Demographic Patterns and Household Saving in China

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Household Saving Rate, 1955-2009
Household Saving Rate, 1955-2009

- Low saving rate
- Trend Break
- High Saving Rate
Declining Fertility Rates
Declining Fertility Rates

Later, Longer, Fewer

Young Society

United States

China

One Child Policy

Older Society
Research Issue

We think the changing age distribution explains a big part of the increase in China’s household saving rate

We investigate this idea
Methodology

- Overlapping Generations (OLG) model with saving and intergenerational transfers
  1. Care for children (family size)
  2. Workers save for retirement (composition effect)
  3. Transfers to elderly (pension)

- Parameterize to Chinese economy

- Examine how well model matches data
Related Literature

- **OLG and Saving**
  - Chen, Imrohoroglu, Imrohoroglu 2006  AER
  - Krueger and Ludwig 2007  JME

- **China and Saving**
  - Wei and Zhang 2011  JPE
  - Banerjee, Meng, Qian
  - Chamon, Liu, Prasad
  - Song and Yang
Why Study China?

- It’s important.
  - Largest population, Second largest economy
- Huge Saving
  - Funds (in part) massive investment
  - Funds (in part) US current account deficit
## Rise in the World Economy

### Share of Output (rows sum to 1)

<table>
<thead>
<tr>
<th>Year</th>
<th>USA</th>
<th>Japan</th>
<th>Germany</th>
<th>China</th>
</tr>
</thead>
<tbody>
<tr>
<td>1978</td>
<td>0.57</td>
<td>0.22</td>
<td>0.16</td>
<td>0.05</td>
</tr>
<tr>
<td>1984</td>
<td>0.55</td>
<td>0.22</td>
<td>0.15</td>
<td>0.08</td>
</tr>
<tr>
<td>1990</td>
<td>0.53</td>
<td>0.23</td>
<td>0.14</td>
<td>0.10</td>
</tr>
<tr>
<td>1995</td>
<td>0.51</td>
<td>0.21</td>
<td>0.13</td>
<td>0.15</td>
</tr>
<tr>
<td>2001</td>
<td>0.51</td>
<td>0.18</td>
<td>0.12</td>
<td>0.18</td>
</tr>
<tr>
<td>2005</td>
<td>0.49</td>
<td>0.16</td>
<td>0.10</td>
<td>0.24</td>
</tr>
<tr>
<td>2008</td>
<td>0.46</td>
<td>0.15</td>
<td>0.10</td>
<td>0.29</td>
</tr>
<tr>
<td>2009</td>
<td>0.44</td>
<td>0.14</td>
<td>0.09</td>
<td>0.32</td>
</tr>
</tbody>
</table>

Source: PWT 7.0
### Investment as Share of GDP

<table>
<thead>
<tr>
<th>Year</th>
<th>USA</th>
<th>Japan</th>
<th>Germany</th>
<th>China</th>
</tr>
</thead>
<tbody>
<tr>
<td>1985</td>
<td>20.8</td>
<td>29.1</td>
<td>24.4</td>
<td>39.2</td>
</tr>
<tr>
<td>1990</td>
<td>19.8</td>
<td>30.5</td>
<td>24.2</td>
<td>37.3</td>
</tr>
<tr>
<td>1995</td>
<td>17.8</td>
<td>29.8</td>
<td>22.8</td>
<td>40.4</td>
</tr>
<tr>
<td>2000</td>
<td>20.1</td>
<td>26.8</td>
<td>21.4</td>
<td>37.4</td>
</tr>
<tr>
<td>2005</td>
<td>19.3</td>
<td>23.5</td>
<td>17.6</td>
<td>40.1</td>
</tr>
<tr>
<td>2010</td>
<td>17.8</td>
<td>22.3</td>
<td>17.7</td>
<td>45.2</td>
</tr>
</tbody>
</table>
## Composition of Gross National Saving

<table>
<thead>
<tr>
<th>Year</th>
<th>Gross Saving as share of GDP</th>
<th>Share of National Saving</th>
<th>Household Saving Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1995</td>
<td>38</td>
<td>7  42  51</td>
<td>17</td>
</tr>
<tr>
<td>2000</td>
<td>37</td>
<td>9  44  49</td>
<td>23</td>
</tr>
<tr>
<td>2002</td>
<td>40</td>
<td>13 45  43</td>
<td>23</td>
</tr>
<tr>
<td>2004</td>
<td>47</td>
<td>10 50  40</td>
<td>24</td>
</tr>
<tr>
<td>2006</td>
<td>50</td>
<td>18 38  44</td>
<td>25</td>
</tr>
<tr>
<td>2008</td>
<td>53</td>
<td>21 35  44</td>
<td>27</td>
</tr>
</tbody>
</table>

Source: Ma and Yang (2009)
Demographic Change

The graph shows the demographic change from 1950 to 2050. The yellow area represents individuals aged 0-19, the red area represents individuals aged 20-63, and the combined area represents individuals aged 64+. The data indicates a decrease in the proportion of younger populations over time, with an increase in the proportion of older populations.
Demographic Change

- Ages 0–19: Children
- Ages 20–63: Parents plus empty nesters
- Ages 64+: Retirees
Saving Rate and Ratio of Parents to Children

- Household Saving Rate (left axis)
- Ratio of Parents to Children (right axis)
- Inverse of family size
Some Micro Data Evidence

- In micro-level survey data, household saving is negatively correlated with number of children (next slide)
- Banerjee et al. (2010) report an even more negative relationship
- Gruber (2012) also reports a negative correlation
# Micro Evidence

Data: 2007 Urban Household Survey

## Table 1: The Effect of the Number of Children on the Household’s Saving Rate, 2007

<table>
<thead>
<tr>
<th>Explanatory Variable</th>
<th>Dependent Variable: Saving Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
</tr>
<tr>
<td>Number of Children</td>
<td>-0.052</td>
</tr>
<tr>
<td></td>
<td>(0.015**)</td>
</tr>
<tr>
<td>log Income</td>
<td>0.241</td>
</tr>
<tr>
<td></td>
<td>(0.011**)</td>
</tr>
</tbody>
</table>

### Sample Restrictions

<table>
<thead>
<tr>
<th>Age of Children</th>
<th>None</th>
<th>Omit HH with Children Age &gt; 19</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observations</td>
<td>3234</td>
<td>2200</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.142</td>
<td>0.127</td>
</tr>
</tbody>
</table>

Notes: Saving rate is defined as (Income - Consumption)/Consumption. The data is restricted to nuclear families. The regressions include controls for the head of household’s age, age squared, and education level. Standard errors are reported in parentheses. Stars denote significance at the * 5 percent and ** 1 percent level.
Wage Growth
Wage Growth

![Graph showing wage growth over time with labeled trends 1 to 4.]
Impressions drawn from casual look at data

➢ Household Saving Rate high if
  1. Families are small (relaxes budget constraint)
  2. Proportion of working age is high (composition effect)
  3. Proportion of future work force is low (fewer children to support in old age)
  4. Expected income growth is low

➢ Over the sample, demographics and income growth may work in opposite directions
➢ Sort out offsetting effects with a model
OLG Model Economy

- Perfect foresight consumers live 85 years
- Ages 0-19
  - Draw on family resources, contribute nothing
- Ages 20 - 49
  - Support Children – Barro and Becker (ECA 1989)
  - Support parents
  - Supply labor inelastically
  - Save for Retirement
- Ages 50 - 63
  - No Children to support, continue to work and save
- Ages 64 - Death
  - Retired: consume transfers and accumulated assets
OLG Model

At time $t$, let

$N_t^c = $ youth population (age 0-19)

$N_t^p = $ parents population (age 20-49)

$N_t^w = $ working population (age 20-63)

$N_t^r = $ retired population (age 64-85)

Households take demographics, interest rates, wages, and taxes as exogenously given
Budget Constraints \((j\ \text{indexes age})\)

- **Parents** (20-49)
  \[
  \frac{N_t^c}{N_t^p} c_{t,j}^c + c_{t,j} + a_{t+1,j+1} = \left(1 - \tau\right) w_t + \left(1 + r_t\right) a_{t,j}
  \]

- **Empty Nesters** (50-63)
  \[
  c_{t,j} + a_{t+1,j+1} = \left(1 - \tau\right) w_t + \left(1 + r_t\right) a_{t,j}
  \]

- **Retirement** (64-85)
  \[
  c_{t,j} + a_{t+1,j+1} = \left(1 + r_t\right) a_{t,j} + P_t
  \]
  Where
  \[
P_t = \frac{N_t^w}{N_t^r} \tau w_t
  \]
Utility Function at Age 20

\[ U_t = \sum_{j=0}^{29} \beta^j \frac{c_{t+j,j}^{1-\sigma} + \mu \left( \frac{N_{t+j}^c}{N_{t+j}^p} \right)^{\eta} \left( c_{t+j,j}^c \right)^{-\sigma}}{1-\sigma} \]

utility in parenting years

\[ + \sum_{j=30}^{65} \beta^j \frac{c_{t+j,j}^{1-\sigma}}{1-\sigma} \]

utility – no kids to support
Modified Discount Rate

- Rewrite Utility function (C is total consumption)

\[ U_t = \sum_{j=0}^{65} \hat{\beta}_{t+j,j} \frac{C_{t+j,j}^{1-\sigma}}{1-\sigma} \]

- The modified discount rate

\[ \hat{\beta}_{t+j,j} = \beta^j \left[ 1 + \mu^{1/\sigma} \left( \frac{N_{t+j}^c}{N_{t+j}^p} \right)^{\frac{\sigma+\eta-1}{\sigma}} \right]^\sigma \]
Representative Firm & National Bank

- Cobb-Douglas production function

\[ Y_t = A_t K_t^\alpha N_t^{1-\alpha} \]

- National bank buys international bonds to clear the capital market

\[ F_t = \sum_{s=0}^{65} \left( N_{t,s} a_{t,s} \right) - K_t \]

\[ \underbrace{\text{Deposits}}_{\text{Loans}} \]
Solution & Prices

- Factor prices set to marginal products observed in the data

\[ w_t = (1 - \alpha) \frac{Y_t}{N_t^w} \quad \quad r_t = \alpha \frac{Y_t}{K_t} - \delta \]
Solution & Prices

➢ To solve the model
  – Firm maximizes profits
  – Consumers maximize utility
    • Labor supply inelastic
    • Family size given
  – 65 generations of decision makers, 85 generations of people present each period.
  – Partial Equilibrium
Quantitative Exercise

- Perfect foresight households take wages, interest rates, and demographics as exogenously given.
  - Maximize lifetime utility subject to budget constraints.
  - Obtain optimal saving decision rules

- Present model households with the data and observe implied saving rates. Compare with the household saving rate data

- Perform counterfactuals, turn on and off features of model to understand contributions of various pieces of model
# Parameters

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\beta$</td>
<td>Discount factor</td>
<td>0.97</td>
</tr>
<tr>
<td>$\mu$</td>
<td>Weight on children</td>
<td>0.65</td>
</tr>
<tr>
<td>$\eta$</td>
<td>Concavity for children</td>
<td>0.76</td>
</tr>
<tr>
<td>$\tau$</td>
<td>Transfer share</td>
<td>0.05</td>
</tr>
<tr>
<td>$\sigma$</td>
<td>Coefficient of relative risk aversion</td>
<td>1.50</td>
</tr>
<tr>
<td>$\delta$</td>
<td>Depreciation rate of capital</td>
<td>0.10</td>
</tr>
<tr>
<td>1-$\alpha$</td>
<td>Labor’s share of output</td>
<td>0.60 – 0.40</td>
</tr>
</tbody>
</table>
Main Result: Household Saving Rate
Turn on and off various features of model
Demographic Changes Only
(r, w constant)
Pure Composition Effect is Small

- Decompose 2009 Saving Rate (model)
  \[ SR_{2009} = \sum_{s=0}^{65} N_{2009,j} \left( \varphi_{2009,j} \right) sr_{2009,j} \]
  \[ SR^{*}_{2009} = \sum_{s=0}^{65} N_{1970,j} \left( \varphi_{1970,j} \right) sr_{2009,j} \]

- Hold saving by age group constant at 2009 values, then calculate ‘counterfactual’ SR

- Composition effect accounts for only 4 percentage points of increase, from 1970 to 2009
No Children in Utility

($mu = 0$)
Variation in Family Size

(hold # dependents constant)
Constant Support Ratio
(9 workers per retiree)
Variations in Old-Age Support
(tau = 0, tau = 0.10)
Constant Replacement Rate
(tau varies over time)
Variation in Wage Growth
(1/2 and 1/4 observed)
Saving Rate by Age

- Benchmark
- Support Children From Ages 20–63
Static Expectations
Final Remarks

- Possible to write down a model of Chinese households and get them to save a large fraction of income.

- Using deterministic model, standard life-cycle considerations go a long way in explaining the evolution of household saving.

- Family size, age distribution matter a great deal.
Model Properties: GDP
## Demographic Change

### Table 2: Total Fertility Rates

<table>
<thead>
<tr>
<th>Year</th>
<th>China</th>
<th>USA</th>
<th>Japan</th>
</tr>
</thead>
<tbody>
<tr>
<td>1950-54</td>
<td>6.1</td>
<td>3.4</td>
<td>3.0</td>
</tr>
<tr>
<td>1955-59</td>
<td>5.5</td>
<td>3.7</td>
<td>2.2</td>
</tr>
<tr>
<td>1960-64</td>
<td>5.6</td>
<td>3.3</td>
<td>2.0</td>
</tr>
<tr>
<td>1965-69</td>
<td>5.9</td>
<td>2.5</td>
<td>2.0</td>
</tr>
<tr>
<td>1970-74</td>
<td>4.8</td>
<td>1.8</td>
<td>2.1</td>
</tr>
<tr>
<td>1975-79</td>
<td>2.9</td>
<td>1.8</td>
<td>1.8</td>
</tr>
<tr>
<td>1980-84</td>
<td>2.6</td>
<td>1.8</td>
<td>1.8</td>
</tr>
<tr>
<td>1985-89</td>
<td>2.0</td>
<td>1.9</td>
<td>1.7</td>
</tr>
<tr>
<td>1990-94</td>
<td>1.8</td>
<td>2.0</td>
<td>1.5</td>
</tr>
<tr>
<td>1995-99</td>
<td>1.8</td>
<td>2.0</td>
<td>1.4</td>
</tr>
<tr>
<td>2000-04</td>
<td>1.8</td>
<td>2.0</td>
<td>1.3</td>
</tr>
<tr>
<td>2005-09</td>
<td>1.8</td>
<td>2.1</td>
<td>1.3</td>
</tr>
</tbody>
</table>
Demographic Change

- With a rise in life expectancy, difficult to support elderly when there are two generations affected by 1-child policy
- The 4-2-1 problem

**Paternal**
1. Grandfather
2. Grandmother

**Maternal**
3. Grandfather
4. Grandmother

1. Father
2. Mother

1. Child
Utility Function with Bequests

\[ U_t = \sum_{j=0}^{39} \beta^j \mu \left( \theta_j \frac{N_{t+j}^y}{N_{t+j}^w} \right)^{\eta} \left( c_{t,j}^y \right)^{-\sigma} + c_{t,j}^{1-\sigma} \]

utility in working years

\[ \sum_{j=40}^{64} \beta^j \gamma_{t,j} c_{t,j}^{1-\sigma} + \left( 1 - \gamma_{t,j} \right) \mu \left( \frac{N_{t+j}^w}{N_{t+j}^r} \right)^{\eta} \left( \frac{N_{t+j}^r}{a_{t,j}} \right)^{1-\sigma} + c_{t,j}^{1-\sigma} \]

utility in retirement
Transfers and Bequests

- Pay-as-you-Go Social Security pension

\[ P_t = \frac{N_t^w}{N_t^r} \tau_t w_t \]

- In last year of life, agents leave remaining assets to current workers (their children)

\[ B_t = \frac{1}{N_t^w} N_t^{67} (1 + r_t) a_{t,67} \]
No Bequests Motive