Are We Doomed? Population and Resources

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Econ/Demog C175

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Week 4, Lecture B

UC Berkeley

Today's Agenda

- A video clip
- What is the question, exactly?
- Can prices save us?
- Lam's take on the last 50 years
- Risk aversion
- Sustainability (a harvest model)

Video clip: The Population Bomb? The retro report

- 1:30 (Ehrlich) to about 2:30
- 10:45 (Ehrlich in 21st century)

https://www.youtube.com/watch?v=HuxSi2JkL3I

Doubling Times through History

Pop	Year	T_{double}
200 million	1 AD	
		999 years
400 million	1000	
		750 years
791 million	1750	
		250 years
1.6 billion	1900	
		60 years
3.0 billion	1960	
		40 years
6.1 billion	2000	

What is next?

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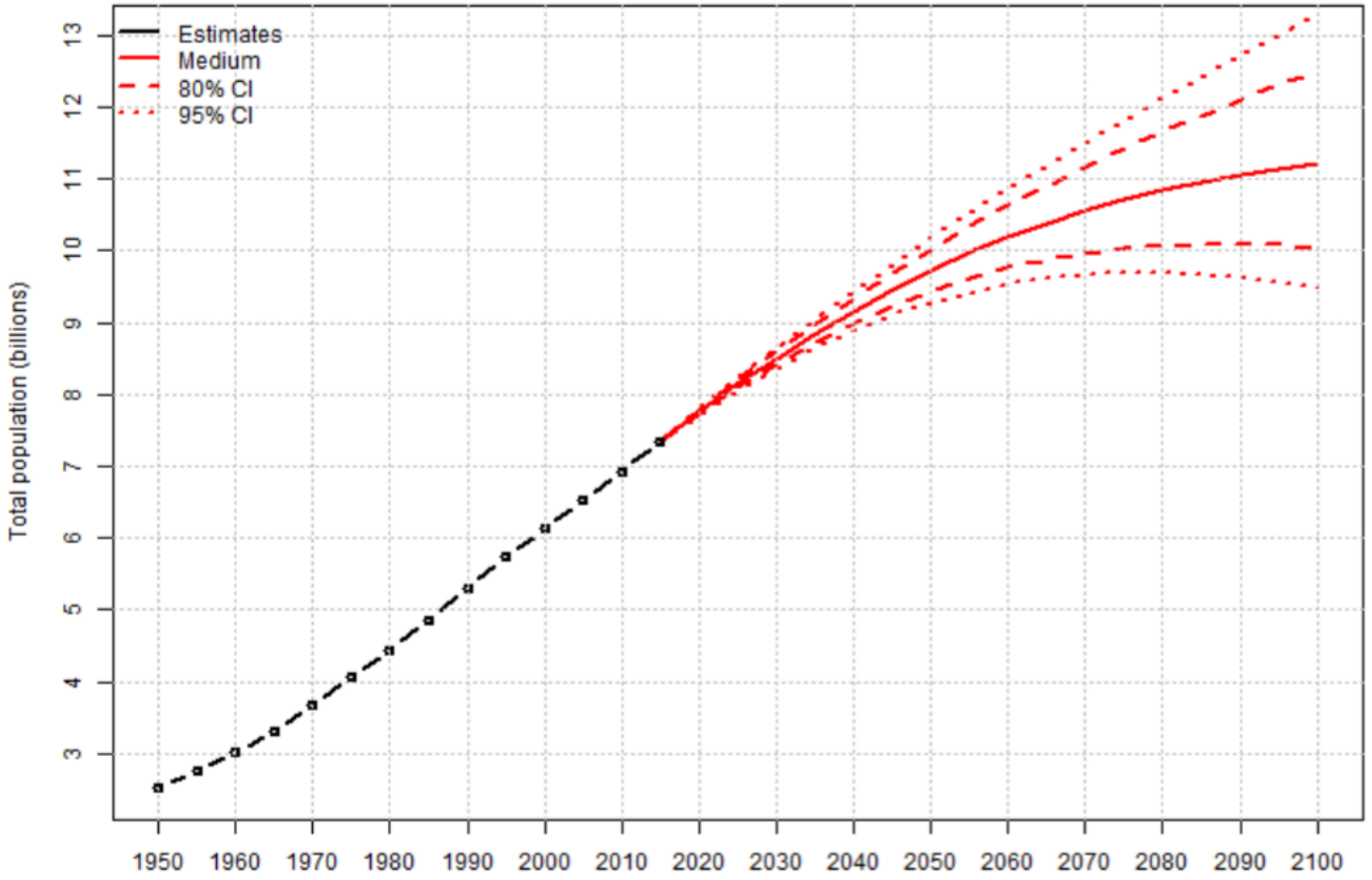
How long will next world population doubling take?

A. 20-30 years
B. 30-40 years
C. 40-60 years
D. 60-100 years
E. 100+ years (or never)

Figure 2. Population of the world: estimates, 1950-2015, medium-variant projection and 80 and 95 per cent confidence intervals, 2015-2100



Source: United Nations, Department of Economic and Social Affairs, Population Division (2015). *World Population Prospects: The 2015 Revision*. New York: United Nations.

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What does it mean, to be “doomed”?

Condition	→	Outcome
1. If pop grows quickly		a) humans go extinct
2. If forecasts true		b) we be worse off in future
3. Even if growth stops		c) progress will slow
4. If pop shrinks		d progress will continue
		e) progress will accelerate

What could go wrong?

"Global warming, acid rain, depletion of the ozone layer, vulnerability to epidemics, and exhaustion of soils and groundwater ..."

"a downward spiral that may well lead to the *end of civilization* in a few decades"

"More frequent draughts, more damaged crops and famines, more dying forests, more smog, more international conflicts, more epidemics, more gridlock, more drugs, more crime, more sewage swimming, and other extreme unpleasantness"

-- The source?

Can prices save us?

Simon says:

“The only meaningful measure of scarcity in peacetime is the cost of the good in question”

Prime example is copper.

“The Bet”

Ehrlich and Simon bet $1,000 in October 1980 that 10 years later prices would be higher/lower.

	1980 $ price	1990 (in 80$s)
Chrome	200	120
Copper	200	163
Nickel	200	193
Tin	200	56
Tungsten	200	86

Distinguishing types of resources

Exhaustible

e.g. copper, coal, “virgin forest”

Renewable

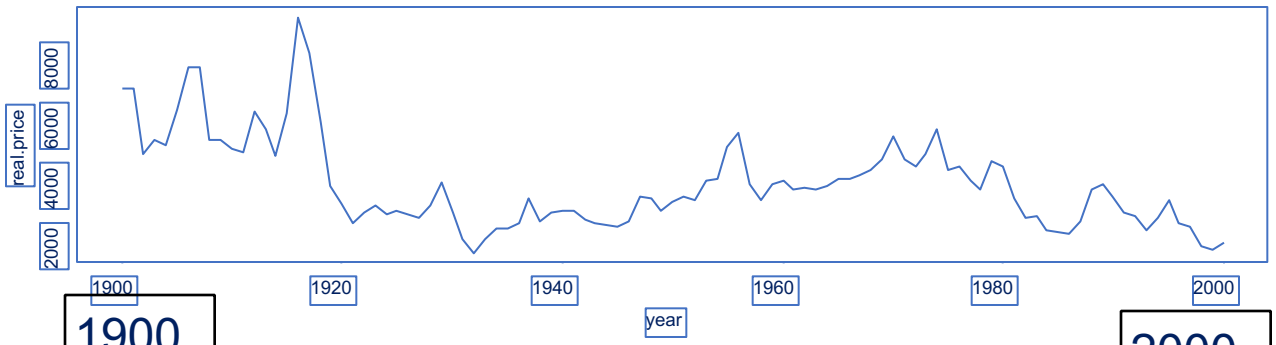
e.g. topsoil, fisheries, forests, water

Substitutability an important issue

Substitutability example: Whale Oil

- Used for lamps
- Overfishing made it more expensive to get
- As price rose → petroleum and lightbulbs
- No time series for whale oil, but for copper

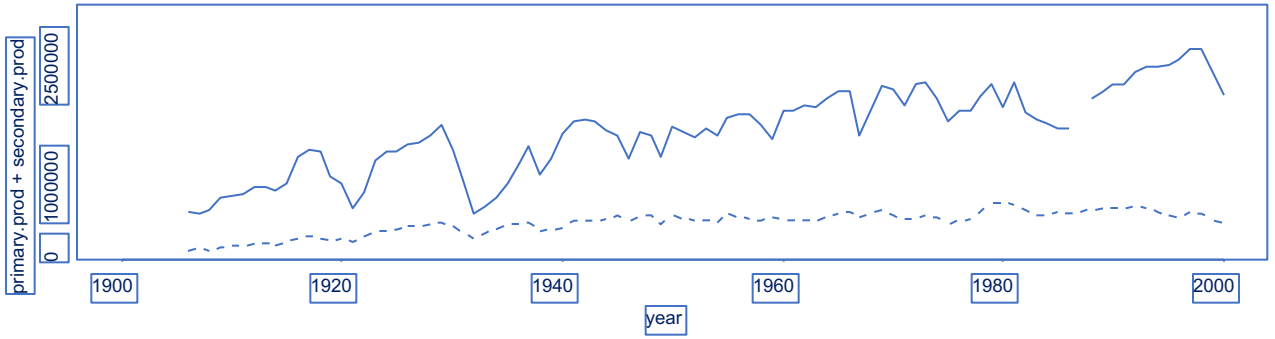
Copper in 20th century



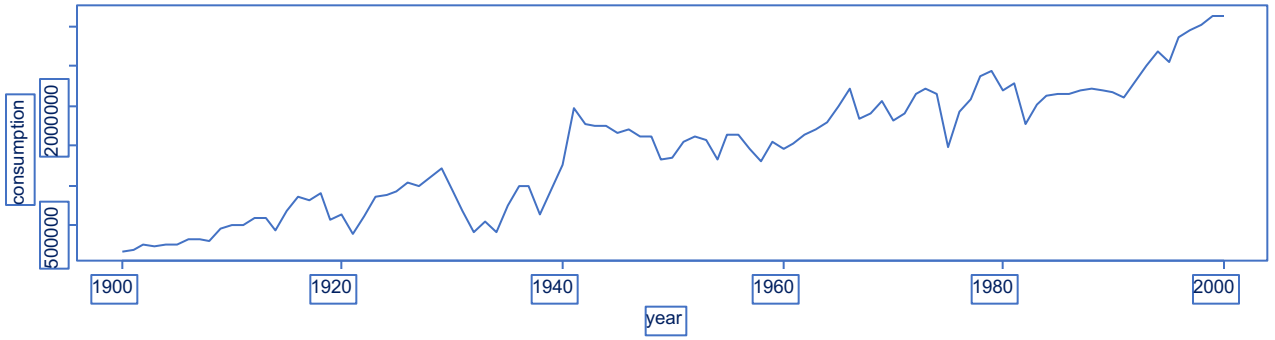
real price

1900

2000



production

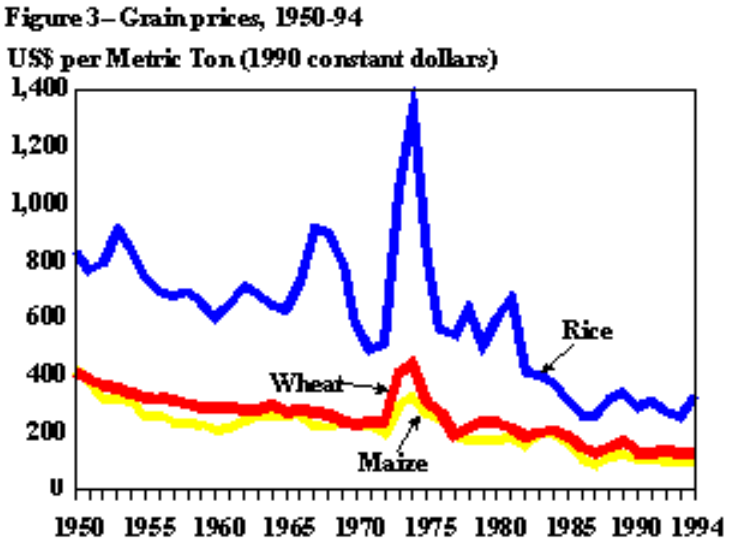


consumption

Food prices

In 1970s, fears of scarcity were not soothed by the data

But since that time …



source:
http://www.ifpri.org/2020/briefs/number30.htm

What has gotten more expensive over the last century?

Pricing problems

- *tragedy of the commons*: an exploiter gets all of the benefit but pays only a tiny fraction of the price (e.g., ocean fisheries, tropical forests, returning books to easiest shelf in library)
- *public goods*: an exploiter consumes but doesn't take from anyone else (e.g., clean air, knowledge). Problem is individuals have little incentive to improve/invest.
- *externalities*: (e.g., pollution) costs not reflected in price
- *poverty*: insensitivity to prices [scarcity signals] because no alternatives available

The “reasonable” economist

- With functioning markets, increasing pop will not cause environmental disaster, but rather adaptation and substitution ([Lam])

BUT

- “When markets are structurally flawed, or when poverty inhibits the operation of market forces, population size and rate of growth usually magnify the adverse impact on natural resources and the environment.” [MacKellar and Horlacher]

Sam Preston's conclusion

"All we can conclude from a concurrence of accelerated economic growth and population growth is that population growth is not so overwhelmingly negative a factor for economic advance as to stamp the impact of all other influences"

(Review of Simon's *The Ultimate Resource*)

Lam's argument

- Argument by looking at extreme case
- Let's look at last 50 years, when population grew the fastest in human history
- 3 indicators
  - Human well-being (e.g. poverty)
  - Renewable resources (e.g. food)
  - Exhaustible (e.g., metals)

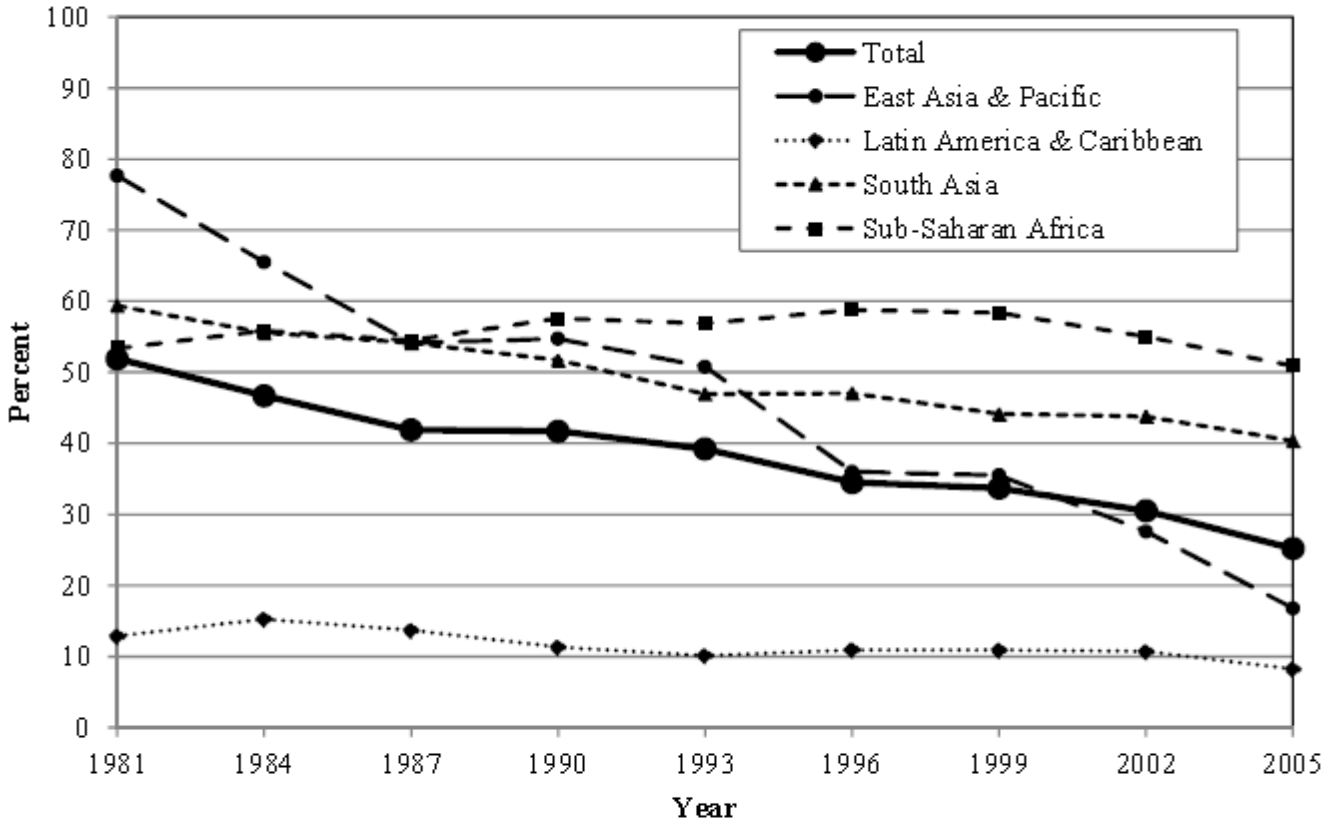


Fig. 9 World Bank estimates of percent in poverty for all low- and middle-income countries and by region, poverty line of per capita household consumption less than $1.25 per day, 2005 U.S. dollars. *Source:* Chen and Ravallion (2010)

Relative price of wheat in England since 1316 (index; 2000=1.0); Lomborg, p.62

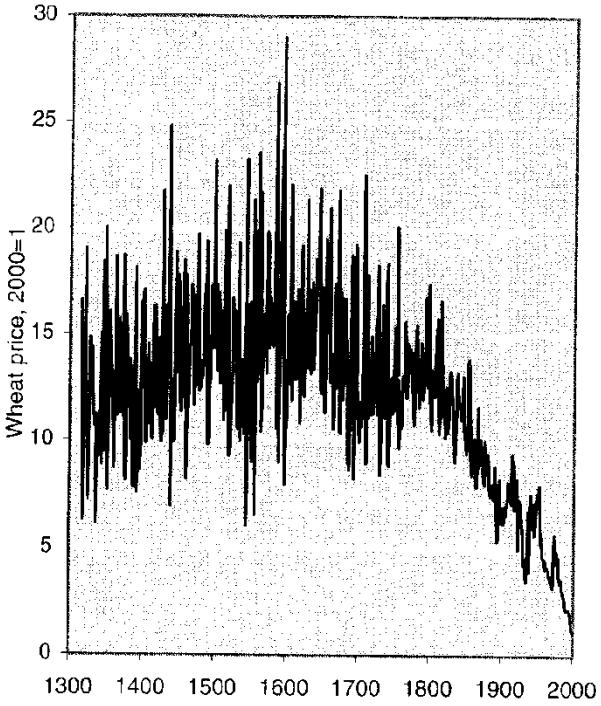


Figure 25 Wheat price index, England 1316–2000 (Exeter 1316–1820, England and Wales 1771–1980, United Kingdom 1966–99). Source: Mitchell 1988:752–8, MAFF 2000:5:4, 2001: 30, FAO 2000, UK CPI 2000, 2001.

From Lomborg, Skeptical Environmentalist, 2001

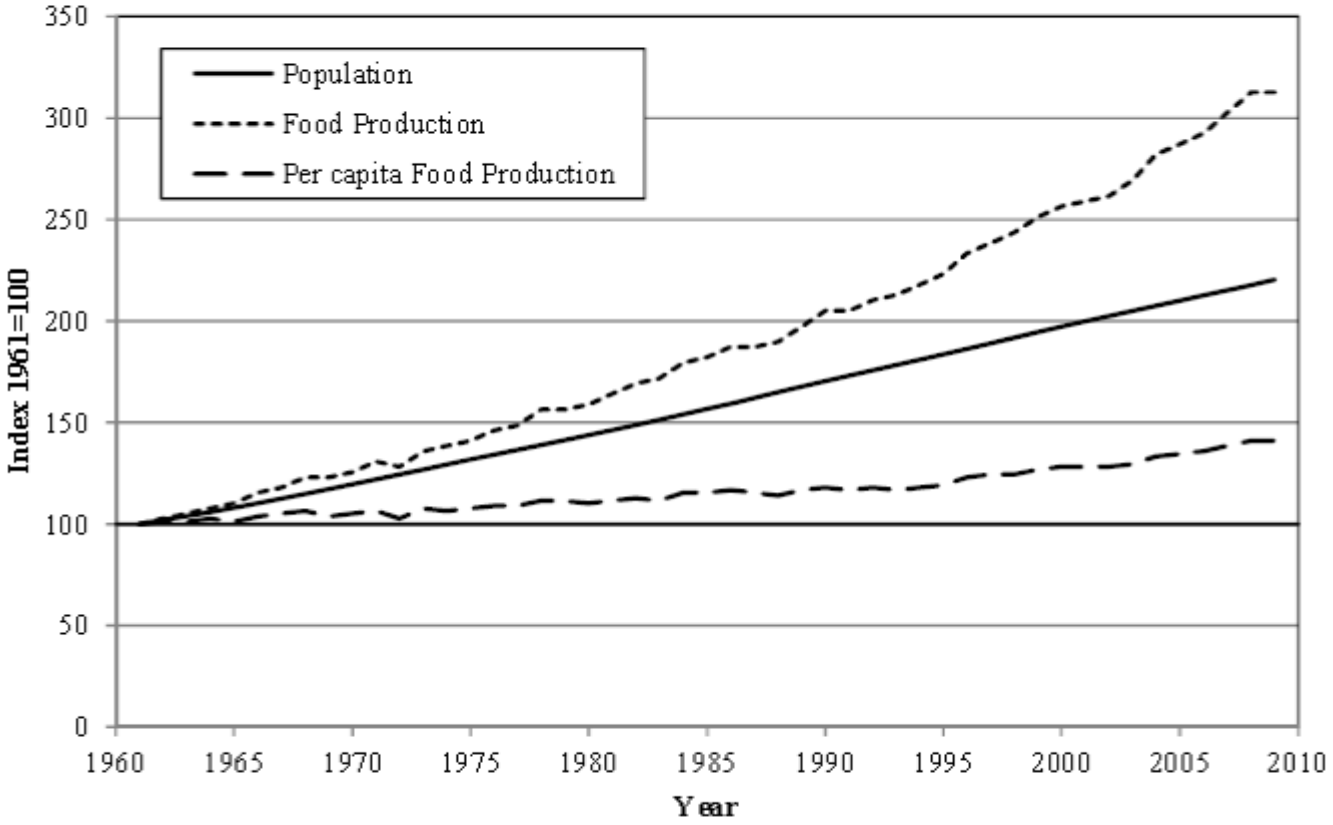


Fig. 4 World food production, 1961 to 2009. *Source:* FAO (2011).

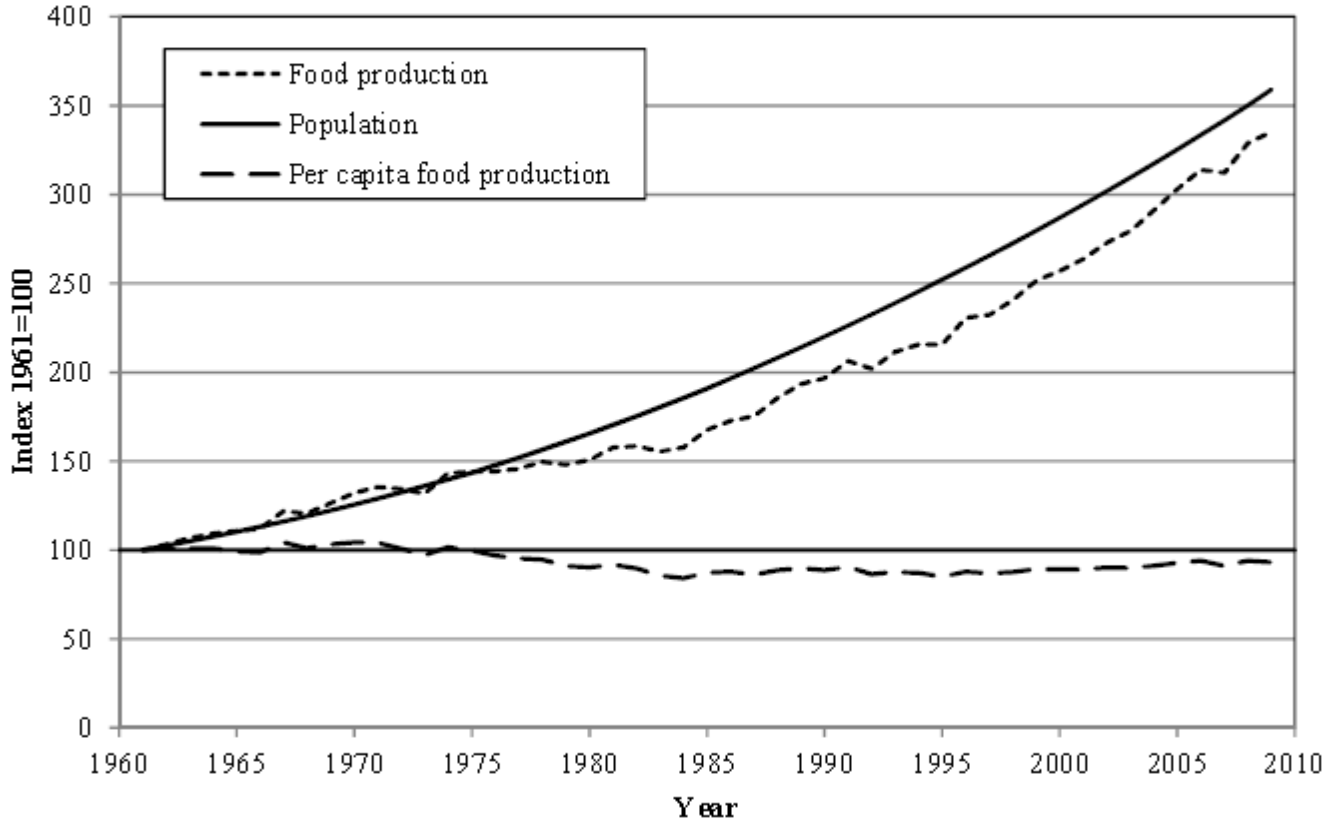


Fig. 6 Sub-Saharan Africa food production, 1961 to 2009. *Source:* FAO (2011).

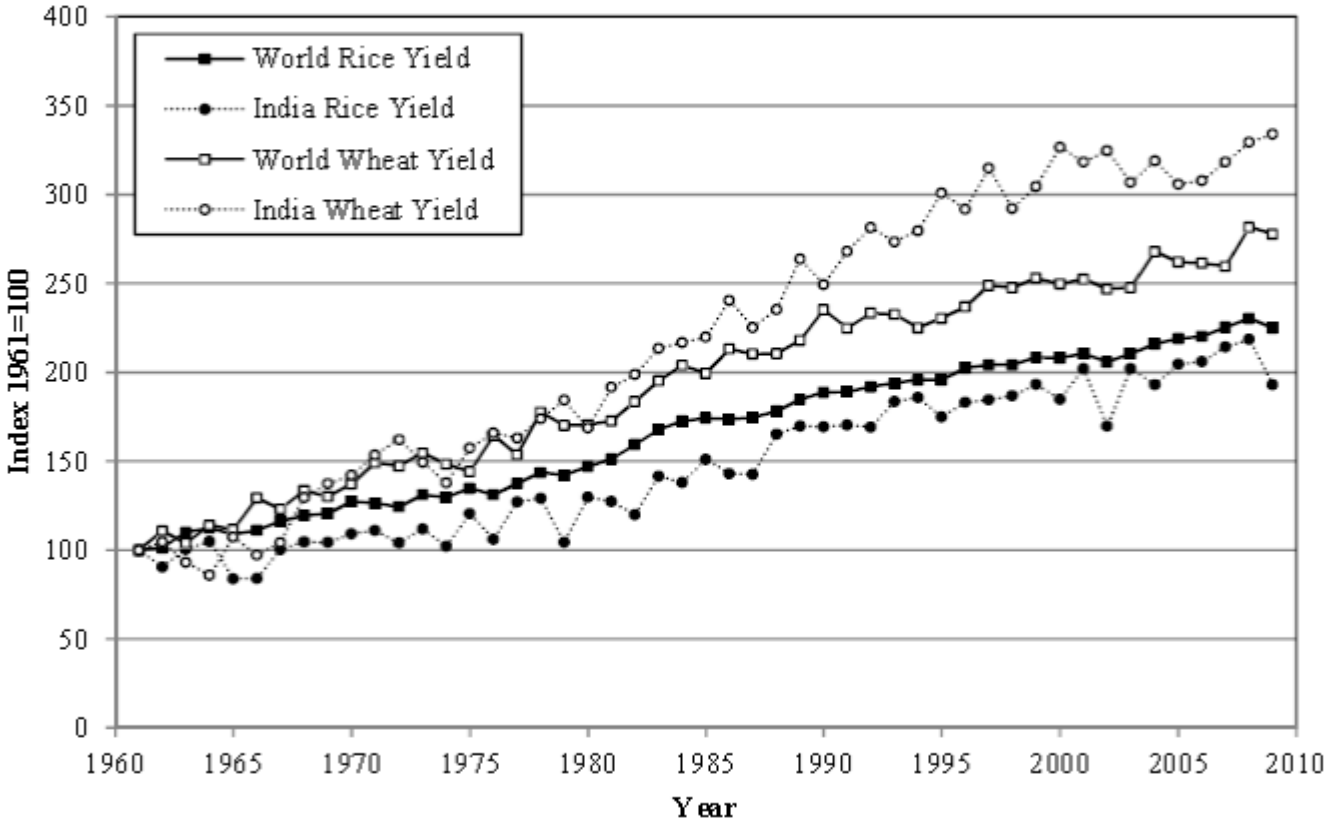
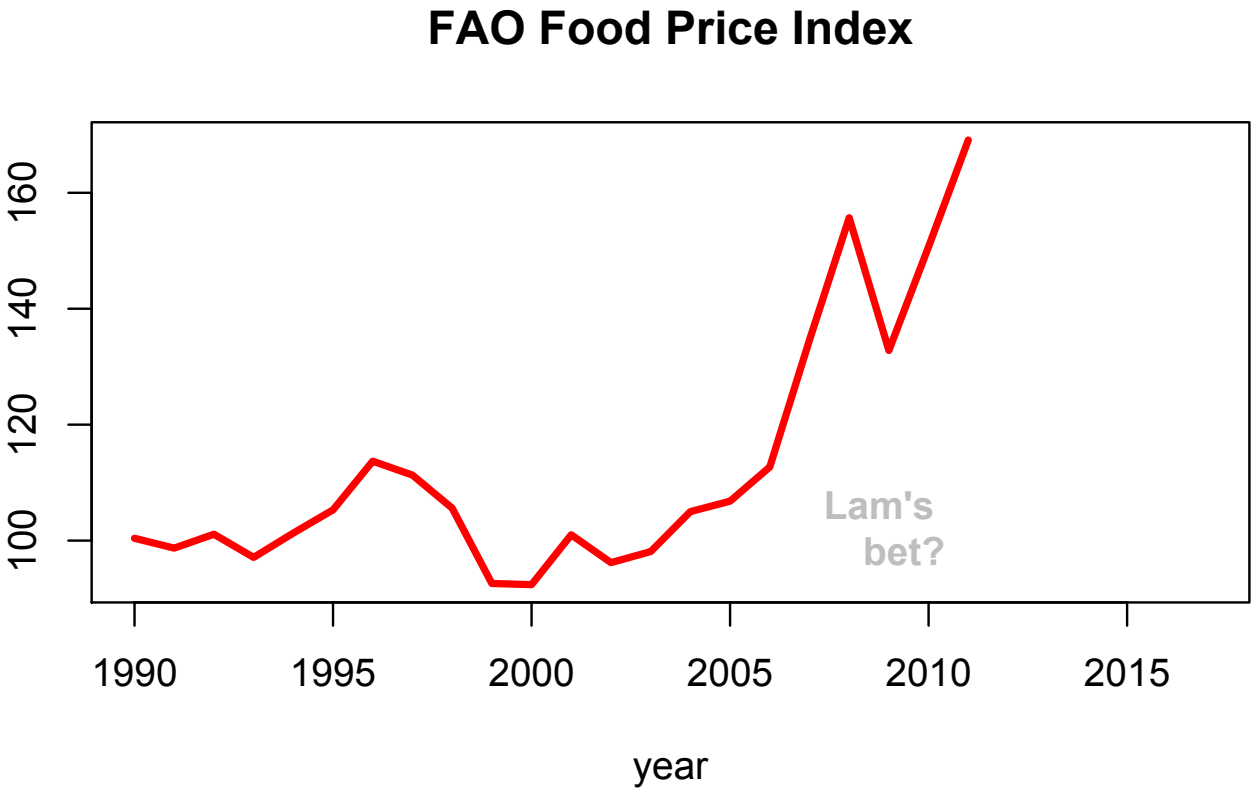


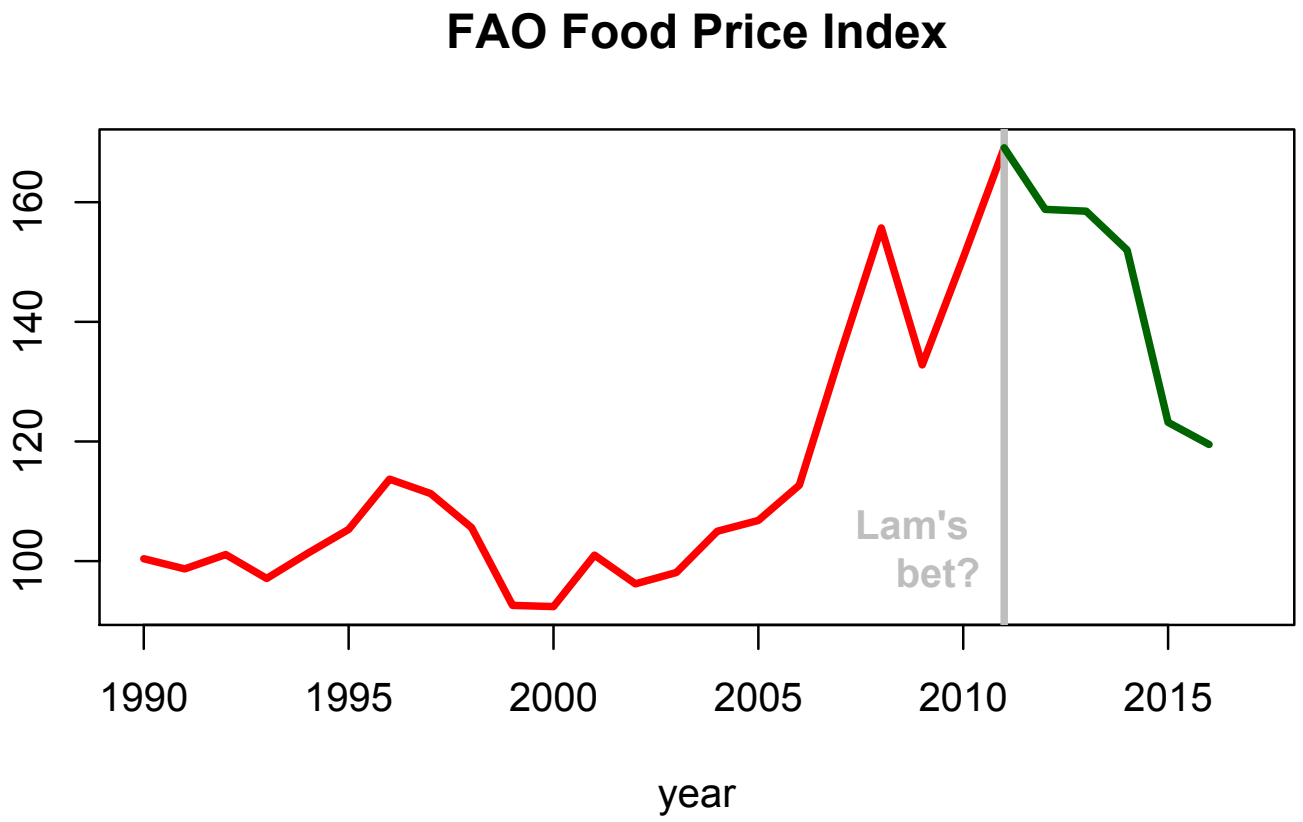
Fig. A7 Productivity: yield per hectare, 1961 to 2009. *Source:* **FAO (2011)**

As Lam writing, food prices spiking … and he asks himself what he would bet



Youtube 52:30

He would have “won”



Lam's conclusion, and ours?

- Things got better for people even during the era of peak population growth
- So, should continue to get better with slowing population growth

BUT (following Preston)

- Last 50 years, a time of enormous economic growth
- Perhaps econ growth will slow down faster than population growth?

Risk aversion

- A lot of uncertainty about major issues
  - Global warming
  - Species extinction
- But if change is basically for the better we don't need to be afraid.
- If we're not so certain, then perhaps we should be careful even if we are not strict conservationists.

- "How fast should we drive in the dark?"

Short break

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Which of these statements sounds *least* plausible?

A. If individual fishermen act in their own interest, fish will go extinct
B. There is a unique sustainable harvest rate, allowing fish survival forever
C. There is a unique optimal harvest rate, maximizing harvest size

Sustainability and Renewable Resources

Renewable resources include

fisheries, forests, soil, aquifers, clean water, atmosphere …

These resources, like other capital, yield a flow of services

fish, lumber, crops, irrigation, oxygen, …

Becker response says big problem is sustainability (not finite resources like copper)

Simple sustainability rule

If "losses" ≤ "renewal rate → "sustainable"
More formally, let

b = birth rate, fraction of resource that becomes newly available each year

d = death rate, fraction of resource that is lost each year without harvest

h = harvest rate, fraction of resource harvested

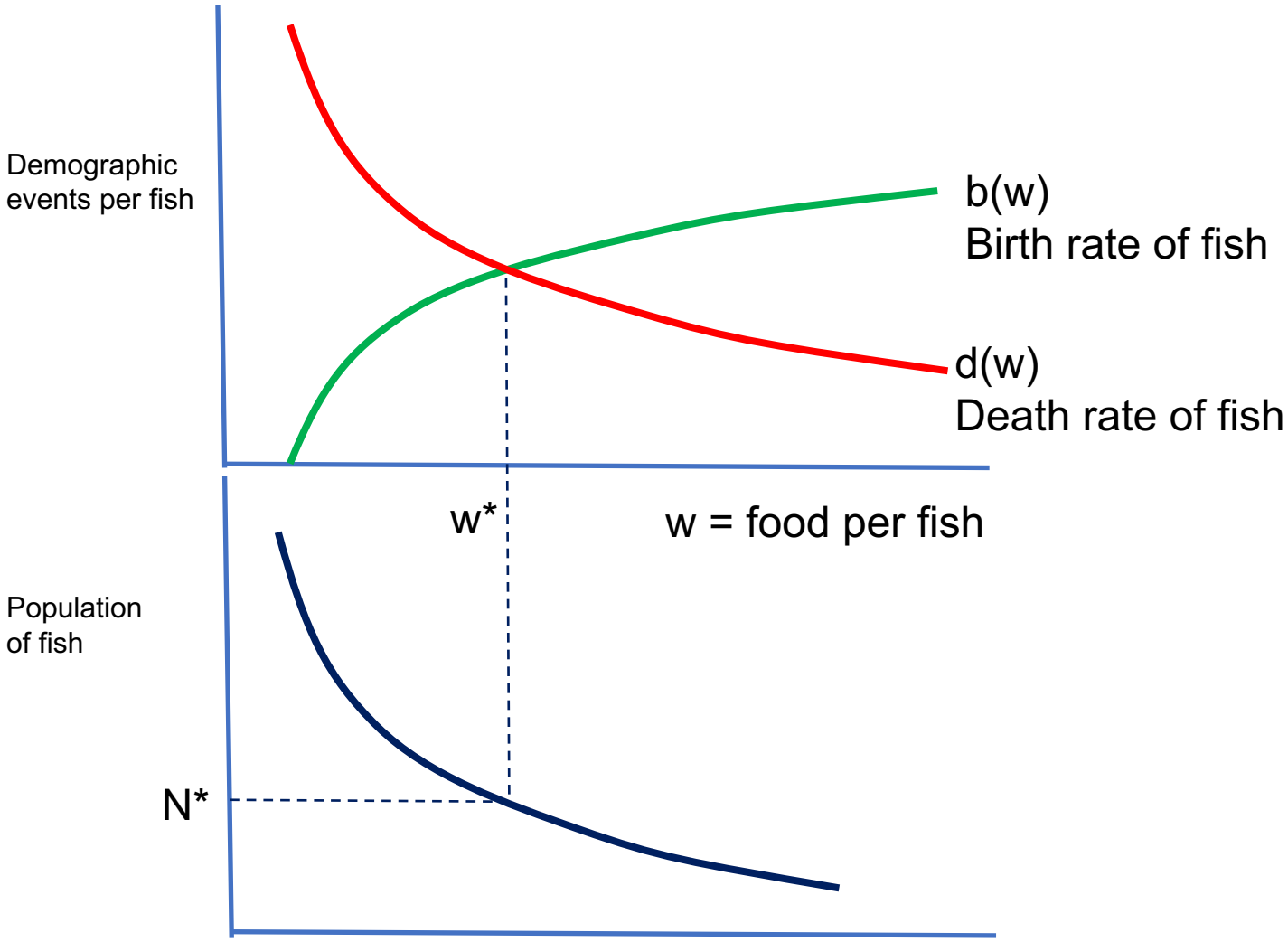
Sustainability when $b \geq d + h$

(for fish, timber, fresh water, …)

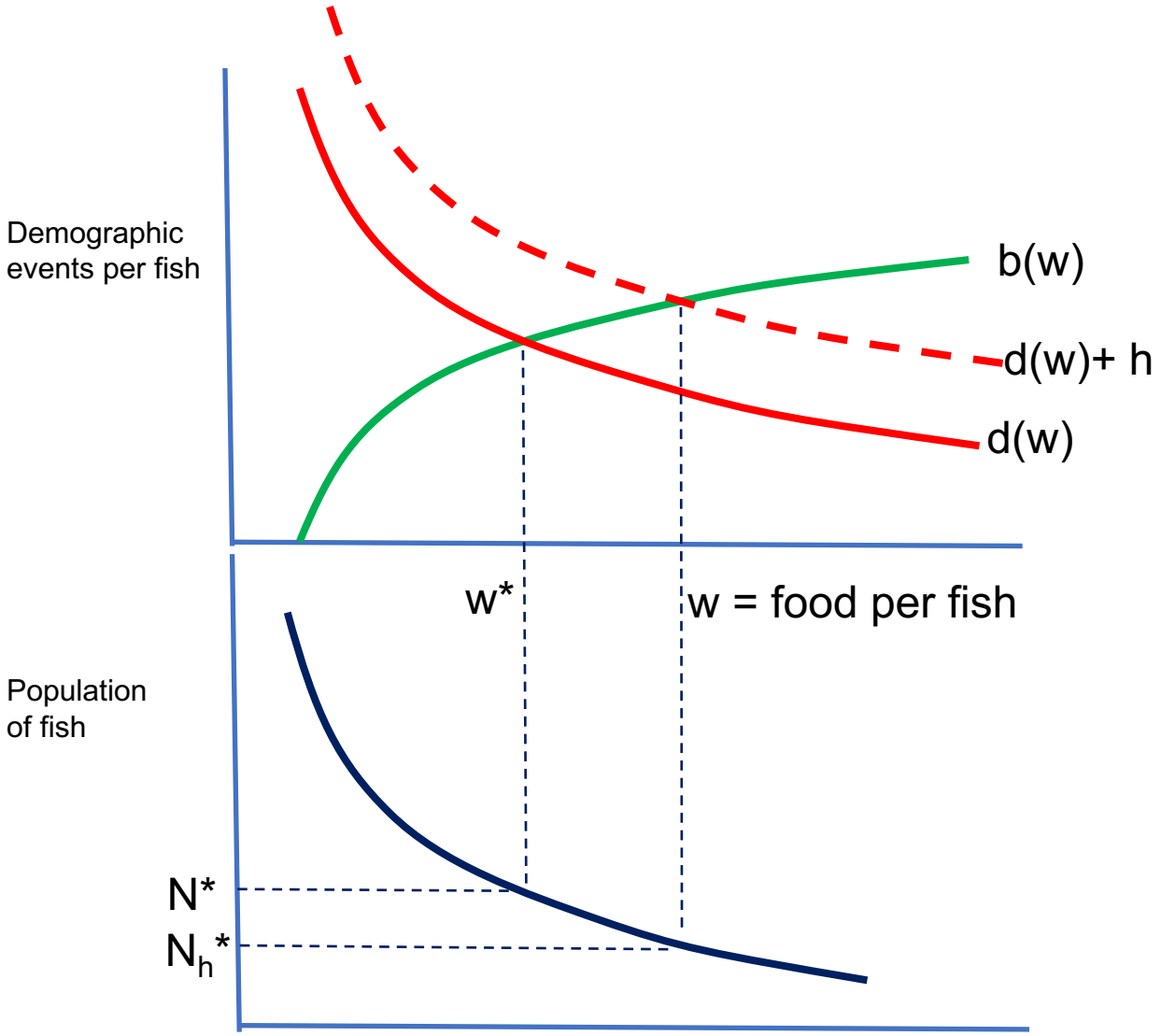
Density dependent sustainability A Malthusian (!) example

- Say fish has a death and a birth curve that depend on density
- We harvest a proportion *h*, to give a total harvest of $H = h * Pop$
- Questions we would like to answer
  What happens to *Pop* if we change *h*?
  What happens to *H* if we change *h*?
  What is non-sustainability?
  Will markets optimize *H*?

Malthusian equilibrium for fish without harvesting (h = 0)



Malthusian equilibrium for fish with harvesting (h > 0), raising mortality



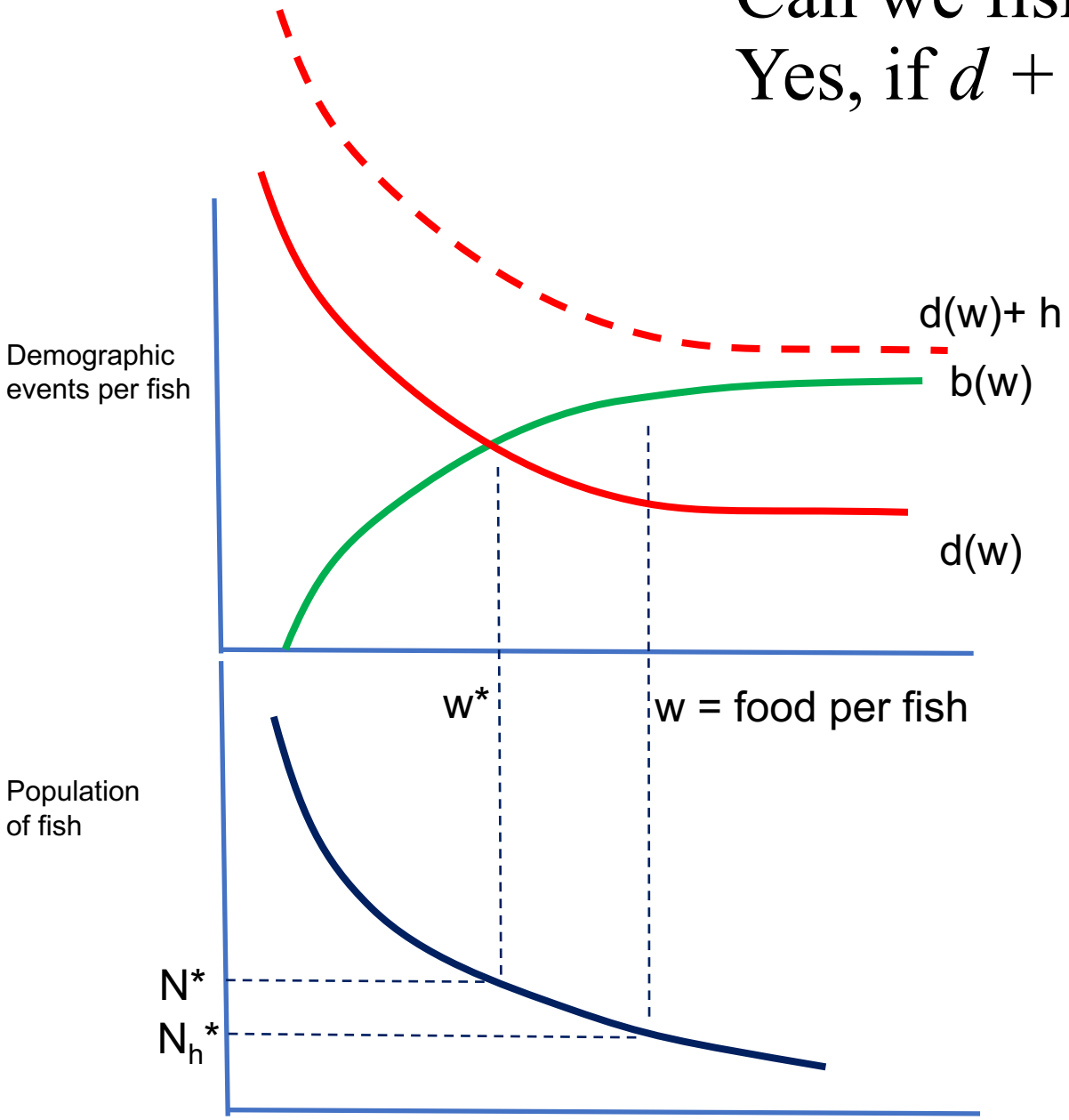
Harvest rate is h.

Total harvest:

$H = h N_h^*$

What is optimal *h* that will maximize *H*?

Can we fish to extinction?
Yes, if $d + h > b$ for all w.



Harvest rate is h.

Total harvest:

$H = h N_h^*$

What is optimal *h* that will maximize *H*?

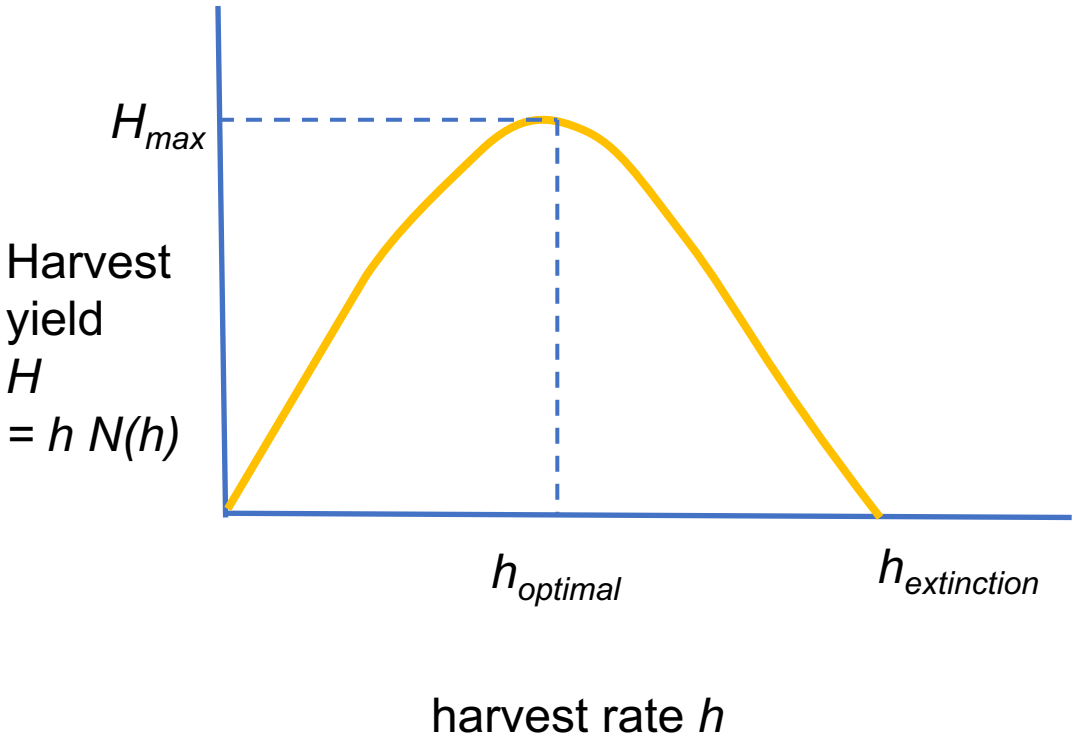
Maximum sustainable harvest

- Harvest is 0, if we don't fish
- Harvest is 0, if we fish too much (extinct)
- But in-between:

$$H = h\ N^*(h) > 0$$

- So we must have a maximum.

Optimal harvesting and the TofC



- Harvesting at a rate higher than h_{opt} is "over exploitation" and leads to a lower sustainable harvest.
- But a higher harvest rate can *temporarily* boost the harvest yield, even though not sustainable.
- So, each individual person fishing has an incentive to fish more, raising *h*, but this leads to smaller, more expensive harvest for all.
- "Tragedy of the commons"

Concluding remarks

- Becker: “need sustainability”
- Lam: “yes, but better institutions, not fewer people, are the answer”
- In the past, Boserup tells us that population pressure and scarcity have been an engine for institutional development.
- We need people (like you) to build those institutions.