Dynastic Precautionary Savings

Corina Boar
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Facing Demographic Change in a Challenging Economic Environment
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Motivation

- Consumption of retired parents is backloaded
- Backloading postdates the resolution of own income risk

![Graph showing consumption of retired parents and backloading over age](image-url)
Motivation

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- Backloading postdates the resolution of own income risk

Possible reasons:

- Health expenditure risk
- Transfers from children
Motivation

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- Backloading postdates the resolution of own income risk

Possible reasons:
- Health expenditure risk
- Transfers from children

This paper:
- Resolution of children’s income risk

\[dynastic\ \textit{precautionary savings}\]
Contributions of this paper

1. Provide empirical evidence for dynastic precautionary behavior
   - Examine the response of parent’s consumption to child’s income risk
   - Exploit variation in permanent income risk across age and sectors
   - Analyze robustness to endogeneity concerns

2. Build a model of dynastic precautionary saving
   - Parent and child save separately: non-cooperative + no commitment
     - Can identify wealth position of overlapping generations + size and timing of intergenerational transfers
     - Strategic interactions between parent and child
     - Contrast with unitary household model (no strategic interactions)
   - Counterfactual
     - Contribution to parental wealth and intergenerational transfers
Empirical

- Parent’s consumption decreases with child’s permanent income risk
  - Response is nearly as large as to own income risk

- Permanent income risk is decreasing over age, with variation across sectors (both in levels and slopes)
  - Parents of children younger than 40 consume $2,945 less per year because uncertainty is yet to be resolved (conditional on controls)
  - Parents of children in finance sector consume 3% less than parents of government employees because of higher uncertainty (conditional on controls)
Quantitative

- Model with strategic interactions predicts dynastic precautionary behavior closer to data than model without strategic interactions
  - *No strategic interactions*: dynastic precautionary motive is more important than precautionary motive
  - *Strategic interactions*: relative importance of precautionary motives is flipped because of overconsumption by children

- Counterfactual
  - Dynastic precautionary wealth is $\approx \frac{1}{4}$ of aggregate wealth
  - Intergenerational transfers are mostly driven by dynastic uncertainty
Related literature

Consumption-saving over the life-cycle, especially at older age


Precautionary savings


Family as insurance

Outline

1 Empirical analysis
   - Data description
   - Income uncertainty
   - Test for dynastic precautionary savings
   - Robustness analysis

2 Model
   - Environment and parameter values
   - Comparison between models
   - Counterfactual

3 Conclusion
Empirical evidence
Empirical test

- Pure life-cycle models (including warm-glow altruism) imply:
  \[ c_p = F_p (Y_p, \sigma_p; X_p) \quad \text{and} \quad c_c = F_c (Y_c, \sigma_c; X_c) \]

- Models with altruism à la Barro (1974) imply:
  \[ c_p = \bar{F}_p (Y_p, \sigma_p, Y_c, \sigma_c; X_p, X_c) \quad \text{and} \quad c_c = \bar{F}_c (Y_c, \sigma_c, Y_p, \sigma_p; X_p, X_c) \]

Test by regressing:

- \( c_p \) on parent’s income uncertainty and child’s income uncertainty
- \( c_c \) on parent’s income uncertainty and child’s income uncertainty
Data

- **Parent-child pairs**
  - PSID Family Identification Mapping System
  - Parent with $n$ children $\Rightarrow n$ parent-child pairs

- **Income uncertainty**
  - PSID 1968-2013
  - Stratify by age and sector ($N$ occupations $\times$ $M$ industries)

- **Consumption**
  - Later years (2005-2013): consumption directly from PSID
  - Early waves (1981-2003): use CEX to impute consumption based on an inverted food demand equation (Blundell et al., 2008)
Income uncertainty about future income stream (permanent income)

\[ Y_h^i \equiv \sum_{j=h+1}^{H} \frac{y_j^i}{R^{j-h}} \]

Treat uncertainty as the standard deviation of forecast error of \( Y_h^i \)

Predicted permanent income as of age \( h \) is

\[ \hat{Y}_h^i \equiv \sum_{j=h+1}^{H} \frac{\hat{y}_{j,h}^i}{R^{j-h}} \]
How are earnings predicted?

\[ y_j^i = \theta_0 + X_h^i \theta_1 + \theta_3 t_j + e_{j,h}^{i,h} \]

\( X_h^i \): current and lagged income, age polynomial, dummies for current educational attainment, marital status, race and family size

\( t_j \): time trend
How are earnings predicted?

\[ y_j^i = \theta_0 + X_{h}^i\theta_1 + \theta_3 t_j + e_{j,h}^i \]

\(X_h^i\): current and lagged income, age polynomial, dummies for current educational attainment, marital status, race and family size

\(t_j\): time trend

\(e_{j,h}\): forecast error of age \(j > h\) income
Income uncertainty

- The forecast error of permanent income is

\[ \mathcal{E}_h^i \equiv \sum_{j=h+1}^{H} \frac{e_{j,h}^i}{R_j-h} \]

where \( e_{j,h}^i = y_j - \hat{y}_{j,h}^i \).

- Permanent income uncertainty

\[ \text{Std}_i (\mathcal{E}_h^i) = \text{Std}_i \left( \sum_{j=h+1}^{H} \frac{e_{j,h}^i}{R_j-h} \right) \]
Income uncertainty

- The forecast error of permanent income is
  \[ \mathcal{E}_h^i \equiv \sum_{j=h+1}^{H} \frac{e_{j,h}^i}{R^{j-h}} \]
  where \( e_{j,h}^i = y_j - \hat{y}_{j,h}^i \).

- Permanent income uncertainty
  \[ \text{Std}_i (\mathcal{E}_h^i) = \text{Std}_i \left( \sum_{j=h+1}^{H} \frac{e_{j,h}^i}{R^{j-h}} \right) \]

- Stratify individuals by sector \( s \):
  \[ \text{Std}_s (\mathcal{E}_h^i) = \left( \sum_{j=h+1}^{H} \frac{\text{Var}_s(e_{j,h}^i)}{R^{2(j-h)}} + 2 \sum_{j=h+1}^{H-1} \frac{1}{R^{j-h}} \sum_{k=j+1}^{H} \frac{\text{Cov}_s(e_{j,h}^i; e_{k,h}^i)}{R^{k-h}} \right)^{\frac{1}{2}} \]
Figure: Age Profile of Income Uncertainty (Relative to Permanent Income)
Figure: Age Profile of Income Uncertainty (Relative to Permanent Income)
Empirical specification

\[
\ln c_p = \beta_0^p + \beta_1^p \sigma_p + \beta_2^p \sigma_c + X_p \beta_3^p + X_c \beta_4^p + \epsilon_p
\]

\[
\ln c_c = \beta_0^c + \beta_1^c \sigma_p + \beta_2^c \sigma_c + X_p \beta_3^c + X_c \beta_4^c + \epsilon_c
\]

\(c_p, c_c\): consumption of parent and child

\(\sigma_p\): parent’s permanent income uncertainty

\(\sigma_c\): child’s permanent income uncertainty

\(X_p, X_c\): full set of age dummies; dummies for marital status, race, gender, educational attainment, family size; permanent income, wealth holdings
### Results

**Table: Regression of Consumption (non-durables and services) on Income Risk**

<table>
<thead>
<tr>
<th></th>
<th>Parent’s consumption</th>
<th>Child’s consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parent’s uncertainty</td>
<td>-0.089** (0.033)</td>
<td>-0.039 (0.025)</td>
</tr>
<tr>
<td>Child’s uncertainty</td>
<td>-0.081* (0.034)</td>
<td>-0.163** (0.038)</td>
</tr>
</tbody>
</table>

Note: Bootstrapped robust std errors clustered at parent level in parentheses; * $p < 5\%$; ** $p < 1\%$

- Parents of children younger than 40 consume, on average, $2,945 less per year because most of dynastic uncertainty is to be resolved.
- Parents of construction workers consume, on average, 2.5% less than parents of services workers because of the uncertainty differential.

[Full table]
Robustness analysis

- **Endogeneity concerns**
  1. Health risk: include health controls
  2. Selection into risky sectors:
     - prob. of moving to high risk sector is not lower if parent looses job
     - control for initial sector

- Also robust to
  1. Heterogeneous bequest motives
  2. Information set used to predict income
  3. Time and geography dummies
Model
Can we write a model that predicts dynastic precautionary saving behavior consistent with the data?

- Model with strategic interactions between parents and children
- Contrast with unitary household model (no strategic interactions)

What are the implications of dynastic precautionary saving for:

- inter-vivos transfers and bequest
- parental wealth?
Life-cycle of an individual

- Work in sector $s$ until retirement and earn risky labor income: $y_p, y_c$
- No income risk after retirement: $\Phi(\hat{y}_p)$
- Pay proportional tax $\tau$ on labor income
- Hold government bond with gross return $R$: $a_p, a_c$
Overlapping generations

Parent-child pairs indexed by age: \((h_p, h_c)\)

Intergenerational altruism: parent places weight \(\gamma\) on child’s utility → makes inter-vivos transfers \(g_p\) and end-of-life bequest

Parent and child overlap for 29 years
Each year they overlap, parent and child play a 2-stage game

1. Stage 1. Parent chooses consumption $c_p$, wealth $a'_p$ and transfers $g_p$
   State variable: $\tilde{s}_p = (a_p, a_c, y_p, y_c, s_p, s_c)$

2. Stage 2. Child decides consumption $c_c$ and wealth $a'_c$
   State variable: $\tilde{s}_c = (a_c, y_c, y_p, g_p, a'_p, s_p, s_c)$

Equilibrium concept is MPE

Solve backwards

Can identify wealth position of overlapping generations, as well as size and timing of intergenerational transfers
Setup

While alive, parent makes all consumption-saving decisions

Family budget constraint: $c_p + c_c + a' = (1 - \tau) (y_p + y_c) + Ra$

Wealth position of parent and child cannot be separately identified

Size and timing of intergenerational transfers is indeterminate
Two sectors: low risk and high risk

→ group the 17 empirical sectors based on whether risk is below/above average

Exogenous transition between sectors (including intergenerational)

\[ P_s = \begin{bmatrix} 0.921 & 0.079 \\ 0.113 & 0.887 \end{bmatrix} \quad \text{and} \quad P_{ig} = \begin{bmatrix} 0.647 & 0.353 \\ 0.493 & 0.507 \end{bmatrix} \]

Income process

\[
\ln y_{hs}^i = f(h) + \tilde{y}_{hs}^i \quad \text{and} \quad \tilde{y}_{hs}^i = \rho_s \tilde{y}_{h-1,s}^i + \epsilon_{hs}, \epsilon_{hs} \sim (0, \sigma_{hs}^2)
\]
Panel A: Income uncertainty

Data

Model fit

Panel B: Variance of the income process

Low risk sector, $\rho = 0.91$

High risk sector, $\rho = 0.95$
### Parameter values

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Justification/Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>$a, b$</td>
<td>0.168, 0.355</td>
<td>$\Phi(\hat{y}) = a\bar{y} + b\hat{y}$, Guvenen et al. (2013)</td>
</tr>
<tr>
<td>$\sigma$</td>
<td>2</td>
<td>Standard</td>
</tr>
<tr>
<td>$\beta$</td>
<td>0.959/0.958</td>
<td>Wealth to income ratio</td>
</tr>
<tr>
<td>$\gamma$</td>
<td>0.201/0.71</td>
<td>Parent-child consumption ratio</td>
</tr>
<tr>
<td>$\tau$</td>
<td>0.246</td>
<td>US average tax rate (OECD Tax Database)</td>
</tr>
<tr>
<td>$R$</td>
<td>1.04</td>
<td>Initial steady-state, $G$ set accordingly</td>
</tr>
<tr>
<td>$A_h$</td>
<td>0</td>
<td>Sensitivity analysis to negative borrowing limit</td>
</tr>
</tbody>
</table>

**Table:** Parameter Values
### Table: Regression of Consumption on Income Risk (Models vs Data)

<table>
<thead>
<tr>
<th></th>
<th>Model without strategic interactions</th>
<th>Model with strategic interactions</th>
<th>Data</th>
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<tbody>
<tr>
<td>Parent’s uncertainty</td>
<td>-0.022**</td>
<td>-0.098**</td>
<td>-0.089**</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>[−0.153 − 0.025]</td>
</tr>
<tr>
<td>Child’s uncertainty</td>
<td>-0.062**</td>
<td>-0.067**</td>
<td>-0.081*</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>[−0.147 − 0.015]</td>
</tr>
</tbody>
</table>
Model predictions: inter-vivos transfers

Panel A: Transfers as fraction of parental wealth

Panel B: Fraction of parents making transfers

Wealth Distribution

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Implementation:

1. Shut down income risk of children (individuals of age 22-50)
   - evaluate effect on intergenerational transfers
   - not suited to evaluate effect on wealth accumulation

2. Two-step approach
   - shut down all income risk $\Rightarrow$ recover precautionary and dynastic precautionary wealth
   - solve life-cycle model with and without risk $\Rightarrow$ recover precautionary wealth
   - difference is dynastic precautionary wealth
Table: The effect of eliminating dynastic uncertainty

<table>
<thead>
<tr>
<th>Aggregate Wealth</th>
<th>Intergenerational Transfers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
</tr>
<tr>
<td>Total effect (%)</td>
<td>-27.37</td>
</tr>
</tbody>
</table>
**Table:** The effect of eliminating dynastic uncertainty

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<td>Total</td>
</tr>
<tr>
<td>Total effect (%)</td>
<td>-27.37</td>
</tr>
</tbody>
</table>

**Caveats:**
- crowding out between wealth components
- missing saving motives relevant at old age
How much consumption insurance via DPS?

- Consumption insurance coefficient in dynastic vs life-cycle model

\[ \phi^e = 1 - \frac{\text{Cov}(\Delta c_{ih}, \epsilon_{ih})}{\text{Var}(\epsilon_{ih})} \]

- Parent’s dynastic precautionary saving accounts for 26% of the total consumption insurance of children

- The benefit is largest for children in high-risk sector
Consumption of retired parents is backloaded

This is largely a reflection of dynastic precautionary saving

Implications:

- Precautionary savings across generations $\Rightarrow$ infinite horizon model
- Design of social insurance policies: guaranteed minimum income, unemployment insurance

Dynastic precautionary savings might help explain other facts

- Retirees deplete wealth slower than the life-cycle model predicts
- There is substantial wealth heterogeneity at retirement, even after controlling for realized lifetime income
ln \( C_{it} = \beta_0 + \beta_{age} f(Age_{it}) + \beta_c Coh_i + \beta_tD_t + \beta_x X_{it} + \epsilon_{it} \)

\( C_{it} \): consumption expenditure

\( f(Age_{it}) \): quartic polynomial in age

\( Coh_i \): 10-year cohort dummies

\( D_t \): year dummies

\( X_{it} \): dummies for race, educational attainment, family size and employment
Age profile of consumption: non-parents

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If measurement error is:

- iid across sectors with variance $\sigma_{0, h}^2$
- uncorrelated with the true forecast error

then measured income uncertainty $\tilde{\text{Var}}_s (\mathcal{E}_h^i)$ is

$$
\tilde{\text{Var}}_s (\mathcal{E}_h^i) = \text{Var}_s (\mathcal{E}_h^i) + \sum_{j=h+1}^{H} \frac{\sigma_{0, h}^2}{R^2(j-h)}
$$

true income risk

measurement error
\[ \text{Std}_{s} (E_{1}^{i}) = \left( \frac{\text{Var}_{s} (e_{2,1}^{i})}{R^2} + \frac{\text{Var}_{s} (e_{3,1}^{i})}{R^4} + 2 \frac{\text{Cov}_{s} (e_{2,1}^{i}; e_{3,1}^{i})}{R \times R^2} \right)^{\frac{1}{2}} \]

where \[ \text{Var}_{s} (e_{3,1}^{i}) = \frac{(e_{3,1}^{A})^2 + (e_{3,1}^{B})^2 + (e_{3,1}^{C})^2}{2} \]
### Sample Attrition - Example

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Period 1</td>
<td>$e^A_{1,1}$</td>
<td>$e^A_{2,1}$</td>
<td>$e^A_{3,1}$</td>
</tr>
<tr>
<td>Period 2</td>
<td>$e^A_{2,2}$</td>
<td>$e^A_{3,2}$</td>
<td>$e^B_{2,2}$</td>
</tr>
<tr>
<td>Period 3</td>
<td>$e^A_{3,3}$</td>
<td>$e^B_{3,3}$</td>
<td>$e^C_{3,3}$</td>
</tr>
</tbody>
</table>

\[
\text{Std}_s \left( E^i_1 \right) = \left( \frac{\text{Var}_s \left( e^i_{2,1} \right)}{R^2} + \frac{\text{Var}_s \left( e^i_{3,1} \right)}{R^4} + 2 \frac{\text{Cov}_s \left( e^i_{2,1}, e^i_{3,1} \right)}{R \times R^2} \right)^{\frac{1}{2}}
\]

where \[
\text{Var}_s \left( e^i_{3,1} \right) = \frac{(e^A_{3,1})^2 + (e^B_{3,1})^2 + (e^C_{3,1})^2}{2}
\]
Figure: Relative Std Dev of the 10-year-ahead Earnings Forecasts
### Estimation results

<table>
<thead>
<tr>
<th></th>
<th>Non-durable consumption</th>
<th>Total consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Parent’s consumption</td>
<td>Child’s consumption</td>
</tr>
<tr>
<td>Parent’s uncertainty</td>
<td>-0.089**</td>
<td>-0.039</td>
</tr>
<tr>
<td></td>
<td>(0.033)</td>
<td>(0.025)</td>
</tr>
<tr>
<td>Child’s uncertainty</td>
<td>-0.081*</td>
<td>-0.163**</td>
</tr>
<tr>
<td></td>
<td>(0.034)</td>
<td>(0.038)</td>
</tr>
<tr>
<td>X_p</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marital status</td>
<td>0.246**</td>
<td>-0.024</td>
</tr>
<tr>
<td></td>
<td>(0.057)</td>
<td>(0.047)</td>
</tr>
<tr>
<td>Race</td>
<td>0.132**</td>
<td>-0.017</td>
</tr>
<tr>
<td></td>
<td>(0.049)</td>
<td>(0.056)</td>
</tr>
<tr>
<td>Educ: some college</td>
<td>0.247**</td>
<td>0.150**</td>
</tr>
<tr>
<td></td>
<td>(0.030)</td>
<td>(0.026)</td>
</tr>
<tr>
<td>Educ: college degree</td>
<td>0.271**</td>
<td>0.066**</td>
</tr>
<tr>
<td></td>
<td>(0.024)</td>
<td>(0.021)</td>
</tr>
<tr>
<td>Permanent income</td>
<td>0.114**</td>
<td>0.063**</td>
</tr>
<tr>
<td></td>
<td>(0.011)</td>
<td>(0.010)</td>
</tr>
<tr>
<td>Asset holdings</td>
<td>0.036**</td>
<td>0.012**</td>
</tr>
<tr>
<td></td>
<td>(0.003)</td>
<td>(0.002)</td>
</tr>
<tr>
<td>X_c</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marital status</td>
<td>-0.053*</td>
<td>0.173**</td>
</tr>
<tr>
<td></td>
<td>(0.023)</td>
<td>(0.028)</td>
</tr>
<tr>
<td>Gender</td>
<td>-0.019</td>
<td>0.288**</td>
</tr>
<tr>
<td></td>
<td>(0.023)</td>
<td>(0.030)</td>
</tr>
<tr>
<td>Educ: some college</td>
<td>0.092**</td>
<td>0.093**</td>
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<tr>
<td></td>
<td>(0.021)</td>
<td>(0.025)</td>
</tr>
<tr>
<td>Educ: college degree</td>
<td>0.164**</td>
<td>0.171**</td>
</tr>
<tr>
<td></td>
<td>(0.023)</td>
<td>(0.022)</td>
</tr>
<tr>
<td>Permanent income</td>
<td>0.014*</td>
<td>0.068**</td>
</tr>
<tr>
<td></td>
<td>(0.006)</td>
<td>(0.006)</td>
</tr>
<tr>
<td>Asset holdings</td>
<td>0.011**</td>
<td>0.049**</td>
</tr>
<tr>
<td></td>
<td>(0.004)</td>
<td>(0.006)</td>
</tr>
<tr>
<td>Constant</td>
<td>10.225**</td>
<td>11.469**</td>
</tr>
<tr>
<td></td>
<td>(0.413)</td>
<td>(0.464)</td>
</tr>
<tr>
<td>R^2</td>
<td>0.288</td>
<td>0.268</td>
</tr>
<tr>
<td>Sample size</td>
<td>8,851</td>
<td>8,330</td>
</tr>
</tbody>
</table>

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Dynastic Precautionary Savings
Table: Regression of Parental Consumption on Income Uncertainty

<table>
<thead>
<tr>
<th></th>
<th>Baseline</th>
<th>Health Controls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parent’s uncertainty</td>
<td>-0.089**</td>
<td>-0.079**</td>
</tr>
<tr>
<td></td>
<td>(0.033)</td>
<td>(0.029)</td>
</tr>
<tr>
<td>Child’s uncertainty</td>
<td>-0.081*</td>
<td>-0.068</td>
</tr>
<tr>
<td></td>
<td>(0.034)</td>
<td>(0.035)</td>
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</tbody>
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Note: Bootstrapped robust std errors clustered at parent level in parentheses; *p < 5%; ** p < 1%
## Table: Regression of Parental Consumption on Income Uncertainty

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<th>Initial Sector</th>
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<td>Parent’s uncertainty</td>
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### Table: Regression of Parental Consumption on Income Uncertainty

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<th>Coefficient on parent’s risk</th>
<th>Coefficient on child’s risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Baseline</td>
<td>-0.089**</td>
<td>-0.081*</td>
</tr>
<tr>
<td></td>
<td>(0.033)</td>
<td>(0.034)</td>
</tr>
<tr>
<td>2. Bequest proxy:</td>
<td>-0.098**</td>
<td>-0.082*</td>
</tr>
<tr>
<td>parent vs non-parent</td>
<td>(0.032)</td>
<td>(0.033)</td>
</tr>
<tr>
<td>3. Bequest proxy:</td>
<td>-0.075</td>
<td>-0.081*</td>
</tr>
<tr>
<td>number of children</td>
<td>(0.040)</td>
<td>(0.034)</td>
</tr>
<tr>
<td>4. How important it is leaving an estate?</td>
<td>-0.089**</td>
<td>-0.083*</td>
</tr>
<tr>
<td></td>
<td>(0.035)</td>
<td>(0.034)</td>
</tr>
</tbody>
</table>

Note: Bootstrapped robust std errors clustered at parent level in parentheses; *p < 5%; **p < 1%
Other robustness tests

**Table: Regression of Parental Consumption on Income Uncertainty**

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Coefficient on parent’s risk</th>
<th>Coefficient on child’s risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Baseline</td>
<td>-0.089**</td>
<td>-0.081*</td>
</tr>
<tr>
<td></td>
<td>(0.033)</td>
<td>(0.033)</td>
</tr>
<tr>
<td>2. Effect on food consumption</td>
<td>-0.041</td>
<td>-0.009</td>
</tr>
<tr>
<td></td>
<td>(0.022)</td>
<td>(0.025)</td>
</tr>
<tr>
<td>3. Consumption in later years</td>
<td>-0.139**</td>
<td>-0.022</td>
</tr>
<tr>
<td></td>
<td>(0.043)</td>
<td>(0.039)</td>
</tr>
<tr>
<td>4. Parents with one child</td>
<td>-0.047</td>
<td>-0.136*</td>
</tr>
<tr>
<td></td>
<td>(0.055)</td>
<td>(0.057)</td>
</tr>
<tr>
<td>5. Income forecast with rich information set</td>
<td>-0.075**</td>
<td>-0.075*</td>
</tr>
<tr>
<td></td>
<td>(0.029)</td>
<td>(0.036)</td>
</tr>
<tr>
<td>6. Time and geography</td>
<td>-0.070*</td>
<td>-0.074*</td>
</tr>
<tr>
<td></td>
<td>(0.031)</td>
<td>(0.033)</td>
</tr>
</tbody>
</table>

Note: Bootstrapped robust std errors clustered at parent level in parentheses; * $p < 5\%$; ** $p < 1\%$
Decision problems: non-terminal parent

Child’s problem:

\[ V_{hc}^c (\tilde{s}_c) = \max_{c, a'_c} \left[ u(c_c) + \beta \mathbb{E} V_{hc+1}^c (\tilde{s}'_c | y, s) \right] \]

s.t. \[ c_c + a'_c = (1 - \tau) y_c + R a_c + g_p; \quad a'_c \geq A_{hc} \]

where \[ \tilde{s}'_c = (a'_c, y'_c, y'_p, g'_p, a''_p, s'_p, s'_c), \quad y = (y_p, y_c), \quad s = (s_p, s_c). \]
Child’s problem:

\[ V_{hc}^c (\tilde{s}_c) = \max_{c_c, a'_c} u(c_c) + \beta \mathbb{E} V_{hc+1}^c (\tilde{s}'_c | y, s) \]

s.t. \( c_c + a'_c = (1 - \tau) y_c + R a_c + g_p; \ a'_c \geq A_{hc} \)

where \( \tilde{s}'_c = (a'_c, y'_c, y'_p, g'_p, a'^*_{p}, s'_p, s'_c) \), \( y = (y_p, y_c) \), \( s = (s_p, s_c) \).

Parent’s problem:

\[ V_{hp}^p (\tilde{s}_p) = \max_{c_p, a'_p, g_p} u(c_p) + \gamma u(c^*_c (\tilde{s}_c)) + \beta \mathbb{E} V_{hp+1}^p (\tilde{s}'_p) \]

s.t. \( c_p + a'_p + g_p = (1 - \tau) y_p + R a_p; \ a'_p \geq A_{hp}, \ g_p \geq 0 \)

where \( \tilde{s}'_p = (a'_p, a'^*_{c} (\tilde{s}_c), y'_p, y'_c, s'_p, s'_c) \).
Decision problems: terminal parent

Child’s problem:

\[ V_{50}^c (\tilde{s}_c) = \max_{c_c, a'_c} u(c_c) + \beta \mathbb{E} V_{51}^p (\tilde{s}'_p | y, s) \]

where \( \tilde{s}'_p = (a'_c + a'_p, 0, y'_p, y'_c, s'_p, s'_c) \).

Parent’s problem:

\[ V_{79}^p (\tilde{s}_p) = \max_{c_p, a'_p, g_p} u(c_p) + \gamma u(c^*_c (\tilde{s}_c)) + \beta \gamma \mathbb{E} V_{51}^p (\tilde{s}'_p | y, s) \]

where \( \tilde{s}'_p = (a'^*_c (\tilde{s}_c) + a'_p, 0, y'_p, y'_c, s'_p, s'_c) \).
Decision problems

Non-terminal parent:

\[ V_{hp}^p (\tilde{s}_p) = \max_{c_p, c_c, a'} u(c_p) + \gamma u(c_c) + \beta \mathbb{E} V_{hp+1}^p (\tilde{s}'|y, s) \]

s.t. \[ c_p + c_c + a' = (1 - \tau) (y_p + y_c) + Ra \]

\[ a' \geq A_{hp} \geq 0 \]

where \( \tilde{s}' = (a', y_p', y_c', s_p', s_c') \).

Terminal parent:

\[ V_{79}^p (\tilde{s}_p) = \max_{c_p, c_c, a'} u(c_p) + \gamma u(c_c) + \beta \gamma \mathbb{E} V_{51}^p (\tilde{s}'|y, s) \]

s.t. \[ c_p + c_c + a' = \Phi (\hat{y}_p) + (1 - \tau) y_c + Ra \]

\[ a' \geq A_{hp} \geq 0 \]

where \( \tilde{s}' = (a', y_p', y_c', s_p', s_c') \).
- Runs balanced budget

\[ G + SS + RB = B' + \tau \bar{Y} \]

- Set \( G \) so that \( R - 1 = 4\% \) in steady state
Wealth and income distribution

Panel A: Wealth distribution

Panel B: Income distribution

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