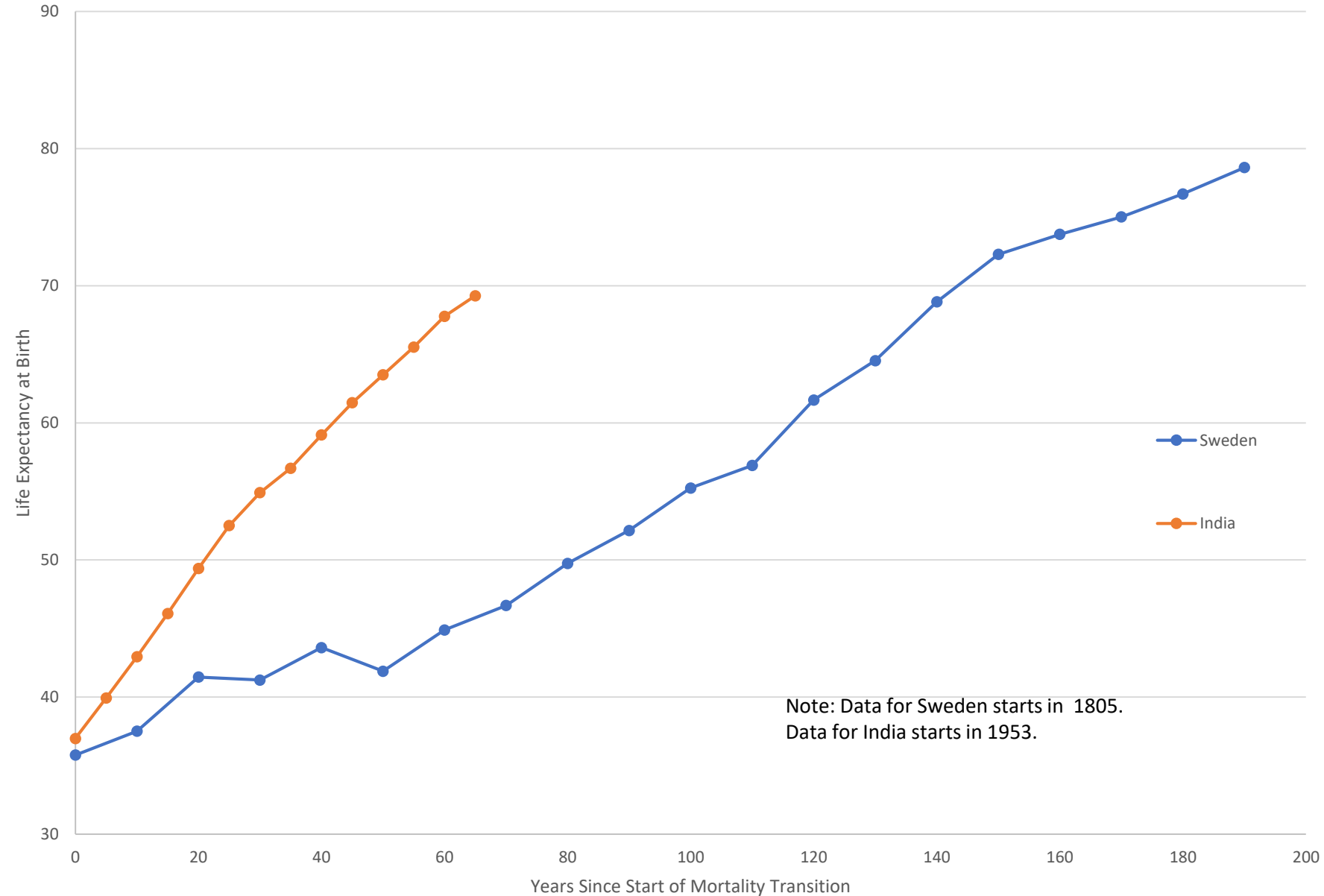
“Now, in forty years the advanced societies have experienced an astounding fall in the death-rate. They have achieved a new longevity, which is destined to be shared soon in varying degrees with all important sections of mankind. Whenever it arrives population leaps like a startled hare.... Certain enlightened peoples, to be sure, have their reproduction under control. But so far probably less than one sixth of the human race has applied any brake to its fertility. Unless this practice spreads much faster than it seems likely to do, overpopulation and therewith misery and degradation, will sensibly increase throughout large parts of the world before the close of our century.

How little the pioneer microbe-quellers divined such an outcome of their exploits!”

International Epidemiological Transition

- Rapid transfer of new and old health technologies from rich to poor countries.
- Sewers, antibiotics, vaccination, DDT.
- Also boiling water, trained birth attendants, low-tech medical tools.
- Enormous humanitarian accomplishment
- In practice, transfer of information that saved lives was much faster than transfer of whatever makes countries richer.
 - Health convergence much faster than income convergence.

Speed of Mortality Transition in Sweden and India



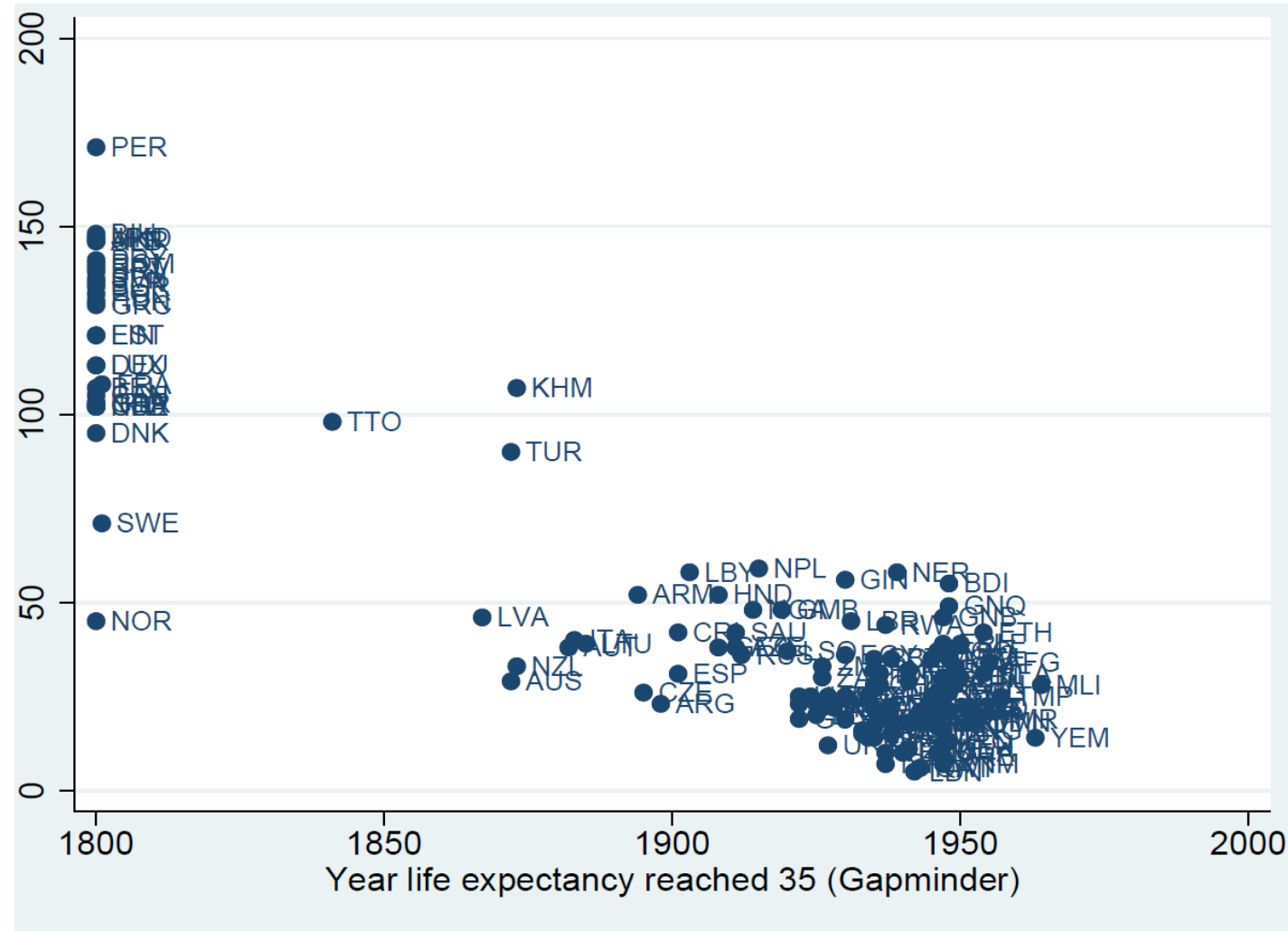
Population Multipliers 1820-2010

- France 2.0
- United Kingdom 3.0
- Spain 3.5
- China 3.6
- Japan 4.0
- S. Korea 5.3
- India 6.3
- Netherlands 7.0
- Iran 11.9
- Thailand 14.6
- Egypt 21.7
- Ethiopia 31.4

Chesnais (1990): The *population multiplier* is “the number by which the population is multiplied during the transition between the pre-transitional phase (high mortality, high fertility) and the post-transitional phase (low mortality, low fertility).”

Life Expectancy Improvement Time

“Life expectancy improvement time”: number of years to get from life expectancy of 35 to 50



Life Expectancy and Population Multipliers

$$\Delta \ln(\text{population}) = \text{constant} - \underset{(0.0018)}{0.0114} \times e_0 \text{ improvement time}$$

- $\Delta \ln(\text{population})$ is the for the period 1820-2010
- Sample of 50 countries in which native population was not displaced
- $R^2 = 0.397$
- One century faster transition \rightarrow population higher by factor of 3.1.

Doomsday Forecasts

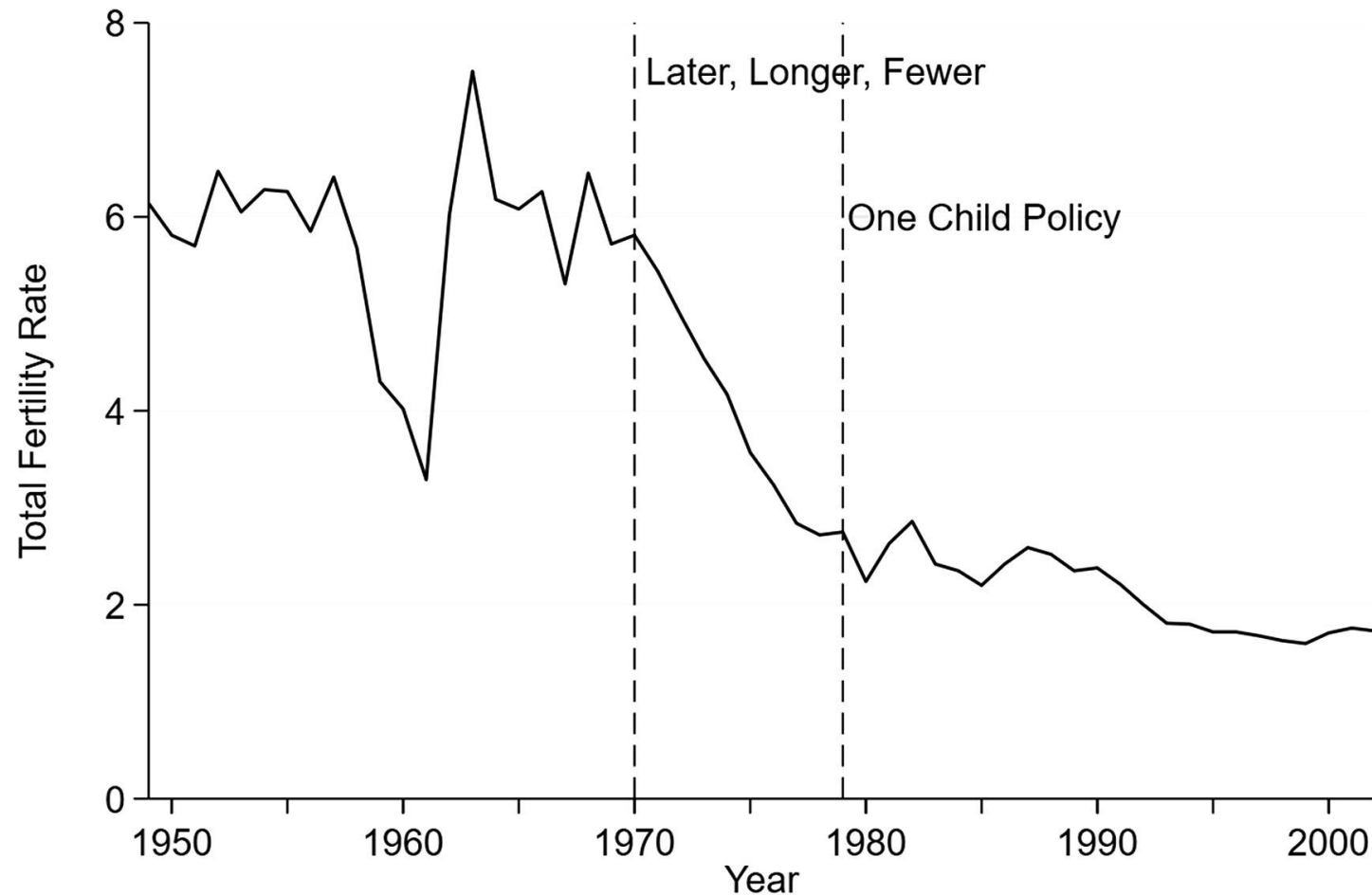
- 1965-66: Massive imports of US grain (\approx 20 kg. per person, 20% of US wheat harvest) stave off a famine in India after a failed monsoon.
- *Famine 1975! America's Decision: Who Will Survive?* (1967), by William and Paul Paddock
- *The Population Bomb* (1968) by Paul Ehrlich

“The battle to feed all of humanity is over. In the 1970s and 1980s, hundreds of millions of people will starve to death in spite of any crash programs embarked upon now. At this late date nothing can prevent a substantial increase in the world death rate.”

Why Were the Doomsday Forecasts Wrong?

- Widespread famine did not happen.
- The immediate reason was the Green Revolution.
- The longer-term reason was that fertility fell faster (and at lower income levels) than most people expected.
 - 1974 UN Population Division projections was world population of 12.2 billion by 2075
 - Exceptions are much of sub Saharan Africa, Pakistan, a few other places.
 - Little coercive policy, except for China.
 - Many interesting questions / counterfactuals

China



- There is a large industry devoted to estimating the path of births in the absence of these policies.
- Semi-official government estimate is 400 million averted births.
- I have not seen a good general equilibrium analysis that looks at the effect of less fertility reduction on economic outcomes.
- Not crazy to believe that without harsh fertility policy, growth would have been much slower.

What Happens at the End of the Demographic Transition?

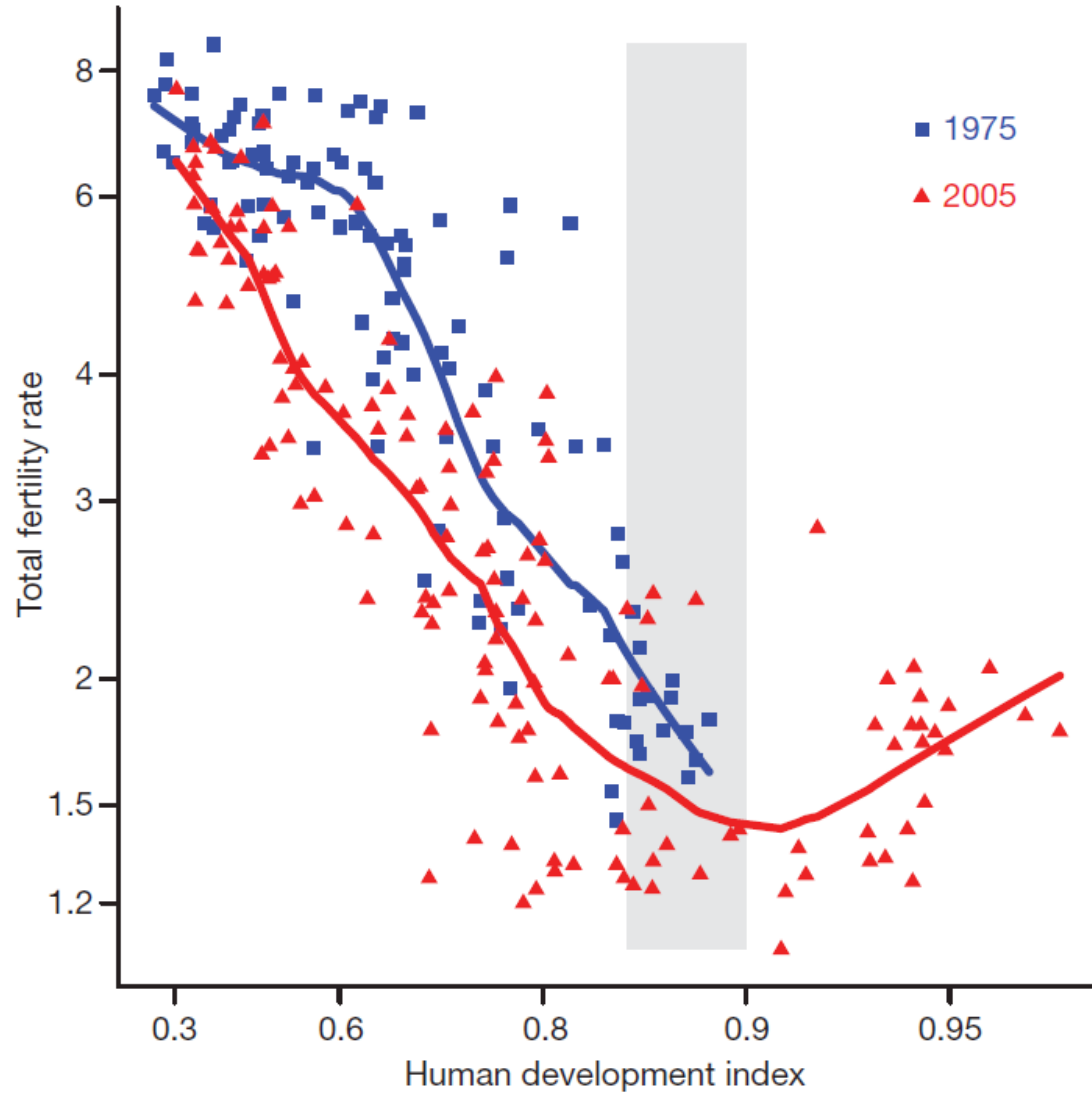
- My own view is that there is no reason for population growth to settle near zero once the mortality transition has happened and countries have developed.
 - Paper: “Replacement Fertility is Neither Natural nor Optimal nor Likely.”
- Depending on preferences, culture, institutions, etc., countries could settle at TFR above or below 2.1.
 - No reason that this shouldn't vary among countries.
- Thus we should not be surprised at
 - “Stalled demographic transitions”
 - Persistent sub-replacement fertility

Sub-Replacement Fertility

- 1985-90: 19% of the world's population lived in countries where fertility was below the replacement level.
- 2015-2020, that had risen to 47%.
- Worldwide, the fraction of countries with explicit pro-natal policies:
 - 1976: 10%
 - 2001: 15%
 - 2015: 28%

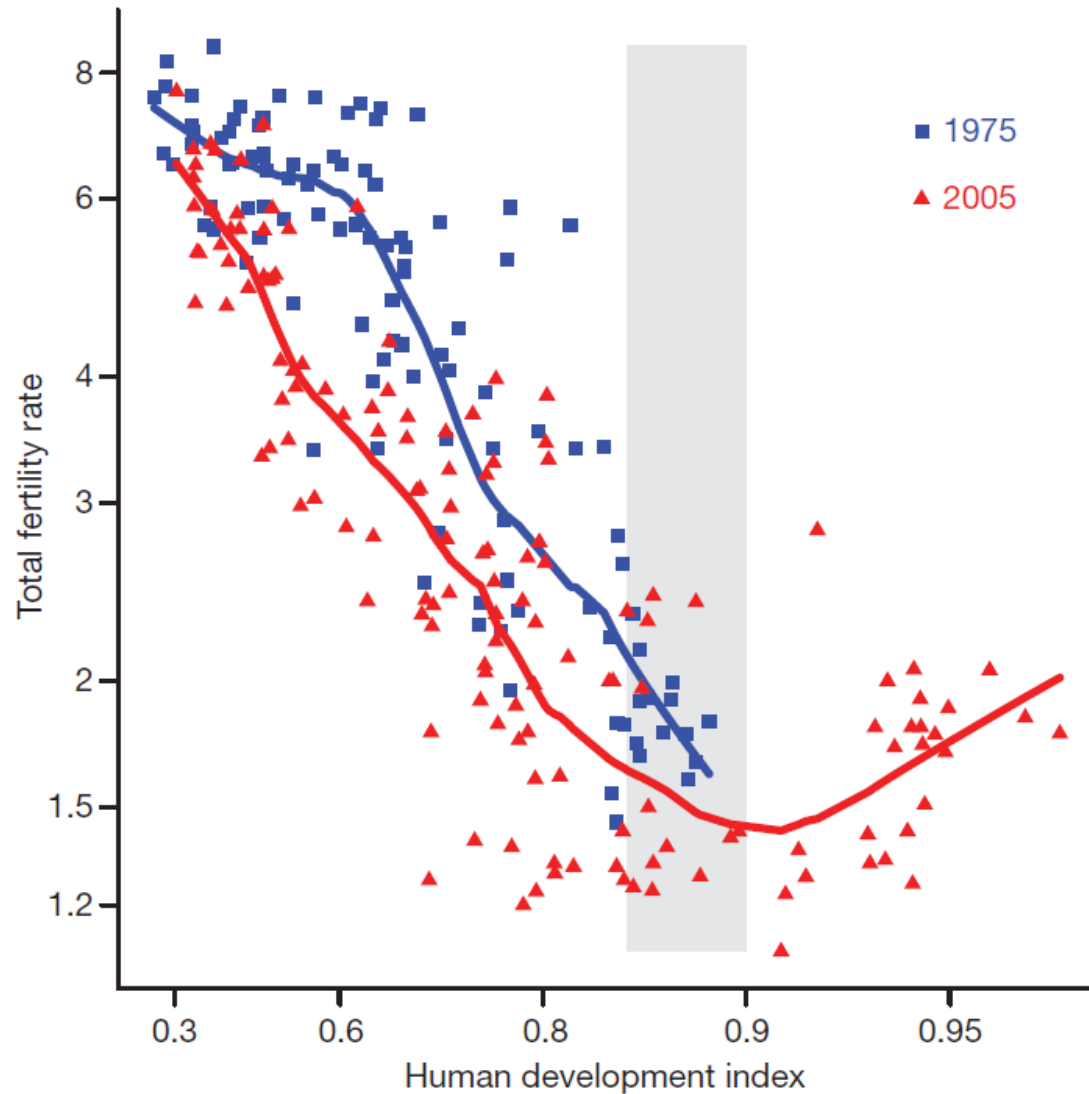
Do Advances in Development Reverse Fertility Declines?

Myrskylä, Kohler, and Billari (2009)

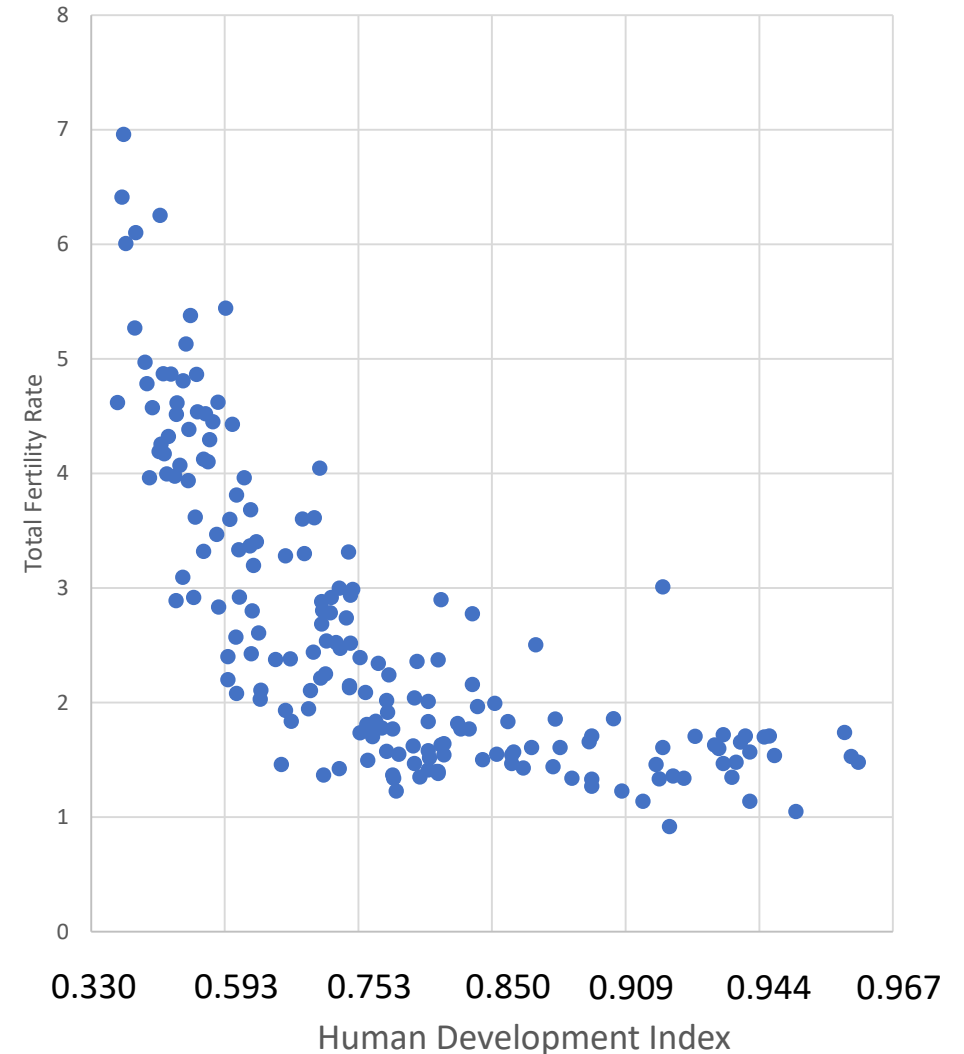


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2019 data, United Nations and World Bank



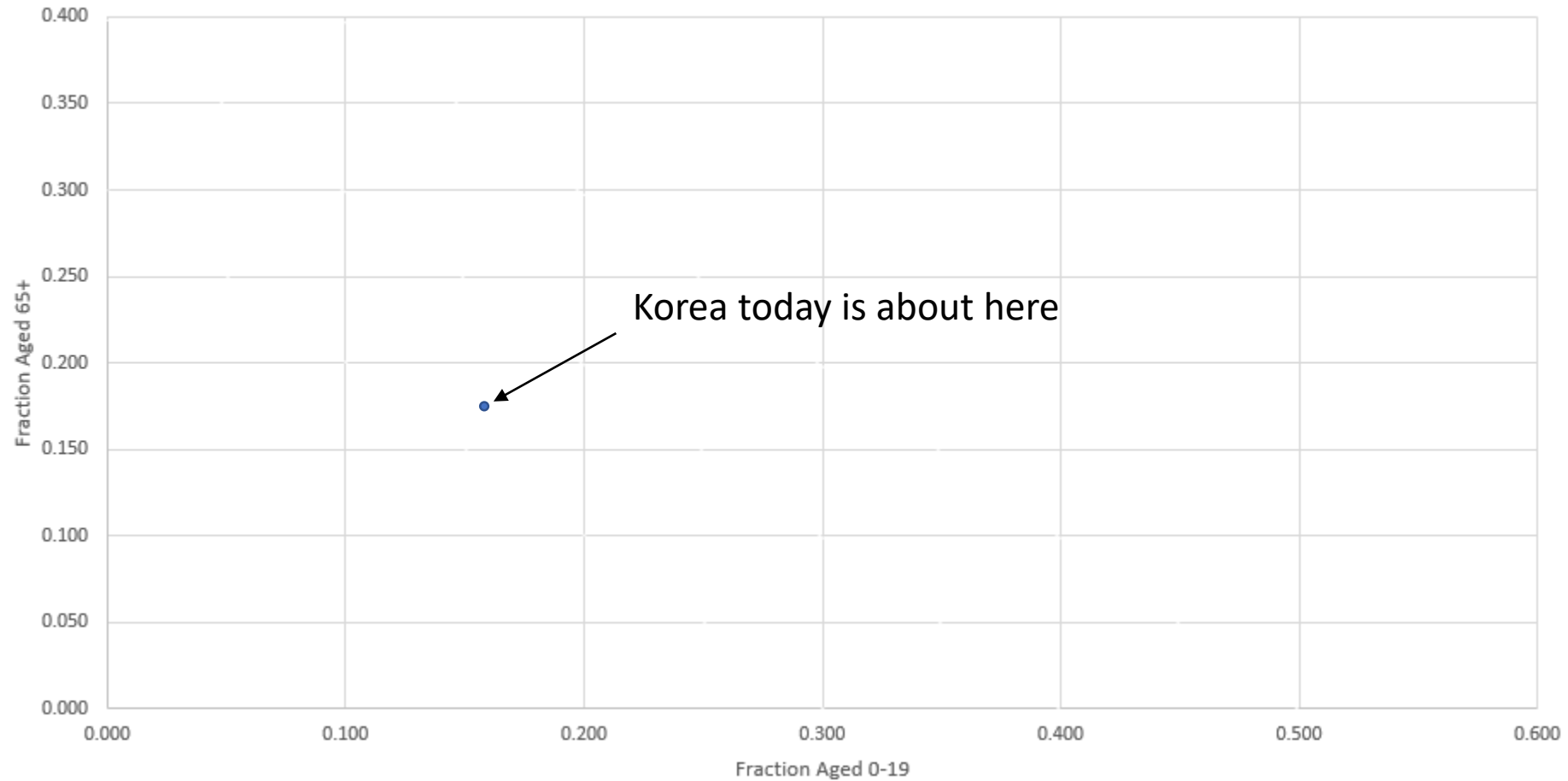
Note: In both figures, horizontal scale is $-\ln(1 - HDI)$

Thinking About Population Aging

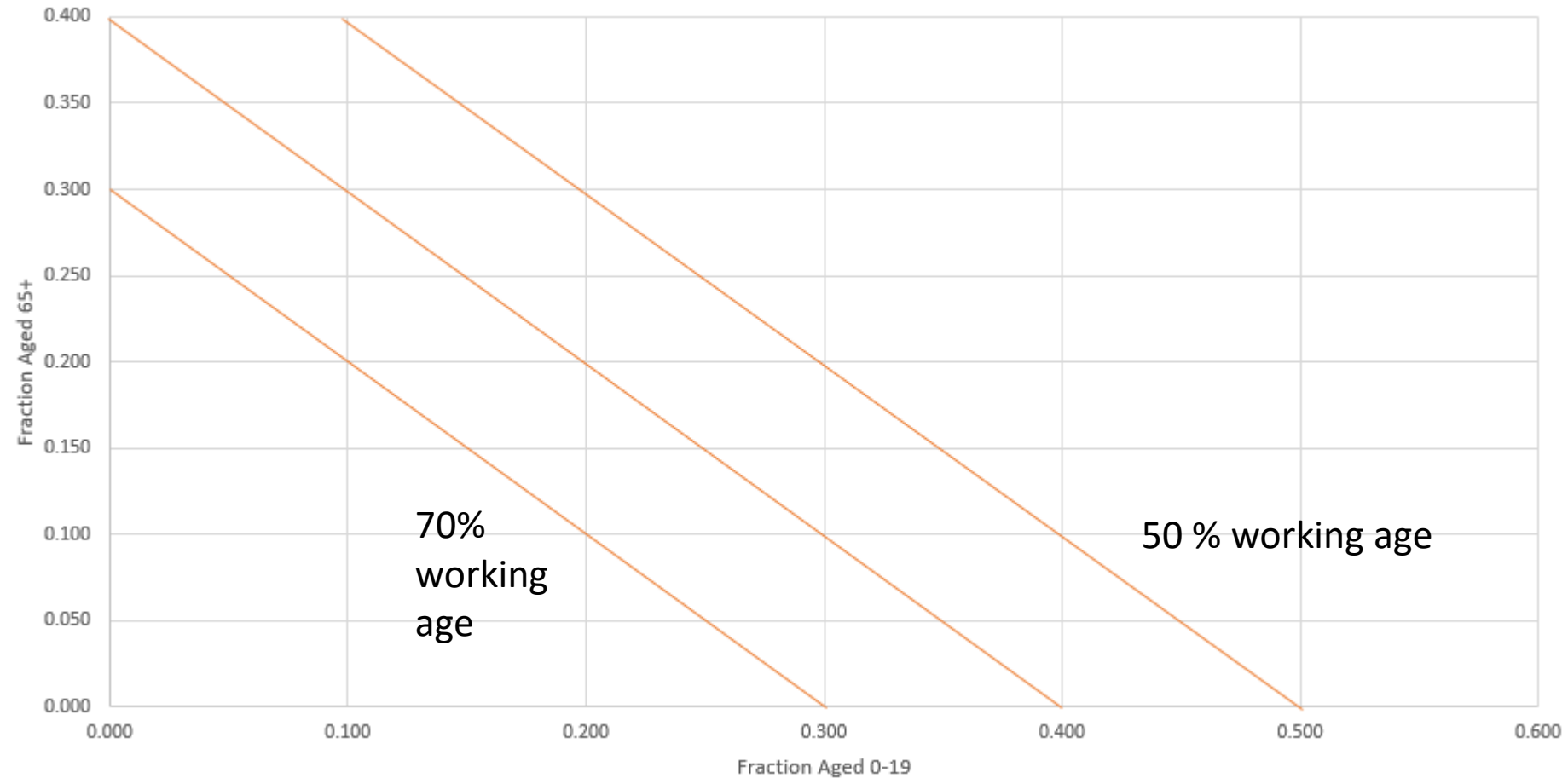
- Higher old-age dependency lowers consumption for all.
- But aging populations have fewer children, and they are dependent as well.
- We need an organizing framework to think this through.



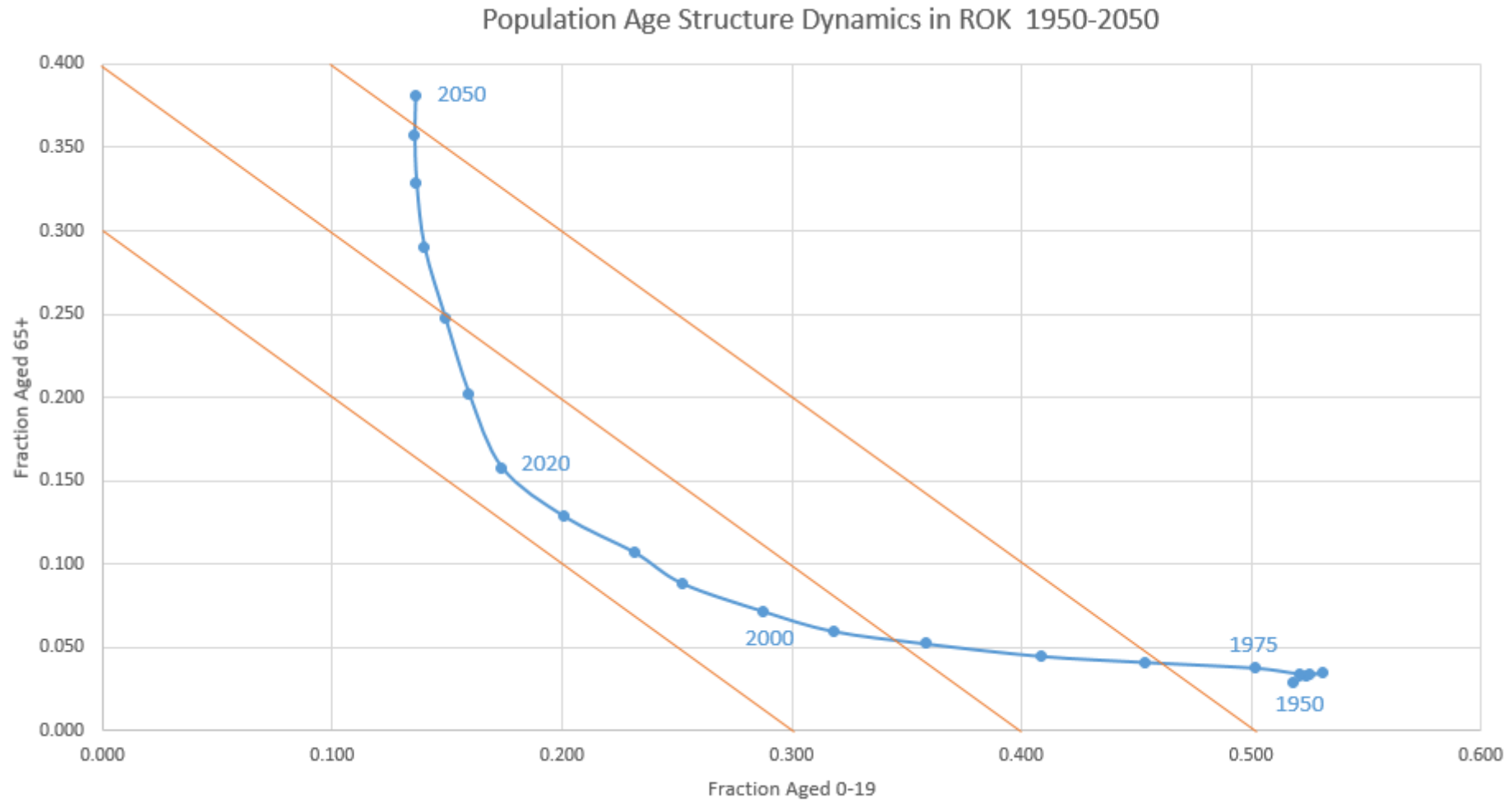
Graphing Population Dependency



Iso-Dependency Lines



Aging in Korea



Quick Calculation

- GDP per capita = GDP per worker \times workers per capita

$$g_{GDP \text{ per capita}} = g_{GDP \text{ per worker}} + g_{workers \text{ per capita}}$$

- Korea working age (20-64) share of the population
- 1975-2000 rose from 0.46 to 0.64 \rightarrow 1.3% per year “tailwind”
 - Definitely not the only reason that Korea grew so quickly. But it helped.
 - Created room in government and household budgets for investment in capital and education.
- 2020-2050 will fall from 0.67 to 0.43 \rightarrow -1.1% per year “headwind”

Demographic Meltdown!

- Future aging is driven by current and recent low fertility.
- That low fertility was *not* due to slow economic growth.
- But if you thought that slow economic growth due to aging would further lower fertility, then there is the possibility of a “demographic meltdown.”

➔ This view is not supported by my analysis below, but you can still find many people who believe in it.

A Different Perspective

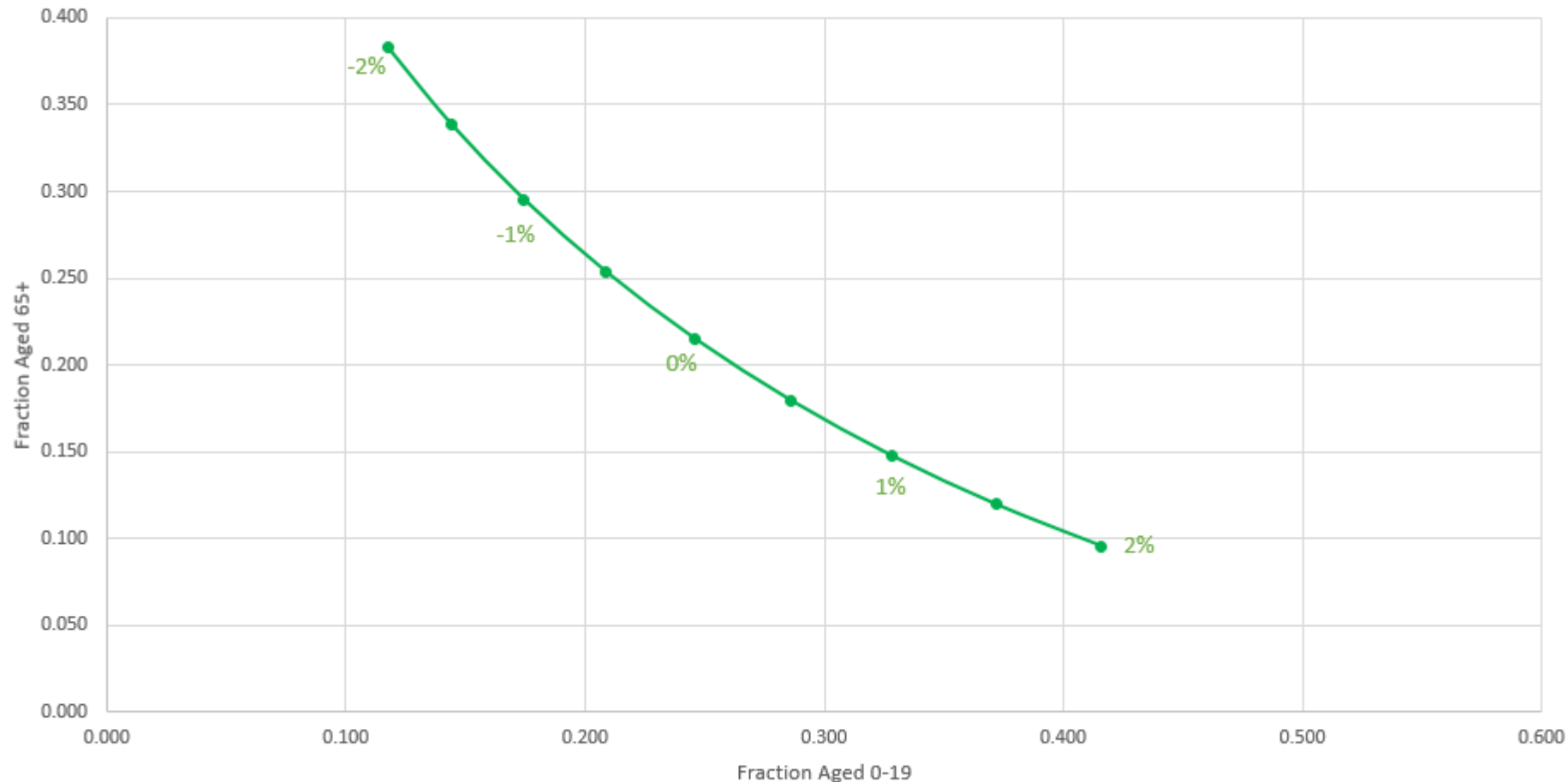
- Changes in fertility feed through to affect the population age structure only gradually.
- When fertility falls rapidly (as in Korea), there is a period during which both old-age and youth dependency rates are low.
 - This is often called “the demographic dividend.”
- This can't last!
- *Stable Population*: A population in which growth rate and the shares of different age groups are constant. (Results from fertility and mortality rates being constant for a long time.)

Possible Stable Populations for Korea

Based on Korean life table for 2020 (both sexes combined).

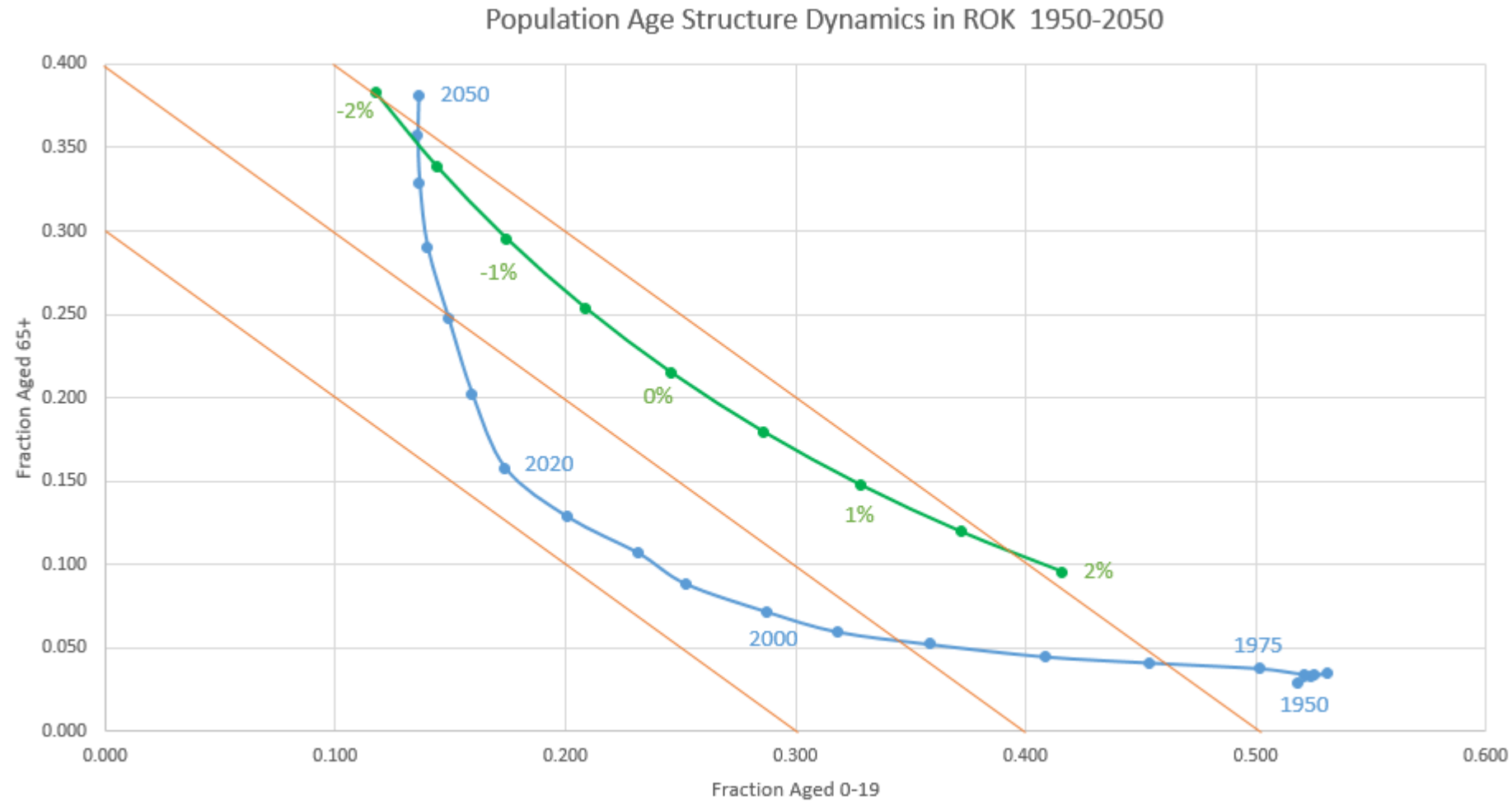
Labels show population growth rates.

The consumption-maximizing stable population is at the tangency of this curve with the iso-dependency line.



Takeaways:

- The current low level of dependency is not feasible as a steady state.
- Dependency differences among different population growth rates are small relative to what Korea is going through.
- Raising fertility to achieve constant population size would mean an even bigger dependency burden for many decades!



Choosing the Right Metaphor

- Hangover
 - You feel good while you are drinking on Saturday night. But on Sunday morning, you feel worse than you would have if you hadn't been drinking.
 - The end of a pleasant vacation
 - You feel good while you are on vacation. When the vacation is over, you feel just as good as you would have if the vacation had not happened.
- ➔ Population aging in Korea is much more like the end of a pleasant vacation than like a hangover.

Some Nuance

- Old people may cost more than children – that would change the slope of the iso-dependency lines.
- Support for the old is done more by governments, while support for the young is done more by families. So aging raises the size of government.
- The borders of what constitutes “old” and “young” can change.
- Simple model ignores capital investment and natural resources.
 - But if you put these in, you get the conclusion that the optimal population growth rate is lower.
- I don't think that these observations affect the basic points.
 - The end of the demographic dividend is a bad thing, but it was inevitable.
 - Consumption per capita in a stable population that is shrinking is not that different from consumption per capita in a stable population with constant size.

Last Thought on Aging

- Aging is driven by low fertility.
- That low fertility was *not* due to slow economic growth.
- But if you thought that slow economic growth due to aging would further lower fertility, then there is the possibility of a “demographic meltdown.”

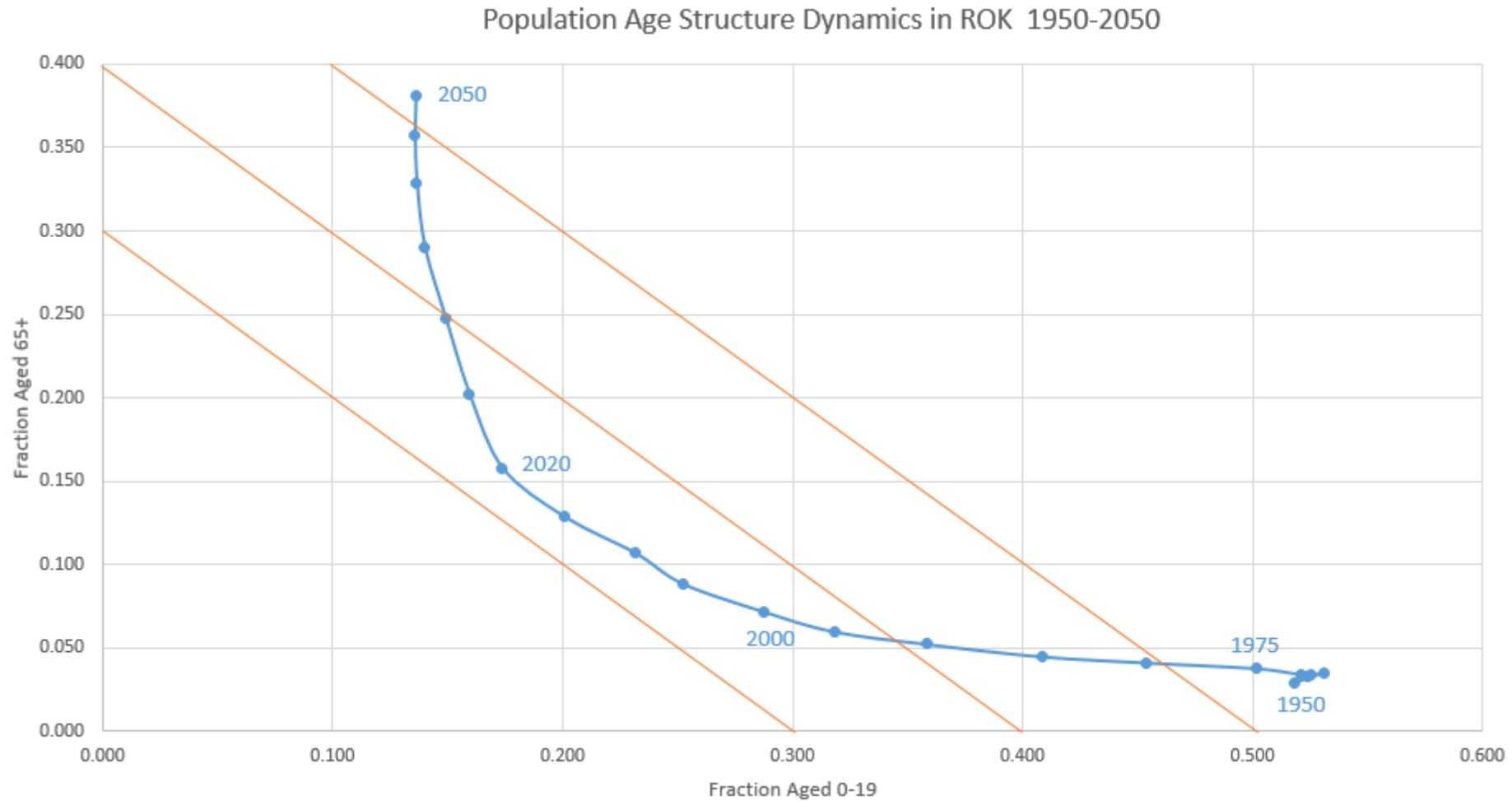
Efficacy of Policies to *Raise* Fertility

- Best policy: provision of high quality child care
- Other policies: cash payments, longer (and better paid) parental leaves, incentives to employers to provide more flexible working hours, and subsidies to assisted reproduction.
- Cost: Average estimated efficacy from various studies, applied to the US case:
 - Raising the Total Fertility Rate from the 2019 level of 1.7 up to replacement would cost \$5,300 per year per child under 18. (total of \$387 billion, or about half of the defense budget in that year.)

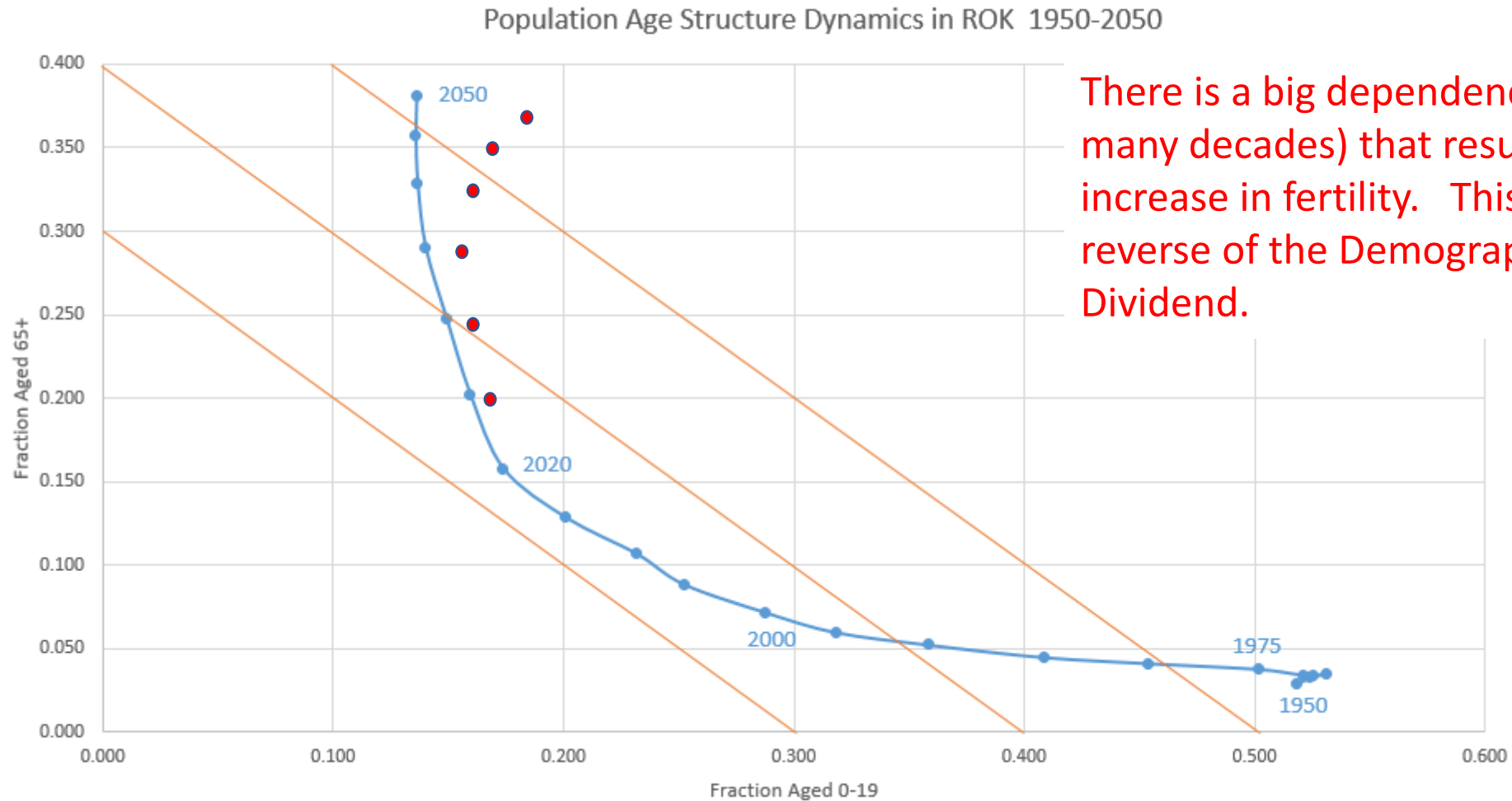
Is Raising Fertility a Good Idea?

- Analysis of steady-state dependency says that it doesn't have a big effect on income per capita.
- Maybe policy-makers care about e.g. military power.
- Maybe policy-makers care about the continuation of the nation, the ethnic group, etc.?
- Maybe policy-makers care about future potential people who will not get to live and enjoy happiness.

Dependency: What if Fertility Increases?



Dependency: What if Fertility Increases?



Conclusions on Sub-Replacement Fertility

- Population aging due to low fertility will impose “headwind” on economic growth for the next several decades.
- This is due to the ending of the Demographic Dividend
- Low fertility and population shrinkage do not greatly lower economic welfare in comparison to e.g. replacement fertility.
 - Although they do place an extra burden on government budgets.
- If low fertility is a problem, it is not for conventional macroeconomic reasons.

General Conclusion

- The end of the Malthusian regime means that population size is not pinned down to some equilibrium level.
- Replacement fertility is neither natural nor optimal nor likely.
- We are very bad at thinking about a world in which this is the case.

Parking Lot

- Ignore below here

Han Fei-Tzu (3rd century BCE)

- In ancient times, “The people were few, there was an abundance of goods, and so no one quarreled.... But nowadays no one regards five sons as a large number, and these five sons in turn have five sons each, so that before the grandfather has died, he has twenty-five grandchildren. Hence the number of people increases, goods grow scarce, and men have to struggle and slave for a meager living. Therefore they fall to quarreling.”

Emperor Augustus in 1st century CE:

- Berating the Roman elite for their low fertility: “For you are committing murder in not begetting in the first place those who ought to be your descendants; you are committing sacrilege in putting an end to the names and honours of your ancestors; and you are guilty of impiety in that you are abolishing your families, which were instituted by the gods.”

Plato, *The Republic* (4th century BCE)

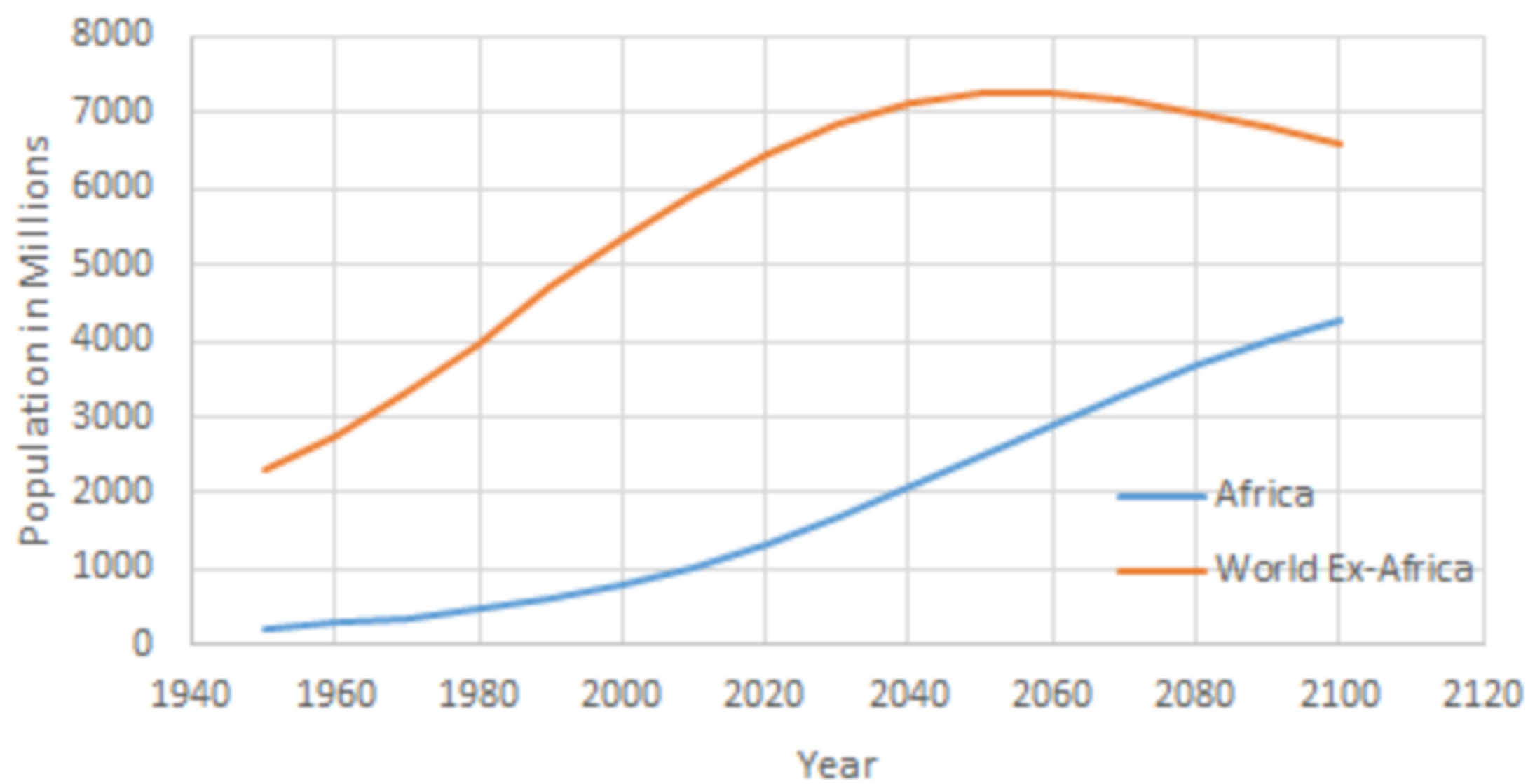
- I see that you have in your house hunting-dogs and a number of pedigree cocks. Have you ever considered something about their unions and procreations?" "What?" he said. "In the first place," I said, "among these themselves, although they are a select breed, do not some prove better than the rest?" "They do." "Do you then breed from all indiscriminately, or are you careful to breed from the best?" "From the best." ... "And if they are not thus bred, you expect, do you not, that your birds and hounds will greatly degenerate?" "I do," he said. "Gracious," said I, "dear friend, how imperative, then, is our need of the highest skill in our rulers, if the principle holds also for mankind."

More Recently....

“Stalled Demographic Transition”

- Places where fertility fell for a while, but slowed down well before reaching replacement level.
- Sub Saharan Africa, Pakistan, a few other places. [see graph]
- Often accompanied by (caused by?) slow economic growth.
- Big questions:
 - Will these countries eventually see population growth fall to near zero?
 - What are the economic consequences if high population growth continues for many more decades.

Actual and Projected Population



Too Much Breeding

- Goes back to Babylonian epic of *Atrahasis*, from the 18th century BCE; Plato, Aristotle, Thomas Moore, etc.

“Indeed it is certain, it is clear to see, that the earth itself is currently more cultivated and developed than in earlier times. Now all places are accessible, all are documented, all are full of business.... Everywhere there is a dwelling, everywhere a multitude, everywhere a government, everywhere there is life. The greatest evidence of the large number of people: we are burdensome to the world, the resources are scarcely adequate to us; and our needs straiten us and complaints are everywhere while already nature does not sustain us. Truly, pestilence and hunger and war and flood must be considered as a remedy for nations, like a pruning back of the human race becoming excessive in numbers.” -Tertullian (≈200 AD)

E. A. Ross in 1906

- Notes that both deaths and births have fallen but expects that decline in fertility will continue even after declining mortality has spent its force.
 - US TFR in 1906 was approximately 3.5.
- This reduction in fertility leads to escape from population pressure, which in his interpretation was responsible for most ills of society. Worried that it is going too far, but mostly a good thing.
- “I shall have against me mystics, clerics, *a priori* moralists, sentimentalists, aesthetes, militarists, capitalists, and politicians; but, nevertheless, I take my stand with those who hate famine, war, saber-tooth competition, class antagonism, the degradation of the masses, the wasting of children, the dwarfing of women, and the cheapening of men.”

Ross, Continued

- Emancipation of women: “The great movement that has burst the fetters on woman's mind, and opened to her so many professional and industrial careers, raises her value and weight in the marriage partnership and causes the heavy physiological and personal cost of excessive maternity to be more considered by husband as well as by wife.”
- But things could go too far: “This exaggerated individualism, that avoids marriage or else dodges its natural consequences, forebodes the extinction of the class, the people, or the race that adopts it.”

“Wrong” Type of People Breeding

- E.A. Ross (1901): “race suicide”

“There is no bloodshed, no violence, no assault of the race that waxes upon the race that wanes. The higher race quietly and unobtrusively eliminates itself rather than endure individually the bitter competition it has failed to ward off from itself by collective action...The prudent, self-respecting natives first cease to expand, and then, as the struggle for existence grows sterner and the outlook for their children darker, they fail even to recruit their own numbers.”

- *La revanche des berceaux* (the revenge of the cradles) (1918)
- Replacement Theory

Population Explosion as an Idea

- What would happen in a country with a traditional demographic equilibrium of high fertility and mortality if there were to be a sudden drop in mortality?

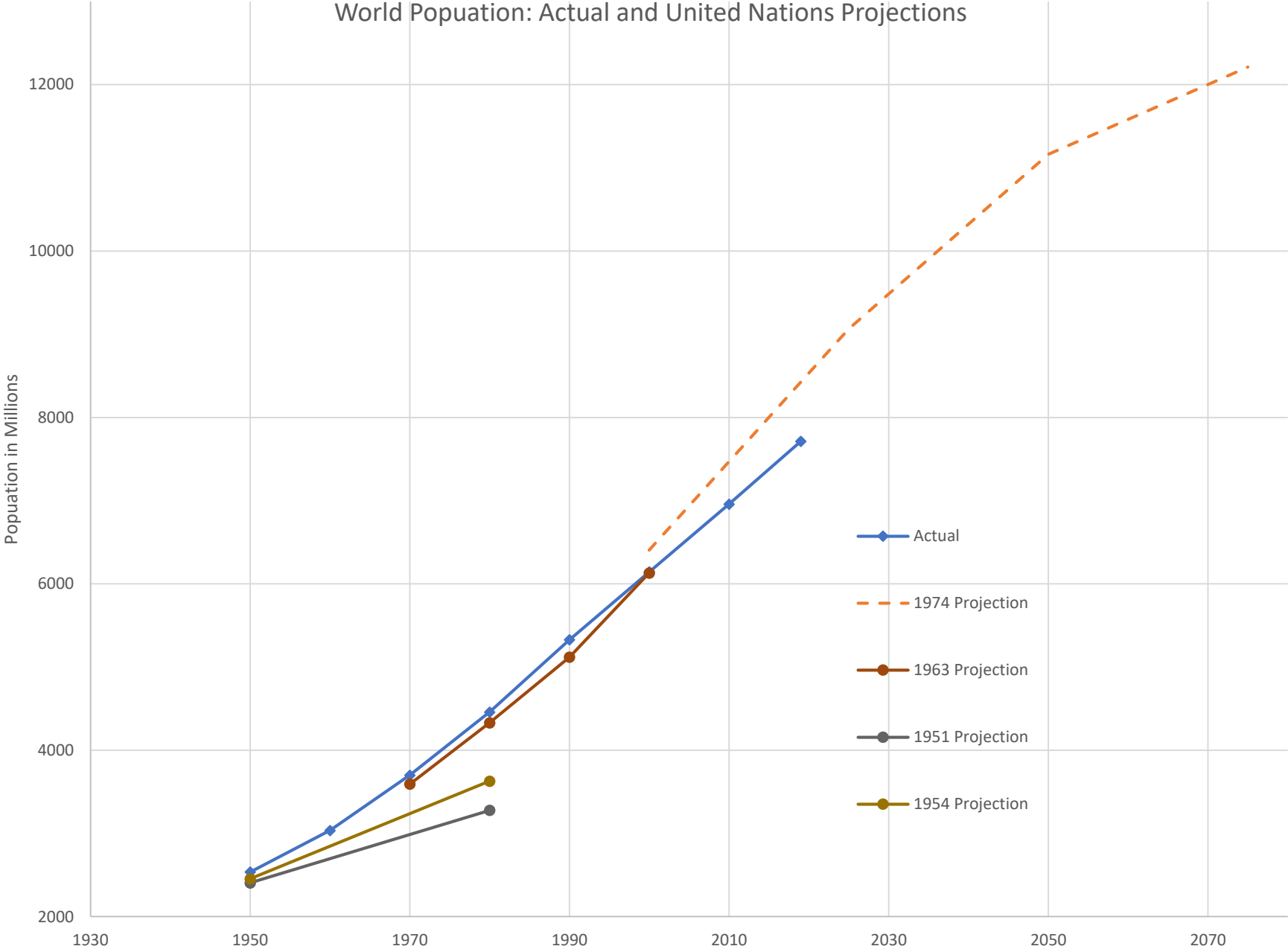
“I shall call it a population explosion: it is often sudden, if not violent.... The fall in mortality is apparently touched off by improvements in standards of living, understood in their wider sense to include such public measures as sanitation and vaccination. At the lowered mortality families can survive with fewer births per generation, but even if individual parents are aware of all the intricate implications of a new mortality situation, they will change only slowly their intimate habits and beliefs, anchored as these are in long tradition and supported by public opinion. Only, as it were, hesitantly (if at all) do birth rates begin to decline.

John Lindberg, “Food Supply Under a Program of Freedom from Want,” (May 1945)

- “Viewed in the long-run perspective, the growth of the earth’s population has been like a long, thin powder fuse that burns slowly and haltingly until it finally reaches the charge and then explodes.”

Kingsley Davis, “World Population in Transition,” (1945)

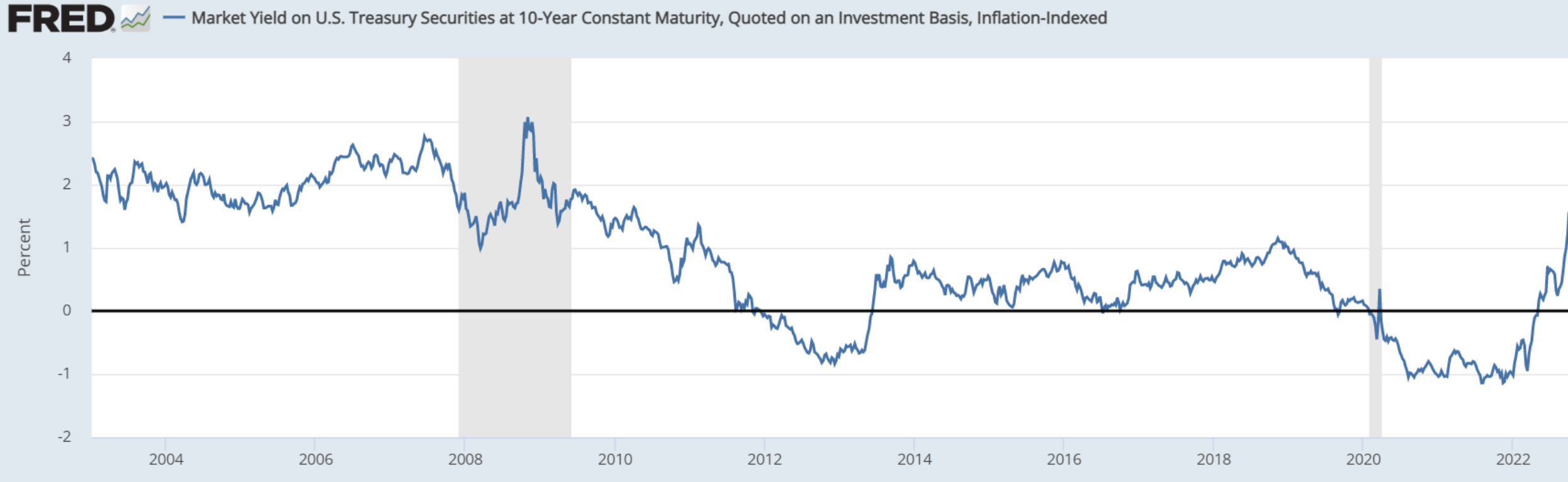
World Population: Actual and United Nations Projections



Macroeconomic Implications (Beyond Slower Growth of Income per Capita)

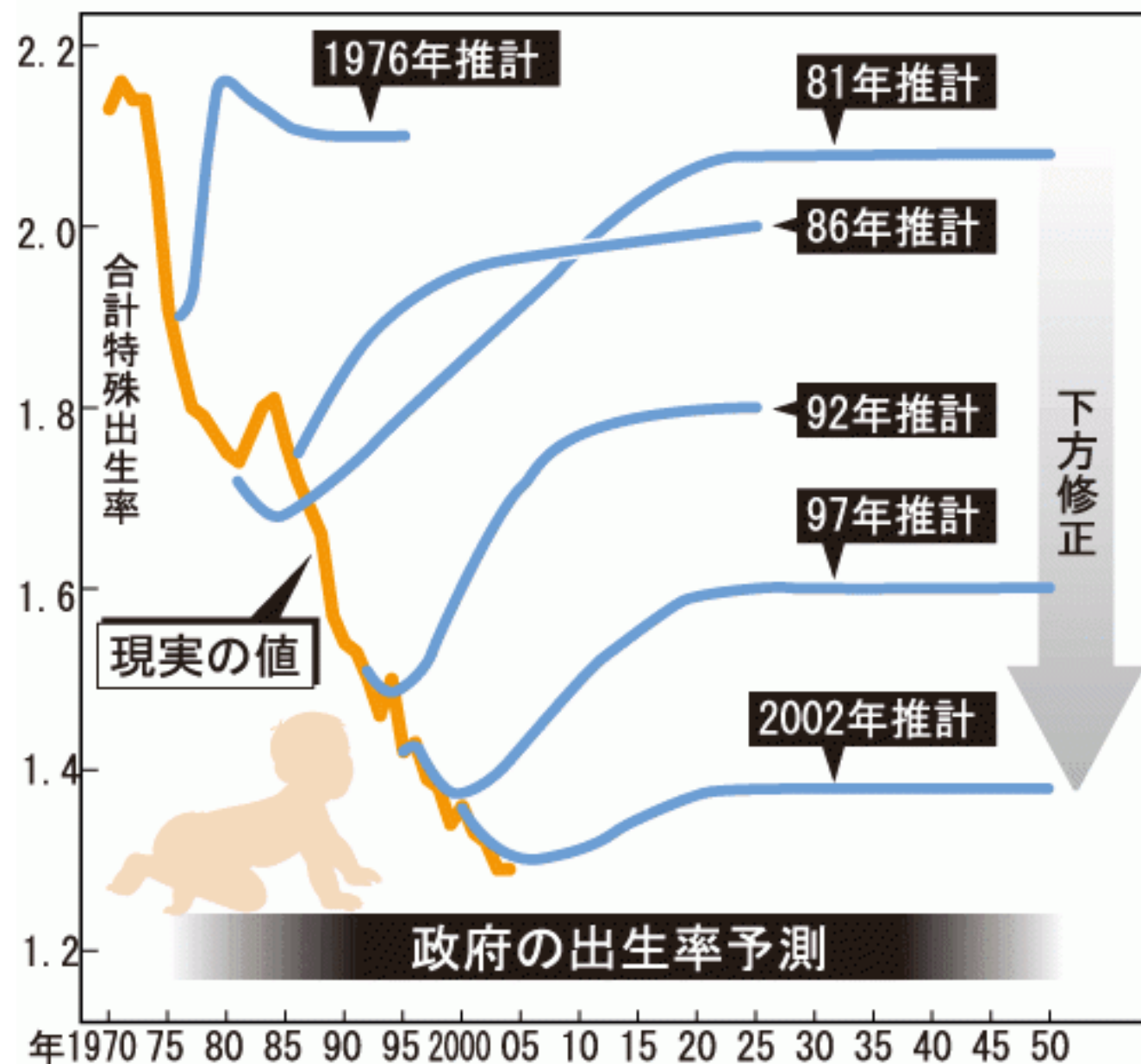
- Slower population growth → reduced investment demand
 - Both housing and new capital equipment
- More old people → higher saving
 - Although this depends on how retirement is funded
- Together these should lead to lower real interest rates.
- Consistent with decline in real rates over the last few decades.
- If you believe this story, then the current rise in real interest rates throughout the developed world will be a temporary phenomenon.

USD Inflation-Indexed 10 Year Yields



Population Growth and Technological Progress

- More people → more ideas → faster technological progress.
- This implies that low fertility will lead to a technology slowdown.
 - Recent Chad Jones paper
- However, technological progress in Japan mostly depends on the state of the “world technological frontier.”
- This is not very much affected by population size in Japan.
- Also, for the next several generations, the number of R&D researchers in the world will keep growing due to higher education in formerly lagging countries such as China and India.



※国立社会保障・人口問題研究所の「中位推計」

Low Fertility: What are the Potential Problems?

- “Too Few Workers”
- Population Aging
- Falling population is
 - Just a bad thing
 - A sign of some underlying social problem

Too Few Workers

- Presumably we care about the number of workers relative to something else like
 - Number of old and young dependents
 - Size of the country
 - Etc.

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Is Low Fertility is Just a Bad Thing?

- For practical reasons
 - Military capacity – definitely not my area of expertise.
 - Environmental footprint – this would say that low fertility is good.
- For welfare reasons
 - Do we put value on the continuation of our national group beyond the value we put on the continuation of our own family?
 - Do we value the welfare of potential people who might not get to be born if fertility remains low?
 - The “repugnant conclusion”

Is Low Fertility a Sign of Some Underlying Social Problem?

- If the answer is yes, then standard economic advice would be to treat the problem, not the symptom.

Green Revolution

- Super low budget, largely done by non-accountable foundations
- Budget for the International Rice Research Institute for the period 1960-71 totaled roughly \$30 million, of which two-thirds came from the Rockefeller and Ford foundations.
- By comparison, the Vietnam war cost the American government \$111 billion between 1965 and 1975, which comes to \$27 million per day. The Apollo space program cost \$25 billion.

[W]e are dealing with two opposing forces, the scientific power of food production and the biologic power of human reproduction. Man has made amazing progress recently in his potential mastery of these two contending powers. Science, invention, and technology have given him materials and methods for increasing his food supplies substantially and sometimes spectacularly.... Man also has acquired the means to reduce the rate of human reproduction effectively and humanely.... But he is not yet using adequately his potential for decreasing the rate of human reproduction....

There can be no permanent progress in the battle against hunger until the agencies that fight for increased food production and those that fight for population control unite in a common effort.

-- Norman Borlaug Nobel Peace Prize acceptance speech, 1970

Population Pessimism

- Early developing countries showed that fertility could fall all the way to replacement, but developing countries had
 - Lower education / literacy
 - Lower urbanization
 - More traditional, less secular, less gender-equal societies
- Causes for optimism
 - Improved contraceptive technology
 - More supportive policy environment
 - More rapid social/cultural change (TV, etc.)

Unexpectedly Fast Fertility Decline

- My simplistic summary:
 - For most countries, fertility declined faster, and at a lower level of income, than folks had expected.
 - See, for example, the 1974 UN Population Division projections (2075=12.2 billion)
 - Exceptions are much of sub Saharan Africa, Pakistan, a few other places.
 - Little coercive policy, except for China.
- Many interesting questions / counterfactuals
 - What was the contribution of new contraceptive technologies?
 - What was the contribution of population control policies?
 - Etc.