Aging and Pension Reform in a Two-Region World: The Role of Human Capital

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13th Annual Joint Conference of the RRC
Washington D.C., August 4 – 5, 2011
Questions & General Setup

- Effects of population aging on
  - Factor prices
  - Welfare

- How do answers change
  1. With endogenous human capital
  2. Under different social security regimes / pension reforms
  3. More interesting: interaction of 1.) and 2.)

- Two-region open economy OLG model with endogenous
  - Consumption/saving decision
  - Labor supply
  - Human capital accumulation
Household Setup

- Agents start making decisions at age 16, retire at age 65 (benchmark) and live at most until age 90

- They choose each period
  - Consumption/saving
  - Labor supply
  - Time investment into human capital

- ... and like consumption and leisure

- Receive labor income or pensions
  - Linear contribution rate $\tau$ to social security
  - Pensions are a fraction $\rho$ of current net wages

Formal Representation
Aggregate production with physical capital and effective labor

Effective labor \( L_t = \sum_{j=0}^{r-1} l_{t,j} N_{t,j} h_{t,j} \)

Factors earn marginal products

Regional labor markets, international capital markets, exogenous technical progress

Balanced budget PAYGO social security with two scenarios

1. Benchmark Retirement: replacement rate \( \rho \) or contribution rate \( \tau \) fixed
2. Pension Reform: increase retirement age given \( \tau/\rho \) – regime
Increasing the Retirement Age

- Simple rule: for additional 1.5 years of life expectancy at age 65 retirement increases by one year
- Retirement age of 71 years

Calibration

- Demographics: United Nations
  - “Old”: basically OECD
  - “Young”: rest of the world
- Targets: $K/Y$, avg. labor supply, $I/Y$, region-specific wage profiles, and region-specific growth of GDP/Capita
Thought Experiment & Results

- Thought experiment
  - Exogenous demographics induces economic transition
  - Two human capital specifications
    - Exogenous human capital
    - Endogenous human capital
    ⇒ during calibration identical, then diverging

- Results
  - Macroeconomic variables
    - Rate of return
    - Detrended GDP per capita
  - Welfare of households alive in 2010
  - Effects of pension reform
  - Focus on
    - Endogenous vs. exogenous human capital
    - Results for “old” countries, open economy
Figure: Rate of Return

Constant Replacement Rate

Constant Contribution Rate

Open vs. Closed
Benchmark Retirement Age: Detrended GDP per Capita

Figure: Detrended GDP per Capita

Constant Replacement Rate

Constant Contribution Rate

Open vs. Closed

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Pension Reform and Human Capital
Figure: Detrended GDP per Capita

- Constant Replacement Rate
- Constant Contribution Rate

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Effects of increasing retirement age on GDP/Capita

- Exogenous human capital
  1. “Mechanical” effect ⇒ more working people
  2. Higher labor supply if $\tau \downarrow$

- Endogenous human capital
  1. “Mechanical” effect ⇒ more working people
  2. Higher investment into human capital
  3. Higher labor supply (to make use of 2.)
  4. Higher labor supply and human capital if $\tau \downarrow$
     ⇒ effects are not additive
Figure: Detrended GDP per Capita

constant replacement rate

constant contribution rate

Endogenous, BM
Exogenous, BM
Endogenous, PR
Exogenous, PR
Welfare Evaluation – Concept

- Define a base year (here 2010)
- Compute (remaining) lifetime utility $V_{GE}$ given GE prices
- “Freeze” prices/transfers from base year and recompute $V_{2010}$
- Welfare difference expressed as Consumption Equivalent Variation (CEV)
- Positive numbers are welfare gains from GE effects
Welfare Effects of Reform: Agents alive in 2010

Figure: Welfare: Agents alive in 2010

Consumption Equivalent Variation – Cohorts alive in 2010

Constant Replacement Rate

Constant Contribution Rate

Open vs. Closed

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Pension Reform and Human Capital
### Table: Maximum Welfare Losses - Agents alive 2010

<table>
<thead>
<tr>
<th>Pension System</th>
<th>Open Economy</th>
<th>Constant $\rho$</th>
<th>Constant $\tau$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Benchmark</strong></td>
<td>-3.0%</td>
<td>-3.6%</td>
<td>-4.4%</td>
</tr>
<tr>
<td><strong>Pension Reform</strong></td>
<td>-1.9%</td>
<td>-3.0%</td>
<td>-3.6%</td>
</tr>
<tr>
<td><strong>Difference</strong></td>
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<td>Difference</td>
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<td></td>
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<td></td>
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Conclusions & Policy Implications

- Investment into human capital substantially dampens
  - effects of aging on factor prices
  - welfare losses

PI: Important to keep this adjustment channel flexible

- A generous pension system is more redistributive but lowers welfare of future generations
- Higher retirement age can substantially increase welfare, especially when distortions are already high

PI: Small distortions are magnified: human capital is “multiplier”
  ⇒ effects are not additive

PI: Inequality best decreased by increasing retirement age

Warning: we assumed a frictionless world ⇒ results are only upper/lower bounds of “true” effects
Table: Model Parameters

<table>
<thead>
<tr>
<th></th>
<th>“Young”</th>
<th>“Old”</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preferences</td>
<td></td>
<td></td>
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<tr>
<td>$\sigma$</td>
<td>Inverse of Inter-Temporal Elasticity of Subst.</td>
<td>2.00</td>
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<tr>
<td>$\beta$</td>
<td>Pure Time Discount Factor</td>
<td>0.985</td>
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<tr>
<td>$\phi$</td>
<td>Weight of Consumption</td>
<td>0.370</td>
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<tr>
<td>Human Capital</td>
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<tr>
<td>$\xi$</td>
<td>Scaling Factor</td>
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<tr>
<td>$\psi$</td>
<td>Curvature Parameter</td>
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<tr>
<td>$\delta^h$</td>
<td>Depreciation Rate of Human Capital</td>
<td>1.4%</td>
</tr>
<tr>
<td>$h_0$</td>
<td>Initial Human Capital Endowment</td>
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<tr>
<td>Production</td>
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<tr>
<td>$\alpha$</td>
<td>Share of Physical Capital in Production</td>
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<tr>
<td>$\delta$</td>
<td>Depreciation Rate of Physical Capital</td>
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<td>$g^A$</td>
<td>Exogenous Growth Rate</td>
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<td>Calibration Period</td>
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<td>1.5%</td>
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<td>Final Steady State</td>
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<td>1.9%</td>
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</tbody>
</table>

Notes: “Young” and “Old” refer to the region. Only one value in a column indicates that the parameter is identical for both regions.
Figure: U.S. Life Expectancy at Age 65

Sources: Human Mortality Database (2011).
**Figure:** Constant vs. Variable Prices

Welfare Evaluation – Graph

Rate of Return in %

General Equilibrium
Constant Prices

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Pension Reform and Human Capital
Figure: Net Foreign Assets

Constant Replacement Rate

Constant Contribution Rate
Figure: Net Foreign Assets

Constant Replacement Rate

Constant Contribution Rate
Benchmark Retirement: Comparison GDP/GNP per Capita

**Figure:** Comparison GDP/GNP per Capita

Constant Replacement Rate

Constant Contribution Rate

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Pension Reform and Human Capital
• Compute equilibrium transition path for closed economies
• We then “surprise” agents by opening up the economy in 1975
• Compute the transition to the open economy steady-state
• Agents alive in 1975 re-optimize for their remaining lifetime, newborns use prices and transfers from open economy
Figure: Rate of Return

Constant Replacement Rate

Constant Contribution Rate
Household Setup – Formal Representation

Formally, agents maximize

\[
\max \sum_{j=0}^{J} \beta^j \pi_j \frac{1}{1-\sigma} \{ c_j^\phi (1 - \ell_j - e_j)^{1-\phi} \}^{1-\sigma}
\]

subject to

\[
a_{j+1} = \begin{cases} 
   (a_j + tr_t)(1 + r_t) + w^n_{t,j} - c_j & \text{if } j < jr \\
   (a_j + tr_t)(1 + r_t) + p_t - c_j & \text{if } j \geq jr 
\end{cases}
\]

\[
w^n_{t,j} = \ell_j h_j w_t (1 - \tau_t)
\]

human capital formation using Ben-Porath (1967) technology

\[
h_{j+1} = h_j (1 - \delta^h) + \xi (h_j e_j)^\psi
\]
Figure: Detrended GDP per Capita

Constant Replacement Rate

Constant Contribution Rate

Net Foreign Assets

Comparison GDP/GNP
Figure: Welfare: Agents alive in 2010

Consumption Equivalent Variation – Cohorts alive in 2010

Constant Replacement Rate

Constant Contribution Rate
Retirement Age & Wage Profiles

**Statutory Retirement Age**
- Benchmark (Constant Retirement)
- Pension Reform (Rising Retirement Age)

**Productivity Profiles**
- Old Countries
- Young Countries
- Observed US-Profile

**Life Cycle Productivity**

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Pension Reform and Human Capital
**Figure: Rate of Return**

- **Constant Replacement Rate**
- **Constant Contribution Rate**

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Pension Reform and Human Capital
Figure: Working Age Population Ratio

Sources: United Nations (2007) and own computations.
“Old” includes USA, Canada, Japan, Australia, New Zealand, Switzerland, Norway and the EU15
“Young” all other countries