Families as Roommates

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Motivation

1. Large decrease in household size over last 150 years.
   $\longrightarrow$ What can explain this decline?

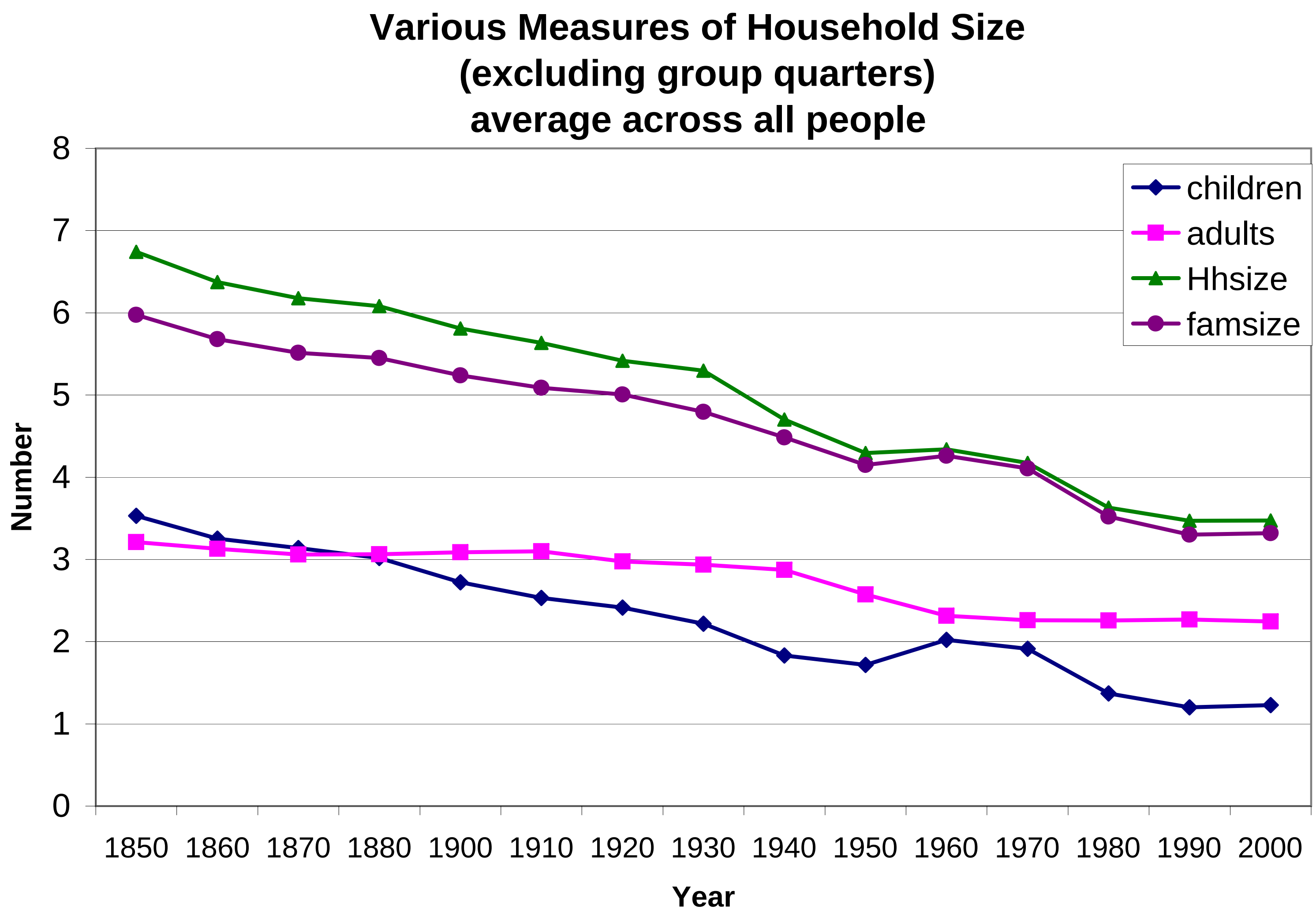
2. Typical analysis: concentrate on specific change in living arrangements:
   - increasing marriage age
   - decreasing fertility
   - increasing divorce rates
   - decline of extended family

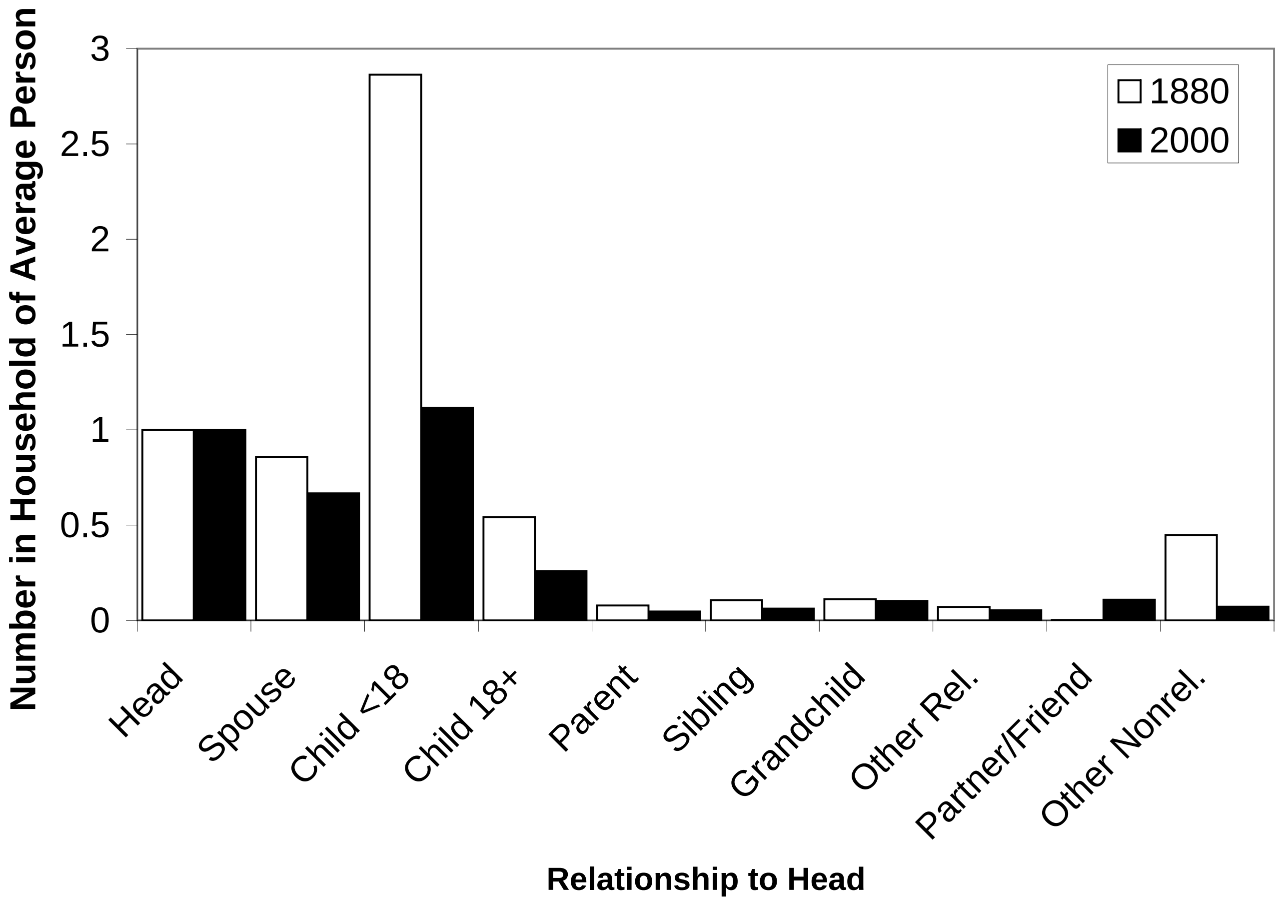
3. We believe that these are different manifestations of the same phenomenon: *people can afford to live in smaller households.*

4. Important for policy analysis: decline in family size not necessarily a concern, but simply an efficient response to growing incomes.

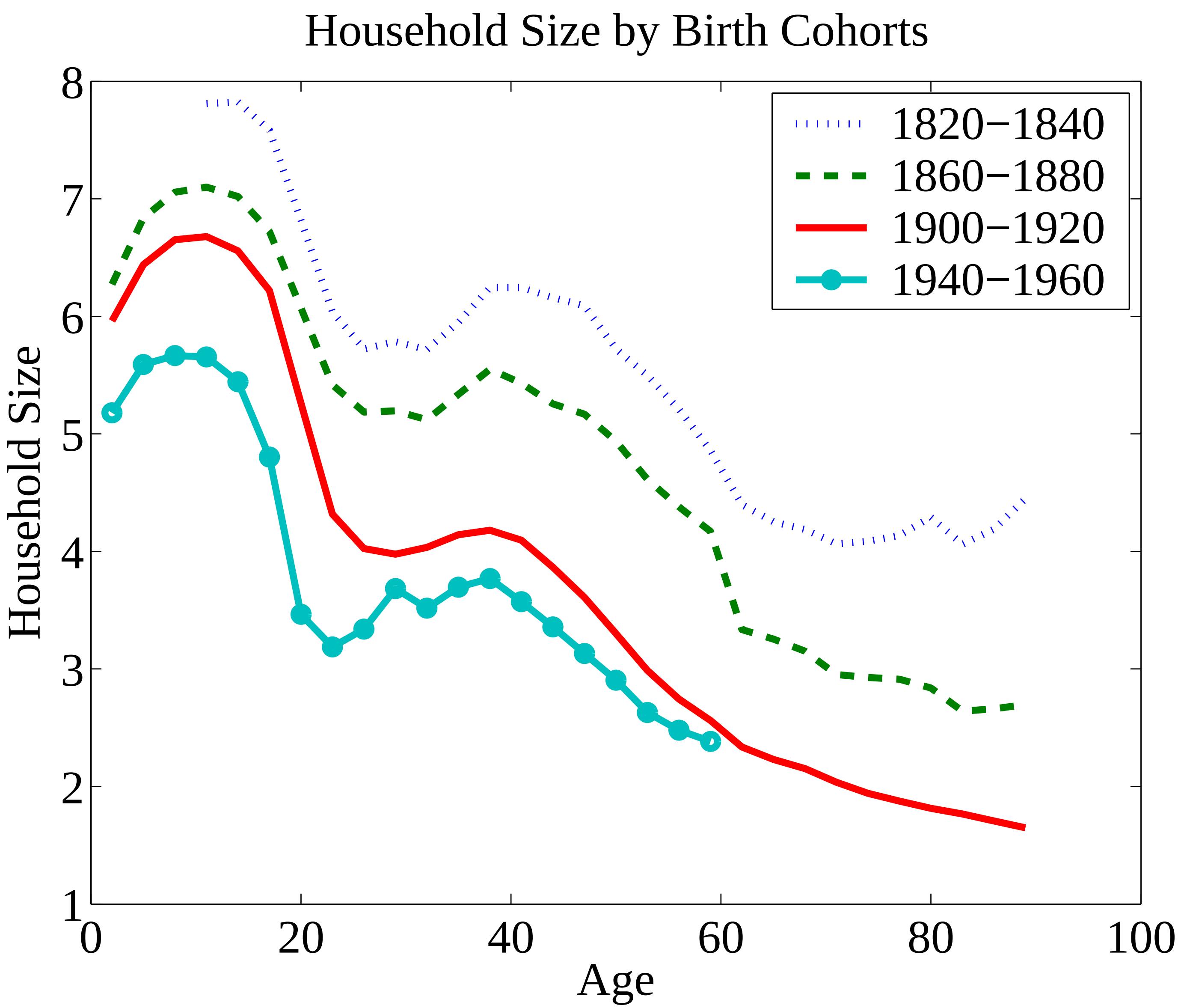
Outline of the Talk

1. Some facts: Changes in household size from U.S. Census data.
2. A model of household size choice.
3. We use 1995-2000 data to calibrate the model.
4. Use model to 'predict' changes in household size 1850-2000.
5. Result: increase in income can account for about 30% of the observed decline in household size.
6. Adding Children: model can account for entire HH size decline.


Various Measures of Household Size
(excluding group quarters)
average across all people
Number
Year
0
1
2
3
4
5
6
7
8
1850 1860 1870 1880 1900 1910 1920 1930 1940 1950 1960 1970 1980 1990 2000
children
adults
Hhsize
famsize



Number in Household of Average Person
3
2.5
2
1.5
1
0.5
0
1880
2000
Head
Spouse
Child <18
Child 18+
Parent
Sibling
Grandchild
Other Rel.
Partner/Friend
Other Nonrel.
Relationship to Head


Household Size by Birth Cohorts
8
7
6
5
4
3
2
1
0
20
40
60
80
100
Household Size
Age
1820−1840
1860−1880
1900−1920
1940−1960

Average Household Size by Income Quintiles, 2000, 30-34 year old persons

	30-34 year old persons			
Q	kids	adults	total	non-family
1	1.69	2.44	4.13	0.32
2	1.55	2.31	3.86	0.23
3	1.40	2.14	3.54	0.16
4	1.17	1.99	3.17	0.11
5	0.96	1.92	2.88	0.09

Summary of the Data

1. An average person in 1850 lived in household of size 6.8.
   An average person in 2000 lives in household of size 3.5.
2. Decrease has occurred at *all* points in the life-cycle.
3. This is *not* simply a decrease in fertility.
4. Decline in all types of household members.
5. Richer people live in smaller households.

Our Story: Substitution from HH public to private goods

- People consume two types of goods:
  - household public goods (living room, TV, garden)
  - pure private goods (dining out, plane trip, movie tickets)
- Benefit of living together: Public goods.
- Time cost of forming/maintaining a HH.
- As people get richer (GDP p.c. $\uparrow$)
  - They want to consume relatively more private goods.
  - Benefit from living together declines endogenously.
  - People choose to live in smaller households.

The Model

- Life-cycle model: $a =$ age.
- OLG: $\tau =$ birth cohort.
- Finite number of types in each cohort: i.
- Efficiency units of time: $z(\tau, a, i)$.
- Household specific public good, h.
- Private good, v.
- Household size, s.
- Age-specific household creation/maintenance (time) costs: $B_a z$.
- Exogenous increase in productivity z over time.

Problem of a Consumer of type (τ, i)

$$
\begin{aligned}
\max_{s,v,h} \quad & \sum_{a=0}^{\bar{a}} \beta^a \left[\frac{h(a)^{1-\sigma}}{1-\sigma} + \omega \frac{v(a)^{1-\phi}}{1-\phi} \right] \\
s.t. \quad & \sum_{a=0}^{\bar{a}} p(\tau+a) \left[\frac{h(a)}{s(a)} + v(a) \right] \\
& \leq \sum_{a=0}^{\bar{a}} p(\tau+a)[1 - B_a(s(a)-1)] z(\tau, a, i) \\
& \quad s(a) \geq 1 \quad \forall a \\
& \quad v(a), h(a) > 0 \quad \forall a
\end{aligned}
$$

Notation: $s(\tau, a, i)$ is optimal household size of agent born in τ of age a and type i.

Families as Roommates

- This is *not* a dynamic theory of family formation.
- There is no cost of changing HH size from one period to the next (e.g. no cost to get divorced).
- Instead: *every* period people can choose who to live with.
- Household members = roommates who share the costs of the public goods, but impose a cost of living together on each other (e.g. time spend arguing about who washes the dishes).
- Too simple?
- Well, let's see how far one get get with such a simple theory...

Equilibrium

An equilibrium for this economy is an allocation $\{s(\tau, a, i), v(\tau, a, i), h(\tau, a, i)\}_{\tau,i}$ and prices $\{p(t)\}$ such that:

1. Each agent type (τ, i) maximizes utility subject to the constraints.

2. Markets clear every period:

$$\sum_{\{(\tau,a,i)|\tau+a=t\}} \left[\frac{h(\tau, a, i)}{s(\tau, a, i)} + v(\tau, a, i)\right] = \sum_{\{(\tau,a,i)|\tau+a=t\}} [1 - B_a(s(\tau, a, i) - 1)]z(\tau, a, i)$$

Household Size and Public Good Share

Result 1 *$\frac{ds}{dz} < 0$ if and only if $\frac{d(\frac{h}{z})}{dz} < 0$.*

Proof. From the FOCs: $\frac{h}{z} = Bs^2$.

Household Size in the Cross-section

Result 2 *Suppose that $z(\tau, a, i) = z(\tau, i)$ for all a.*
Assume $\sigma > 0.5, \sigma > \phi$. Then $z(\tau, i) > z(\tau, j)$ implies that $s(\tau, a, i) \leq s(\tau, a, j)$ for all a, with strict equality if $1 < s(\tau, a, i)$.

Household Size Across Cohorts

Result 3 *Suppose* $B_a = B$ *for all* a *and that for all* i, $z(\tau, a, i) = z(\tau, i)$ *for all* a.

a) If $\sigma > 0.5$, $\phi < \sigma$, *then* $z(\tau', i) > z(\tau, i)$ *implies that* $s(\tau', a, i) < s(\tau, a, i)$ *for all* (a, i).

b) If $\sigma > 0.5$, $\phi > \sigma$, *then* $z(\tau', i) > z(\tau, i)$ *implies that* $s(\tau', a, i) > s(\tau, a, i)$ *for all* (a, i).

Empirical Strategy

- Our theory proposes that if $\sigma > \phi$, then higher incomes lead to a larger private goods share and smaller households.
- How do we know if $\sigma > \phi$?
- We use cross-sectional data (from CEX) to test $\sigma \gtrless \phi$ and to calibrate our model.
- We then project the model back to 1850 to see how important this channel is in explaining the falling household size.

Consumer Expenditure Survey

- 125,000 households total, 1980-2001.
- Use 1995-2000 as a cross-section.
- Detailed expenditure data, plus income data.
- Public goods (h) = housing, utilities, books, house services.
  Private goods (sv) = food, health care, education, clothing,
  transport, personal services, entertainment.
- Exclude most durable goods.

CEX Data: s, v and h by Income Quintiles

- Break people into five income types in model and data.
- In data we identify these with five income quintiles.

quintile	HH size	h	v	h/v
1	4.33	1,600	534	3.00
2	3.90	2,046	741	2.76
3	3.56	2,360	929	2.54
4	3.07	2,658	1,166	2.28
5	2.32	3,200	1,757	1.82

Calibration Strategy

- Consider agents in 5-year age groups: 0-4,5-9, . . . , 75-79 (16 groups).
- 19 parameters: $\sigma, \phi, \omega, \{B_a\}$.
- 19 Moments to match.

Average h/v ratio for 40-49 year-old in 2000	2.48	ω
Income elasticity of h/v for 40-49 year-old in 2000	-0.24	σ, ϕ
Standard intertemporal elasticity of substitution	0.50	σ, ϕ
Household size for age groups from 2000 Census		$\{B_a\}$

- Elasticity is defined between the five income quintiles.

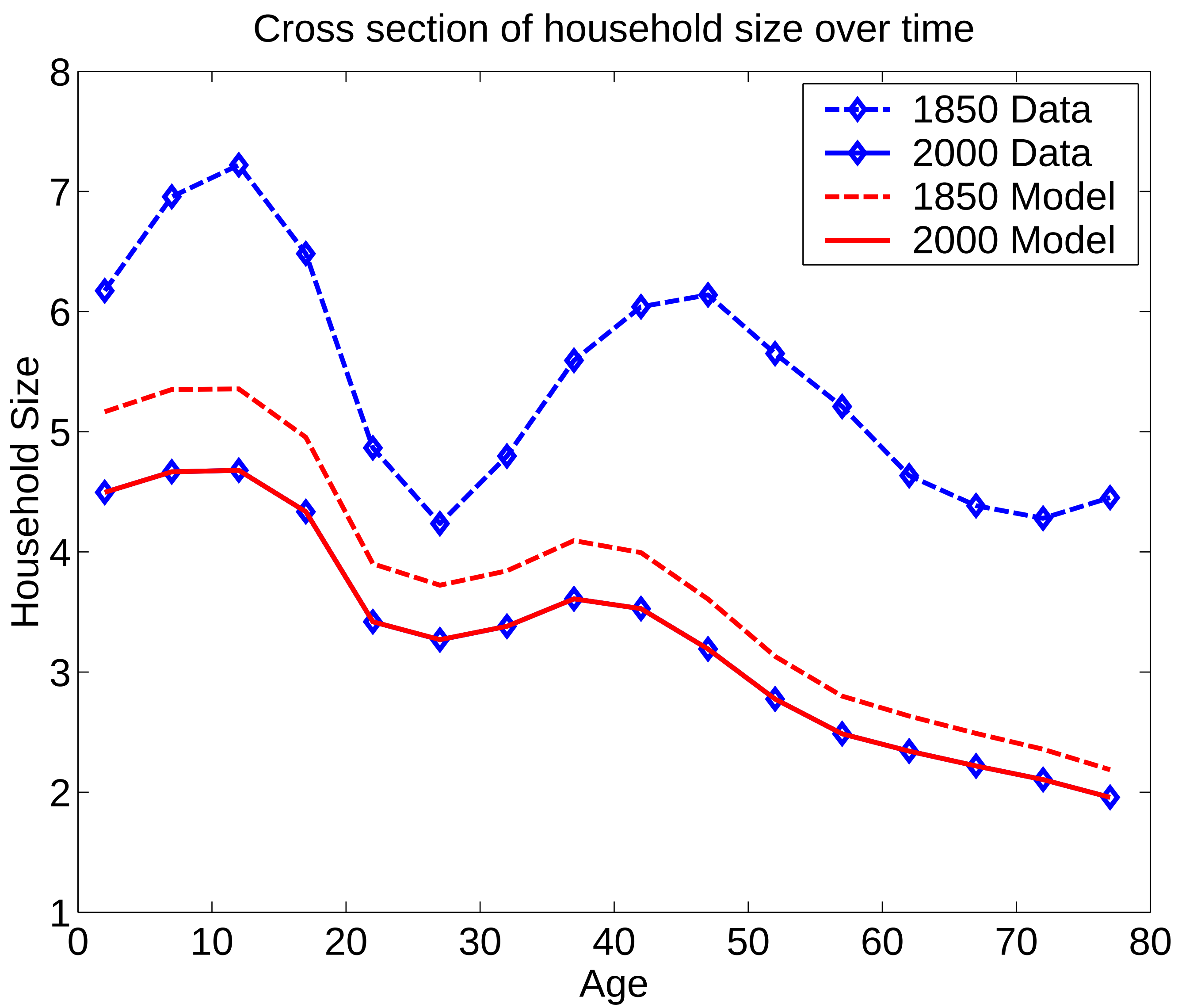
Calibration Results

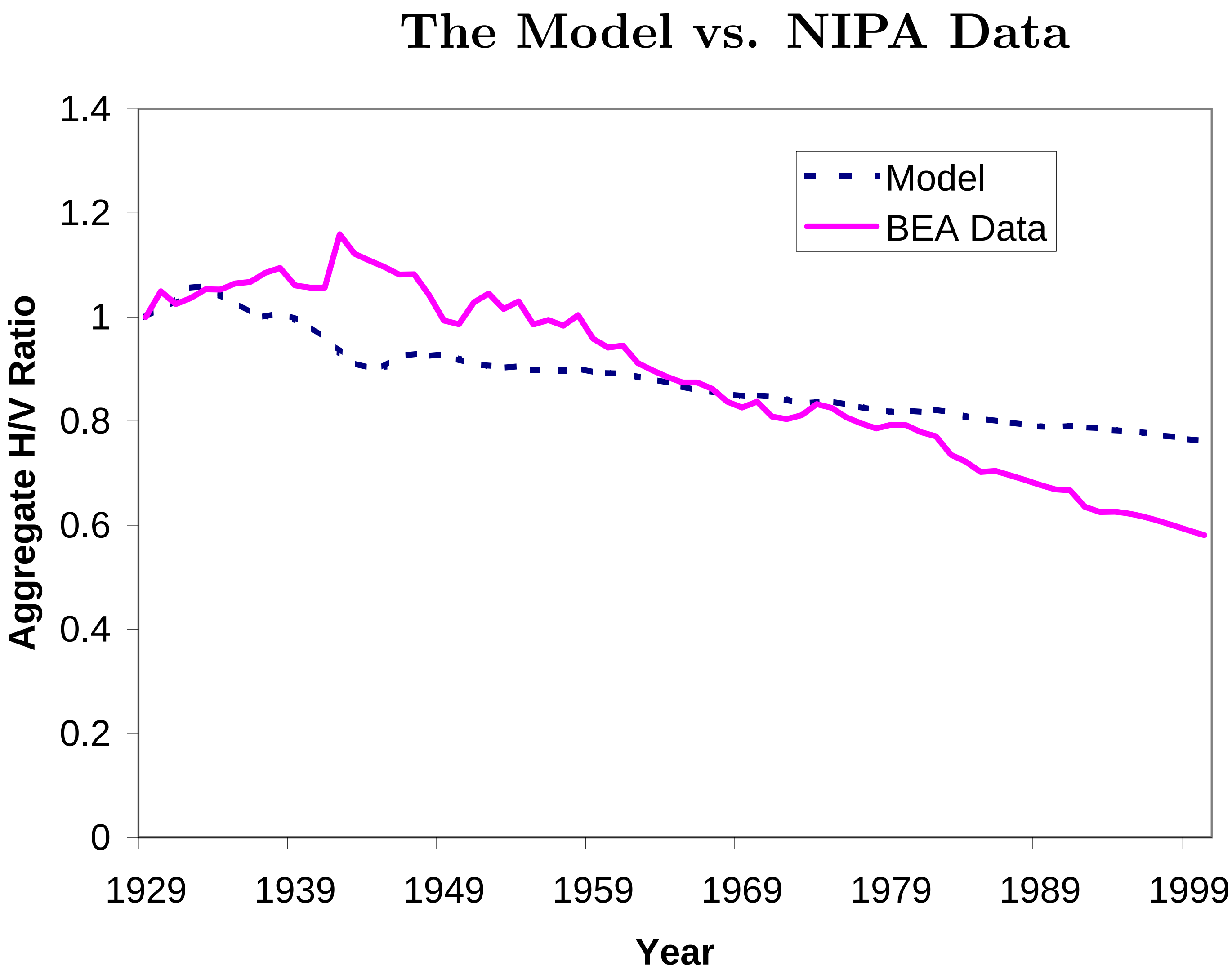
- $\sigma = 1.91 > \phi = 1.66, \quad \omega = 0.057$

age	0-4	5-9	10-14	15-19	20-24	25-29	30-34	35- 39
B_a	6.7%	6.3%	6.3%	7.0%	9.8%	10.4%	9.8%	8.8%
age	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79
B_a	9.1%	10.4%	12.7%	14.8%	16.0%	17.2%	18.4%	20.4%

Time Series Projection

- We match 2000 levels of household size and relative consumption.
- We match the 2000 elasticity of relative consumption with respect to income.
- Now we project the model backwards.
  - We use GDP/capita Y_t
  - Assume relative incomes are constant over time (z_i).
  - Then $z(\tau, a, i) = z_i Y_{t+a}$.


Cross section of household size over time
Household Size
Age
1850 Data
2000 Data
1850 Model
2000 Model
1
2
3
4
5
6
7
8
0
10
20
30
40
50
60
70
80

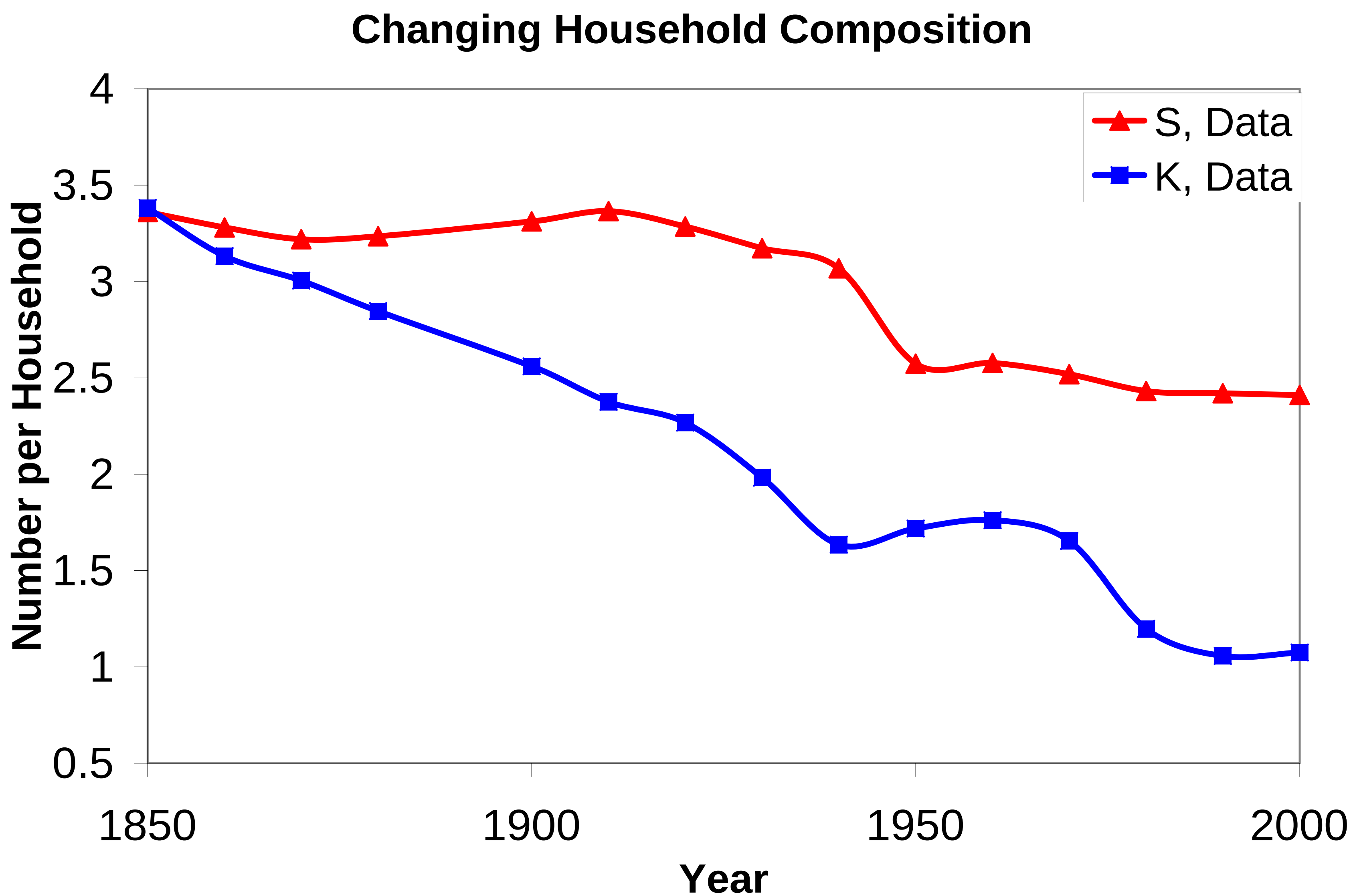

The Model vs. NIPA Data
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Aggregate H/V Ratio
Model
BEA Data
1929
1939
1949
1959
1969
1979
1989
1999
Year

Adding Children

1. So far, the model can explain about 20-30% of the decline in household size.
2. We believe this channel is also relevant for decision to have children.
3. Modify the model to include children:
   - Adults care about children in household.
   - Children also consume private and public goods.
   - Richer parents $\rightarrow$ more private goods for their kids and fewer children.
   - A version of the "quantity-quality" trade-off.

Adults vs. Children in the Data: 3 Interesting Features

- Both, the number of children and the number of adults in a household has fallen over the last 150 years.
- The decline in the number of children is relatively larger.
- Asymmetry in timing: Most of the fall in child household size occurred before 1940, while most of the decline in adult HH size occurred after 1940.


Changing Household Composition
Number per Household
Year
S, Data
K, Data
4
3.5
3
2.5
2
1.5
1
0.5
1850
1900
1950
2000

Model with Children

$$\max_{s,k,h,v,v^k} \sum_{a=0}^{\bar{a}} \beta^{\tau+a} U(a)$$

$$U(a) = \omega \frac{v(a)^{1-\phi}}{1-\phi} + \frac{h(a)^{1-\sigma}}{1-\sigma}$$
$$+ \delta k(a)^{\alpha} \left\{ \Omega + \frac{h(a)^{1-\sigma}}{1-\sigma} + \omega \frac{(v^k(a))^{1-\phi}}{1-\phi} \right\}$$

$$s.t. \sum_{a=0}^{\bar{a}} p(\tau+a) \left[\frac{h(a)}{s(a)} + v(a) + \frac{v^k(a)k(a)}{s(a)} \right]$$
$$\leq \sum_{a=0}^{\bar{a}} p(\tau+a) z(\tau, a, i)[1 - B_a(s(a)-1) - B_a^k k(a)]$$

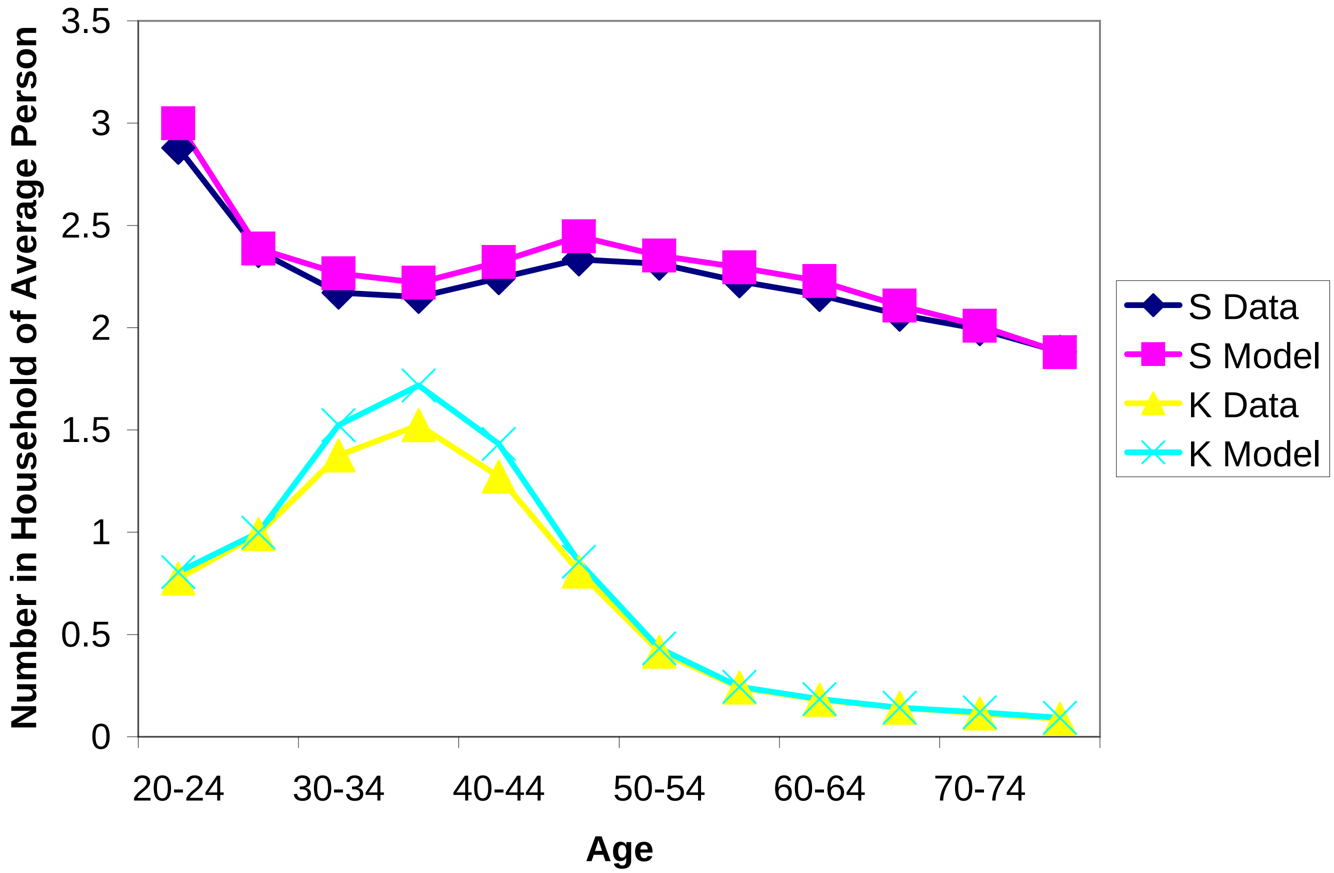
Empirical Strategy

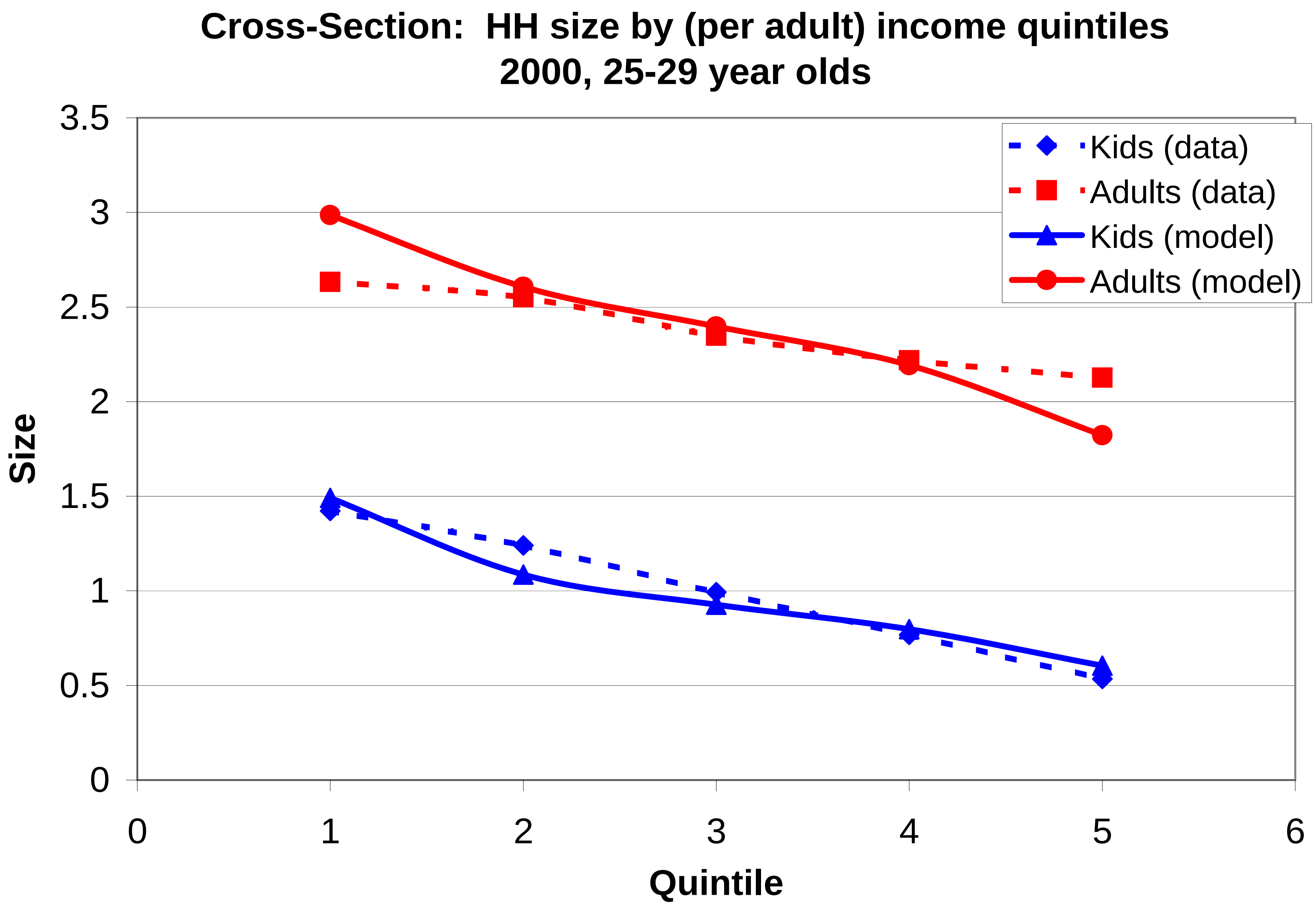
- CEX does not distinguish between children's and adult consumption $\rightarrow$ no data on h, v.
- Instead: pick parameters to match some time series moments.

Calibration: Data Targets

	Kids	Adults
1850 Household Size	3.38	3.36
Fall, 1850-1940	-51.70%	-8.67%
Fall, 1940-2000	-34.27%	-27.30%
Quintile* 1, 2000	1.42	2.63
Quintile* 2, 2000	1.24	2.55
Quintile* 3, 2000	0.99	2.35
Quintile* 4, 2000	0.77	2.22
Quintile* 5, 2000	0.53	2.13

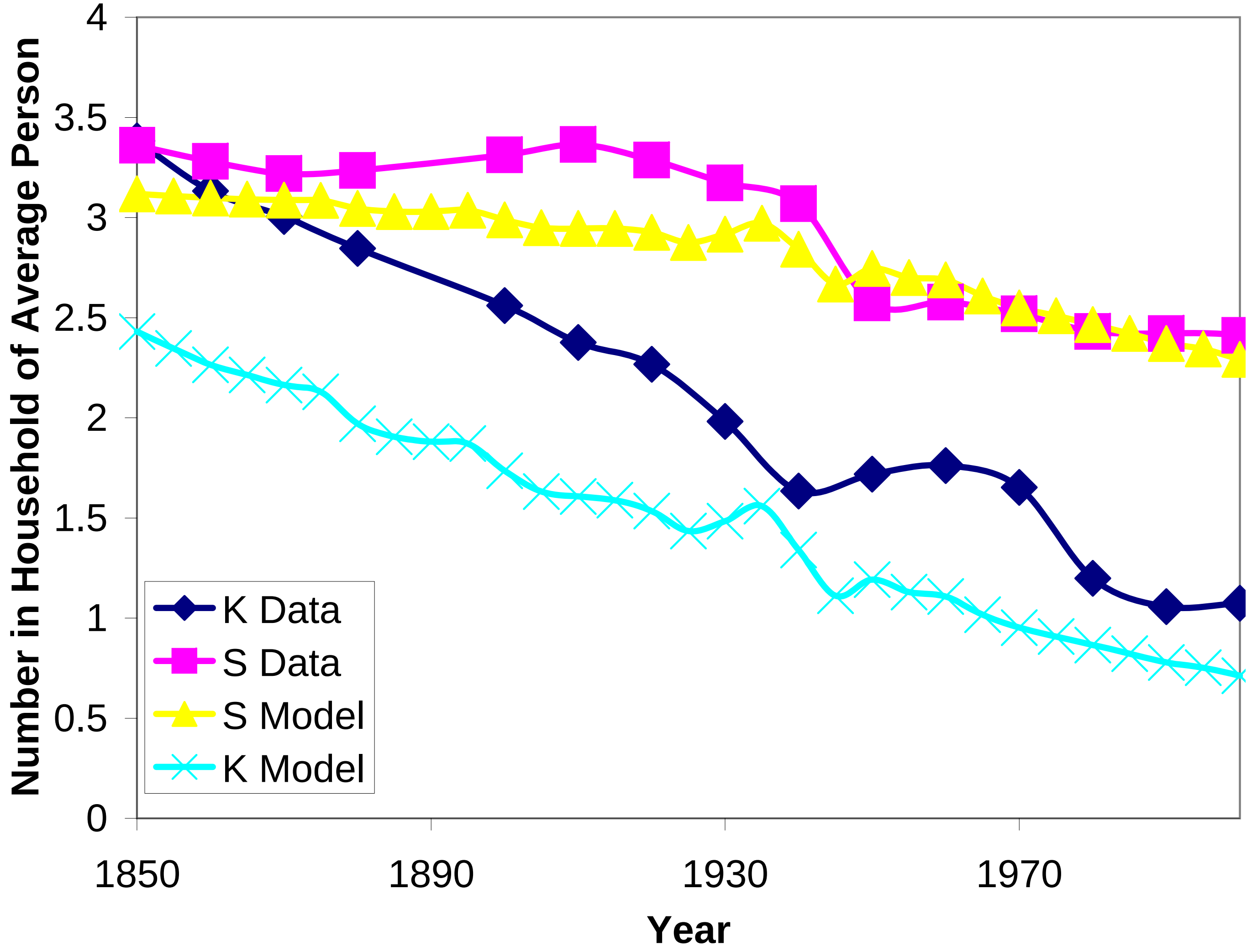
* among 25-29 year old adults.


Number in Household of Average Person
3.5
3
2.5
2
1.5
1
0.5
0
20-24
30-34
40-44
50-54
60-64
70-74
Age
S Data
S Model
K Data
K Model



Cross-Section: HH size by (per adult) income quintiles
2000, 25-29 year olds
Size
Quintile
3.5
3
2.5
2
1.5
1
0.5
0
0
1
2
3
4
5
6
Kids (data)
Adults (data)
Kids (model)
Adults (model)

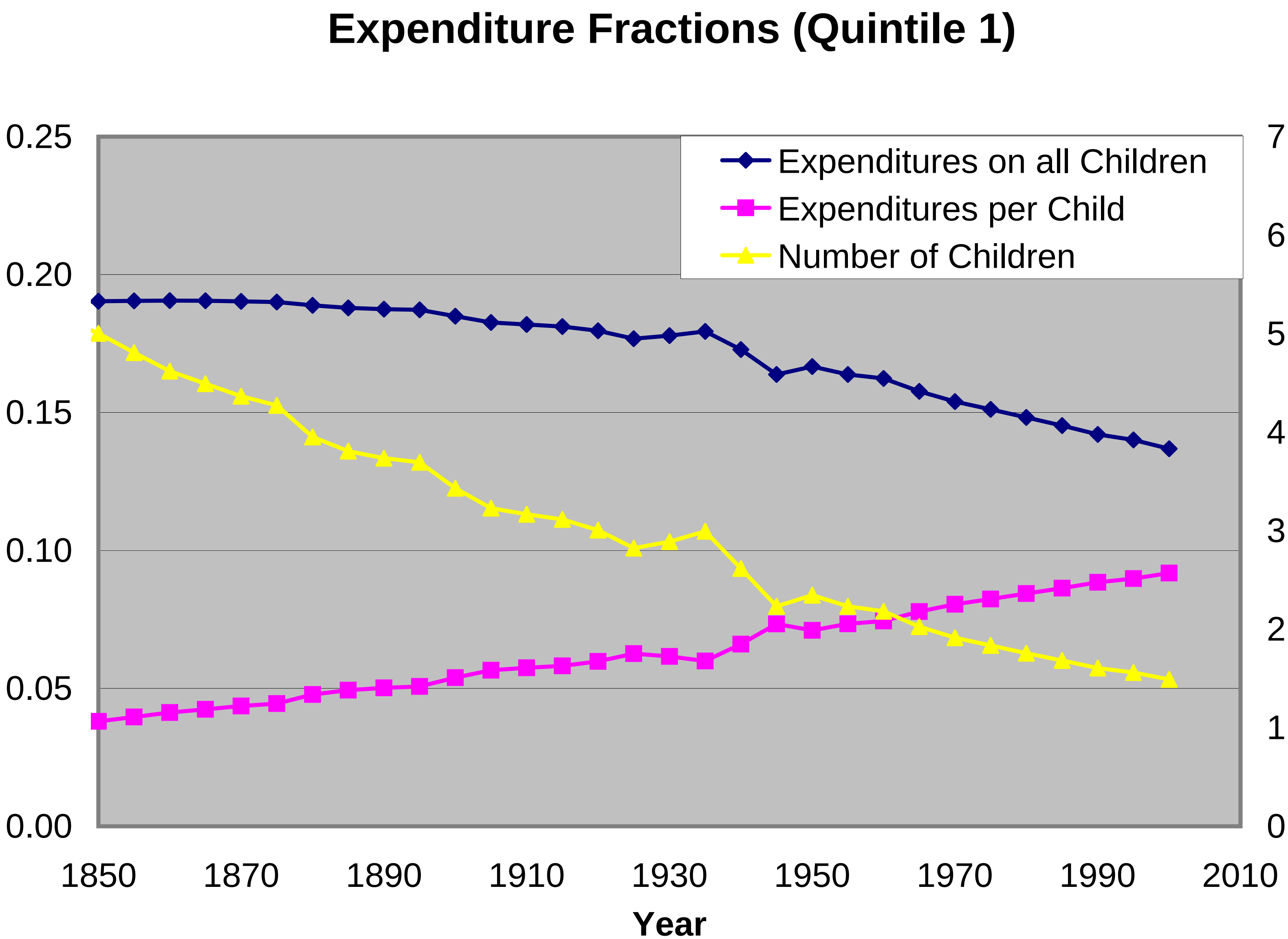
Time Series



Number in Household of Average Person
4
3.5
3
2.5
2
1.5
1
0.5
0
1850
1890
1930
1970
Year
K Data
S Data
S Model
K Model

Intuition for Asymmetry in Adults vs. Children

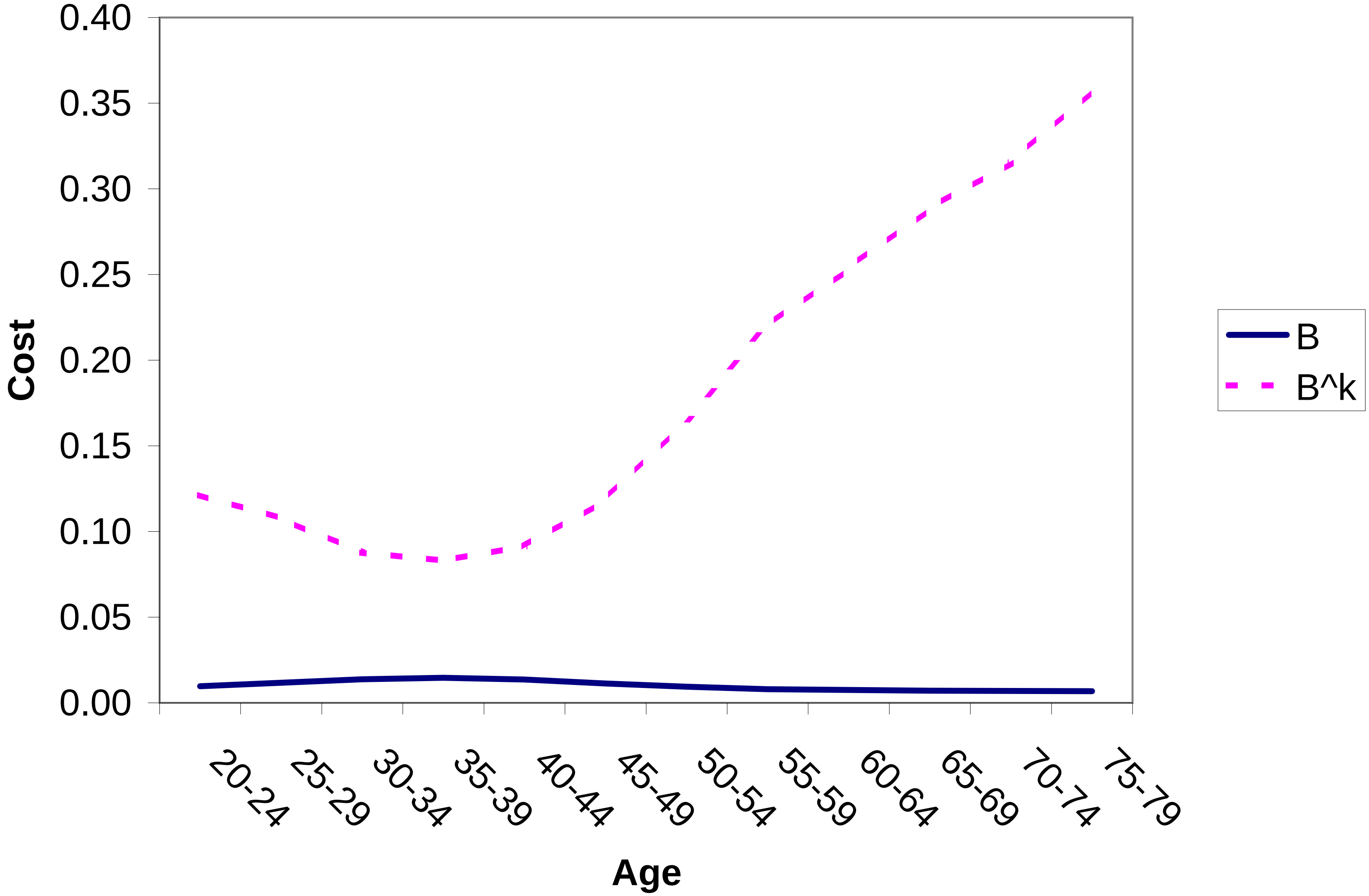
- Note: children are also a public good
- As incomes go up, people choose less public consumption (h) and more private goods (v, v^k).
- This makes children more costly. So k falls.
- Adults share the cost of h and kv^k.
- Initially kv^k does not fall much, which makes it beneficial to have large adult households (to share kv^k expenditures).
- Eventually k has fallen so much that kv^k falls and adult household size falls too.


Expenditure Fractions (Quintile 1)
0.25
0.20
0.15
0.10
0.05
0.00
7
6
5
4
3
2
1
0
Expenditures on all Children
Expenditures per Child
Number of Children
1850
1870
1890
1910
1930
1950
1970
1990
2010
Year

Conclusion

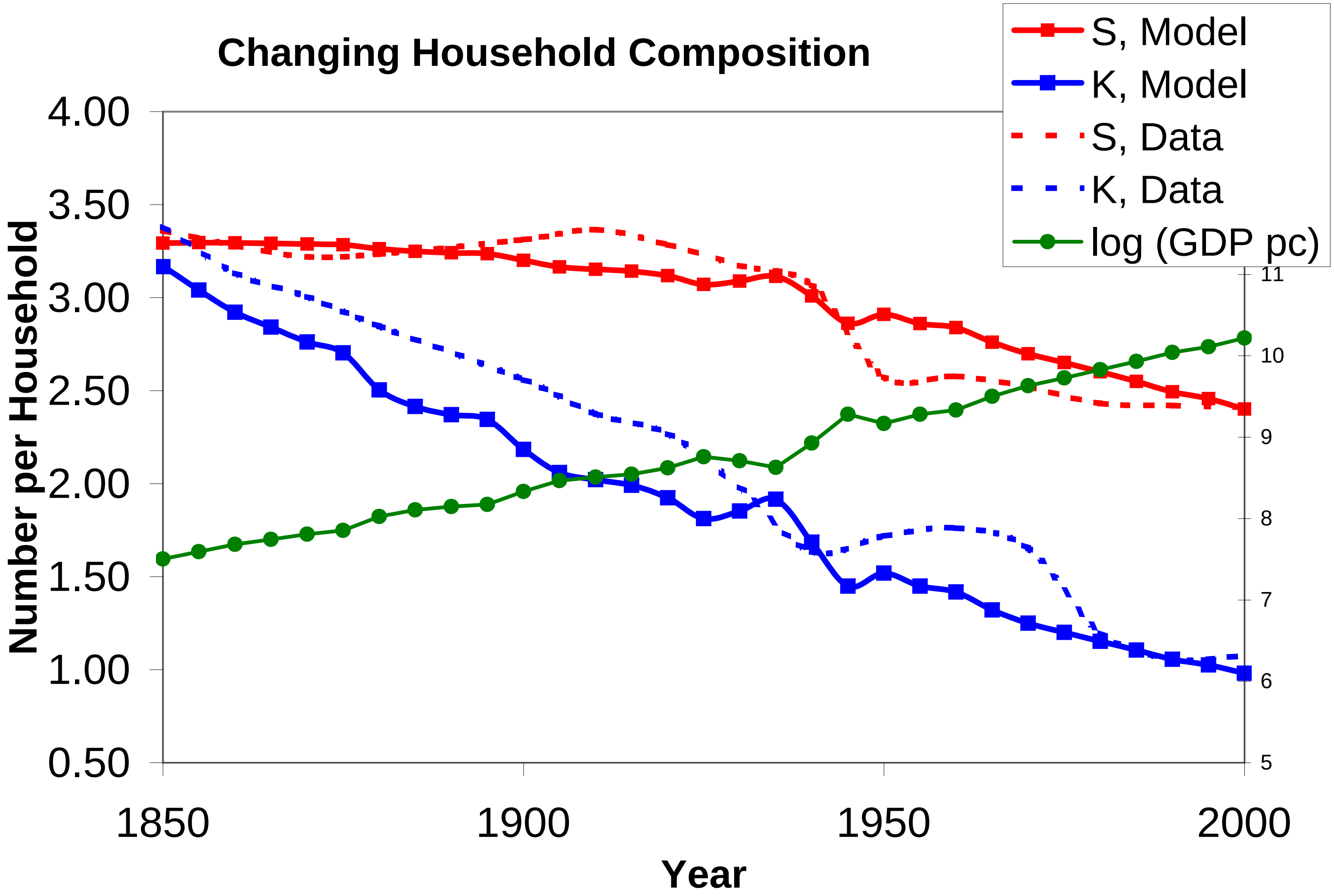
- Data – Household size decline along many different margins: adults, children, non-family living together, different ages, ...
- This paper – Explores possibility of one common driving force behind these (seemingly unrelated) changes.
- Story
  - Income growth leads people to want to buy more private goods (health, movie tickets, restaurant meals, ...).
  - This endogenously decreases the benefits of (a) sharing a household with other adults and (b) having children.
- Model does fairly well in replicating data quantitatively.

Figure 1: Time Costs of Family Members



Calibrated Parameters

Parameter	α	δ	ω	σ	ϕ	Ω
Value	0.5521	0.0795	1.68×10^{-5}	9.5176	0.6592	0.0011


Changing Household Composition
S, Model
K, Model
S, Data
K, Data
log (GDP pc)
Number per Household
Year
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
1850
1900
1950
2000
11
10
9
8
7
6
5

First Order Conditions

$$v(\tau, a, i): \qquad \beta^a \omega v(\tau, a, i)^{-\phi} = \lambda(\tau, i) p(\tau + a)$$

$$h(\tau, a, i): \qquad \beta^a h(\tau, a, i)^{-\sigma} = \frac{\lambda(\tau, i) p(\tau + a)}{s(\tau, a, i)}$$

$$s(\tau, a, i): \qquad B_a z(\tau, a, i) = \frac{h(\tau, a, i)}{s(\tau, a, i)^2}$$

Relationship between h, v and s

$$h(\tau, a, i) = B_a z(\tau, a, i) s^2(\tau, a, i)$$

$$v(\tau, a, i) = \left(\frac{\omega h^\sigma(\tau, a, i)}{s(\tau, a, i)} \right)^{1/\phi}$$

$$s(\tau, a, i) = \left(\frac{p(\tau)}{p(\tau + a)} \beta^a \right)^{\frac{1}{2\sigma - 1}} \left(\frac{B_0 z(\tau, 0, i)}{B_a z(\tau, a, i)} \right)^{\frac{\sigma}{2\sigma - 1}}$$