Household Risk Management

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Understanding Household Risk Management

- **Research agenda**: Determinants of risk management and insurance

- **Household risk management**
  - Insurance against shocks to income/expenditures/asset values
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■ **Basic patterns**
  ■ Limited; at times completely absent especially for poor households
    ■ “the poor cannot afford insurance”
  ■ Richer households are better insured
  ■ “[T]he near absence of derivatives markets for real estate ... is a striking anomaly that cries out for explanation and for actions to change the situation.” – Shiller (2008)
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- **Trade off between financing needs and risk management**
  - Smoothing over time and insurance across states linked by **collateral constraints**
  - Household risk management is limited and increasing in net worth
Stylized Facts on Household Risk Management

- **Insurance by U.S. households**
  - **Cross section** – Brown/Finkelstein (2007)
    - Health/long-term care coverage increase in income, wealth, age
  - **Within-household variation** – Fang/Kung (2012)
    - “[I]ndividuals who experience negative income shocks are more likely to lapse all [life insurance] coverage.”
  - **Consumption data** – Blundell/Pistaferri/Preston (2008)
    - “full insurance of transitory shocks except among poor households”
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- **Risk management by farmers in rural India**
  - **Consumption data** – Townsend (1994)
    - “[some] evidence that the landless are less well insured”
  - **Rainfall insurance** – Giné et al. (2008), Cole et al. (2013)
    - Participation increases in wealth; decreases in borrowing constraints
    - Most frequently stated reason for not purchasing insurance: “insufficient funds to buy insurance”
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- **Corporate risk management**
  - **Fuel price risk management** – Rampini/Sufi/Viswanathan (2014)
    - Hedging by U.S. airlines increases in net worth in panel data
Overview: Models of Household Finance

- **Household income risk management** (no collateral)
  - Limited enforcement implies short sale constraints
  - Risk management is incomplete, increasing, and precautionary

- **Household risk management with durable goods** (collateral)
  - Limited enforcement implies collateral constraints
  - In practice, over 90% of household liabilities collateralized by durable goods (real estate ≈ 80%, vehicles ≈ 6%, ...)
  - Durable goods force households to save, further reducing insurance

- **Durable goods price risk management**
  - Limited or no hedging of price risk

- Risk management and **rent vs. buy decision**
Household Finance in an Endowment Economy: Model

- Discrete time, infinite horizon

- **Households**
  - Preferences: \( E \left[ \sum_{t=0}^{\infty} \beta^t u(c_t) \right] \) where \( \beta \in (0, 1) \), \( u(c) \) strictly increasing, strictly concave, continuously differentiable, \( \lim_{c \to 0} u_c(c) = \infty \), \( \lim_{c \to \infty} u_c(c) = 0 \)
  - Income \( y(s) \) Markov chain on state space \( s \in S \) with transition matrix \( \Pi(s, s') > 0 \) and \( \forall s, s_+, s_+ > s, y(s_+) > y(s) \)
  - Notation: \( y' \equiv y(s') \), \( \underline{s} = \min\{s : s \in S\} \), \( \bar{s} = \max\{s : s \in S\} \), etc.

- **Lenders**
  - Risk neutral, discount at \( R^{-1} \in (\beta, 1) \), deep pockets, abundant collateral

- **Limited enforcement – default without exclusion**
  - Optimal dynamic contract can be implemented with **complete markets** in one-period ahead Arrow securities subject to short sale constraints (special case of **collateral constraints**)
  - Related: Rampini/Viswanathan (2010, 2013)
Household’s Income Risk Management Problem

- Recursive formulation

- Given $s$ and $w$, household solves

$$V(w, s) \equiv \max_{c, h', w' \in \mathbb{R}_+ \times \mathbb{R}^{2S}} u(c) + \beta E[V(w', s')|s]$$  \hspace{1cm} (1)

subject to budget constraints for current and next period, $\forall s' \in S$

$$w \geq c + E[R^{-1}h'|s]$$  \hspace{1cm} (2)

$$y' + h' \geq w'$$  \hspace{1cm} (3)

and short sale constraints, $\forall s' \in S$

$$h' \geq 0$$  \hspace{1cm} (4)

- Arrow securities $h'$ for each state $s'$ (and associated net worth $w'$)

- Endogenous state variable: net worth $w$ (cum current income)
Characterization of Household Risk Management

- Well-behaved dynamic program
  - Return function concave; constraint set convex
  - Operator defined by (1) to (4) satisfies Blackwell’s sufficient conditions
  - Solution: ∃! value function $v$; strictly increasing; strictly concave

- First order conditions
  - Denote multipliers on (2) and (3) by $\mu$ and $\beta \Pi(s, s') \mu'$ and on (4) by $\beta \Pi(s, s') \lambda'$
  - Ignore non-negativity constraints on consumption (not binding)

\[
\begin{align*}
\mu &= u_c(c) \\
\mu' &= v_w(w', s') \\
\mu &= \beta R \mu' + \beta R \lambda'
\end{align*}
\]

- Envelope condition: $v_w(w, s) = \mu$
  - Value function continuously differentiable
Increasing Household Risk Management (Proposition 1)

- **Richer households hedge more states**
  - (i) Set of states that household hedges $S_h \equiv \{s' \in S : h(s') > 0\}$ is increasing in net worth $w$ given current state $s$, $\forall s \in S$

- **Richer households better insured/spend more on hedging**
  - (ii) For $w_+ > w$ and denoting net worth next period associated with $w_+ (w)$ by $w'_+ (w')$, we have
    - $w'_+ \geq w'$ and $c'_+ \geq c'$, $\forall s' \in S$, i.e., $w'_+$ and $c'_+$ statewise dominate and hence FOSD $w'$ and $c'$, respectively; moreover, $h'_+ \geq h'$, $\forall s' \in S$, and $E[h'_+ | s] \geq E[h' | s]$
    - consumption across hedged states constant, i.e., $c' = c_h$, $\forall s' \in S_h$, and $c_h$ is strictly increasing in $w$

- **Remarks:**
  - This does not say which states are hedged
  - All statements are conditional on state $s$
First order stochastic dominance

Consider Markov chains which exhibit a notion of positive persistence

**Definition 1.** A Markov chain $\Pi(s, s')$ displays **first order stochastic dominance (FOSD)** if $\forall s, s_+, s', s_+ > s$,

$$\sum_{s' \leq \hat{s}'} \Pi(s_+, s') \leq \sum_{s' \leq \hat{s}'} \Pi(s, s')$$

**Remarks:**

- Distribution of states next period conditional on current state $s_+$
- FOSD distribution conditional on current state $s$ for all $s_+ > s$

**IID is special case:** $\Pi(s, s') = \Pi(s')$, $\forall s \in S$, exhibits FOSD
Increasing Household Risk Management with FOSD (Proposition 2)

- Assume that $\Pi(s, s')$ displays FOSD

- **Key property**
  - *(i)* Marginal value of net worth $v_w(w, s)$ is decreasing in state $s$

- **Risk management is increasing**
  - *(ii)* Household hedges a lower interval of states, $S_h = \{s', \ldots, s'_h\}$ given $w$ and $s$; net worth next period $w'$, hedging $h'$, set of hedged states $S_h$, and hedged consumption $c_h$ are all monotone increasing in $w$ and $s$

- Intuition:
  - Higher current income means FOSD shift in income next period $\Rightarrow$ lower marginal value of current net worth
  - If property is satisfied, households hedge lower income realizations more
Proof of key property - Proposition 2

Define operator $T$ as

$$Tv(w, s) \equiv \max_{c, h', w' \in \mathbb{R}_+ \times \mathbb{R}^2} u(c) + \beta E[v(w', s')|s]$$

subject to equations (2) through (4)

Sketch: Show that if $v$ has property that $\forall s, s_+, s_+ > s$, $v_w(w, s_+) \leq v_w(w, s)$, then $Tv$ (and fixed point) inherit property
“Richer Households are Better Insured” (Proposition 2)

- Decreasing variance of net worth and consumption with IID income
- Assume income process independent: $\Pi(s, s') = \pi(s')$, $\forall s, s' \in S$

- Richer households hedge more states/higher net worth
  - (ii) Net worth in hedged states $w(s') = w_h$, $\forall s' \in S_h$, and $w_h$ is increasing in $w$

- Richer households lower variance of net worth and consumption
  - (iii) Variance of net worth $w'$ and consumption $c'$ next period is decreasing in current net worth $w$
Precautionary Nature of Household Risk Management (Proposition 3)

**Definition:** Behavior is **precautionary** if it increases when risk increases (MPS on $y'$)

Assume income process independent: $\Pi(s, s') = \pi(s')$, $\forall s, s' \in S$

**Risk management is precautionary**

- $\tilde{\pi}(s')$ is a mean-preserving spread (MPS) of $\pi(s')$
- Then $\tilde{E}[\tilde{h}'] \geq E[h']$

Remarkably: **Risk aversion sufficient**

- No assumptions on prudence ($u_{ccc}(c)$) required
- Contrast: Classic precautionary savings result in models with incomplete markets (Bewley (1977), Aiyagari (1994), Leland (1968))
Incomplete Household Risk Management (Proposition 4)

- Assume income process satisfies \( FOSD \)

- “Poor households cannot afford insurance”
  - (i) At net worth \( w = y \) in state \( s \), household does not hedge at all, that is, \( \lambda' > 0 \), \( \forall s' \in S \), and \( S_h = \emptyset \)

- High income households are not completely hedged
  - (ii) At net worth \( w = \bar{y} \), household does not hedge highest state next period, that is, \( \lambda(\bar{s}') > 0 \) and \( S_h \subsetneq S \), \( \forall s \in S \)
Increasing Household Risk Management

- A theory of the insurance function?
- Behavior of insurance similar to savings (see Friedman)
  - Insurance is “state-contingent saving”
- Friedman (1957), *A Theory of the Consumption Function*, page 39:
  - “These regressions show savings to be negative at low measured income levels, and to be a successively larger fraction of income, the higher the measured income. If low measured income is identified with “poor” and high measured income with “rich,” it follows that the “poor” are getting poorer and the rich are getting richer. The identification of low measured income with “poor” and high measured income with “rich” is justified only if measured income can be regarded as an estimate of expected income over a lifetime or a large fraction thereof.”
Parameters: $y' \in \{0.8, 1.2\}$, $p = 0.5$, CRRA with $\gamma = 2$
Comparison to Bewley (1977) Economy

- **Precautionary savings** $h$ instead of risk management $h'$, $\forall s' \in S$

- Given $s$ and $w$, household solves

\[
V(w, s) \equiv \max_{c,h,w' \in \mathbb{R}_+ \times \mathbb{R}^{S+1}} u(c) + \beta E[V(w', s') | s]
\]

subject to budget constraints for current and next period, $\forall s' \in S$

\[
w \geq c + R^{-1}h
\]

\[
y' + h \geq w'
\]

and short sale constraint

\[
h \geq 0
\]

- Same key property: $v_w(w, s)$ decreasing in $w$ and $s$ (same proof strategy)

- With $FOSD$, $h$ (weakly) increasing in $w$ given $s$, but (weakly) decreasing in $s$ given $w$

- “Bewley household risk management” not increasing in $s$ (Prop. 5)
Comparison to Bewley (1977) Economy (Cont’d)

- **Precautionary savings vs. risk management**

- **Parallels**
  - Since $v_w(w, s)$ decreasing in $w$ and $s$, envelope condition implies consumption $c$ increasing in $w$ and $s$
  - Thus precautionary savings $h$ and risk management expenditure $E[R^{-1}h'|s]$ both increasing in $w$ (given $s$) and decreasing in $s$ (given $w$)

- **Key distinction**
  - Household risk management $h'$ increasing in $s$ (although risk management expenditure $E[R^{-1}h'|s]$ decreasing in $s$)
    - Household risk management is increasing in $s$ ($w'$ increasing in $s$)
  - Precautionary savings $h$ decreasing in $s$ implies $w(s')$ decreasing in $s$
    - “Bewley household risk management” not increasing in $s$
Precautionary Savings in Bewley Model (Proposition 6)

- **Key condition:** Convexity of marginal utility $u_c(c)$

- Assume income process independent: $\Pi(s, s') = \pi(s')$, $\forall s, s' \in S$

- **Marginal value of net worth**
  - If $u_c(c)$ is convex, then $v_w(w)$ is convex

- **Precautionary savings guaranteed only if $u_c(c)$ convex**
  - Suppose $\tilde{\pi}(s')$ MPS of $\pi(s')$
  - If $u_c(c)$ convex, then $\tilde{h} \geq h$

- New proof of classic result
  - Leland (1968), Sandmo (1970), Sibley (1975), and Kimball (1990)

- Contrast: Precautionary risk management requires only risk aversion
Parameters: \( y(s') \in \{0.8, 1, 1.2\} \); \( \pi(s') = \pi_{\sigma}, 1 - 2\pi_{\sigma}, \pi_{\sigma} \); with \( \pi_{\sigma} = 0, 0.2, 0.5 \).
Household Risk Management in the Long Run

- **Household risk management under stationary distribution (Prop. 7)**
  - ... is increasing, incomplete with probability 1, and completely absent with strictly positive probability

- **Net worth distribution for** $\beta R = 1$
  - Full insurance in limit but net worth remains finite (unlike buffer stock savings models)
Household Finance with Durable Goods

Preferences: \( u(c) + g(k) \) where \( k \) is durable good (e.g., housing)

Durable goods

- ... as collateral for state-contingent debt \( b' \)

\[
\theta k(1 - \delta) \geq Rb'
\]

- ... imply additional financing needs

Equivalent risk management formulation

- Fully lever durables: set \( \hat{b}' = R^{-1} \theta k(1 - \delta) \) and pay down

\[
\phi \equiv 1 - R^{-1} \theta (1 - \delta)
\]

- Hedging with Arrow securities \( h' \) subject to short sale constraints

\[
h' \equiv \theta k(1 - \delta) - Rb'
\]
Household’s Problem with Durable Goods

Given $s$ and $w$, household solves

$$v(w, s) \equiv \max_{c, k, h', w' \in \mathbb{R}_+^2 \times \mathbb{R}^2} u(c) + \beta g(k) + \beta E[v(w', s')|s]$$  \hspace{1cm} (9)

subject to the budget constraints for the current and next period, $\forall s' \in S$

$$w \geq c + \varsigma k + E[R^{-1}h'|s]$$  \hspace{1cm} (10)

$$y' + (1 - \theta)k(1 - \delta) + h' \geq w'$$  \hspace{1cm} (11)

and the short sale constraints, $\forall s' \in S$

$$h' \geq 0$$  \hspace{1cm} (4)

Remarks

- Net worth $w$ is cum income and durable goods net of borrowing
- Investment Euler equation for durable goods

$$1 = \beta \frac{g_k(k)}{\mu} \frac{1}{\phi} + E \left[ \beta \frac{\mu'}{\mu} \frac{(1 - \theta)(1 - \delta)}{\phi} \right] s$$
Household’s Problem with Durable Goods

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Risk Management with Durable Goods: Properties

- **Properties generalize (Proposition 9)**

- **Monotonicity**
  - Net worth next period $w'$ strictly increases in $w$, given $s$
  - Hedging $h'$ does not necessarily increase in $w$

- **Incomplete hedging** (with $\Pi(s, s') = \pi(s'), \forall s, s' \in S$)
  - Household never hedges the highest state next period

- **Increasing household risk management with FOSD**
  - Household hedges lower interval of states
    - Marginal value of net worth $v_w(w, s)$ is decreasing in $s$
Financing needs for durables reduce hedging and increase net worth accumulation.

Parameters: \( y' \in \{0.8, 1.2\} \), \( p = 0.5 \), CRRA with \( \gamma = 2 \) and \( g = 2 \), \( \theta = 0.8 \).
Effect of Collateralizability on Hedging

- Income insurance with lower collateralizability ($\theta = 0.6$)

Collateralizability $\theta$ affects durable consumption, hedging, and net worth accumulation.
Financing Needs Override Risk Management

- **Absence of risk management for poor households**
  - For sufficiently low net worth, household is constrained against all states next period (Proposition 10)
    - Net worth next period
    \[ w' \geq y' + (1 - \theta)k(1 - \delta) > y' \]

- **Financing education**
  - Investment in education
    - Income next period \( A'f(e) \) where \( e \) is investment in education
    - \( f \) is strictly increasing and strictly concave, \( \lim_{e \to 0} f_e(e) \)
    - Raises financing need and increasing income profile
  - If net worth is sufficiently low, households do not engage in risk management (Proposition 11)
Durable Goods Price Risk Management

- Stochastic durable goods price \( q(s) \)
- Down payment \( \varphi(s) \equiv q(s) - R^{-1} \theta E[q'|s](1 - \delta) \)

**Household’s problem:** Given \( s \) and \( w \), household maximizes (9) subject to the budget constraints for the current and next period, \( \forall s' \in S \)

\[
\begin{align*}
w & \geq c + \varphi(s)k + E[R^{-1}h'|s] \quad (12) \\
y' + (1 - \theta)q'k(1 - \delta) + h' & \geq w' \quad (13)
\end{align*}
\]

and the short sale constraints, \( \forall s' \in S \)

\[
h' \geq 0 \quad (4)
\]

**Effect of durable goods price**

- Investment Euler equation for durable goods

\[
1 = \beta \frac{g_k(k)}{\mu} \frac{1}{\varphi(s)} + E \left[ \beta \frac{\mu'}{\mu} \frac{(1 - \theta)q'(1 - \delta)}{\varphi(s)} \bigg| s \right]
\]

- Price affects down payment \( \varphi(s) \) and net worth \( w' \) directly
Durable Goods Price Risk: Example

- Hedging durable goods prices \( (q' \in \{0.95, 1.05\}) \) (and income)

- Durable goods price affects cost of durables, net worth, and required down-payments
Increasing Durable Goods Price Risk Management

- **Full pledgeability of resale value** ($\theta = 1$) (Proposition 12)

- With logarithmic preferences, household income risk management is increasing and household does not hedge price risk
  - Why? - Price risk separable; does not affect marginal utility of net worth

- With isoelastic preferences and $\gamma < 1$, risk management is increasing

  - Intuition
    - Equivalent to economy with preference shocks
    - With $\gamma < 1$, $q(s)$ lowers marginal utility (similar: Campbell (1996))
Renting: Ease of repossession allows higher leverage

- See Eisfeldt/Rampini (2009) and Rampini/Viswanathan (2013)
- Pay rental fee in advance

\[
    u_l(s) \equiv rq(s) - (E[q'|s] - q(s)) + E[q'|s](\delta + m)
\]

where \( m \) is monitoring cost

Financially constrained households rent

Renting affects incentives to hedge

- High (implicit) leverage induces hedging
- Sign of hedging demand can flip (related: Sinai/Souleles (2005))
Household’s problem: Given $s$ and $w$, household maximizes (9) subject to the budget constraints for the current and next period, $\forall s' \in S$

$$w \geq c + \varphi(s)k_o + R^{-1}u_l(s)k_l + E[R^{-1}h'|s]$$

$$y' + (1 - \theta)q'k_o(1 - \delta) + h' \geq w'$$

the non-negativity constraints on owned and rented durables,

$$k_o, k_l \geq 0$$

and the short sale constraints, $\forall s' \in S$

$$h' \geq 0$$

with $k = k_o + k_l$
High leverage of renting induces risk management \( (m = 0.02) \)
Renters hedge states with high house prices!
Conclusion

- **Main result:** Optimal household risk management
  - ... is incomplete, increasing, and precautionary

- **Intuition**
  - Intertemporal “financing need” overrides hedging concern
  - Key: **Collateral constraints**; in contrast
    - “[m]argin requirements might deal with this [collection] problem, but only for people who have sufficient assets as margin. We will disregard these kinds of ... problems.” – Athanasoulis/Shiller (2000)

- **Trade off between financing and risk management** explains patterns in
  - household insurance in developed and emerging economies
  - corporate risk management
Research Agenda on Risk Management

- **Macro finance theory**
  - **Financial frictions** provide powerful amplification and propagation
    - Net worth of households/firms/intermediaries declines in downturns
    - Possible result: Severe “crises”
  - Households/institutions should have strong **incentive to insure/hedge**
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- In practice, risk management is limited or completely lacking
  - **Why?** - Markets for hedging instruments may not exist; but why not?
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- In theory, risk management typically simply ruled out **ex cathedra**

- **Question:** Why might households/institutions choose not to hedge?
  - **Answer:** Same financial frictions that constrain financing impede hedging
Stylized Facts on Household Risk Management

- **Households’ insurance coverage varies across income, wealth, and age**

- **Evidence in cross section**
  - Fraction of people without health insurance decreases with income
    - 25% vs. 8% for people with income below $25,000 vs. above $75,000
  - Fraction of people without health insurance decreases in age
    - 28% vs. 2% for adults aged 24 and below vs. 65 and above
  - Fraction of people with private long-term care insurance increases with wealth – Brown/Finkelstein (2007)
    - 3% vs. 20% for people in bottom vs. top wealth quartile
  - Flood insurance coverage (number of policies and amount) positively related to personal income at state level – Browne/Hoyt (2000)

- **Within-household variation** – Fang/Kung (2012)
  - Probability of lapsing coverage decreases with income
    - “[I]ndividuals who experience negative income shocks are more likely to lapse all coverage.”
Evidence on Risk Management by U.S. Households

- Blundell/Pistaferri/Preston (2008)
  - Data on income and consumption distribution for U.S. households
  - “some partial insurance of permanent shocks, especially for college educated and those near retirement”
  - “... full insurance of transitory shocks except among poor households”
Evidence on Risk Management by Farmers in Rural India

- Townsend (1994)
  - “a hint of a pattern by land class”
  - “… evidence that the landless are less well insured than their village neighbors in one of the three villages”

  - Participation in rainfall insurance programs increases in wealth and decreases with measures of borrowing constraints

  - Evidence from randomized field experiments on importance of credit constraints for adoption of rain fall insurance
  - Most frequently stated reason for not purchasing insurance
    - “insufficient funds to buy insurance”
Evidence on Corporate Risk Management

- Rampini/Sufi/Viswanathan (2014)
  - Strong positive relation between net worth and hedging in panel data on fuel price risk management by U.S. airlines

- Size pattern in derivatives use
  - Nance/Smith/Smithson (1993)
    - Positive relation between size (and dividend yield) and hedging
  - Géczy/Minton/Schrand (1997)
    - Use of derivatives increases from 33% to 90% across quartiles by size

- See also: Tufano (1996)
Evidence on Fuel Price Risk Management

- Fuel hedging by airlines around financial distress
- Dramatic decline in hedging as airlines approach distress; slow recovery
Puzzling Relation between Financing and Insurance?

- **Wall Street Journal** [December 5, 2012]

  - “*Forward contracts are convenient for small businesses because they generally don’t have any upfront cost, and business owners can lock in a forward contract up to a year ahead.*”

  - “*Certainly many small companies are still uncomfortable with hedging. Startups, which are generally strapped for resources, typically can’t afford it.*”
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- *Wall Street Journal* [December 5, 2012]
  - “Forward contracts are convenient for small businesses because they generally don’t have any upfront cost, and business owners can lock in a forward contract up to a year ahead.”
  - “Certainly many small companies are still uncomfortable with hedging. Startups, which are generally strapped for resources, typically can’t afford it.”

- Basic insight - Rampini/Viswanathan (2010, 2013)
  - Collateral constraints link financing (payments to financier) and risk management (payments to counterparty)
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- Basic empirical pattern
  - Among U.S. households, Indian farmers, and in corporate America, more constrained are less well insured!
Households’ Financing Risk Management Trade-off

- **Basic trade-off**

  - Poor households shift net worth to present, not across states next period

\[
V_w(w, s) \quad \Pi(s, s'_H) \quad V_w(w(s'_H), s'_H) \\
\Pi(s, s'_L) \quad V_w(w(s'_L), s'_L)
\]

- Financing need

- No risk management:
  \[ V_w(w(s'_H), s'_H) \neq V_w(w(s'_L), s'_L) \]
Persistence of Income vs. Persistence of Productivity

**Household finance**
- Positive persistence of income further lowers marginal value of net worth when current income realization is high
- Yields *increasing household risk management* theorem

**Corporate finance**
- Positive persistence in cash flows due to productivity shocks
  - Positive persistence productivity shocks implies conditional expected productivity higher
  - *Investment opportunities* raise marginal value of net worth when current productivity is high
- Effects go in opposite direction; no general monotonicity result
Household Risk Management in the Long Run

- **Household risk management under stationary distribution** (Prop. 7)

- Assume that $\Pi(s, s')$ displays FOSD

- **Existence and uniqueness**
  - (i) There exists a unique stationary distribution of net worth

- **Support of net worth distribution**
  - (ii) Support of stationary distribution is subset of $[\underline{w}, w_{bnd}]$ where $\underline{w} = \underline{y}$ and $w_{bnd} \geq \bar{y}$ with equality if $\Pi(s, s') = \pi(s')$, $\forall s, s' \in S$

- **Incomplete household risk management**
  - (iii) Under stationary distribution, household risk management is increasing, incomplete with probability 1, and completely absent with strictly positive probability
Distribution of Household Net Worth

- **Stationary distribution with incomplete hedging**

![Graphs showing marginal density and density low state against current net worth (w)]

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Household Risk Management
Stationary Distribution of Net Worth for $\beta R = 1$

- **Full insurance under stationary distribution in limit** (Prop. 8)

- When $\beta R = 1$, household insures fully under stationary distribution
  - Intuition: Households eventually unconstrained

- Classic class of *income fluctuations problems with non-contingent debt* and borrowing constraints
  - Full insurance in limit, but net worth grows without bound
Stationary Distribution for $\beta R = 1$ – Example

- Full insurance under stationary distribution
- Symmetric two state Markov chain for income
  - $S = \{s_L, s_H\}$ with $s_L < s_H$
  - $\Pi(s_H, s_H) = \Pi(s_L, s_L) \equiv p$ with $\rho = 2p - 1 \geq 0$
- Independent income ($p = 1/2$):
  $$h_L = y_H - y_L, \quad w_H = w_L = y_H, \quad c = E[y] + \frac{1}{2} \frac{R - 1}{R}(y_H - y_L)$$
- General case:
  $$h_L = \frac{R}{R - \rho}(y_H - y_L), \quad w_L - w_H = \frac{\rho}{R - \rho}(y_H - y_L),$$
  $$c = E[y] + \frac{1}{2} \frac{R - 1}{R - \rho}(y_H - y_L)$$
- PV of income (ex current income) $PV_s$ “human capital”
  $$w_H + PV_H = w_L + PV_L$$
Durable Goods Price Risk: Persistence

- Hedging persistent shocks to durable goods prices

Persistence ($p = 0.75$) increases hedging of low state

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Hedging Income Risk: Persistence

- Hedging persistent shocks to income only

Persistence ($p = 0.75$) increases hedging of low state

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Household Risk Management
High leverage of renting induces risk management! ($m = 0.02$)