Insurance in Human Capital Models with Limited Enforcement

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Motivation

- Bankruptcy Code limits pledgeability of future labor income
- Constrains household investments in high-return human capital (education, on the job training, health investment)
- Can also limit insurance against human capital risk (health, death, disability, labor market risk)
Questions

- Is effect of limited enforcement on insurance quantitatively important?
  - Cordoba (2004) and Kruger & Perri (2006) find almost perfect insurance in calibrated macro model with aggregate capital accumulation
  - Krebs, Kuhn & Wright (2015) find significant underinsurance for young and middle aged households in life cycle model with physical and (risky) human capital accumulation

- This paper: what features drive the results of Kuhn, Krebs and Wright (2015)?
  - Present generalized version of their model
  - Illustrate main results using simplified version
What We Find

• Two features necessary to reconcile imperfect consumption insurance with large aggregate savings:
  1. Life cycle borrowing and/or high return human capital investment opportunities necessary to drive households onto borrowing constraints
  2. Rich asset structure allows households to be simultaneously borrowing constrained (in some states) and net savers

• Limited enforcement models with human capital accumulation are a tractable framework for studying imperfect consumption insurance
  • our implementation especially tractable
• Limited enforcement and insurance:

• Limited enforcement and human capital accumulation:
  • Andolfatto & Gervais (2006), Lochner & Monge (2011)

• Exogenously incomplete markets with human capital:
  • Krebs (2003), Guvenen, Kuruscu & Ozkan (2011), Hugget, Ventura & Yaron (2011)
Households

- Continuum of households maximize:

\[
E \left[ \sum_{t=0}^{\infty} \beta^t u \left( c_t \right) \mid s_0 \right]
\]

- \( u \left( c \right) \) isoelastic/CRRA
- expectation over histories \( s^t \) with probability \( \pi \left( s^t \right) \) generated by \( \pi \left( s_{t+1} \mid s_t \right) \).

- Face flow budget constraints

\[
c_t + x_{ht} + \sum_{s_{t+1}} a_{t+1} \left( s_{t+1} \right) q_t \left( s_{t+1} \right) \leq \tilde{r}_{ht} \left( s_t \right) h_t + a_t \left( s_t \right)
\]

human capital accumulation equations

\[
h_{t+1} = \left( 1 + e \left( s_t \right) \right) h_t + \phi x_{ht}
\]

non-negativity constraints and initial conditions \( \left( a_0, h_0 \right) \).
Households II

- Enforcement constraints:
  \[ E \left[ \sum_{n=0}^{\infty} \beta^n u(c_{t+n} | s^t) \right] \geq V_d \left( h_t \left( s^{t-1} \right), s_t \right) \]

- Function \( V_d \) captures the value to defaulting on all financial contracts.

- In this paper:
  - all assets seized: \( a_t(s_t) = 0 \)
  - excluded financial markets for an average of \( 1 / (1 - p) \) periods
  - retain ability to work/supply human capital

- Can accommodate alternative assumptions e.g. proportional garnishment, some financial market access
Firms and Technology

• Representative firm hires physical $K_t$ and human capital $H_t$ to produce using CRS production function yielding

\[ \tilde{r}_{kt} = f' \left( \frac{K_t}{H_t} \right) \equiv f' \left( \tilde{K}_t \right) \]
\[ \tilde{r}_{ht} = f \left( \tilde{K}_t \right) - f' \left( \tilde{K}_t \right) \tilde{K}_t \]

• Aggregate capital accumulation

\[ K_{t+1} = (1 - \delta) K_t + X_{kt}. \]
Equilibrium

- Risk neutral pricing of financial contracts

\[ q_t (s_{t+1}) = \frac{\pi (s_{t+1} \mid s_t)}{1 + r_{ft}} \]

where

\[ r_{ft} = \tilde{r}_{kt} - \delta_k. \]

- Market clearing

\[ K_{t+1} = E \left[ \sum_{s_{t+1}} a_{t+1} (s_{t+1}) q_t (s_{t+1}) \right]. \]
Theoretical Results

- This limited enforcement framework is especially tractable:
  - all policy functions are linear in wealth
  - allows reduction in aggregate state space
- Can deal with a large amount of heterogeneity across households: Krebs, Kuhn and Wright (2015)
Calibration

- Annual with $\beta = 0.95$
- Log utility in benchmark
- Three ages: $s_1 \in \{y, m, o\} = \{[20, 40], [41, 60], [61-80]\}$.
  - $\pi(y|y) = \pi(m|m) = \pi(o|o) = 19/20$
  - $\pi(y|o) > 0$ household dies and is replaced by grandchildren who they care about
- Enforcement: $1 - p = 1/7$
Calibration: Investment Returns

- \( r_f = 3\% \)
- Idiosyncratic human capital shock
  
  \[ \epsilon (s_t) \equiv \epsilon (s_{1t}, s_{2t}) = \varphi (s_{1t}) + \eta (s_{2t}) - \delta_h \]
  
- Mean zero \( \eta (s_2) \) yields expected return to human capital
  
  \[ \bar{r}_h (s_1) = \tilde{r}_h + \varphi (s_1) - \delta_h \]

- choose returns to match empirical earnings growth
  - young: earnings growth 4.1\% \( \implies \bar{r}_h (y) = 9.77\% \)
  - middle: earnings growth -0.76\% \( \implies \bar{r}_h (m) = 4.65\% \)

- Assume \( \bar{r}_h (o) = 0\% \)
- Earnings risk: \( \sigma_\eta = 0.15 \)
Calibration: Technology

- Capital share $\alpha = 0.32$
- Aggregate $K/Y = 2.94$ and $r_f = 3\% \implies \delta_k = 0.0785$
- Aggregate $X_h/Y = 0.06$ and market clearing $\implies \tilde{r}_h = 1.6\%$ and $\phi = 4.721$
Focus on three features of equilibrium:

1. Human capital choice $\theta_h$
2. Consumption insurance

$$CI(s_1) = 1 - \frac{\sigma_c}{\sigma_{c,d}}$$

3. Welfare $\Delta(s_1)$: equivalent variation of moving to full insurance, $\theta_h$ fixed
### General Equilibrium Results

<table>
<thead>
<tr>
<th></th>
<th>young</th>
<th>middle</th>
<th>old</th>
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<tbody>
<tr>
<td>$\theta_h$</td>
<td>0.98</td>
<td>0.91</td>
<td>0.00</td>
</tr>
<tr>
<td>CI</td>
<td>0.43</td>
<td>0.76</td>
<td>1.00</td>
</tr>
<tr>
<td>$\Delta$</td>
<td>3.5%</td>
<td>1.4%</td>
<td>0.0%</td>
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</table>
Portfolio Shares

\[
\frac{\text{wealth}}{\text{earnings}} = \frac{1 - \theta_h}{\tilde{r}_h \theta_h}
\]

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<thead>
<tr>
<th></th>
<th>young</th>
<th>middle</th>
<th>old</th>
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<tbody>
<tr>
<td><strong>SCF</strong></td>
<td></td>
<td></td>
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<tr>
<td>Total</td>
<td>0.63</td>
<td>2.49</td>
<td>7.34</td>
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<tr>
<td>excl. Housing</td>
<td>0.36</td>
<td>1.17</td>
<td>3.34</td>
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<tr>
<td><strong>Model</strong></td>
<td></td>
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<tr>
<td></td>
<td>0.37</td>
<td>1.88</td>
<td>inf</td>
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Partial Equilibrium Results

- What forces matter?
  - excess returns to human capital
  - risk aversion
  - income risk
  - enforcement (plausible variation doesn’t matter)

- Assume types are permanent and plot effects on:
  - human capital investment
  - consumption insurance
  - welfare costs of imperfect insurance
Figure 1: Portfolio choice for benchmark model

Notes: Human capital share in total wealth as a function of excess human capital returns in the baseline model.

Figure 2: Consumption insurance for benchmark model

Notes: Consumption insurance as a function of excess human capital returns in the baseline model. The insurance measure is one minus the ratio of the standard deviation of consumption relative to the standard deviation of consumption in financial autarky.
Figure 1: Portfolio choice for benchmark model

Notes: Human capital share in total wealth as a function of excess human capital returns in the baseline model.

Figure 2: Consumption insurance for benchmark model

Notes: Consumption insurance as a function of excess human capital returns in the baseline model. The insurance measure is one minus the ratio of the standard deviation of consumption relative to the standard deviation of consumption in financial autarky.
Figure 3: Welfare cost of underinsurance for benchmark model

Notes: Welfare cost of underinsurance as a function of excess human capital returns in the baseline model. Welfare costs are the equivalent variation in lifetime consumption for a household without constraints. Welfare costs are in percentage points.

Figure 4: Portfolio choice for different degrees of risk aversion

Notes: Human capital share in total wealth as a function of excess human capital returns in the baseline model ($\gamma = 1$, log utility) in comparison to a case with higher risk aversion ($\gamma = 2$).
Figure 3: Welfare cost of underinsurance for benchmark model

![Graph showing welfare cost of underinsurance as a function of human capital excess return for the benchmark model.](image)

Notes: Welfare cost of underinsurance as a function of excess human capital returns in the baseline model. Welfare costs are the equivalent variation in lifetime consumption for a household without constraints. Welfare costs are in percentage points.

Figure 4: Portfolio choice for different degrees of risk aversion

![Graph showing portfolio choice for different risk aversion levels.](image)

Notes: Human capital share in total wealth as a function of excess human capital returns in the baseline model ($\gamma = 1$, log utility) in comparison to a case with higher risk aversion ($\gamma = 2$).
Figure 5: Consumption insurance for different degrees of risk aversion

Notes: Consumption insurance as a function of excess human capital returns in the baseline model ($\gamma = 1$, log utility) in comparison to a case with higher risk aversion ($\gamma = 2$). The insurance measure is one minus the ratio of the standard deviation of consumption relative to the standard deviation of consumption in financial autarky.

Figure 6: Welfare cost of underinsurance for different degrees of risk aversion

Notes: Welfare cost of underinsurance as a function of excess human capital returns in the baseline model ($\gamma = 1$, log utility) in comparison to a case with higher risk aversion ($\gamma = 2$). Welfare costs are the equivalent variation in lifetime consumption for a household without constraints. Welfare costs are in percentage points.
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Notes: Welfare cost of underinsurance as a function of excess human capital returns in the baseline model ($\gamma = 1$, log utility) in comparison to a case with higher risk aversion ($\gamma = 2$). Welfare costs are the equivalent variation in lifetime consumption for a household without constraints. Welfare costs are in percentage points.
Figure 7: Portfolio choice for different levels of income risk

Notes: Human capital share in total wealth as a function of excess human capital returns in the baseline model ($\sigma = 0.15$) in comparison to a case with lower income risk ($\sigma = 0.1$).

Figure 8: Consumption insurance for different levels of income risk

Notes: Consumption insurance as a function of excess human capital returns in the baseline model ($\sigma = 0.15$) in comparison to a case with lower income risk ($\sigma = 0.1$). The insurance measure is one minus the ratio of the standard deviation of consumption relative to the standard deviation of consumption in financial autarky.
Figure 7: Portfolio choice for different levels of income risk

Notes: Human capital share in total wealth as a function of excess human capital returns in the baseline model ($\sigma = 0.15$) in comparison to a case with lower income risk ($\sigma = 0.1$).

Figure 8: Consumption insurance for different levels of income risk

Notes: Consumption insurance as a function of excess human capital returns in the baseline model ($\sigma = 0.15$) in comparison to a case with lower income risk ($\sigma = 0.1$). The insurance measure is one minus the ratio of the standard deviation of consumption relative to the standard deviation of consumption in financial autarky.
Figure 9: Welfare cost of underinsurance for different levels of income risk

![Figure 9](image)

Notes: Welfare cost of underinsurance as a function of excess human capital returns in the baseline model ($\sigma = 0.15$) in comparison to a case with lower income risk ($\sigma = 0.1$). Welfare costs are the equivalent variation in lifetime consumption for a household without constraints. Welfare costs are in percentage points.

Figure 10: Portfolio choice for different levels of enforcement

![Figure 10](image)

Notes: Human capital share in total wealth as a function of excess human capital returns in the baseline model ($\sigma = 0.15$) in comparison to a case with lower income risk ($\sigma = 0.1$).
Conclusion

• Existing models of imperfect enforcement predict too much insurance
  • Insufficient reason for households to borrow
• Limited enforcement with life cycle earnings and/or high returns to human capital investment give greater incentive to borrow and produce significantly imperfect consumption insurance
• Also consistent with high levels of aggregate savings
Figure 11: Networth to labor income ratio

Notes: Life-cycle profile of the median ratio of networth to labor income for married households age 23 - 60 with children. Blue solid line shows model and red dots SCF data.

Figure 12: Consumption inequality

Notes: Life-cycle profile of the cross-sectional variance of consumption. The blue solid line shows the model prediction. The red diamonds show the profile estimated by Deaton and Paxson (1994), the green dots are the estimates of Aguiar and Hurst (2008), and the pink squares are the estimates of Primiceri and van Rens (2009). The data have been normalized to 0 at age 25.
Figure 9: Life insurance for husband and wife

Notes: Life-cycle profile of face value of life-insurance contracts (thousands of year 2000 dollars) for married households age 23 - 60 with children. Red solid line shows face value of life insurance for wife's death from model. Red dots show face value of life insurance for wife's death from data. Blue dashed line shows face value of life insurance for husband’s death from model. Blue diamonds show face value of life insurance for husband’s death from data. Data are from the SCF and the SIPP. See appendix for details of the construction of data profiles.

Figure 10: Consumption insurance

Notes: Consumption insurance in the model for married households age 23 - 60 with children. The insurance measure is one minus the ratio of the standard deviation of consumption in equilibrium relative to the standard deviation of consumption in financial autarky.