Population Aging and PAYGO pension systems

Economic Demography
Econ/Demog c175
Prof. Goldstein
Spring 2017
Week 6, Lecture A
UC Berkeley

Plans

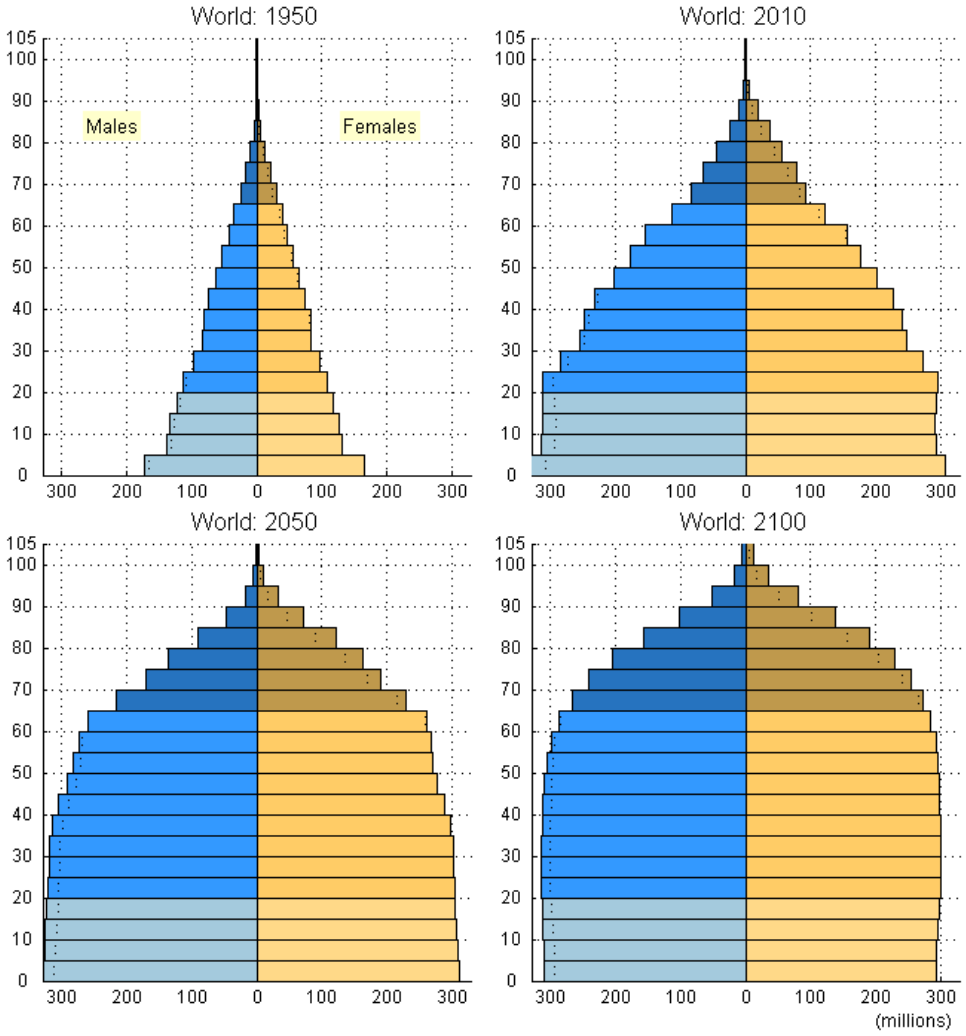
- Tuesday: Life-cycle savings and the creation of transfer wealth
- Thursday: Demographic Transition

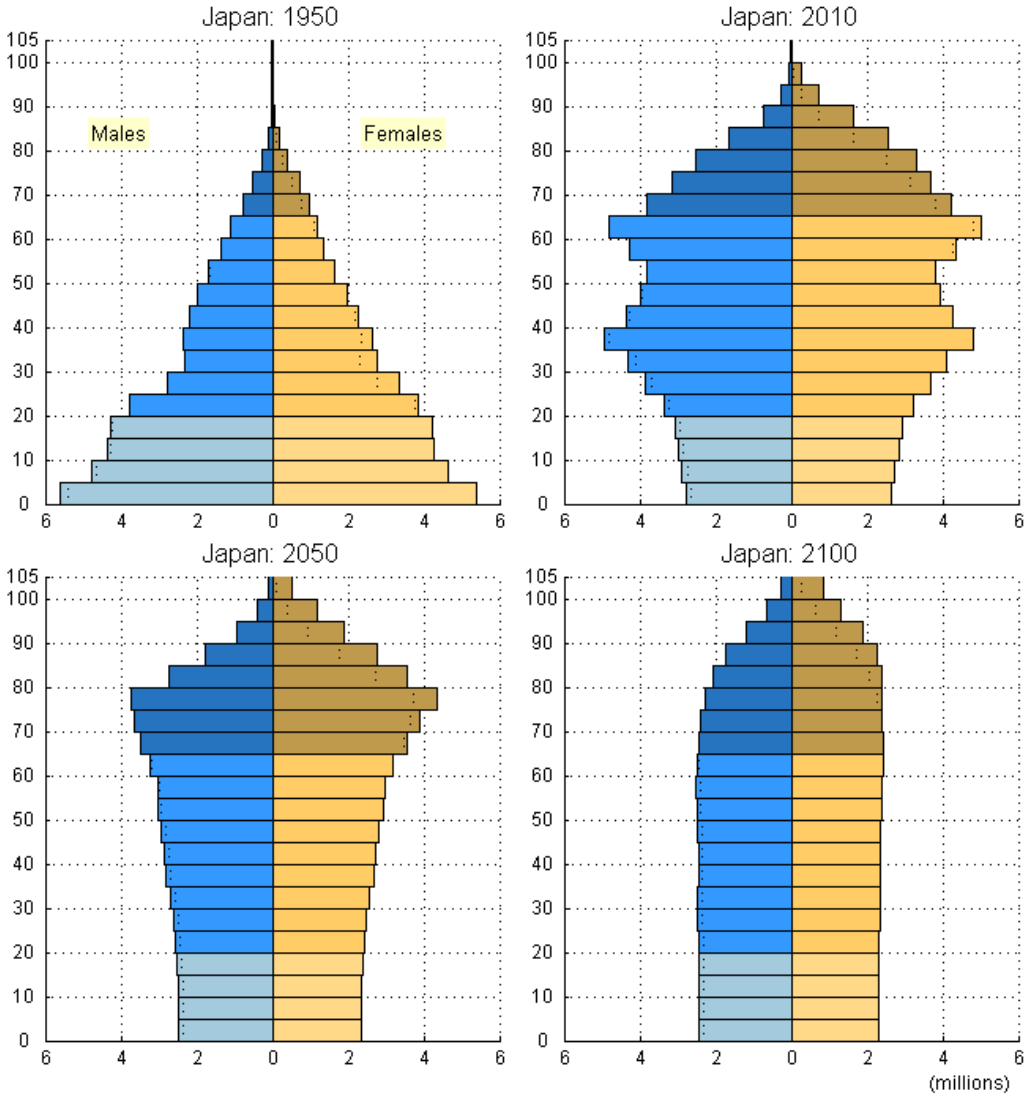
- Next Tuesday: any overflow +
  (lab review : lessons from each lab)

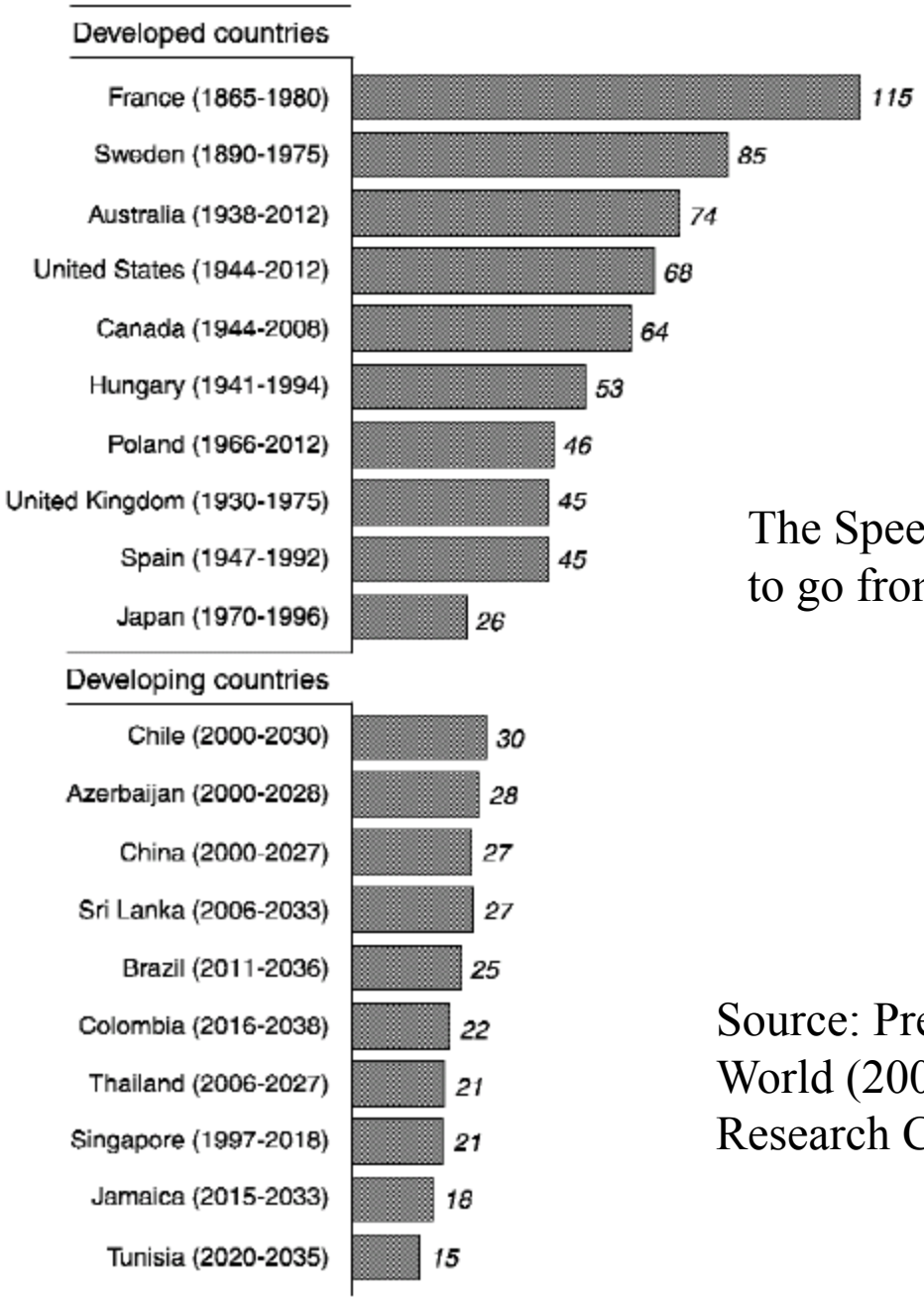
Agenda

- Aging around the world
- Revisiting the stable population model
- Life-cycle dilemma
- PAYGO pensions and wealth creation in growing populations
- Next time (transition costs & 3 applications: U.S. Social Security, Piketty Inequality, & Optimal fertility)

UN, 2011; 2010 Revision




Japan: 1950
Japan: 2010
Japan: 2050
Japan: 2100
Males
Females
105
100
90
80
70
60
50
40
30
20
10
0
6
4
2
0
2
4
6
(millions)



The Speed of Aging: Years to go from 7 to 14% 65+.

Source: Preparing for an Aging World (2001) National Research Council, NAP

FIGURE 2-5 Speed of population aging (number of years required or expec for percent of population aged 65 and over to rise from 7% to 14%).
SOURCE: Kinsella and Gist (1995).

Stable Age Structures

A simple but powerful model

Stable populations

1. Grow exponentially at an annual rate “ *n* ”

2. Arise if age-specific fertility and mortality rates remain constant for a “long” time.

(We omit migration here)

The stable population age-structure

In counts, today's people are surviving babies born in the past

$$N(x, t) = B(t\text{-}x)\ \ l(x)$$

If births have been growing exponentially,

$$= B(t)\ e^{-nx}\ l(x)$$

Stable population age-structure (cont.)

In counts,

$$N(x, t) = B(t)\, e^{-nx}\, l(x)$$

In proportions (divide both sides by pop size)

$$n(x, t) = N(x, t) / N(t) = B(t)/N(t)\, e^{-nx}\, l(x)$$

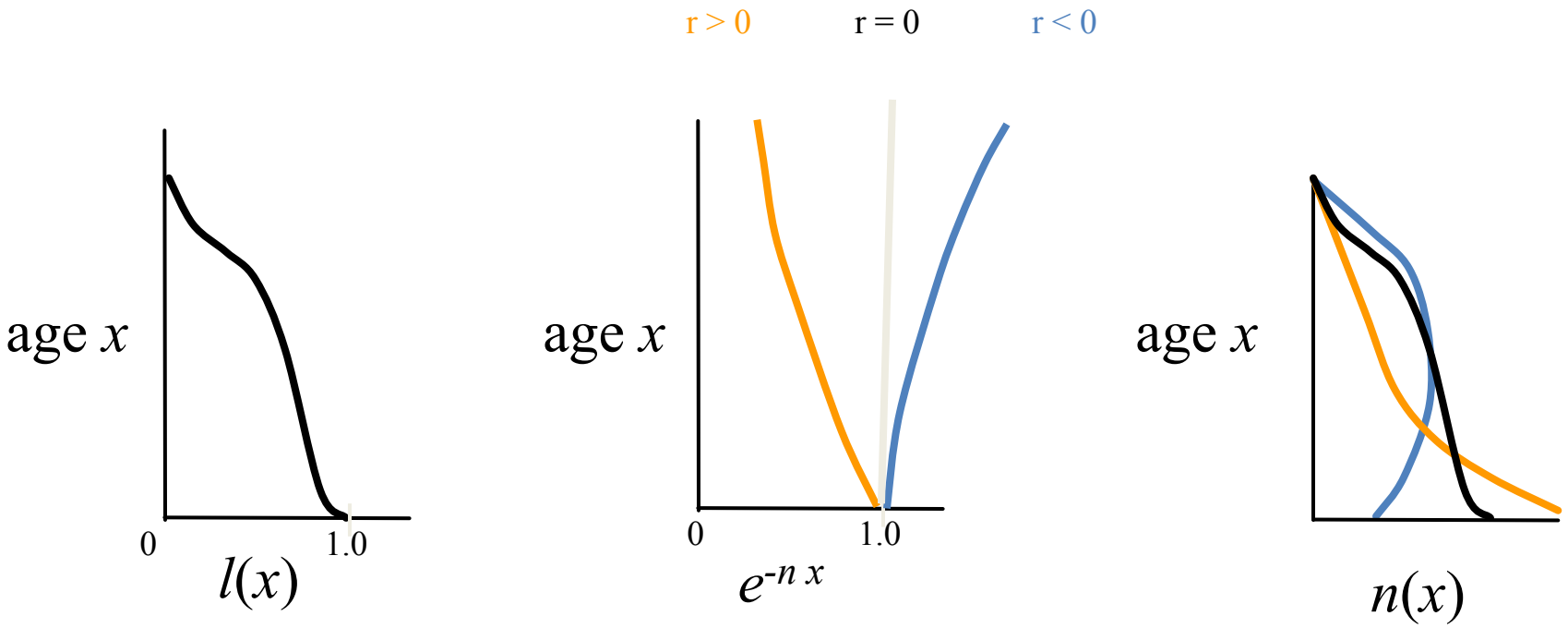
$$n(x) = b\, e^{-nx}\, l(x)$$

where b is crude birth rate

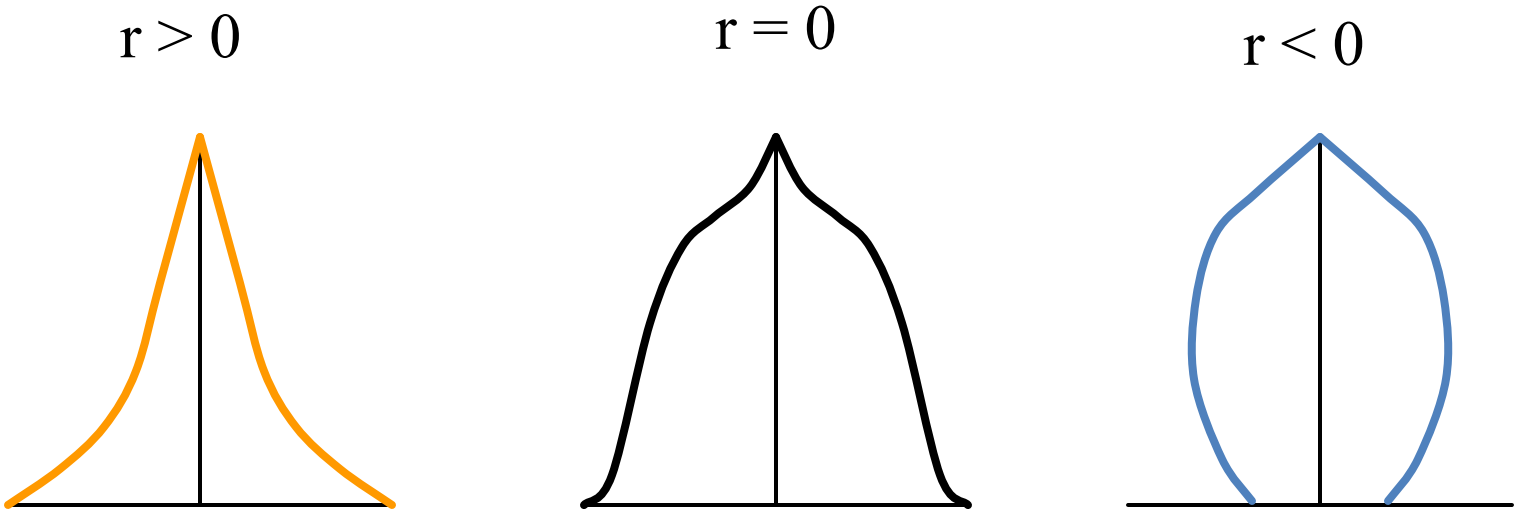
and shape of age structure is constant over time

Survival and history of births combine

$$l(x) \times b\, e^{-n\,x} = n(x)$$



Only three stable cases

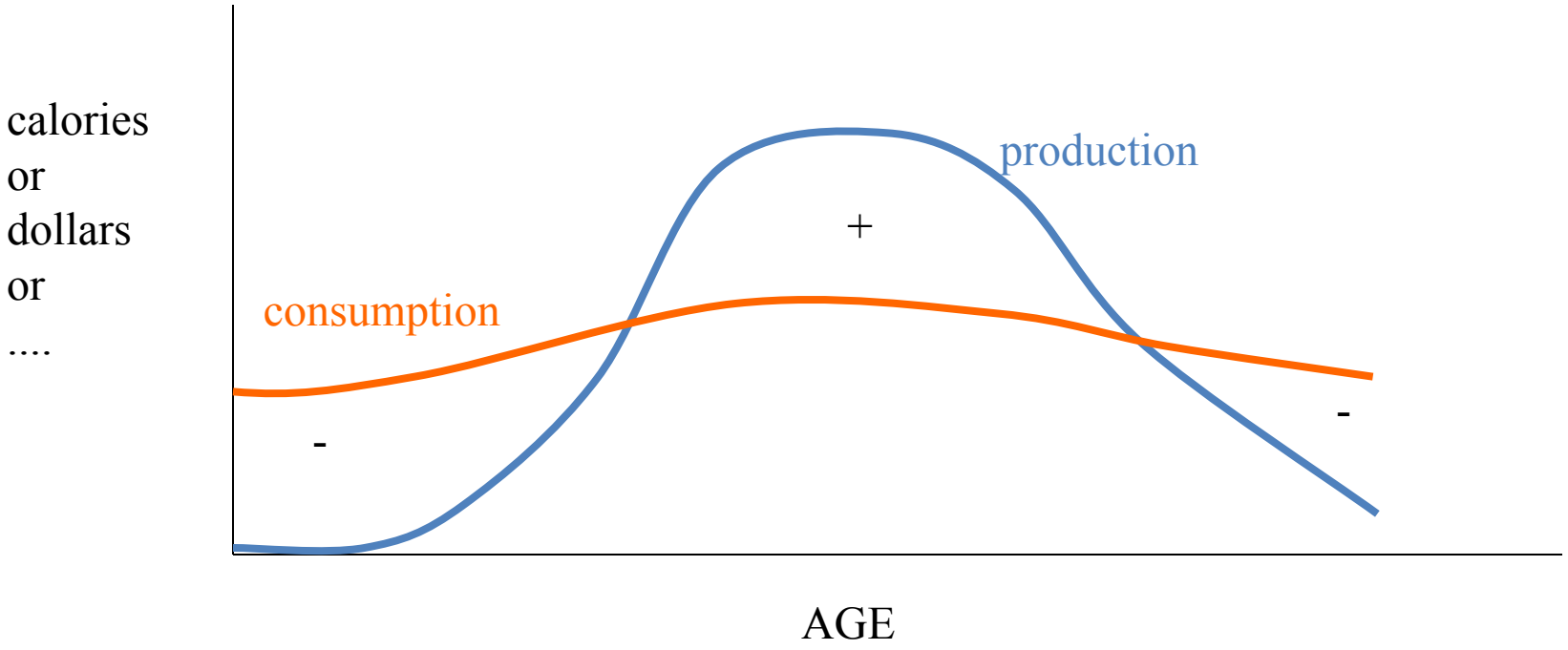


What age structure is best?

The life-cycle savings dilemma

The life-cycle savings dilemma

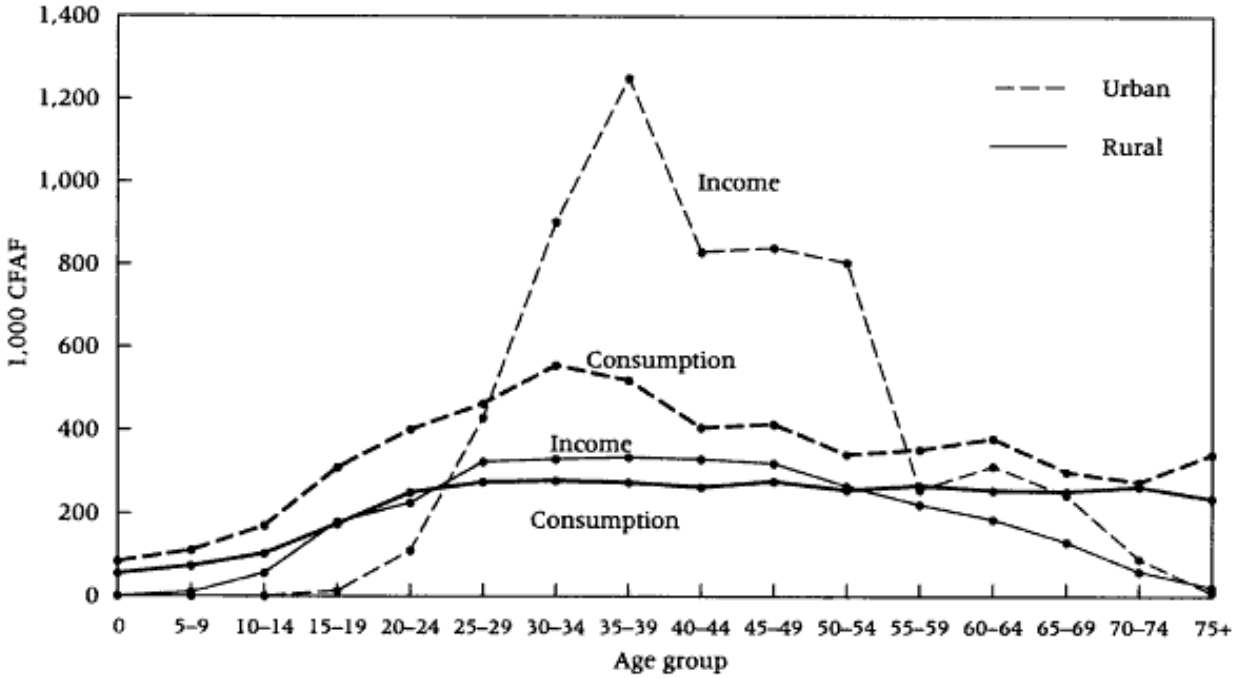
- People are dependent in childhood (and possibly in adulthood)
- In general, want to smooth consumption over their lives



Examples of these age profiles

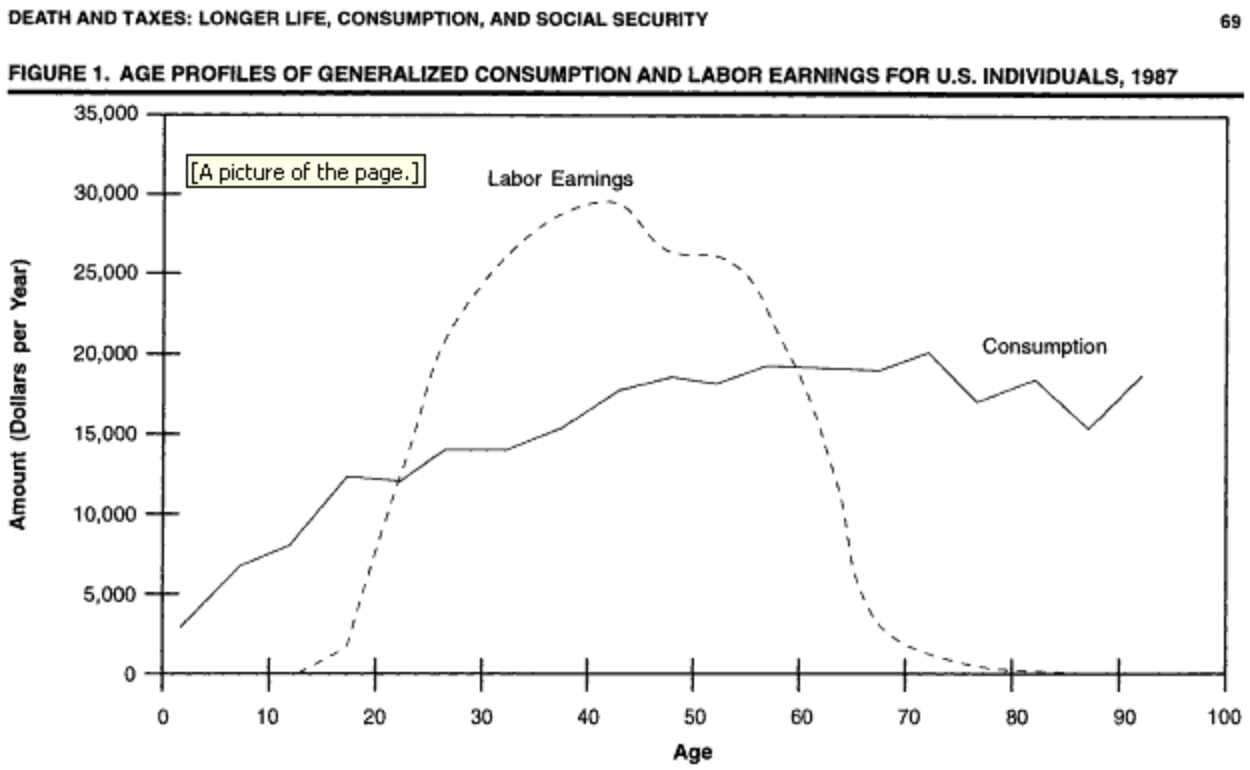
(a) In Cote d'Ivoire, Africa (Stecklov 1997)

FIGURE 1 Urban and rural per capita consumption and labor income by age group: Côte d'Ivoire 1986



Age-earnings/consumption profiles in the United States

source: Lee and Tuljapurkar (997)



Consumption/Production in Amazonian Hunter-gatherer society

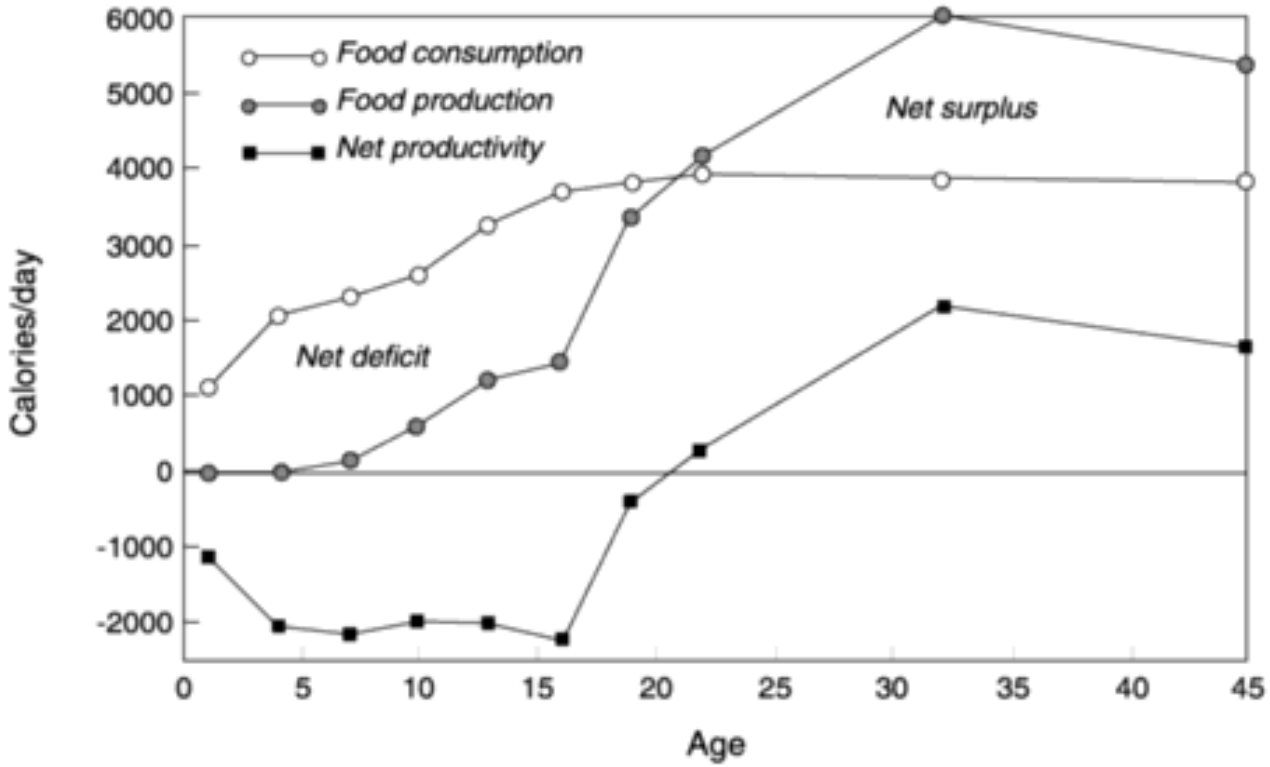


FIGURE 10-3c Aché food production and consumption by age: both sexes combined.
SOURCE: Kaplan (1994).

To solve the dilemma?

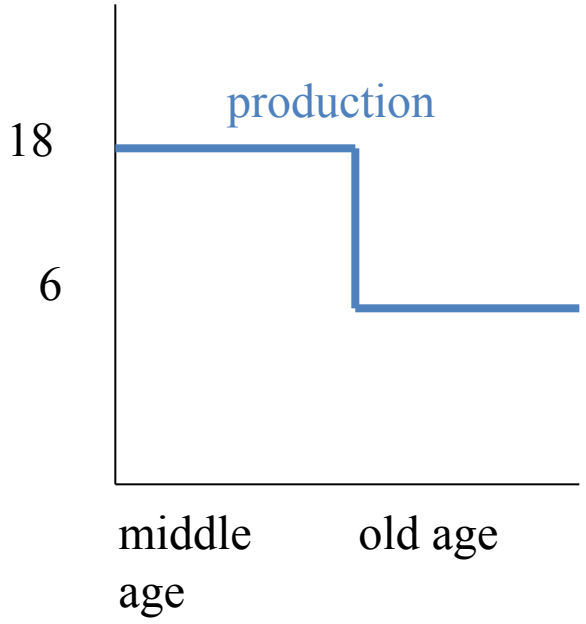
- Private transfers:
  - Children "borrow" from parents, and pay back when they grow up (what could go wrong?)
- Public transfers
  - Tax people in surplus ages and redistribute to deficit ages (what could go wrong)?
- Private savings: save your own surplus
  - Requires durables (or still have to rely on younger generation)
  - Doesn't help you as a child

Solving the life-cycle savings dilemma: a simple worked example

(Walnuts and chocolate)

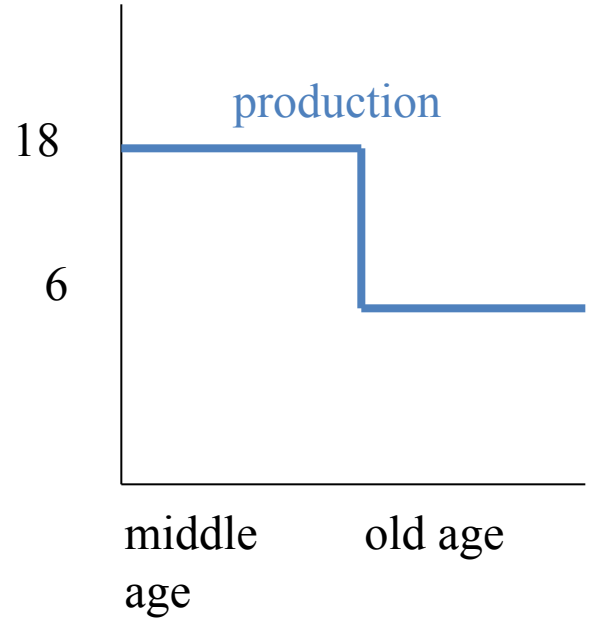
An example

- Simplifying but not necessary assumptions
  - life has only 2 stages, separated in age by one generation of time
  - no mortality until 2nd stage is over
  - perfect smoothing of consumption is goal



“Nut” economy with durable goods

For an individual, who could save, what would smoothed consumption be (lifetime and per period)?

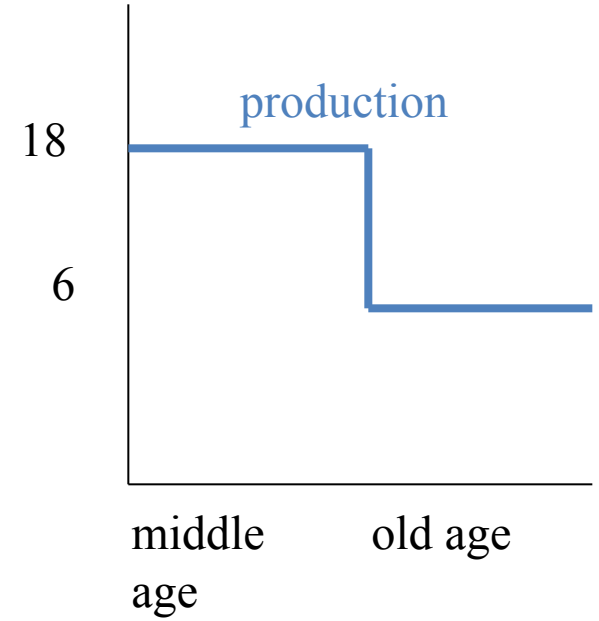


“Chocolate” economy with no durable goods

In order to smooth consumption, those in middle age transfer to those in old age.

If population growth is zero, what is transfer and what is smoothed consumption?

Assume 100 middle age and 100 old age people.

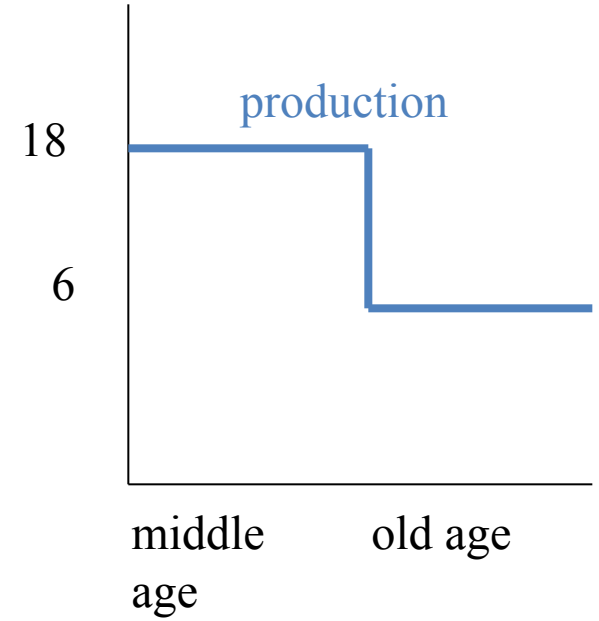


“Chocolate” economy with no durable goods

In order to smooth consumption, those in middle age transfer to those in old age.

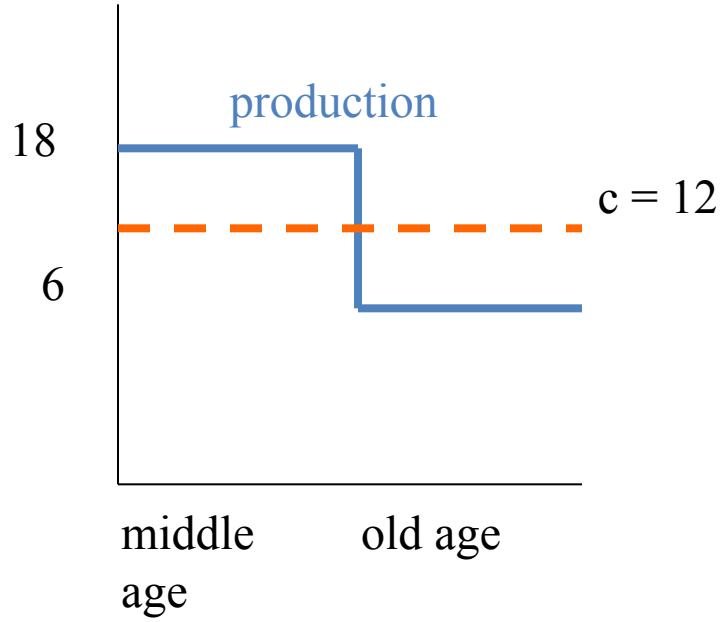
If population growth doubles generation size, what is transfer and smoothed consumption?

Say 200 middle age and 100 old age.

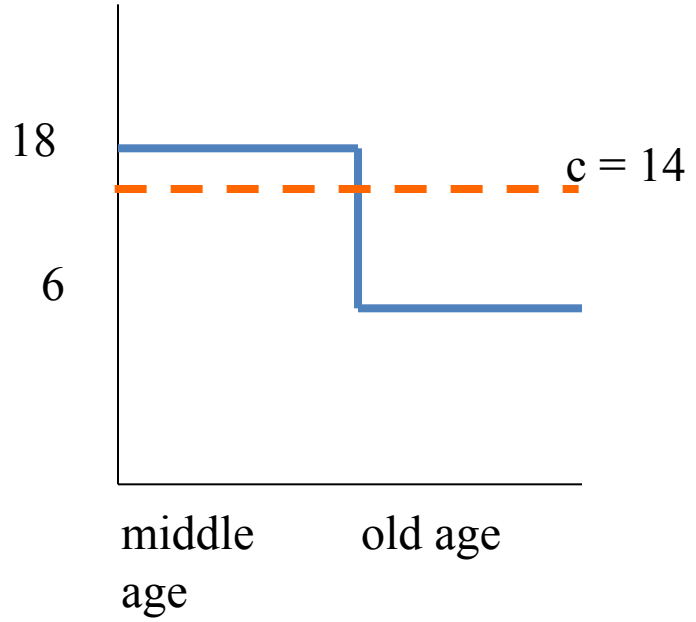


Answers

(100) * 18 + (100) * 6 = 2400 total
or 12 = 2400 / 200 per person per stage
or 24 per person per lifetime



(200) * 18 + (100) * 6 = 4200 total
or 14 = 4200/ 300 per person per stage
or 28 per person per lifetime



So for transfers from young to old (Social Security), population growth is good

- increases lifetime consumption
- by creating "transfer" wealth
- In our example, better than private saving of durable goods
- Equal to private savings and investments if …

PAYGO identity

- PAYGO short for pay-as-you-go:

  annual inflows = annual outflows

- If workers (N_W) and old-folks (N_O)

  Benefits(this year)= Taxes(this year)

  $b\,N_O = t\,y\,N_W$ (t is tax rate; y is wage rate)

- PAYGO Identity:

$$t = (b/y) * (N_O / N_W)$$

tax rate = (“replacement rate”) × (“old age dep. ratio”)

PAYGO identity (applications)

Worked example

$$t = (b/y) * (P_O / P_W)$$

In U.S., we have about 200 million of working age and about 40 million of retired ages.

Say we want a replacement rate of 70%.

What tax rate would we need? Is this realistic?

Comparative statics

- What if we increase OADR from 20 to 30 percent? How much will this increase taxes?
- How much would we have to reduce benefits by if taxes were held constant?

A result from stable population theory

proportional change in OADR ≈

$$\text{change in } r * (A_w - A_o) \approx \Delta r * 30$$

Where A_w is average age of workers (e.g., 40) and A_o is average age of elderly (e.g., 70).

So if we increase long-term growth rate by 1%, we reduce OADR by 30%, can increase benefits or reduce taxes. Vice versa for falling growth rate.

From Total Fertility to “r”

TFR	approx. r (when mortality is very low)
1	-2.8%
1.5	-1.2%
2	0
2.5	0.9%
3	1.6%
3.5	2.2%
4	2.8%

Japan vs. USA

If TFR(Japan) = 1.5 and TFR(USA) = 2, how much higher will taxes have to be?

Difference in TFR → 1% lower growth rate

→ 30% higher OADR → 30% higher taxes

Instead of ~15% payroll → ~20% payroll tax

Conclusions

- PAYGO pensions creates transfer wealth (if $r > 0$)
- Decline in fertility, requires long-term increases in tax rate or cuts in benefits to keep PAYGO system
- Question to think about: is there an optimal age-structure, an optimal growth rate?