Why Are Older Women Missing in India?
The Age Profile of Bargaining Power and Poverty

Rossella Calvi

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Workshop on Human Capital Formation and Family Economics - October 28, 2016
**Missing Women in India**

- 45% of missing women in India are of **post-reproductive ages (45+)**
- 0.9% of women over 45 are missing (800,000 in year 2000)

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**Missing Women By 5-year Age Group**

(Anderson-Ray, 2010)
Why Are Older Women Missing?

Anderson-Ray

Women's Age

Intra-Household Bargaining Power

Women's Health

Female Mortality & Missing Women

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Why Are Older Women Missing?

1) Natural Experiment

Women's Age

Intra-Household Bargaining Power

Women's Health

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Anderson-Ray

Inheritance Rights

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Why Are Older Women Missing?

1) Natural Experiment
   - Inheritance Rights
   - Intra-Household Bargaining Power
   - Women's Health

2) Structural Model
   - Women's Age
   - Female Mortality & Missing Women

Anderson-Ray

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Why Are Older Women Missing?

1) Natural Experiment
   - Inheritance Rights

2) Structural Model
   - Intra-Household Bargaining Power
   - Women’s Health
   - Anderson-Ray

3) Poverty Analysis

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“Why Are Older Women Missing in India?”

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Preview of Results

- Women’s bargaining power within the family positively affects their health (*natural experiment*).

- Women’s bargaining power and access to household resources drop at older ages (*structural model*).
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- Women’s bargaining power and access to household resources drop at older ages (*structural model*).

- Poverty rates are higher among older women (*poverty analysis*).
  - The age profile of excess female mortality exactly matches the age profile of female poverty relative to males’.
Preview of Results

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- Women’s bargaining power and access to household resources drop at older ages (*structural model*)

- Poverty rates are higher among older women (*poverty analysis*)
  - The age profile of excess female mortality exactly matches the age profile of female poverty relative to males’

- Intra-household gender inequality explains up to 89% of missing women at post-reproductive ages (*counterfactual analysis*)
Related Literature

1. **Age distribution of missing women**
   (e.g., Anderson-Ray, 2010, 2012, 2015; Milazzo, 2014)
   Much wider literature on missing women: son preference, sex-selective abortion (Sen, 1990, 1992; DasGupta, 2005; Jha et al., 2006; Bhalotra et al., 2010, 2015)

2. **Plight of elderly and older women in South Asia**
   (e.g., *Widows*: Chen-Drèze, 1995; Drèze-Srinivasan, 1997. *Poverty among the elderly*: Deaton-Paxton, 1995; Pal-Palacios, 2006)

3. **Inheritance rights and women’s outcomes**

4. **Collective household models and bargaining power**
   (e.g., Chiappori 1988, 1992; Lewbel-Pendakur, 2008; Browning-Chiappori-Lewbel, 2013; Dunbar-Lewbel-Pendakur, 2013)
Natural Experiment

1) Natural Experiment

Women's Age 

Intra-Household Bargaining Power 

Women's Health 

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Inheritance Rights

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Hindu Succession Act and Amendments

▶ **Law changes**: State-level reforms equalizing inheritance rights between genders

▶ **Hindu Succession Act (1956)**


▶ Hindu, Buddhist, Jain and Sikh women who married after the reforms
Hindu Succession Act and Amendments

- **Law changes**: State-level reforms equalizing inheritance rights between genders
  - **Hindu Succession Act (1956)**
  - Hindu, Buddhist, Jain and Sikh women who married after the reforms
- ↑ women’s bargaining power
Bargaining Power and Health

- Data: 2005-2006 National Family Health Survey
  - Married women 15-49

- Empirical specification:
  
  \[ y_{irsc} = \beta \times \text{Treat}_{irsc} + X'_{irsc} \gamma + \alpha_r + \alpha_c + \alpha_s + \alpha_{rs} + \alpha_{rc} + \alpha_{sc} + \epsilon_{irsc} \]

  - \( y_{irsc} \): Woman \( i \)'s health outcome (\( r \): religion; \( c \): cohort; \( s \): state)
    - Body Mass Index
    - Pr(Underweight)
    - Pr(Anaemia)
  
  - \( \text{Treat}_{irsc} = (\text{Hindu,Buddhist,Jain,Sikh}) \times (\text{Unmarried at time of reform}) \)
  
  - \( X_{irsc} \): Individual and household controls
  
  - \( \alpha \): Fixed effects
### More Bargaining Power, Better Health

<table>
<thead>
<tr>
<th>Body Mass Index</th>
<th>Pr(BMI ≤ 18.5)</th>
<th>Pr(Anaemia)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMI</td>
<td>Pr(BMI ≤ 18.5)</td>
<td>Severe</td>
</tr>
<tr>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
</tr>
<tr>
<td>OLS</td>
<td>OLS</td>
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</tr>
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</table>

<table>
<thead>
<tr>
<th>HSAA Exposed</th>
<th></th>
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</tr>
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<tbody>
<tr>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>(1)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>OLS</td>
</tr>
</tbody>
</table>

|               | **0.205***      | -0.0446***  | -0.0123***  | -0.0304***  | -0.0316***  |
| total          | (0.0776)        | (0.0102)    | (0.00316)   | (0.00897)   | (0.0110)    |

| N              | 81,534          | 81,534      | 77,777      | 77,777      | 77,777      |
| Mean Dependent Variable | 21.42 | 0.2648 | 0.0154 | 0.1559 | 0.5298 |

**Note:** *p < 0.10, **p < 0.05, ***p < 0.01. NFHS-3 data. Married women of age 15 to 49 included in the sample. Robust standard errors in parentheses. Standard errors clustered at the primary sampling unit (village) level (3,753). Sampling weights applied.
More Bargaining Power, Better Health

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- Validity of empirical strategy  ✓
- Robustness checks          ✓
2) Structural Model

Women's Age → Anderson-Ray → Female Mortality & Missing Women

Intra-Household Bargaining Power → Women's Health

Inheritance Rights → Women's Health
Collective Households

- Chiappori (1988, 1992)
- Separate utility functions over goods for each household member
- Pareto efficient outcomes (bargaining process unspecified)
- Goods can be shared (economies of scale in consumption)
- Caring preferences
- Children as separate agents
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- Children as separate agents

- 3 types of individuals within each household \((j = f, m, c): \text{women}, \text{men}, \text{and children}\)
- \(J = F, M, C: \) Total number of household members of type \(j\)
Collective Households

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Household Program: Details

- Nuclear and extended households, with and without children under 15
  - Nuclear households: 35\% of the sample
  - No children under 15: 1/3 households
Resource Shares ($\Lambda_j$)

- $\Lambda_j$: Fraction of household expenditure consumed by individuals of type $j$, $j = m, f, c$
- $y$: Total household expenditure
- $y_j$: Household expenditure consumed by individuals of type $j$
- $\Lambda_f = y_f/y$: Women’s resource shares
- $\Lambda_m = y_m/y$: Men’s resource shares
- $\Lambda_c = y_c/y$: Children’s resource shares
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Resource Shares ($\Lambda_f, \Lambda_m, \Lambda_c$)

Measure of bargaining power and access to household resources but
  - not observable
  - not identified, without additional assumptions
Identification

Identification of resource shares using **Engel curves of private assignable goods**: Clothing (Dunbar-Lewbel-Pendakur, 2013)

- **Engel curve**: Relationship between a budget share and total expenditure, holding prices constant
- **Assignable clothing**: Clothing items that are consumed *exclusively* by women, men or children
Identification of resource shares using **Engel curves of private assignable goods: Clothing** (Dunbar-Lewbel-Pendakur, 2013)

- **Engel curve**: Relationship between a budget share and total expenditure, holding prices constant
- **Assignable clothing**: Clothing items that are consumed *exclusively* by women, men or children

Assumptions (all testable, with additional data):

1. Observability of one private assignable good (clothing)
2. Restrictions on individual preferences (similar-tastes for clothing)
3. Restrictions on how resource shares vary with expenditure

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Identification

Engel curves for women’s, men’s and children’s clothing ($g_j$):

$$W_f = g_f(\Lambda_f y, \Lambda_f)$$

$$W_m = g_m(\Lambda_m y, \Lambda_m)$$

$$W_c = g_c(\Lambda_c y, \Lambda_c)$$

- $W_j$: Budget share spent on type $j$’s clothing
- $y$: Total household expenditure
- $\Lambda_j$: Type $j$’s resource share
- $\Lambda_f + \Lambda_m + \Lambda_c = 1$

Important: $W_j \neq \Lambda_j$
Identification

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$$W_f = g_f(\Lambda_f y, \Lambda_f)$$
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- $\Lambda_f + \Lambda_m + \Lambda_c = 1$

- Important: $W_j \neq \Lambda_j$

- Estimate $g_j$ (with variation in $y$ and $W_j$ across households)

- Given $y$, $W_j$, and $g_j^{-1}$, back out $\Lambda_j$
**Identification**

- **Strengths:**
  - Exact identification of parameters of interest
  - Resource shares (bargaining power)
  - Preference parameters on assignable clothing
  - Mild data requirement
  - No price variation needed

- **Limitation:**
  - Not estimating the full model
Data

- NSS Consumer Expenditure Survey (68th round, 2011-2012)

- Detailed consumer expenditure and **assignable clothing items**
  - Women: Saree, shawls, chaddar, kurta-pajamas suits for females
  - Men: Dhoti, lungi, kurta-pajamas suits for males, salwar
  - Children: School uniforms, infant clothing

- Household characteristics: Composition (number of women, men, children, fraction of female children, presence of widow, daughter in law, unmarried daughter above 15), religion, caste, region, rural areas, land ownership, presence of salary earner, age of household members

- Women’s eligibility to Hindu Succession Act amendments

- No data on health status/outcome

- ≈ 87,000 households

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System of Engel Curves

\[ W_j = \alpha_j \Lambda_j + \beta \Lambda_j \ln \left( \frac{\Lambda_j}{J} \right) + \beta \Lambda_j \ln y + \epsilon_j \]

- Linear in \( \ln y \)
- Engel curves of assignable clothing for adults and children \((j = f, m, c)\)
- \(\beta = \beta_j\): Similar-tastes assumption
  - \(W_j\): Budget share on assignable clothing
  - \(\alpha_j, \beta\): Preference parameters
  - \(\Lambda_j\): Resource share
  - \(y\): Total household expenditure
  - \(J\): Number of individuals of type \(j\)

- \(W_j, y, J\) are observable

- Heterogeneity: \(\alpha_j, \beta, \Lambda_j\) allowed to vary linearly with household characteristics
System of Engel Curves

\[
W_j = \alpha_j \Lambda_j + \beta \Lambda_j \ln \left( \frac{\Lambda_j}{J} \right) + \beta \Lambda_j \ln y + \epsilon_j
\]

1. Estimate the system for households **with** and **without** children (Non-Linear SUR)

2. For each household, predict
   - Resource shares: \( \hat{\Lambda}_f, \hat{\Lambda}_m, \hat{\Lambda}_c \)
   - Preference parameters: \( \hat{\alpha}_f, \hat{\alpha}_m, \hat{\alpha}_c, \hat{\beta} \)
Estimation Results

- Women get less than men (64-85% of men’s resources)

- Determinants of women’s resource shares
  - **Women’s age** —, especially in hhs without children
  - **Hindu Succession Act amendments** +
  - Household composition (number of women +, number of men —, fraction of female children +, widow —)
  - Socio-economic characteristics (salary earner —, high caste —, female and male education +)
  - Location (rural areas —, North —, North-East +)

Results Table

Predicted Resource Shares - Descriptive Statistics
Bargaining Power and Age

- How does women’s bargaining power vary with age?

- Cross-sectional variation to trace out the **age profile of women’s bargaining power**

- Caveat: *Cannot disentangle age from cohort*
How does women’s bargaining power vary with age?

Cross-sectional variation to trace out the age profile of women’s bargaining power

Caveat: Cannot disentangle age from cohort

Resource share ratio \((\hat{A}_f/\hat{A}_m)\): Measure of women’s bargaining power relative to men’s

\[= 1 \rightarrow \text{No gender asymmetry in intra-household allocation} \]
\[\neq 1 \rightarrow \text{Gender asymmetry in intra-household allocation} \]
Women’s Bargaining Power Decreases With Age

- Average ratio $\hat{\Lambda}_f / \hat{\Lambda}_m$, among households with women of age equal to 15, ..., 79

Resource Share Ratio ($\hat{\Lambda}_f / \hat{\Lambda}_m$) and Women’s Age

(The model does not impose restrictions on the shape of this relation)
Summary So Far

1) Natural Experiment

2) Structural Model

Women’s Age

Intra-Household Bargaining Power

Women’s Health

Inheritance Rights

Female Mortality & Missing Women

Anderson-Ray

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Andersen-Ray

3) Poverty Analysis

Women's Age

Inheritance Rights

Women's Health
Poverty Analysis

- Poverty rates that take into account *unequal sharing* of household resources
- Gender and gender-age specific poverty rates
- Different from standard poverty measures that assume *equal sharing*
Poverty By Gender and Age

- Poverty rates by gender and age group (5-year, 15-19 to 75-79)
- World Bank extreme poverty line (1.90$/day)

Unequal Sharing (Model Predictions)

Equal Sharing

3.10$/day Poverty Line
Nuclear Hhs Only

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Relative Poverty

- **Poverty Sex Ratio**: Measure of female poverty relative to that of males

\[
\text{Poverty Sex Ratio} = \frac{\text{Female Poverty Rate}}{\text{Male Poverty Rate}}
\]

- \( = 1 \rightarrow \) No gender asymmetry in poverty
- \( \neq 1 \rightarrow \) Gender asymmetry in poverty
- \( > 1 \rightarrow \) *Excess female poverty*
Relative Poverty, Missing Women and Age

- Poverty Sex Ratio by age group (5-year, 15-19 to 75-79)
Relative Poverty, Missing Women and Age

- Poverty Sex Ratio by age group (5-year, 15-19 to 75-79)
- Missing women by age group (Anderson-Ray, 2010)

The age distribution of excess female poverty matches almost perfectly that of excess female mortality.
## Counterfactual Analysis

1. Equal sharing of household resources

<table>
<thead>
<tr>
<th></th>
<th>Female poverty</th>
<th>Male poverty</th>
<th>Excess female poverty (45-79)</th>
<th>Excess female mortality (45-79)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equal sharing of household resources</td>
<td>↓ 34%</td>
<td>≈ (but 3.10$/day ↑)</td>
<td>↓ 94%</td>
<td>↓ 85%</td>
</tr>
</tbody>
</table>

No excess female poverty (Poverty Sex Ratio = 1):

<table>
<thead>
<tr>
<th></th>
<th>Excess female mortality (45-79)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excess female mortality (45-79)</td>
<td>↓ 89%</td>
</tr>
</tbody>
</table>

2. Equal inheritance rights for all women:

<table>
<thead>
<tr>
<th></th>
<th>Female poverty</th>
<th>Male poverty</th>
<th>Excess female poverty (45-79)</th>
<th>Excess female mortality (45-79)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equal inheritance rights for all women</td>
<td>↓ 9%</td>
<td>≈ (3.10$/day ↑)</td>
<td>↓ 27%</td>
<td>↓ 24%</td>
</tr>
</tbody>
</table>
Mechanism to explain missing women at post-reproductive ages in India: intra-household bargaining power and resource allocation

1. Women’s bargaining power positively affects their health
2. Women’s bargaining position deteriorates at post-reproductive ages
3. Poverty rates are higher among women than men, especially at older ages
Concluding Remarks

- Mechanism to explain missing women at post-reproductive ages in India: intra-household bargaining power and resource allocation

  1. Women’s bargaining power positively affects their health
  2. Women’s bargaining position deteriorates at post-reproductive ages
  3. Poverty rates are higher among women than men, especially at older ages

- Policy implications:
  - Need to focus on gender asymmetries among the elderly
  - Poverty measures should account for intra-household allocation
  - Policies aimed at promoting equality within households can have a large impact on female health, poverty and mortality
Thank you!
Missing Women in India

- Sex ratio (males/females) by age

Developed countries: Canada, Germany, Italy, Japan, Portugal, Spain, US.

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Sex Ratio and Age

(A) Sex Ratio By Age Group

(B) Cohort Comparison

(C) Urban vs. Rural

(D) Distribution Across States
Assumptions

- *Similar tastes*: Pendakur, 1999; Blundell-Chen-Kristensen, 2007
- *y-independence*: Menon-Pendakur-Perali, 2012; Cherchye-De Rock-Vermeulen, 2012
- Can depend on stuff that is correlated with expenditure (e.g. wealth)
- Predicted women’s resource shares and total expenditure
## Descriptive Statistics: NSS Full Sample

<table>
<thead>
<tr>
<th></th>
<th>Obs.</th>
<th>Mean</th>
<th>Median</th>
<th>St. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Expenditure</td>
<td>87,373</td>
<td>8,108.98</td>
<td>6,775.00</td>
<td>5,042.64</td>
</tr>
<tr>
<td>Expenditure On Non-Durable Goods</td>
<td>87,373</td>
<td>7,694.28</td>
<td>6,538.33</td>
<td>4,579.95</td>
</tr>
<tr>
<td>Expenditure On Durable Goods</td>
<td>87,373</td>
<td>414.70</td>
<td>106.85</td>
<td>1,156.44</td>
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<tr>
<td>Food Budget Share</td>
<td>87,373</td>
<td>39.24</td>
<td>39.26</td>
<td>9.62</td>
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<tr>
<td>Female Assignable Clothing Budget Share</td>
<td>87,373</td>
<td>1.37</td>
<td>1.17</td>
<td>1.16</td>
</tr>
<tr>
<td>Male Assignable Clothing Budget Share</td>
<td>87,373</td>
<td>1.68</td>
<td>1.41</td>
<td>1.42</td>
</tr>
<tr>
<td>Children Assignable Clothing Budget Share</td>
<td>87,373</td>
<td>0.51</td>
<td>0.00</td>
<td>0.76</td>
</tr>
<tr>
<td>No. Adult Females</td>
<td>87,373</td>
<td>1.68</td>
<td>1.00</td>
<td>0.85</td>
</tr>
<tr>
<td>No. Adult Males</td>
<td>87,373</td>
<td>1.76</td>
<td>1.00</td>
<td>0.92</td>
</tr>
<tr>
<td>Fraction of Female Children</td>
<td>57,158</td>
<td>0.45</td>
<td>0.50</td>
<td>0.39</td>
</tr>
<tr>
<td>Number of Children Under 5</td>
<td>87,373</td>
<td>1.32</td>
<td>1.00</td>
<td>1.26</td>
</tr>
<tr>
<td>(Daughter in Law)</td>
<td>87,373</td>
<td>0.20</td>
<td>0.00</td>
<td>0.40</td>
</tr>
<tr>
<td>(Unmarried Daughter Above 15)</td>
<td>87,373</td>
<td>0.23</td>
<td>0.00</td>
<td>0.42</td>
</tr>
<tr>
<td>(Widow)</td>
<td>87,373</td>
<td>0.15</td>
<td>0.00</td>
<td>0.35</td>
</tr>
<tr>
<td>Avg. Age Men 15 to 79</td>
<td>87,089</td>
<td>37.77</td>
<td>36.00</td>
<td>10.52</td>
</tr>
<tr>
<td>Avg. Age Women 15 to 79</td>
<td>87,263</td>
<td>36.96</td>
<td>35.00</td>
<td>10.15</td>
</tr>
<tr>
<td>Avg. Age Gap 15 to 79 (Men - Women)</td>
<td>87,005</td>
<td>0.88</td>
<td>3.00</td>
<td>11.15</td>
</tr>
<tr>
<td>Avg. Age Children 0 to 14</td>
<td>57,158</td>
<td>7.57</td>
<td>8.00</td>
<td>3.97</td>
</tr>
<tr>
<td>(HSAA Eligible)</td>
<td>74,127</td>
<td>0.12</td>
<td>0.00</td>
<td>0.33</td>
</tr>
<tr>
<td>(Hindu, Buddhist, Sikh, Jain)</td>
<td>87,373</td>
<td>0.79</td>
<td>1.00</td>
<td>0.41</td>
</tr>
<tr>
<td>(Sch. Caste, Sch. Tribe or Other Backward Classes)</td>
<td>87,373</td>
<td>0.69</td>
<td>1.00</td>
<td>0.46</td>
</tr>
<tr>
<td>(Salary Earner)</td>
<td>87,373</td>
<td>0.30</td>
<td>0.00</td>
<td>0.46</td>
</tr>
<tr>
<td>(Land Ownership)</td>
<td>87,373</td>
<td>0.89</td>
<td>1.00</td>
<td>0.31</td>
</tr>
<tr>
<td>(Female Higher Education)</td>
<td>87,373</td>
<td>0.12</td>
<td>0.00</td>
<td>0.32</td>
</tr>
<tr>
<td>(Male Higher Education)</td>
<td>87,373</td>
<td>0.19</td>
<td>0.00</td>
<td>0.39</td>
</tr>
<tr>
<td>(Rural)</td>
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<tr>
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<tr>
<td>(South)</td>
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<td>0.00</td>
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<td>(West)</td>
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<td>0.12</td>
<td>0.00</td>
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Descriptive Statistics: NSS Two Samples

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<tr>
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<tr>
<td></td>
<td>Obs.</td>
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<tr>
<td>Total Expenditure</td>
<td>57,158</td>
<td>8,226.58</td>
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<td>Expenditure On Non-Durable Goods</td>
<td>57,158</td>
<td>7,849.90</td>
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<tr>
<td>Expenditure On Durable Goods</td>
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<tr>
<td>Female Assignable Clothing</td>
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<td>Male Assignable Clothing</td>
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<td>1.62</td>
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<tr>
<td>No. Adult Females</td>
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<tr>
<td>No. Adult Males</td>
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<tr>
<td>Fraction of Female Children</td>
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<td>0.45</td>
</tr>
<tr>
<td>Number of Children Under 5</td>
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<tr>
<td>I(Unmarried Daughter Above 15)</td>
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<tr>
<td>I(Widow)</td>
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<td>0.14</td>
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<tr>
<td>Avg. Age Men 15 to 79</td>
<td>57,158</td>
<td>36.94</td>
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<td>Avg. Age Women 15 to 79</td>
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<td>Avg. Age Gap 15 to 79 (Men - Women)</td>
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<td>Avg. Age Children 0 to 14</td>
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<td>I(Hindu, Buddhist, Sikh, Jain)</td>
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<td>I(Sch. Caste, Sch. Tribe or Other Backward Classes)</td>
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<td>I(Salary Earner)</td>
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<tr>
<td>I(East)</td>
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<td>I(North-East)</td>
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<td>0.16</td>
</tr>
<tr>
<td>I(South)</td>
<td>57,158</td>
<td>0.19</td>
</tr>
<tr>
<td>I(West)</td>
<td>57,158</td>
<td>0.12</td>
</tr>
</tbody>
</table>

Rossella Calvi (Rice University)  
“Why Are Older Women Missing in India?”  
HCEO Workshop - Oct. 28, 2016
<table>
<thead>
<tr>
<th></th>
<th>All Households Sample</th>
<th>With Children &lt; 15 Only</th>
<th>Without Children &lt; 15 Only</th>
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<tbody>
<tr>
<td>No. Adult Women</td>
<td>0.0396***</td>
<td>0.0319***</td>
<td>0.0552***</td>
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<td></td>
<td>(0.00406)</td>
<td>(0.00473)</td>
<td>(0.00908)</td>
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<tr>
<td>No. Adult Men</td>
<td>-0.0283***</td>
<td>-0.0217***</td>
<td>-0.0267***</td>
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<td></td>
<td>(0.00315)</td>
<td>(0.00364)</td>
<td>(0.00660)</td>
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<td>No. Children</td>
<td>0.00553**</td>
<td>0.00592**</td>
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<td></td>
<td>(0.00219)</td>
<td>(0.00246)</td>
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<td>Fraction of Female Children</td>
<td>0.0205***</td>
<td>0.0108*</td>
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<tr>
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<td>(0.00563)</td>
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<td>(0.00658)</td>
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<td>(0.0179)</td>
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<tr>
<td>I(Unmarried Daughter above 15)</td>
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<td>(0.00715)</td>
<td>(0.00803)</td>
<td>(0.0169)</td>
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<tr>
<td>I(Widow)</td>
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<td>-0.0316***</td>
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<tr>
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<tr>
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<td>I(Hindu, Buddhist, Sikh, Jain)</td>
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<td>(0.00960)</td>
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<td>I(SC, ST, Other Backward Caste)</td>
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<td>0.0613***</td>
<td>0.0555**</td>
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<tr>
<td></td>
<td>(0.00802)</td>
<td>(0.00873)</td>
<td>(0.0123)</td>
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<tr>
<td>I(Salary Earner)</td>
<td>-0.0283***</td>
<td>-0.0225***</td>
<td>-0.0126</td>
</tr>
<tr>
<td></td>
<td>(0.00479)</td>
<td>(0.00502)</td>
<td>(0.00995)</td>
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<td>I(Land Ownership)</td>
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<td>0.00432</td>
<td>-0.0155</td>
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<tr>
<td></td>
<td>(0.00899)</td>
<td>(0.00912)</td>
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<tr>
<td>I(Female Higher Education)</td>
<td>0.0302***</td>
<td>0.0277***</td>
<td>0.0368**</td>
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<tr>
<td></td>
<td>(0.00732)</td>
<td>(0.00867)</td>
<td>(0.0159)</td>
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<tr>
<td>I(Male Higher Education)</td>
<td>0.0303***</td>
<td>0.0387***</td>
<td>0.0813***</td>
</tr>
<tr>
<td></td>
<td>(0.00562)</td>
<td>(0.00673)</td>
<td>(0.0126)</td>
</tr>
<tr>
<td>I(Rural)</td>
<td>-0.0353***</td>
<td>-0.0300***</td>
<td>-0.0402***</td>
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<tr>
<td></td>
<td>(0.00667)</td>
<td>(0.00707)</td>
<td>(0.0116)</td>
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<tr>
<td>Avg. Age Diff. (Men 15 to 79 - Women 15 to 79)</td>
<td>0.00202</td>
<td>-0.115**</td>
<td>0.0514</td>
</tr>
<tr>
<td></td>
<td>(0.0404)</td>
<td>(0.0485)</td>
<td>(0.0805)</td>
</tr>
<tr>
<td>Avg. Age Women 15 to 79</td>
<td>-0.572</td>
<td>-0.208</td>
<td>-1.632</td>
</tr>
<tr>
<td></td>
<td>(0.597)</td>
<td>(0.801)</td>
<td>(1.144)</td>
</tr>
<tr>
<td>(Avg. Age Diff. (Men 15 to 79 - Women 15 to 79))^2</td>
<td>-0.199*</td>
<td>0.129</td>
<td>-0.504***</td>
</tr>
<tr>
<td></td>
<td>(0.112)</td>
<td>(0.139)</td>
<td>(0.188)</td>
</tr>
<tr>
<td>(Avg. Age Women 15 to 79)^2</td>
<td>0.959</td>
<td>0.374</td>
<td>2.912</td>
</tr>
<tr>
<td></td>
<td>(1.437)</td>
<td>(2.027)</td>
<td>(2.658)</td>
</tr>
<tr>
<td>(Avg. Age Diff. (Men 15 to 79 - Women 15 to 79))^3</td>
<td>0.0456</td>
<td>0.478</td>
<td>-0.705</td>
</tr>
<tr>
<td></td>
<td>(0.514)</td>
<td>(0.741)</td>
<td>(0.762)</td>
</tr>
<tr>
<td>(Avg. Age Women 15 to 79)^3</td>
<td>-0.354</td>
<td>-0.262</td>
<td>-1.623</td>
</tr>
<tr>
<td></td>
<td>(1.110)</td>
<td>(1.666)</td>
<td>(1.970)</td>
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<tr>
<td>Avg. Age Children 0 to 14</td>
<td>-0.0710</td>
<td>-0.0151</td>
<td>-</td>
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<tr>
<td></td>
<td>(0.0488)</td>
<td>(0.0681)</td>
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<tr>
<td>I(North)</td>
<td>-0.0785***</td>
<td>-0.0984***</td>
<td>-0.0652***</td>
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<tr>
<td></td>
<td>(0.0150)</td>
<td>(0.0168)</td>
<td>(0.0232)</td>
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<tr>
<td>I(East)</td>
<td>-0.0141</td>
<td>-0.0171</td>
<td>-0.0234</td>
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<tr>
<td></td>
<td>(0.0164)</td>
<td>(0.0180)</td>
<td>(0.0254)</td>
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<tr>
<td>I(North-East)</td>
<td>0.0512**</td>
<td>0.0374</td>
<td>0.168**</td>
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<tr>
<td></td>
<td>(0.0229)</td>
<td>(0.0241)</td>
<td>(0.0284)</td>
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<tr>
<td>I(South)</td>
<td>-0.00814</td>
<td>-0.0254</td>
<td>-0.0537**</td>
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<tr>
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<td>(0.0163)</td>
<td>(0.0181)</td>
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<tr>
<td>Constant</td>
<td>0.439***</td>
<td>0.298***</td>
<td>0.715**</td>
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<tr>
<td></td>
<td>(0.0835)</td>
<td>(0.105)</td>
<td>(0.161)</td>
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</tbody>
</table>

N = 73,759 47,262 26,497

p < 0.10, **p < 0.05, ***p < 0.01. NSS data. Robust standard errors in parentheses. Standard errors clustered at the first sampling unit level. West India is the excluded region.
# Predicted Resource Shares

<table>
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<tr>
<th></th>
<th>Reference Households</th>
<th>All Households</th>
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<td></td>
<td>Estimate (1)</td>
<td>Mean (3)</td>
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<tr>
<td></td>
<td>Sd. Error (2)</td>
<td>Sd. Dev. (4)</td>
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<td>Median (5)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Min. (6)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Max. (7)</td>
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<tr>
<td>Panel A: Without Children &lt; 15 Only</td>
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<td></td>
</tr>
<tr>
<td>Women’s Resource Share $\hat{\Lambda}_f$</td>
<td>0.3710</td>
<td>0.4593</td>
</tr>
<tr>
<td></td>
<td>0.0221</td>
<td>0.1136</td>
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<tr>
<td>Men’s Resource Share $\hat{\Lambda}_m$</td>
<td>0.6290</td>
<td>0.5407</td>
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<tr>
<td></td>
<td>0.0221</td>
<td>0.1136</td>
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<tr>
<td>Panel B: With Children &lt; 15 Only</td>
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<tr>
<td>Women’s Resource Share $\hat{\Lambda}_f$</td>
<td>0.2275</td>
<td>0.3015</td>
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<td></td>
<td>0.0160</td>
<td>0.0726</td>
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<tr>
<td>Men’s Resource Share $\hat{\Lambda}_m$</td>
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<td>0.4784</td>
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<tr>
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<td>0.0339</td>
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<tr>
<td>Children’s Resource Share $\hat{\Lambda}_c$</td>
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<td>0.2200</td>
</tr>
<tr>
<td></td>
<td>0.0333</td>
<td>0.1129</td>
</tr>
</tbody>
</table>

Note: Reference households are nuclear households for which all other covariates are equal to their median values.
Household Program

Household program:

\[
\max_{x_f, x_m, x_c, h} \tilde{U}[U_f, U_m, U_c, p/y] = \sum_{j \in \{f, m, c\}} \mu_j(p/y)\tilde{U}_j
\]

subject to

- Budget constraint: \( y = h'p \)
- Consumption technology function (goods can be shared):

\[
h = A(Fx_f + Mx_m + Cx_c)
\]

- \( \tilde{U}_j = \tilde{U}_j(U_j(x_j), U_{-j}(x_{-j})) \): Individual utility functions, \( j = f, m, c \)
- \( \mu_j \): Pareto weight
- \( p \): Prices
- \( y \): Total expenditure
- \( h \): Quantities purchased by the household
- \( x_j \): Quantities consumed by women, men and children

Back
Identification

- Budget Shares $W_j$ vs. Resource Shares $\Lambda_j$
- Example: $M = F = 1$, $y = 10,000$ Rps.

\[ \Lambda_f = 40\% \quad \Lambda_m = 60\% \]
Identification

- **Budget Shares** $W_j$ vs. **Resource Shares** $\Lambda_j$
- Example: $M = F = 1$, $C = 0$ $y = 10,000$ Rps.
  - $W_j \neq \Lambda_j$, $j = m, f$
  - $W_f > W_m \iff \Lambda_f > \Lambda_m$, and viceversa

![Circle diagram]

- **Woman**
  - $\Lambda_f = 40\%$
  - $W_f = 15\%$

- **Clothing Woman**
- **Clothing Man**
- **Man**
  - $\Lambda_m = 60\%$
  - $W_m = 10\%$

Other Goods

*Rossella Calvi (Rice University)*

*“Why Are Older Women Missing in India?”*
Identification: Linear Case

- Engel curves linear in $\ln y$
- Example: $F = M = 1, C = 0$
- Women’s clothing: $W_f = a_f + c_f \ln y$

\[ W_f \]

\[ \text{ln } y \]

\[ \text{H1} \]

\[ \text{H2} \]

$c_f = \beta \Lambda_f$
Identification: Linear Case

- Engel curves linear in $\ln y$
- Example: $F = M = 1, C = 0$
- Woman's clothing ($W_f$) and man's clothing ($W_m$)

\[ k = \frac{c_f}{c_m} = \frac{\beta \Lambda_f}{\beta \Lambda_m} = \frac{\Lambda_f}{1 - \Lambda_f} \rightarrow \Lambda_f = \frac{k}{1+k} \]
Piglog Preferences

- Price-Independent Generalized Logarithmic preferences
- Muellbauer (1976)
- Piglog utility function (subutility of each individual of type $j$):
  \[ v_j = \ln\left(\frac{y}{G_j(p)}\right)/F_j(p) \]
  where $G$ and $F$ are arbitrary (up to regularity) price functions
- The Piglog class of demand systems has the form
  \[ x_j(y, p) = b_j(p)y + d_j(p)y \ln(y) \]
  which gives Engel curves linear in the logarithm of $y$
System of Engel Curves: Details

\[
\begin{align*}
W_f &= \alpha_f \Lambda_f + \beta \Lambda_f \ln \left( \frac{\Lambda_f y}{F} \right) + \epsilon_f \\
W_m &= \alpha_m \Lambda_m + \beta \Lambda_m \ln \left( \frac{\Lambda_m y}{M} \right) + \epsilon_m \\
W_c &= \alpha_c \Lambda_c + \beta \Lambda_c \ln \left( \frac{\Lambda_c y}{C} \right) + \epsilon_c
\end{align*}
\]

where

\[
\begin{align*}
\alpha_f &= \delta_{\alpha_f}^0 + \delta_{\alpha_f}^1 X_1 + \ldots + \delta_{\alpha_f}^n X_n \\
\alpha_m &= \delta_{\alpha_m}^0 + \delta_{\alpha_m}^1 X_1 + \ldots + \delta_{\alpha_m}^n X_n \\
\alpha_c &= \delta_{\alpha_c}^0 + \delta_{\alpha_c}^1 X_1 + \ldots + \delta_{\alpha_c}^n X_n \\
\beta &= \delta_{\beta}^0 + \delta_{\beta}^1 X_1 + \ldots + \delta_{\beta}^n X_n \\
\Lambda_f &= \delta_{\Lambda_f}^0 + \delta_{\Lambda_f}^1 X_1 + \ldots + \delta_{\Lambda_f}^n X_n + \delta_{\Lambda_f}^d HSAA \\
\Lambda_m &= \delta_{\Lambda_m}^0 + \delta_{\Lambda_m}^1 X_1 + \ldots + \delta_{\Lambda_m}^n X_n + \delta_{\Lambda_m}^d HSAA \\
\Lambda_c &= 1 - \Lambda_f - \Lambda_m
\end{align*}
\]

- Additional Engel curve for food to improve efficiency
- 318 parameters in hhs with children; 188 parameters in hhs without children
Lower Women’s Resource Shares at Older Ages

- Average $\hat{\Lambda}_f$, among hhs with women of age equal to 15, ..., 79

Women’s Resource Shares and Age

(A) Hhs Without Children, $\hat{\Lambda}_f$

(B) Hhs With Children, $\hat{\Lambda}_f$
Nuclear Households

- Average $\hat{\Lambda}_f$, among nuclear hhs with women of age equal to 15, ..., 79

Women’s Resource Shares in Nuclear Hhs

(A) Hhs Without Children, $\hat{\Lambda}_f$

(B) Hhs With Children, $\hat{\Lambda}_f$
Reference Households

- Third-order polynomials in women’s age

(A) Hhs Without Children, $\Lambda f$

(B) Hhs With Children, $\Lambda f$

Women’s Resource Shares in Reference Hhs
Resource Shares and Age

- Average $\hat{\Lambda}_f$ ($\hat{\Lambda}_m$), among hhs with women (men) of age equal to 15, ..., 79

(A) Hhs Without Children, $\hat{\Lambda}_f$ and $\hat{\Lambda}_m$

(B) Hhs With Children, $\hat{\Lambda}_f$ and $\hat{\Lambda}_m$

Average Predicted Resource Shares
Poverty and Age

Unequal Sharing
(Model Predictions)

Equal Sharing

3.10US$/day Poverty Line
Poverty and Age

Unequal Sharing (Model Predictions)

Equal Sharing

1.90US$/day Poverty Line (Nuclear Hhs Only)
Excess Female Poverty and Mortality

\[ EFM = 10,237 + 97,465 \times EFP \]

\[ R^2 = 0.68 \]
Future Work

- Disentangle age from cohort effect
  - Additional survey waves
  - Intertemporal model of the household
- IV to account for measurement error in expenditure
- Effects of women’s resource shares on health
- Identify alternative mechanisms generating excess female mortality at post-reproductive ages
- Applications to other developing countries