Consequences of the Demographic Transition

Economic Demography
Demog/Econ c175
Prof. Ryan Edwards
Spring 2020

3/2/2020
Announcements

• Lab 6 will be due this Friday by midnight

• Today is Super Tuesday! Don’t forget to vote
COVID-19

• If you’re like me, you’re amazed at:
  – The rapid pace of developments
  – The lack of centralized messaging by our government and media

• Latest(?) news
  – 6 deaths in WA state, 1 confirmed case in Alameda County, a health care worker in Solano County
  – CDC is ramping up testing; previous standards allowed little

• The UC Berkeley EVC/Provost Paul Alivisatos is on it

• We need to think about potential changes to C175
Preparedness & Plans

• I think instruction can continue regardless. We are all committed to getting you your units & training

• Tech is awesome. Zoom can handle many hundreds of users on videoconference
  – Regular class meetings would become Zoom videoconference
  – Sections would become Zoom, or video, or online chat
  – Office hours would become Zoom or chat

• If we need to, the midterm would become a take-home with Honor Code as usual (if we did: sadly, no questions)

• We will keep you updated
Questions?
Otherwise…

• Next meeting: in-class review
  – Good strategy: look at 2019 midterm and formulate questions
  – I’ll have nothing prepared for Thu, please bring Qs

• One week from today: midterm exam in class

• Then new instruction on Thu 3/12 and Tue 3/17 and Thu 3/19

• Then Spring Break week
Agenda

• How to study for the Midterm exam

• Social Security & OADR
  – Transitional windfalls and costs
  – Rates of return
  – The US case (and abroad)

• Demographic Transition
  – Some facts
  – Impact on age structure
Priorities for studying

1. Lecture (slides, videos, any discussion), Section, Office Hours
2. Labs
3. Required readings
4. Other readings to help understand 1 & 2.
5. Ask questions on Piazza, in office hours, during in-class review
More on Social Security
(PAYGO pensions)
PAYGO identity

• PAYGO short for pay-as-you-go:
  annual outflows = annual inflows

• If workers \((N_W)\) and old-folks \((N_O)\)
  
  \[\text{Benefits (this year)} = \text{Taxes (this year)}\]
  
  \[b \times N_O = t \times y \times N_W\]
  
  where \(t\) = tax rate; \(y\) = earnings per worker; and \(b\) = benefits per retiree

• Rearranging the PAYGO Identity:

  \[t = \frac{b}{y} \times \frac{N_O}{N_W}\]

  tax rate = (“replacement rate”) \(\times\) (“old age dependency ratio”)
Recall OADRs from earlier:
Up 33% in the U.S. by 2040

<table>
<thead>
<tr>
<th>Country</th>
<th>OADR in 2020</th>
<th>OADR in 2040</th>
<th>OADR in 2060</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S.</td>
<td>0.28</td>
<td>0.39</td>
<td>0.45</td>
</tr>
<tr>
<td>China</td>
<td>0.19</td>
<td>0.42</td>
<td>0.58</td>
</tr>
<tr>
<td>Japan</td>
<td>0.52</td>
<td>0.71</td>
<td>0.83</td>
</tr>
</tbody>
</table>

OADR = pop aged 65+ / pop aged 20-64. Source: UN Pop WPP 2019
PAYGO identity

\[ t = \frac{b}{y} \times \frac{N_o}{N_W} \]

- Suppose the OADR \( \frac{N_o}{N_W} \) were to rise by 33%
- If you wanted to maintain the same replacement rate \( \frac{b}{y} \)
- Then the PAYGO tax rate would have to rise by 33%
- Currently the Social Security payroll tax rate is 12.4% (said to be “shared equally” between workers and employers). An increase of 33% would produce a payroll tax rate of 16.5%
Suppose the OADR $\frac{N_o}{N_W}$ rises by 10%. What must happen to the replacement rate $\frac{b}{y}$ if the tax rate remains the same?

$$t = \frac{b}{y} \times \frac{N_o}{N_W}$$

A. Rises by 10%

B. Falls by 10%

C. Remain the same
iq12.1. Suppose the OADR $\frac{N_o}{N_W}$ falls by 20%. What must happen to the tax rate if the replacement rate $\frac{b}{y}$ remains the same?

\[ t = \frac{b}{y} \times \frac{N_o}{N_W} \]

A. Rises by 20%
B. Falls by 20%
C. Remain the same
Implicit rate of return

• To simplify, imagine that all taxes are paid at age 40 and all benefits received at age 70

• Then, implicit return on PAYGO contribution

\[ r^P = \log(\text{benefit} \times \text{chance still alive} / \text{tax}) / \text{time} \]

e.g., in our generational doubling example from last time: Benefit = 8 = 14 – 6; tax = 4; survival 1.0; time was 30 years:

\[ r^P = \log(8 \times 1.0 / 4) / 30 = 2.3\% \]
Estimated rates of return based on history of taxes and benefits and survival

Table 1
Redistribution across cohorts in the US Social Security system (OASI)\(^a\)

<table>
<thead>
<tr>
<th>Birth cohort</th>
<th>Internal rate of return (%)</th>
<th>Aggregate lifetime net intercohort transfer evaluated in 1989 (billions of 1989 dollars)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1876</td>
<td>36.5</td>
<td>12.1</td>
</tr>
<tr>
<td>1900</td>
<td>11.9</td>
<td>112.0</td>
</tr>
<tr>
<td>1925</td>
<td>4.8</td>
<td>99.6</td>
</tr>
<tr>
<td>1950</td>
<td>2.2</td>
<td>14.0</td>
</tr>
<tr>
<td>1975</td>
<td>1.9</td>
<td>−8.0</td>
</tr>
<tr>
<td>2000</td>
<td>1.7</td>
<td>−15.2</td>
</tr>
</tbody>
</table>

\(^a\) Source: Leimer (1994). Intercohort transfer calculation uses 2% real discount rate.

Note: assumes PAYGO balance in future, Accounts for inflation, Mixes rich and poor

Source: Feldstein
Is 2% a good deal?

• Something like you would earn on a risk free investment like treasury bills
• Less than stock market average
• BUT insures against many risks
  – Annuity against longevity risks (dying too early, too late)
  – Poor timing of the market (e.g., retiring in 2008)
  – Individual variation in investments
Trust fund

Scheduled spending and revenue

Currently trust fund invests in treasury debt, some propose to diversify into stocks (controversial)
What happens when trust fund runs out?

Figure II.D2.—OASDI Income, Cost, and Expenditures as Percentages of Taxable Payroll
[Under Intermediate Assumptions]
For other countries, a different story

- Demography is less favorable

- Benefits are higher
### Examples for industrial nations, OADR projected to 2050

<table>
<thead>
<tr>
<th>Country</th>
<th>Earnings replacement rate</th>
<th>Old Age Dependency Ratio</th>
<th>Implied payroll tax rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>France</td>
<td>.91</td>
<td>.55</td>
<td>.50</td>
</tr>
<tr>
<td>Italy</td>
<td>.75</td>
<td>.58</td>
<td>.44</td>
</tr>
<tr>
<td>Spain</td>
<td>.63</td>
<td>.60</td>
<td>.38</td>
</tr>
<tr>
<td>Japan</td>
<td>.54</td>
<td>.59</td>
<td>.32</td>
</tr>
<tr>
<td>US</td>
<td>.41</td>
<td>.41</td>
<td>.17</td>
</tr>
</tbody>
</table>

Ron Lee’s calculations from data in Gruber and Wise.
The Demographic Transition

A story of changing birth and death rates
Puzzle of the demographic transition

- The Demographic Transition seems obvious today
  - Birth and death rates used to be high, now both low
- Put ourselves in the position of 1970s
  - World population growth accelerating
  - Energy prices skyrocketing
  - Environmental worries
  - Economic slowdown
- Less obvious then probably!
Idealized description

• Pre-transition
  – High fertility, high mortality
  – Mortality fluctuating due to random shocks

• Transition
  – Mortality falls first, fertility decline lags
  – Result is “transitional growth”

• Post-transition
  – Fertility finally falls
  – Fluctuations in growth are due to fertility
  – Sub-replacement demography?
Thumbnail sketch of the demographic transition

Note crude rates are per capita (e.g., CBR = births / population)
Demographic Transition in Sweden and Mexico (Crude Rates)


Source: PRB
Transition statistics

• Pre-transition
  – TFR greater than 6
  – life expectancy about 40 to 50
  – Korea (1950): CBR – CDR = 0.037 - 0.032 = 0.005

• Transitional growth
  – crude growth rates reach 1-2% in historical Europe, 3-4% in Africa
  – Iraq (1985): CBR – CDR = 42/1000 – 8/1000 = 0.034

• Post-transition
  – TFR about 2
  – life expectancy 70 or 80
  – Belgium (1984): CBR – CDR = 0.012 - 0.011 = 0.001
Population growth rates over the course of the demographic transition

Figure 4
Population Growth Rates, 1750–2150
Consequences of the Demographic Transition

Not just population size, also age structure
Dependency ratios are “shortcut” statistics, easier and quicker to read.

They reveal the ratios of those in dependent ages (<15 & >65) to those of working ages.
Dependency measures

• Old-Age Dependency Ratio (OADR)
  OADR = Pop aged 65+ / Pop aged 15-65

• Youth Dependency Ratio (YDR)
  YDR = Pop aged < 15 / Pop aged 15-65

• Total Dependency Ratio = YDR + OADR
Example: Vietnam’s age-structure during DT

- When is dependency the lowest?
- What is growth rate in 1950? In 2075?
- Why so many kids in 1975?
- Is fertility sub-replacement in 2000?

Fig. 1.3 The changing age structure of Vietnam over the course of the demographic transition. Females only
Source: United Nations (2000) and author’s projection. (Perfil demo only)
A Classic Demographic Transition:
India 1900-2100 (Lee, 2003)

- YDR increases before it decreases
- OADR increases long after
- A window of low-dependency ("demographic dividend")
est. + 0.5% per capita gdp growth per year
Optimal Population Growth Rates
Three sides of the story

- Population growth is …
  - Good because there are more workers per elderly
  - Bad because there are more children per worker
  - Bad because of capital dilution; saving is costly
Lee-Mason et al. (2014)

Look at current age-profiles of consumption and production (private and public) to measure effect of age-structure

Use Solow framework to model capital

Calculate optimal fertility
Optimal Long-run Total Fertility Rates

<table>
<thead>
<tr>
<th></th>
<th>Public (age-structure only)</th>
<th>Public &amp; Private (age-structure only)</th>
<th>Consumption (+ capital effects)</th>
<th>Observed today</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low income countries</td>
<td>1.1</td>
<td>1.8</td>
<td>1.2</td>
<td>4.0</td>
</tr>
<tr>
<td>Middle income countries</td>
<td>3.0</td>
<td>2.0</td>
<td>1.5</td>
<td>2.1</td>
</tr>
<tr>
<td>High income countries</td>
<td>2.9</td>
<td>2.3</td>
<td>1.8</td>
<td>1.7</td>
</tr>
</tbody>
</table>

Public is higher because child costs born by parents
Striking result is that low fertility (< 2) is "optimal"

Source: Lee et al 2014
Optimal fertility conclusions

• Moderately low fertility might be something to aim for, not be scared of ...

• Why?
  – Both kids and elderly are expensive. Stable pyramid, increase in one cancelled out by decrease in other.
  
  – Capital deepening (Solow effect) makes slow population growth attractive

• Caveats
  – Age-schedules are exogenous and fixed, and that’s not fully realistic
  
  – Technology growth is exogenous, but Romer/Boserup say it’s a function of population!