Course Goals

1. Help you get started writing your second year paper and job market paper.

2. Introduce you to macro literatures with a strong empirical component and the datasets used in these literatures.

Towards those goals:

- Problem sets
- Class discussion
- Final Paper/Presentation

Course Outline

1. Income and consumption inequality; time use and home production.
2. Regional economics
3. Structural transformation
4. Firm dynamics
5. Impact of uncertainty on output and investment.
6. Importance of industry/firm-specific shocks for aggregate fluctuations.

What good are micro data for macroeconomics?

1. Heterogeneity among individuals is a topic of interest (e.g., Heathcote et al., 2010).

2. Identify macro models' key parameters.
   - Aguiar et al. (2013): Elasticity of substitution, in preferences, between home-produced goods and market-produced goods (Benhabib, Rogerson, and Wright, 1991)
   - Oberfield and Raval (2014): Elasticity of substitution, in production, between capital and labor.

What good are micro data for macroeconomics?

3. Distinguish between models (e.g., Herrendorf et al., 2013: Why do certain industries grow or shrink as countries become richer?).
    - Goods produced by different industries have different income elasticities (Kongsamut et al. 2001).
    - Industries' productivity grow at different rates (Ngai and Pissarides, 2007).
4. Atif Mian's 2012 lecture gives more detail, with an emphasis on finance.
    - Source: http://www.princeton.edu/princeton_initiative/previous-pi/2012/

Notes on Heathcote et al. (2010): "Unequal we stand: An empirical analysis of economic inequality in the United States, 1967-2006"

Research Questions

- How has cross-sectional inequality changed in the US over the last 4+ decades?
- How does our understanding of inequality depend on...
  - the income/consumption measure?
  - the measure of inequality (e.g. variance of log, gini coefficient)?
  - the data source?

Why are these questions important?

- Differences between income and consumption inequality are informative about interesting objects:
  - duration/persistence of random income shocks
  - effectiveness of insurance and public policy mechanisms available to households
- Many datasets, each with their own strengths and weaknesses.
  - Important to know whether the income measures line up.

Current Population Survey (CPS)

- Approx. 150K individuals per year.
- Monthly Sample
  - Individuals surveyed for 4 months, then 4 months a year later.
  - Employment, education, demographic and geographic variables.
  - 1976 to present.
- March Sample
  - Richer data on sources of income, work.
  - 1962 to present.
- Disadvantages: Weak panel dimension. Little info on consumption.

Panel Survey of Income Dynamics (PSID)

- Approx. 5-10K individuals, 1968 to the present.
  - Annual up to 1996; bi-annual beginning in 1999.
- Main advantages:
  - Can track individuals/families over time.
  - Income, asset holding, and demographic data.
- Disadvantages:
  - Not nationally representative (oversamples whites).
  - Little info on consumption, especially early on in the sample
    - Food and housing since '68
    - Education and health care since '99
    - Furnishing, clothing, recreation, transportation since '05

Consumption Expenditure Survey (CEX)

- Approx. 5K individuals.
- Two types: Weekly Diary Survey and Interview.
- Rich data on expenditures on different (approx. 700) categories of goods and services.
- Some data on sources of income, education, demographics.
- How to access:
  - 1980-present: ICPSR
  - 2002-present: BLS Website: http://www.bls.gov/cex/pumdhome.htm
- Disadvantages: Much less geographic info. Missing a large, growing fraction of consumption expenditures.

Survey of Consumer Finances (SCF)

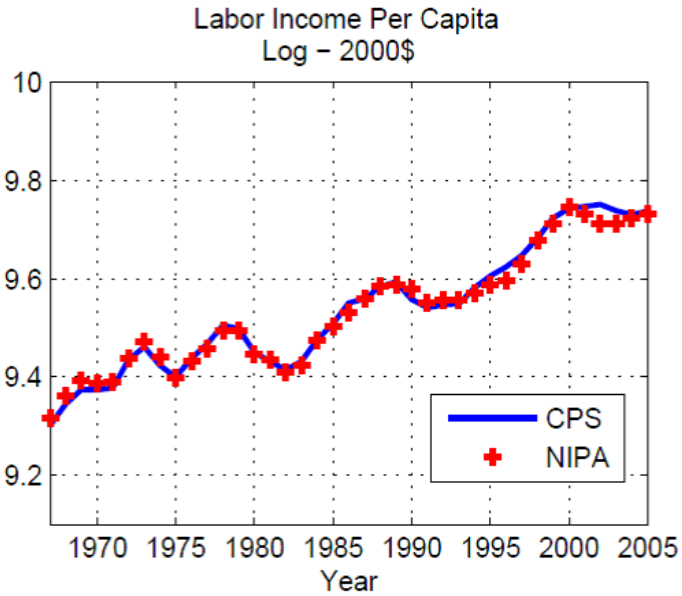
- Approx. 3-7K individuals; rich are oversampled
- 1980s to the present, every 3 years
- Rich data on labor income, loans, asset holdings, income from assets.
- Limited panel dimension (short panels in 1983-89 and 2007-09)

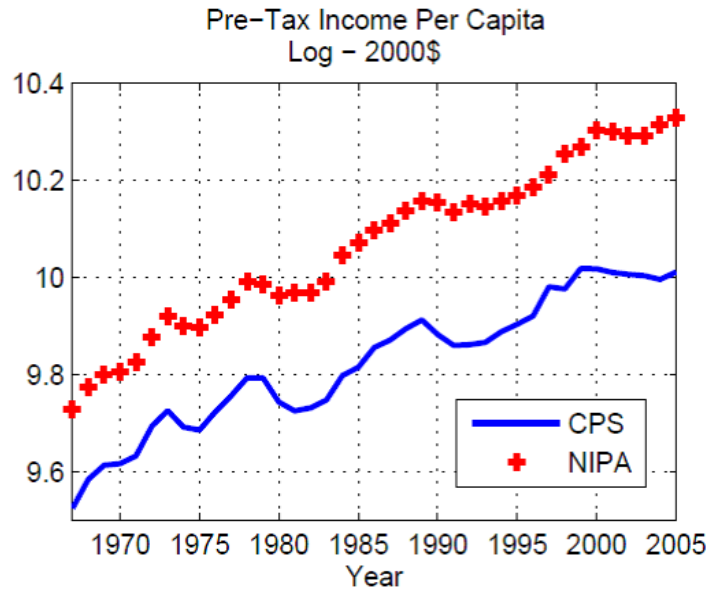
Basis of Comparison

How well do survey aggregates match up to those in the NIPA data?

- National Income and Product Accounts (NIPA) are 7 sets of tables on
  - GDP and its components
  - personal income
  - government income and expenditures
  - foreign transactions
  - saving and investment
  - (labor and capital) income by industry.
  - etc...
- Many data sources: Census, BLS, IRS, Treasury Department, Dept. of Agriculture, Office of Management and Budget.
- Double entry; Adjustments seek consistency across tables.
- Only data on aggregates.

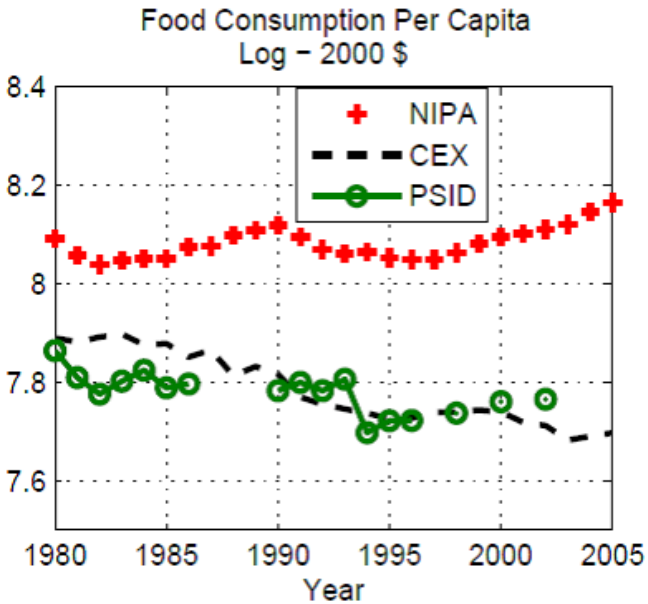
CPS and NIPA match up for labor income, not for pre-tax income

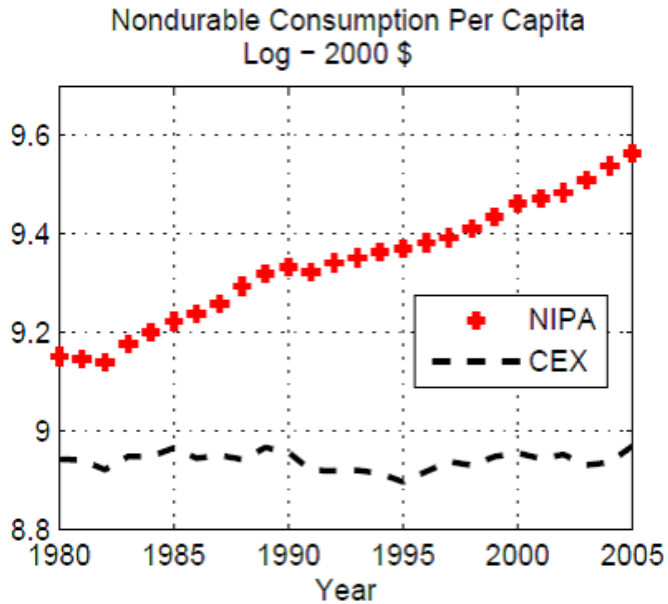




- CPS "misses" in-kind compensation (e.g., employer contributions to pension and health insurance funds).

Discrepancy between aggregate CEX consumption and NIPA consumption is big, increasing.





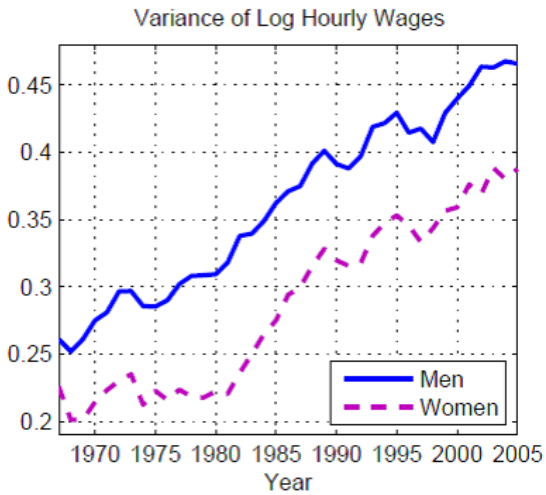
The household budget constraint

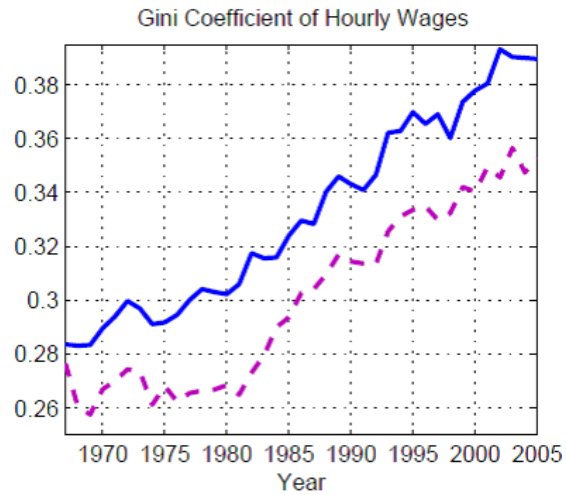
$$c + \left(a' - a\right) = w^{\mathrm{m}} l^{\mathrm{m}} + w^{\mathrm{m}} l^{\mathrm{w}} + y^{\mathrm{Asset}} + t^{\mathrm{Private}} + t^{\mathrm{Govt.}}$$

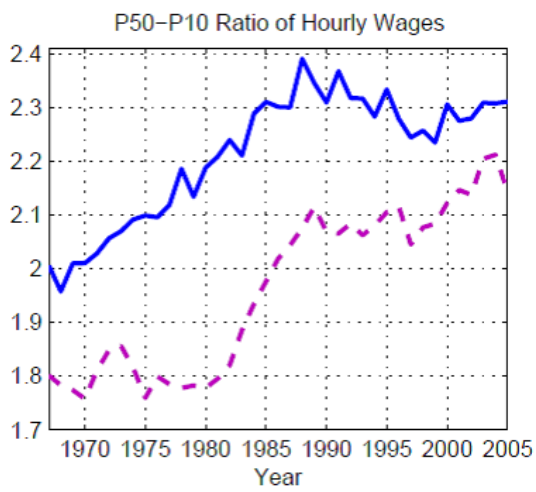
- Several determinants of household consumption inequality:
  - individual labor supply
  - labor income pooling within the family
  - income from asset ownership
  - private transfers
  - government taxes and transfers
- The shares of income from these different income sources, and the correlations across income sources, shape consumption inequality.

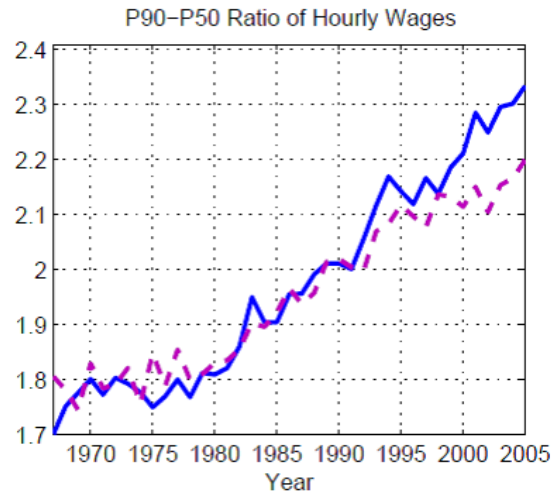
Inequality in hourly wages is increasing.

$$c + \left(a' - a\right) = w^{\mathrm{m}}\ l^{\mathrm{m}} + w^{\mathrm{w}}\ l^{\mathrm{w}} + y^{\mathrm{Asset}} + t^{\mathrm{Private}} + t^{\mathrm{Govt.}}$$



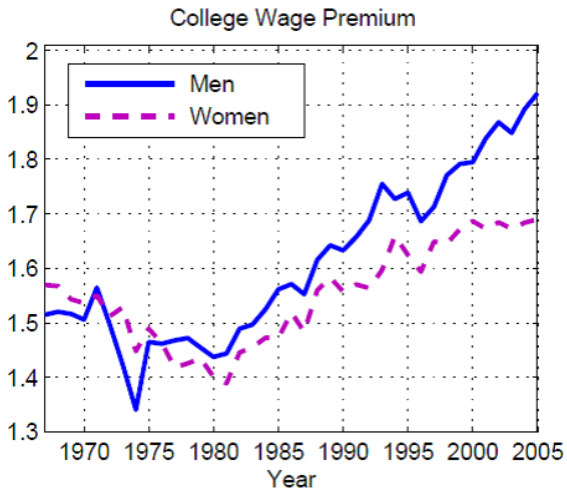


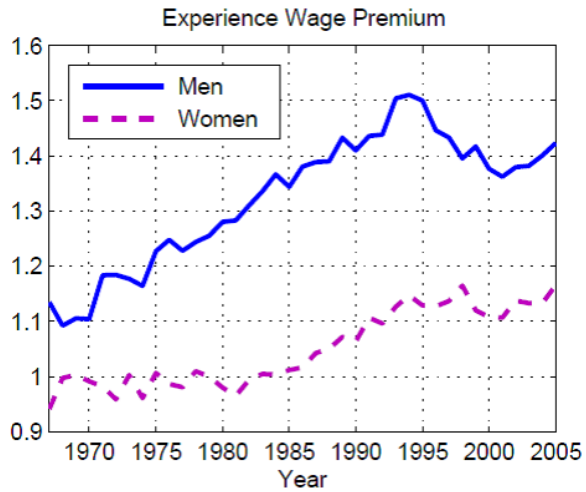


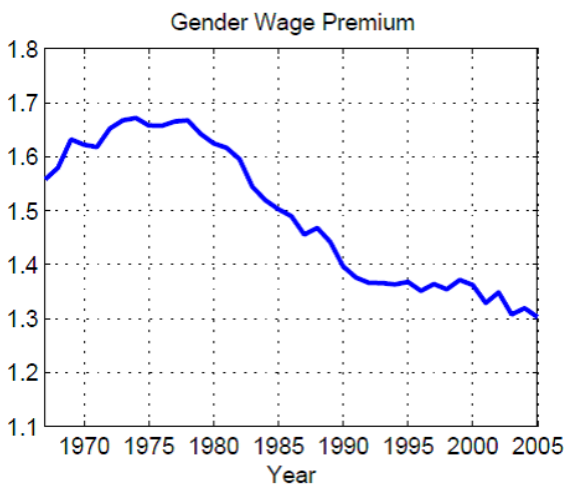


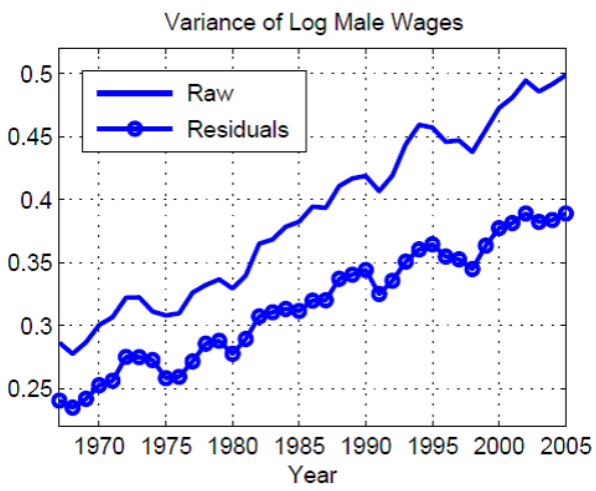
2/3 of the increase is from "residual" income inequality.

$$c + (a' - a) = w^{m} \; l^{m} + w^{w} \; l^{w} + y^{\text{Asset}} + t^{\text{Private}} + t^{\text{Govt.}}$$



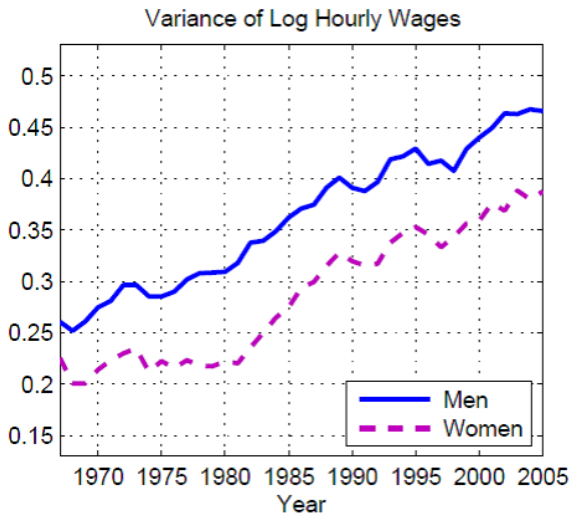


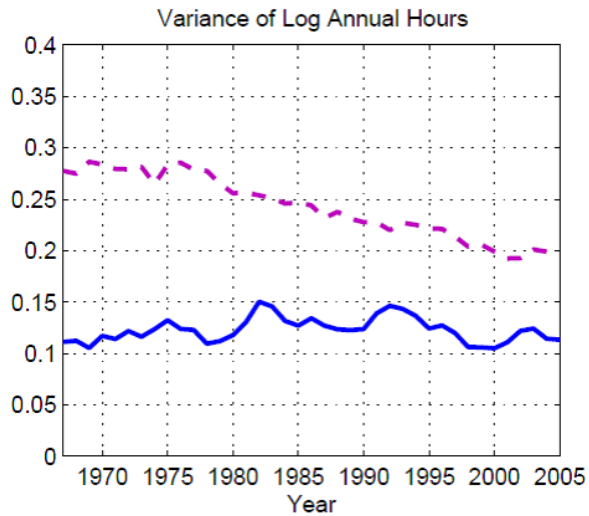


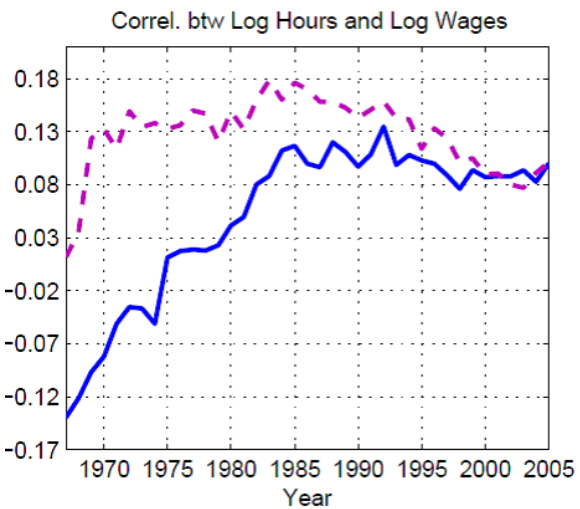


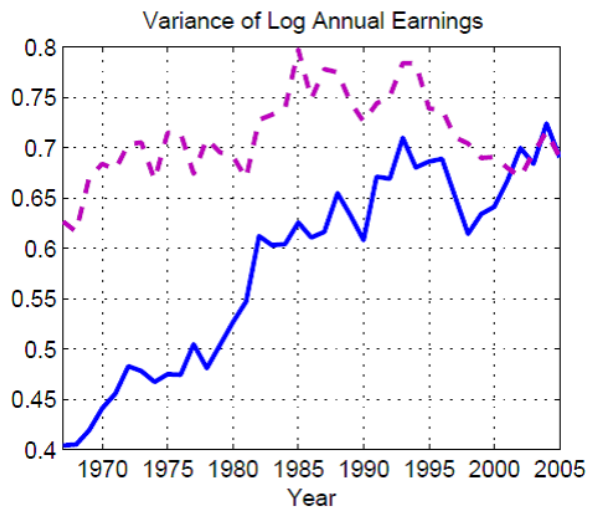
Inequality in labor earnings is increasing for men.

$$c + (a' - a) = w^{m} \; l^{m} \; + w^{w} \; l^{w} \; + y^{\text{Asset}} + t^{\text{Private}} + t^{\text{Govt.}}$$



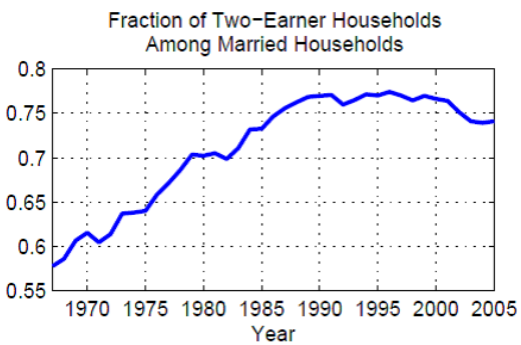


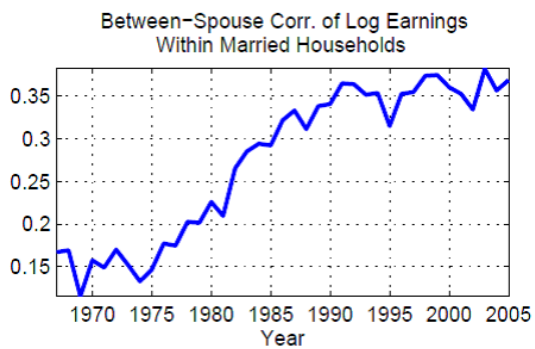




Inequality in household labor earnings is increasing.

$$c + (a' - a) = w^{m} l^{m} + w^{w} l^{w} + y^{\text{Asset}} + t^{\text{Private}} + t^{\text{Govt.}}$$





Inequality in household labor earnings is increasing.

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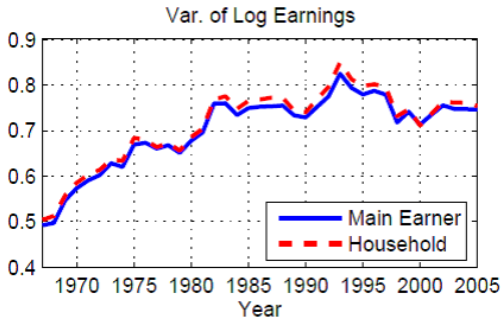
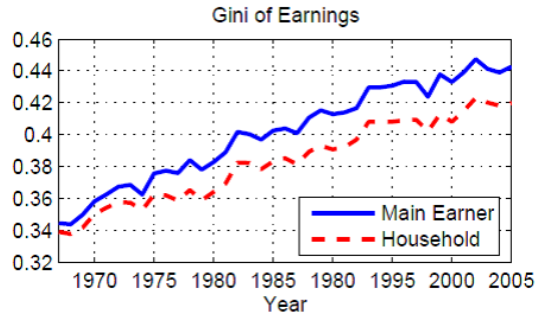
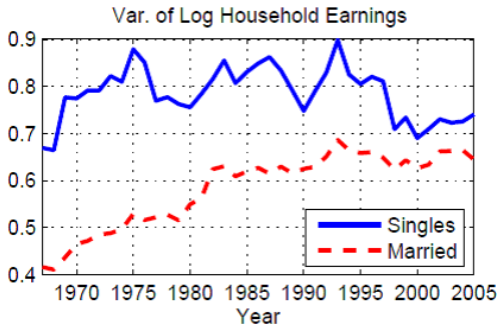
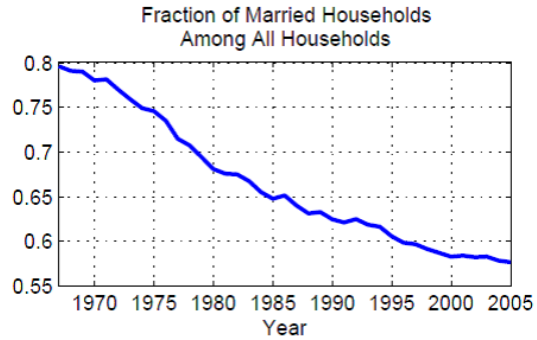
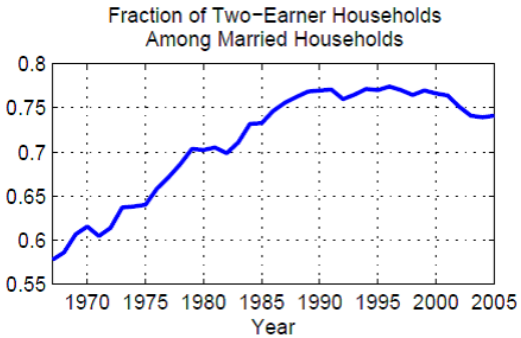
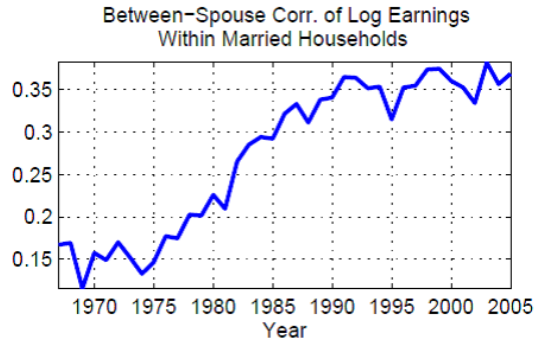






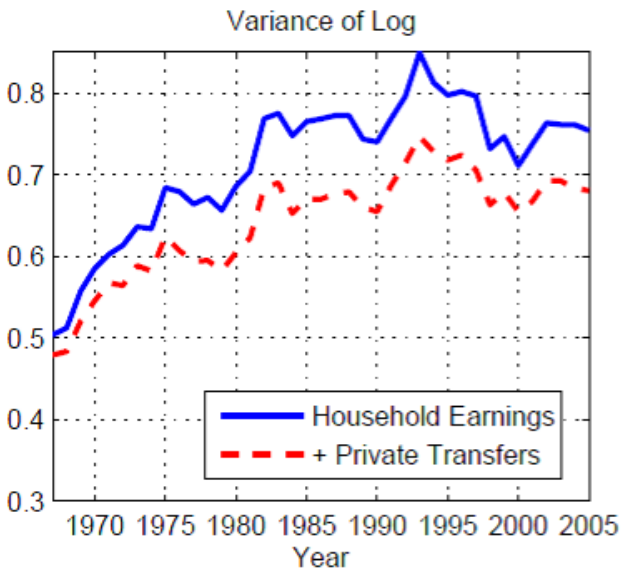


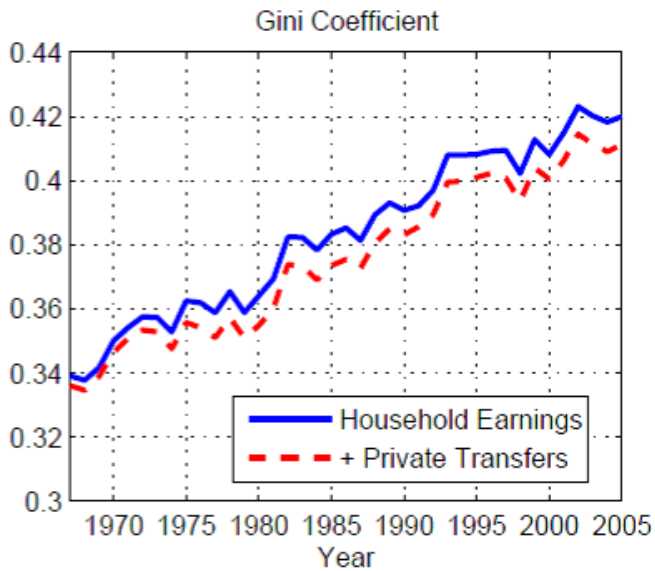




Inequality, when including asset income and private transfers, is lower

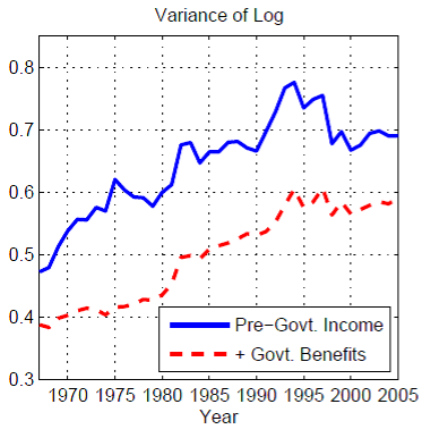
$$c + (a' - a) = w^{m} l^{m} + w^{w} l^{w} + y^{\text{Asset}} + t^{\text{Private}} + t^{\text{Govt.}}$$

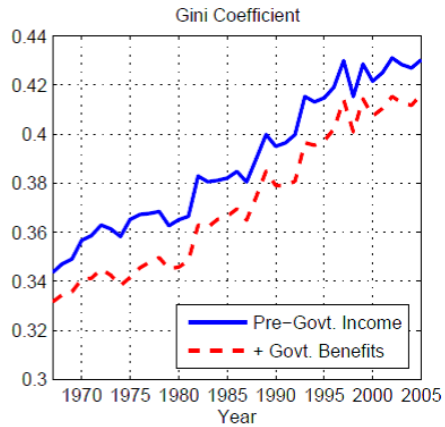


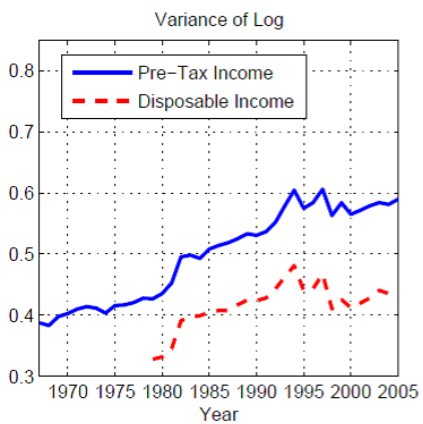


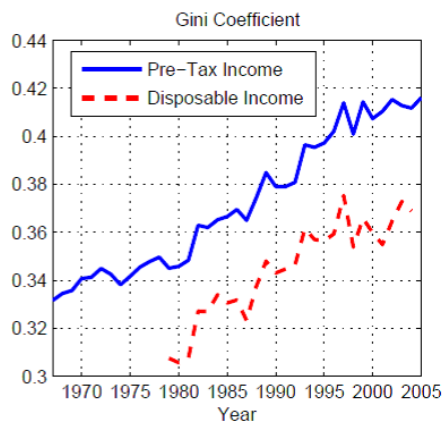
Inequality, when including taxes and government transfers, is even lower

$$c + (a' - a) = w^{m} l^{m} + w^{w} l^{w} + y^{\text{Asset}} + t^{\text{Private}} + t^{\text{Govt.}}$$



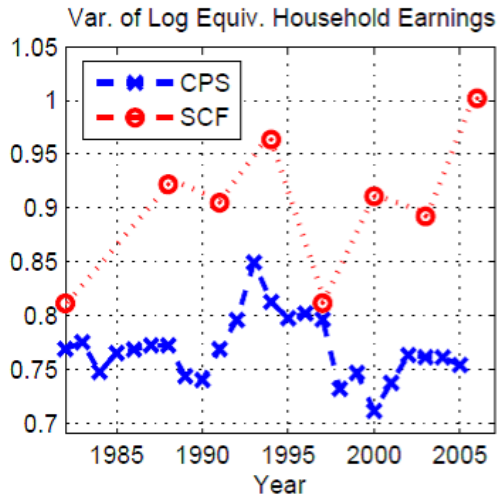


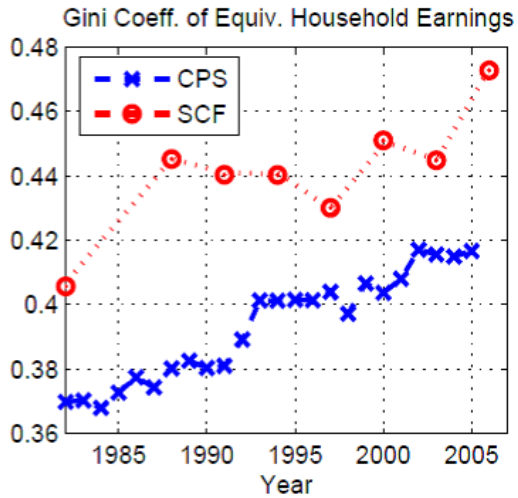


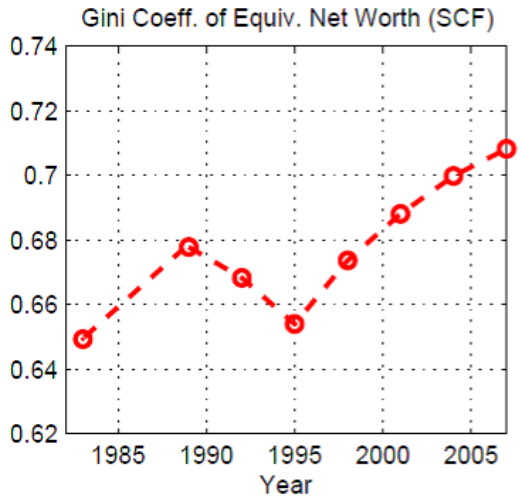


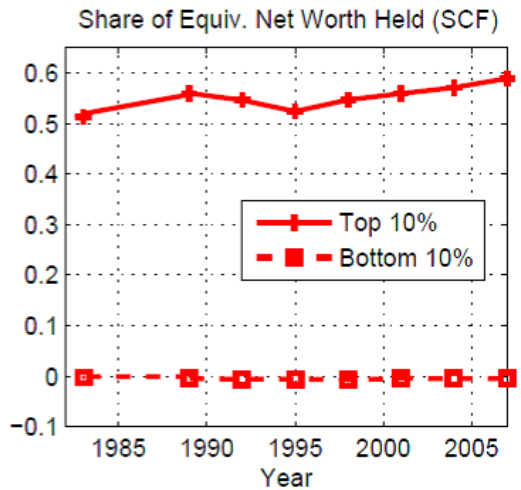
Inequality in wealth is increasing

$$c + \left(a' - a\right) = w^{\mathrm{m}} l^{\mathrm{m}} + w^{\mathrm{m}} l^{\mathrm{w}} + y^{\mathrm{Asset}} + t^{\mathrm{Private}} + t^{\mathrm{Govt.}}$$



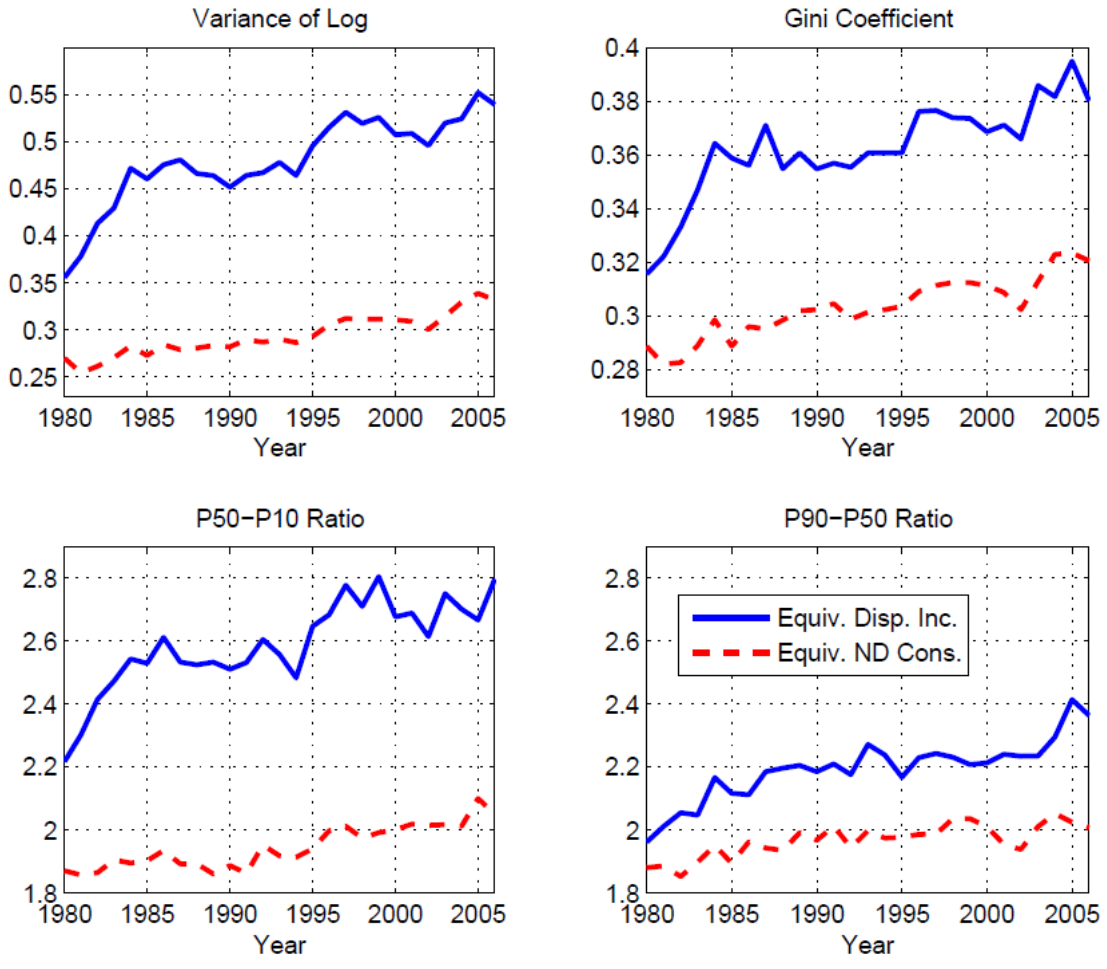






CEX: Inequality in expenditures is relatively flat.

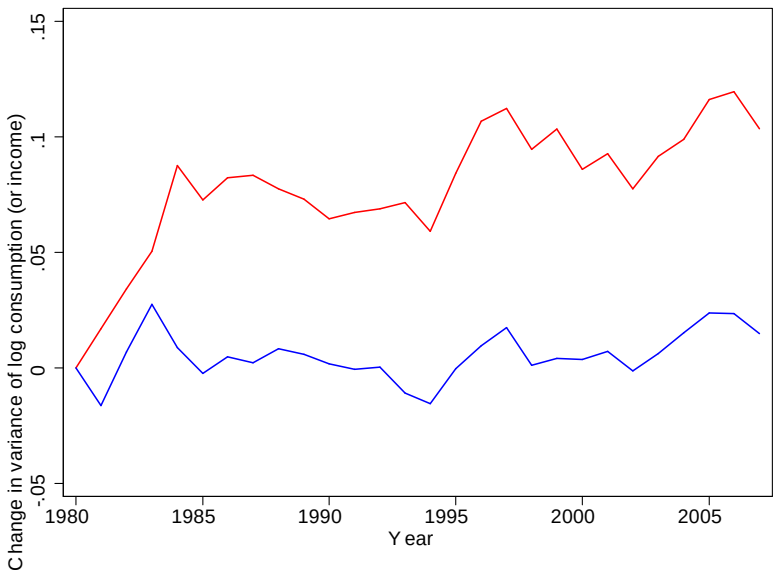
$$c + (a' - a) = w^{m} l^{m} + w^{w} l^{w} + y^{\text{Asset}} + t^{\text{Private}} + t^{\text{Govt.}}$$



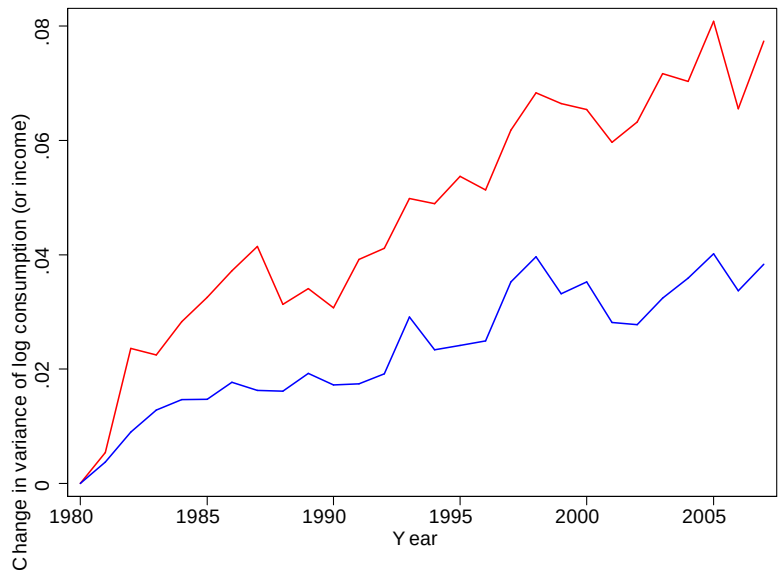
CEX: Between/within group changes in inequality

$$c + (a' - a) = w^{m} l^{m} + w^{w} l^{w} + y^{\text{Asset}} + t^{\text{Private}} + t^{\text{Govt.}}$$

Residual Variance



Between-Group Variance

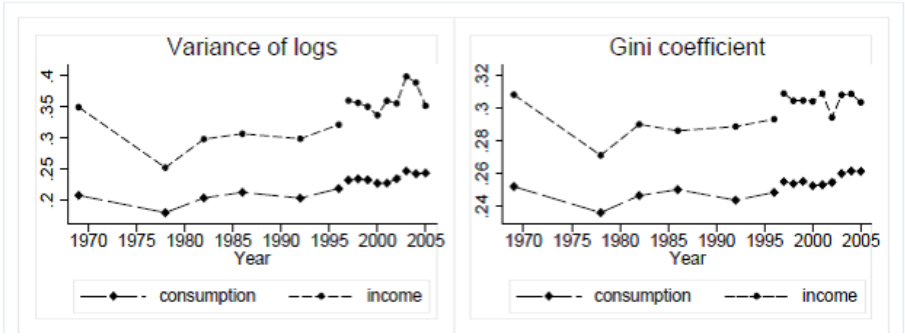


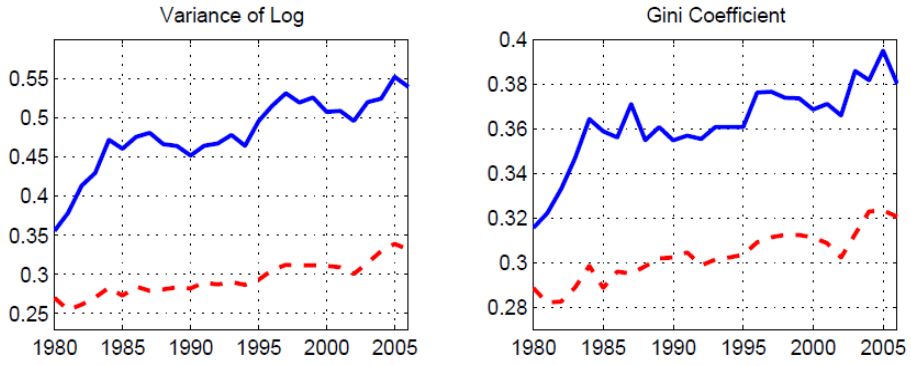
- Income inequality growth is largely *within* group.
- Consumption inequality growth is largely *between* group.
- Krueger and Perri (2006): These patterns are indicative of effective within-group insurance.

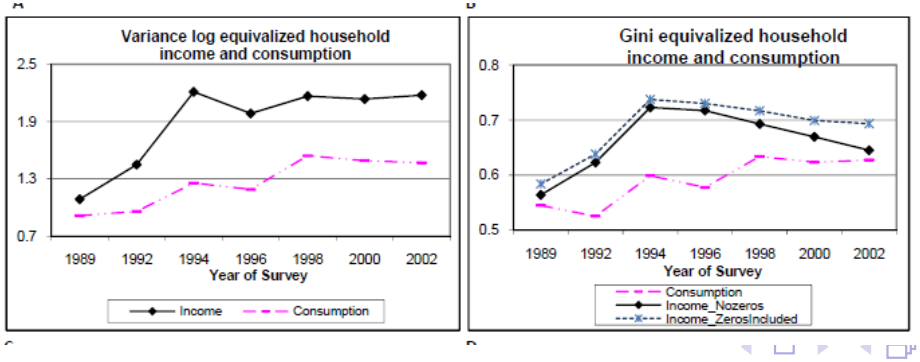
Summary

- Inequality is increasing
  - First half of the sample: both 50-10 inequality and 90-50 inequality
  - Second half of the sample: 90-50 inequality only
- According to the CEX, expenditure inequality increases only a little.
- Trends in earnings inequality are similar in the four datasets we looked at.
- Micro data aggregates (increasingly) miss some components of income and expenditures.
- Also part of the same issue of the *Review of Economic Dynamics*: Analysis of inequality in Canada, GB, Germany, Italy, Spain, Sweden, Russia, Mexico.

Mexican/Canadian consumption inequality is also increasing.

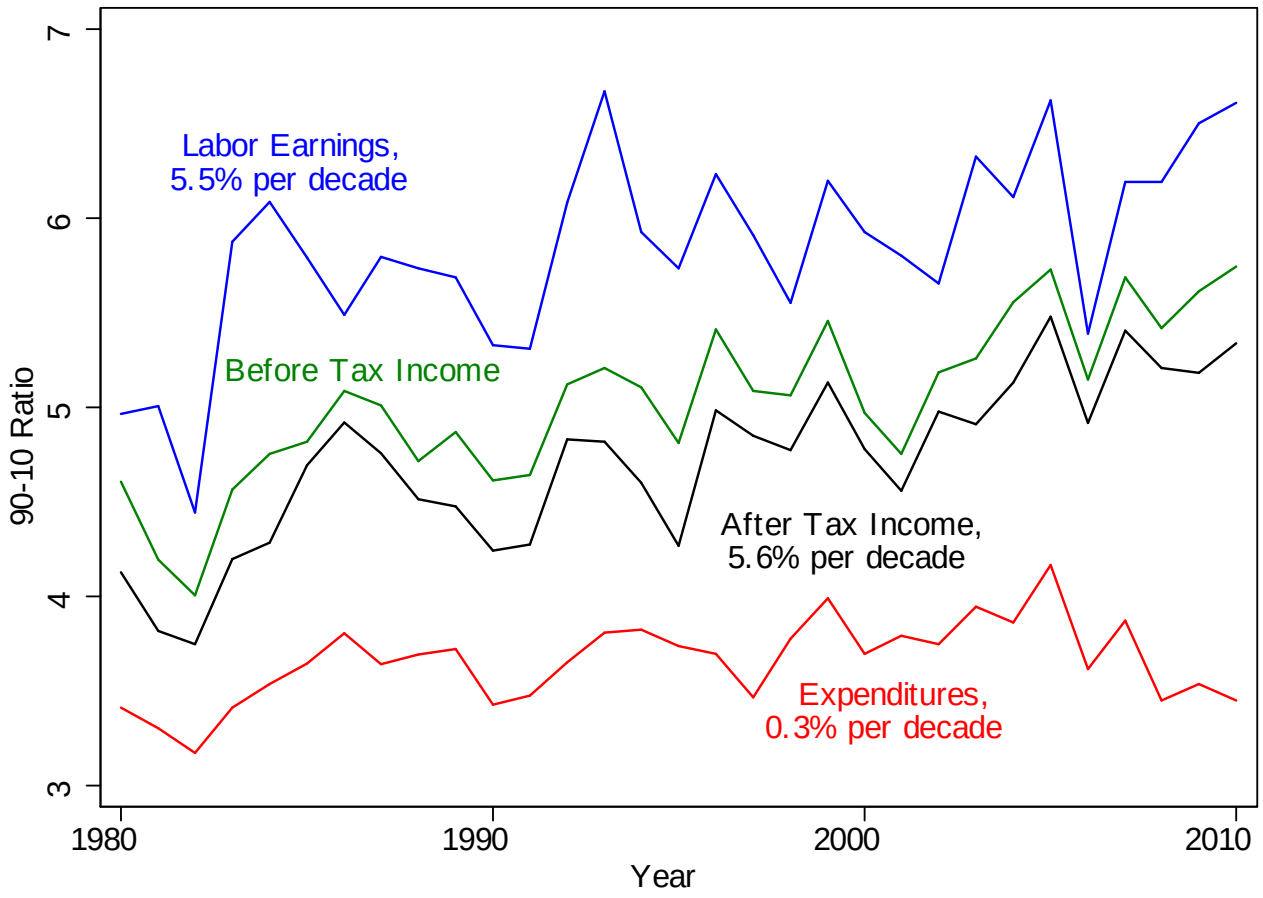




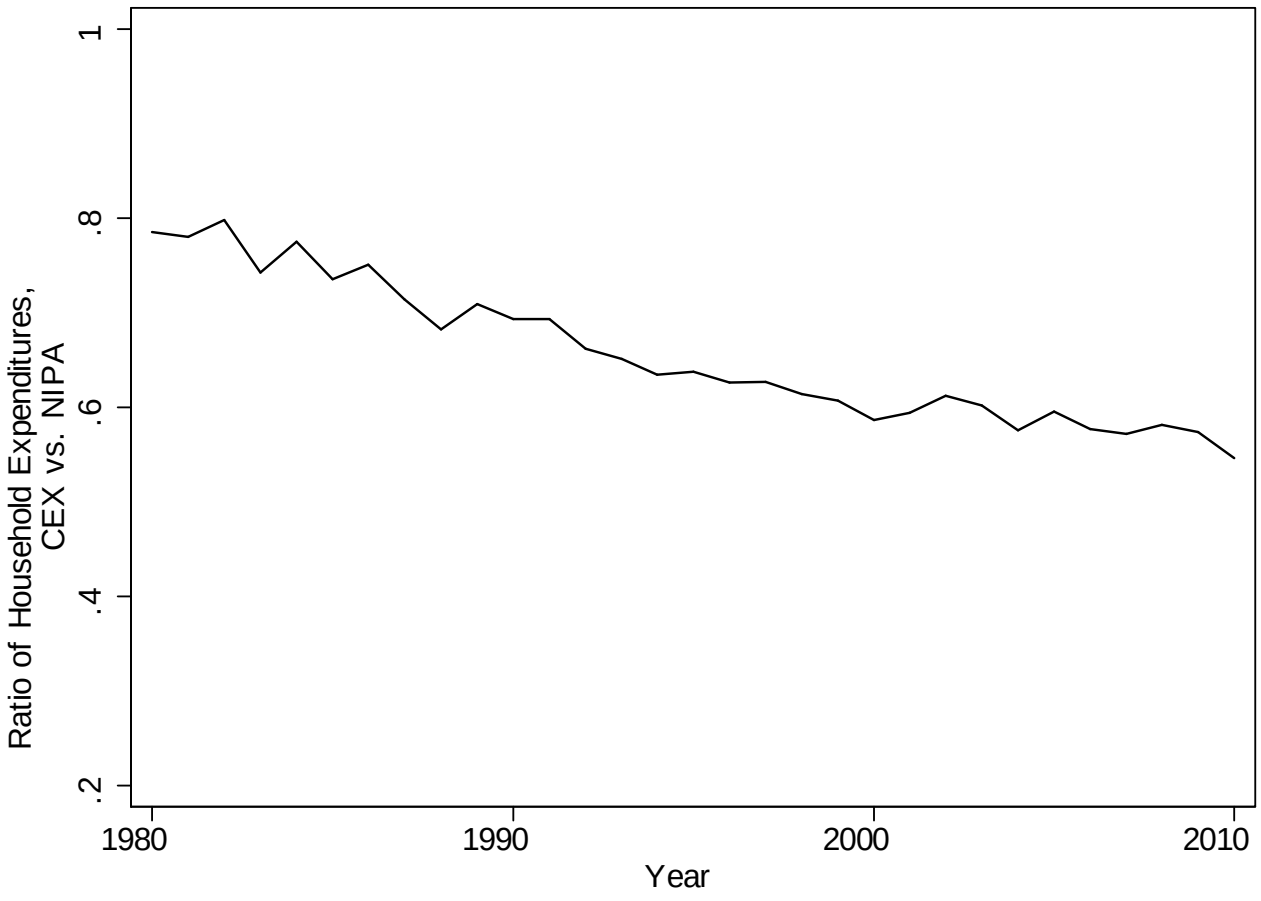


Notes on Aguiar and Bils (2013): "Has Consumption Inequality Mirrored Income Inequality?"

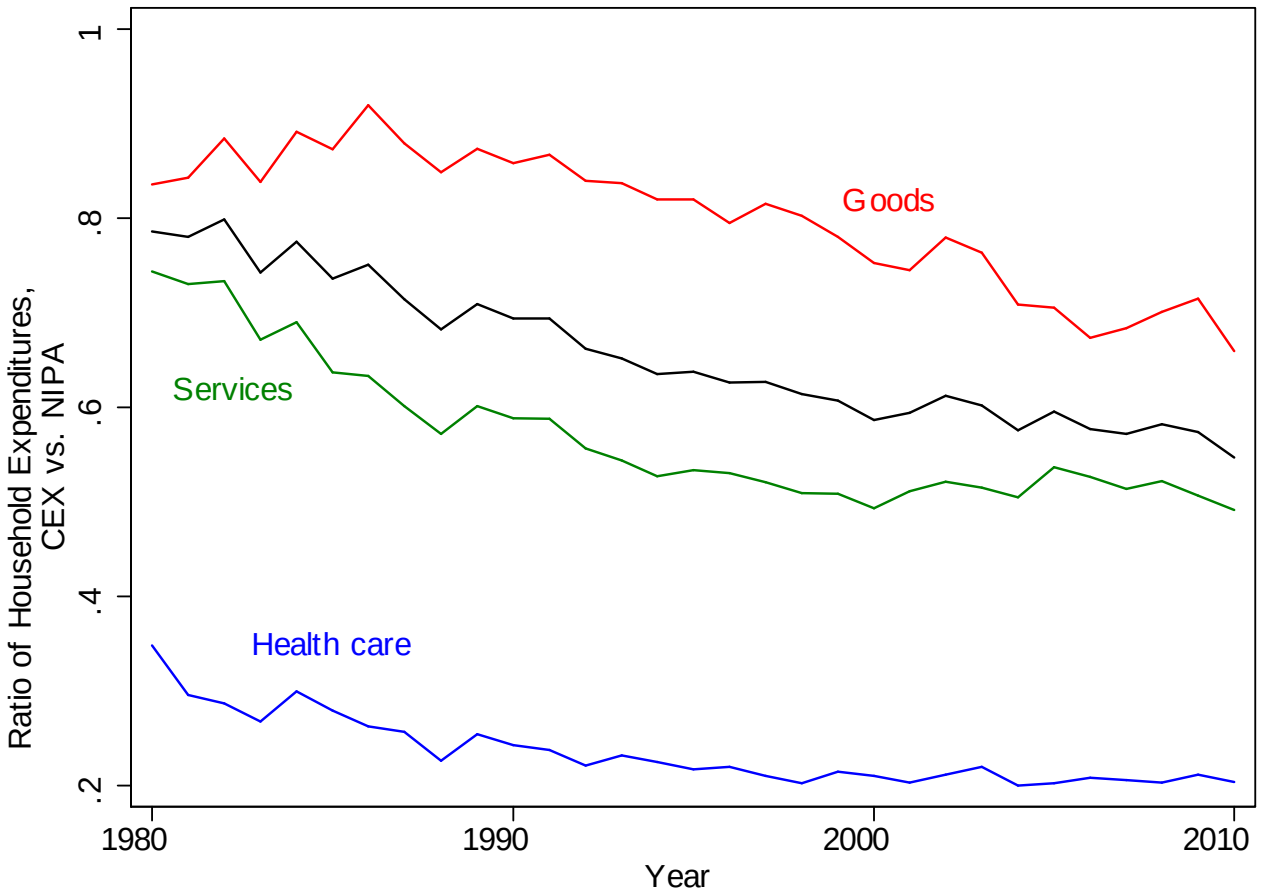
CEX : Consumption inequality is flat



Measurement error is increasing...

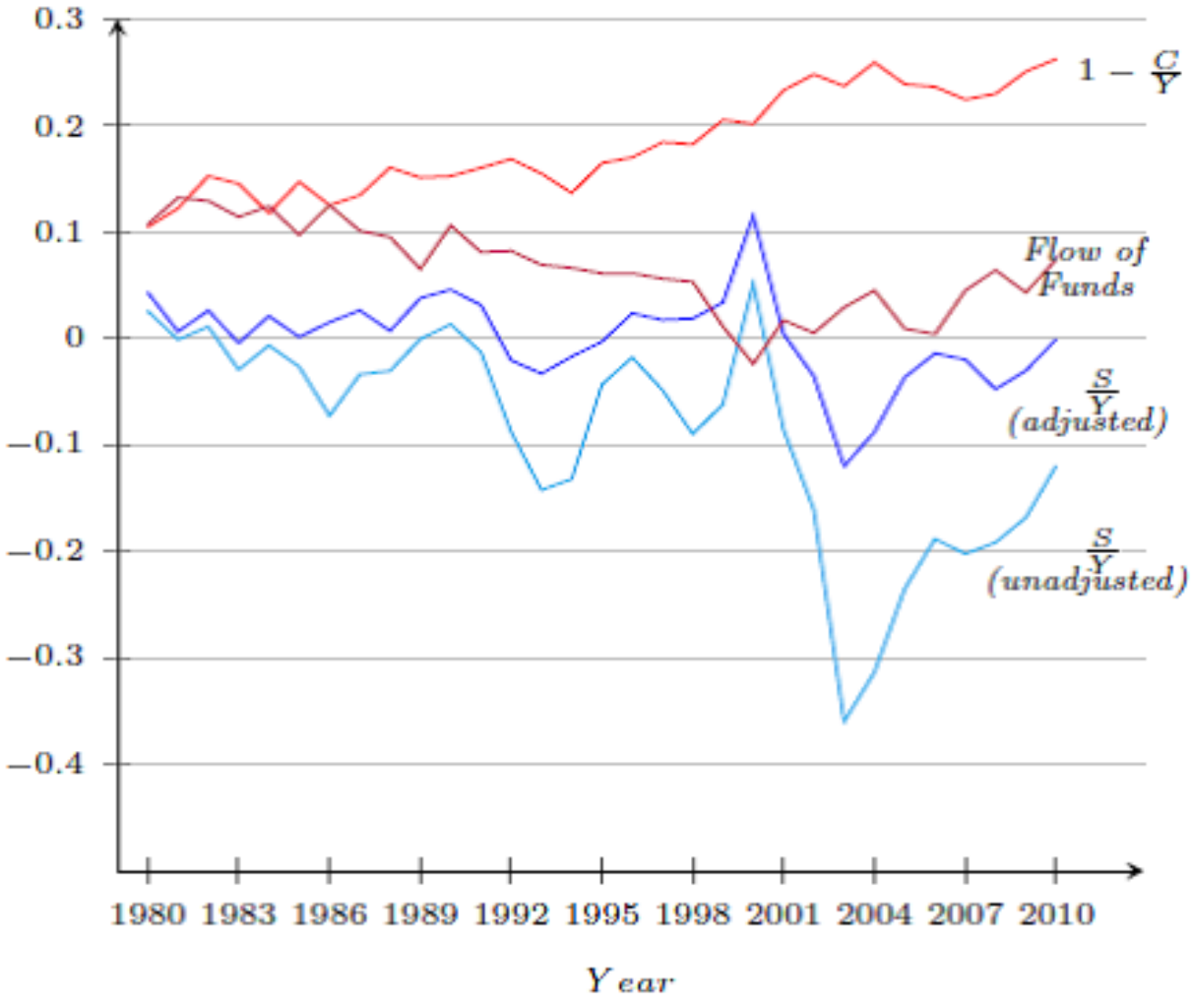


... and heterogeneous across consumption goods



More evidence that consumption is mismeasured

Consumption and Saving Rates



Aguiar and Bils' hypothesis

- Hypothesis: Measurement error accounts for the "missing" increase in consumption inequality.
- Goal: Estimate X_{it}^{*}, "true" expenditures at time t for households with income i. (star=true; no star=measured)

Aguiar and Bils' approach

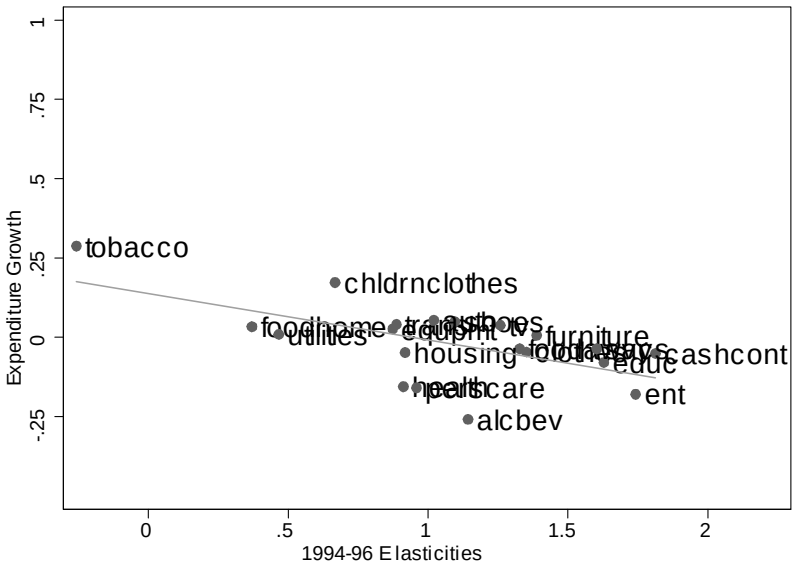
- Goal: Estimate X_{it}^*, "true" expenditures at time t for households with income i.
- Old approach: Measurement error in household expenditures is orthogonal to household characteristics$\Rightarrow$ Dispersion(X_{it}^*)=Dispersion(X_{it})
- Aguiar and Bils approach: x_{hjt} (also X_{ht}) is mismeasured.
  - Allow for measurement error to be income-group-specific and time-specific (these will be "controlled for using fixed effects").
  - Back out true total expenditures by assuming log-linear Engel curves.

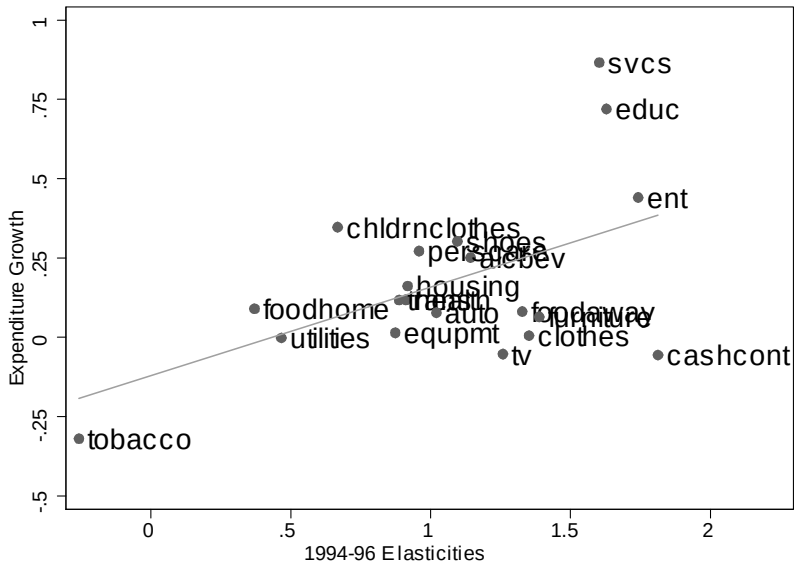
$$\log x_{ijt} = \alpha_{jt} + \phi_t^i + \log X_{it}^* \underbrace{\beta_j}_{\text{dep. variable}} + \epsilon_{ijt},$$

where β_j: expenditure elasticity of good j; (i =income quintile, j =good, h =household, t =time)

Growth of expenditures for high and low income groups

$$\log x_{ijt} = \alpha_{jt} + \phi_t^i + \log X_{it}^* \beta_j + \epsilon_{ijt} \tag{1}$$





- Left: $\log\left(\frac{x_{\text{Poor},j,2007}}{x_{\text{Poor},j,1980}}\right) = \Delta\alpha_{j,2007-1980} + \log\left(\frac{X^*_{\text{Poor},2007}}{X^*_{\text{Poor},1980}}\right)\beta_j$
- Right: $\log\left(\frac{x_{\text{Rich},j,2007}}{x_{\text{Rich},j,1980}}\right) = \Delta\alpha_{j,2007-1980} + \log\left(\frac{X^*_{\text{Rich},2007}}{X^*_{\text{Rich},1980}}\right)\beta_j$
- Slopes $= -0.15,\ 0.28 \Rightarrow$ Expenditure inequality increases by 43 log points.
- Backing up: How to jointly estimate (1) and the β_j?

Two main assumptions

1. Log-linear Engel curves:

$$\log x^*_{hjt} - \log \bar{x}^*_{jt} = \alpha^*_{jt} + \beta_j \log X^*_{ht} + \underbrace{\Gamma_j Z_h}_{\text{hh characteristics}} + \underbrace{\varphi_{hjt}}_{\text{taste shock}} \tag{2}$$

   - Z_h = number of earners (<2, 2+); household size; age (25-37, 38-50, 51-64)

2. Household expenditures measurement error takes three components:

$$x_{hjt} = x^*_{hjt} e^{\zeta_{hjt}}, \text{ where} \tag{3}$$
$$\zeta_{hjt} = \psi^j_t + \phi^i_t + \upsilon_{hjt}$$

   - ψ^j_t : good-specific measurement error
   - ϕ^i_t : income-group-specific measurement error.
   - Main assumption: υ_{hjt}, φ_{hjt} are orthogonal to household characteristics or β_j .

What does the main assumption rule out?

- Rich start under-reporting luxuries (but not necessities)
  - $\Rightarrow$ corr$(\upsilon_{hjt}, \beta_j) > 0$
  - $\Rightarrow$ slope in figure from two slides ago will be downward biased
  - $\Rightarrow$change in expenditure inequality is also downward biased (we would be understating the rise in consumption inequality).
- Opposite bias if rich tend to underreport necessities rather than luxuries.

First stage: Estimating β

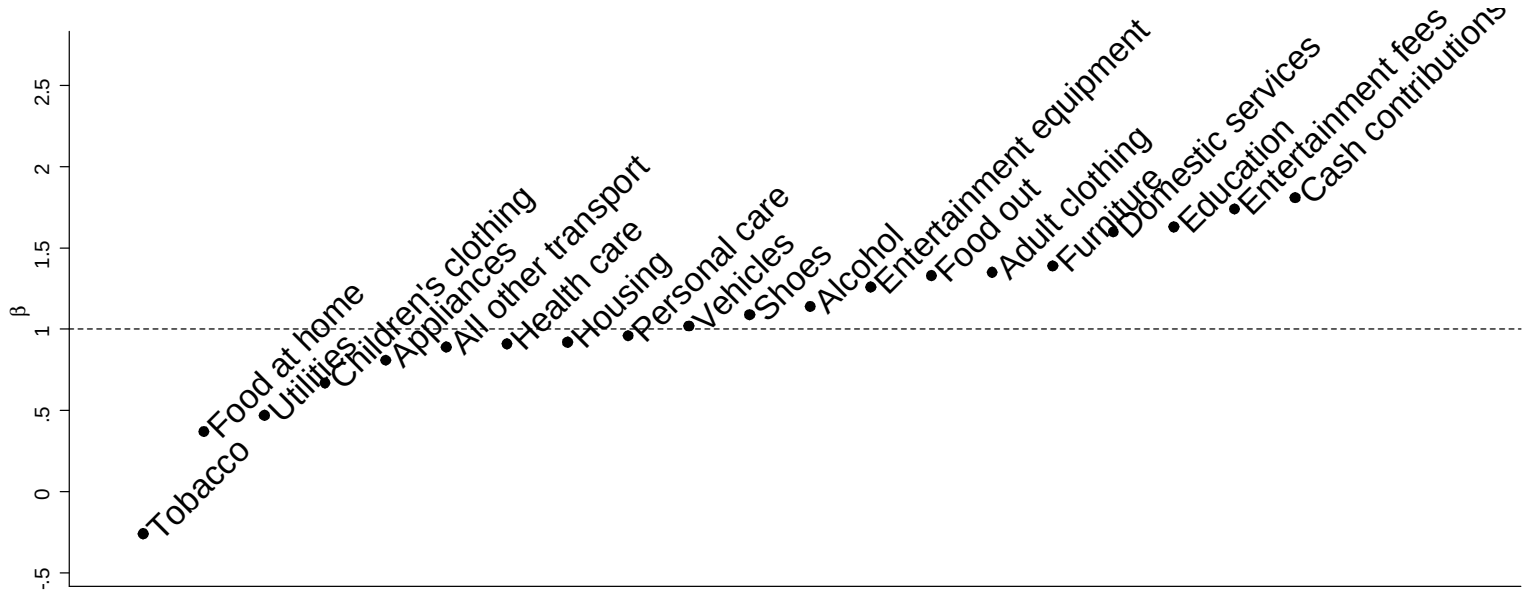
Plug equation (3) into equation (2):

$$\log x_{hjt} - \log \bar{x}_{jt} \approx \tilde{x}_{hjt} \equiv \frac{x_{hjt} - \bar{x}_{jt}}{\bar{x}_{jt}} = \alpha_{jt} + \beta_j \log X_{ht} + \Gamma_j Z_h \quad (4)$$
$$+ \underbrace{\varphi_{hjt} + \psi_t^j + \phi_t^i + \beta_j \left(\log X_{ht}^* - \log X_{ht}\right)}_{u_{hjt}}$$

- Key challenge: Measurement error in individual goods, φ_{hjt}, will be correlated with $\log X_{ht}$ term in the first line.
- Solution: Instrument $\log X_{ht}$ with $\log X_{ht'}$ or $\log I_{ht}$
  - Measurement error, for a given household-good, is independent across periods.
  - $\log X_{ht'}$ will be uncorrelated with measurement error in period t (conditional on all of the other household characteristics).
  - Idea behind $\log I_{ht}$ instrument: Consumption reflects permanent income, which will be correlated with current income, but uncorrelated with the φ_{hjt} measurement error.

First stage: Estimating β

Results



Second stage: Estimating X^*_{ht}

Manipulating Equation (4):

$$\begin{aligned}\tilde{x}_{hjt} - \hat{\Gamma}_j Z_h &= \alpha_{jt} + \phi^i_t + \log X^*_{ht}\hat{\beta}_j + \varphi_{hjt} + \upsilon_{hjt} \\ &= \alpha_{jt} + \phi^i_t + \log X^*_{it}\hat{\beta}_j \\ &+ \underbrace{\varphi_{hjt} + \psi^j_t + \beta_j\left(\log X^*_{ht} - \log X_{ht}\right)}_{\varepsilon_{hjt}}\end{aligned}$$

- Include time-income-quintile dummies (ϕ^i_t) and interactions of $\hat{\beta}_j$ with time-income-quintile dummies.

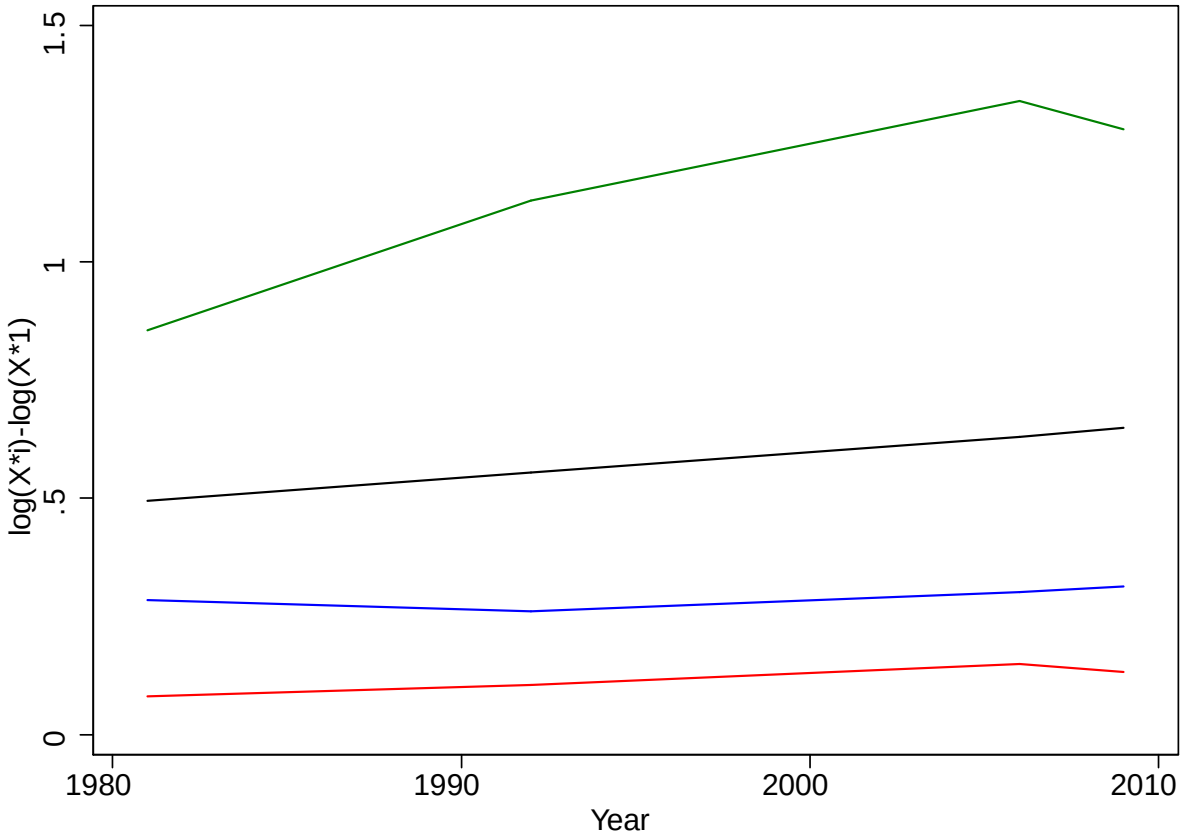
$$\tilde{x}_{hjt} - \hat{\Gamma}_j Z_h = \alpha_{jt} + \phi^i_t + \sum_{i=2}^{5} D_{it}\hat{\beta}_j + \varepsilon_{hjt}$$

- Coefficients on the interaction terms are the estimates of $\log X^*_{it}$ for different income quintiles.

Two details

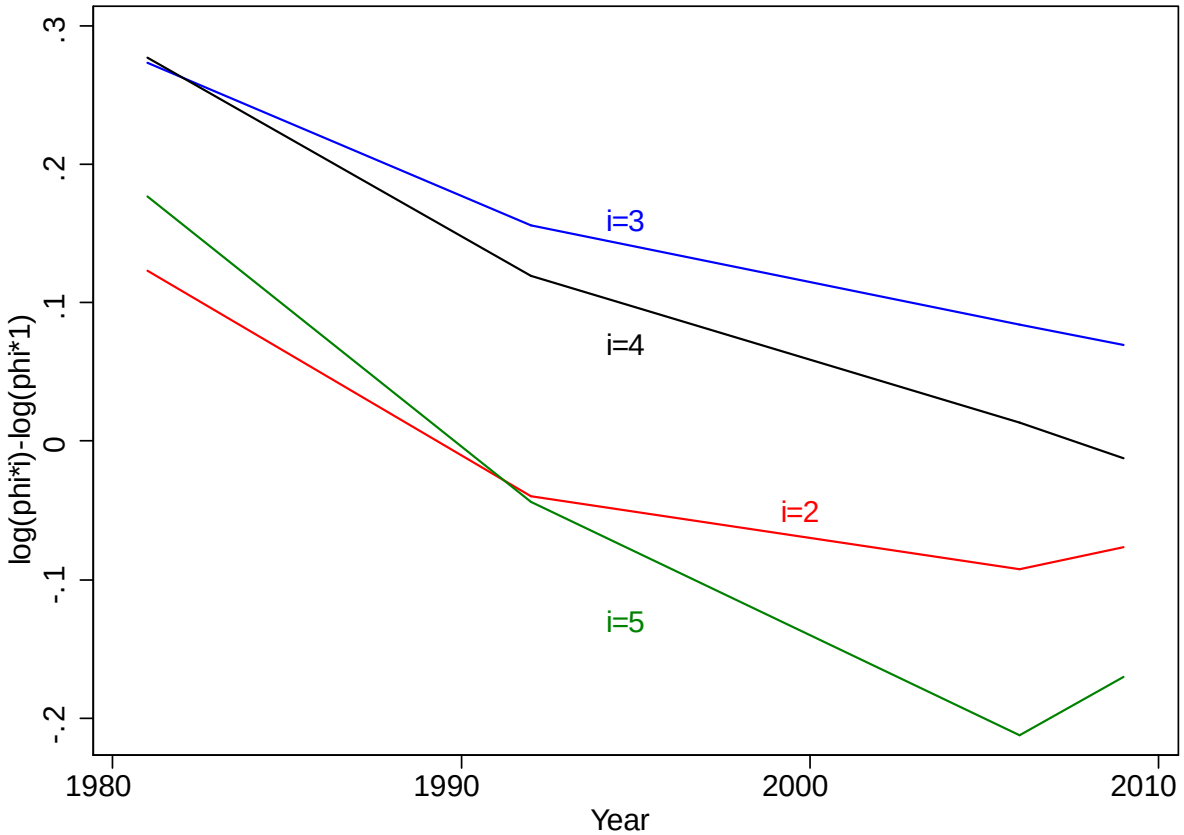
- Can only identify α_{jt} plus four of the five D_{it} dummies. The mean of $\log X^*_{it}$ is unidentified.
  - Normalize $\log X^*_{1t} = 0$. All other X^*_{it} are *relative* to the lowest income quintile.
- $\hat{\beta}_j$ is a generated regressor in the second stage regression (standard errors will be understated) :
  - Use data from first two quarters of interviews in first stage
  - Latter two quarters in second stage.

Expenditure dispersion

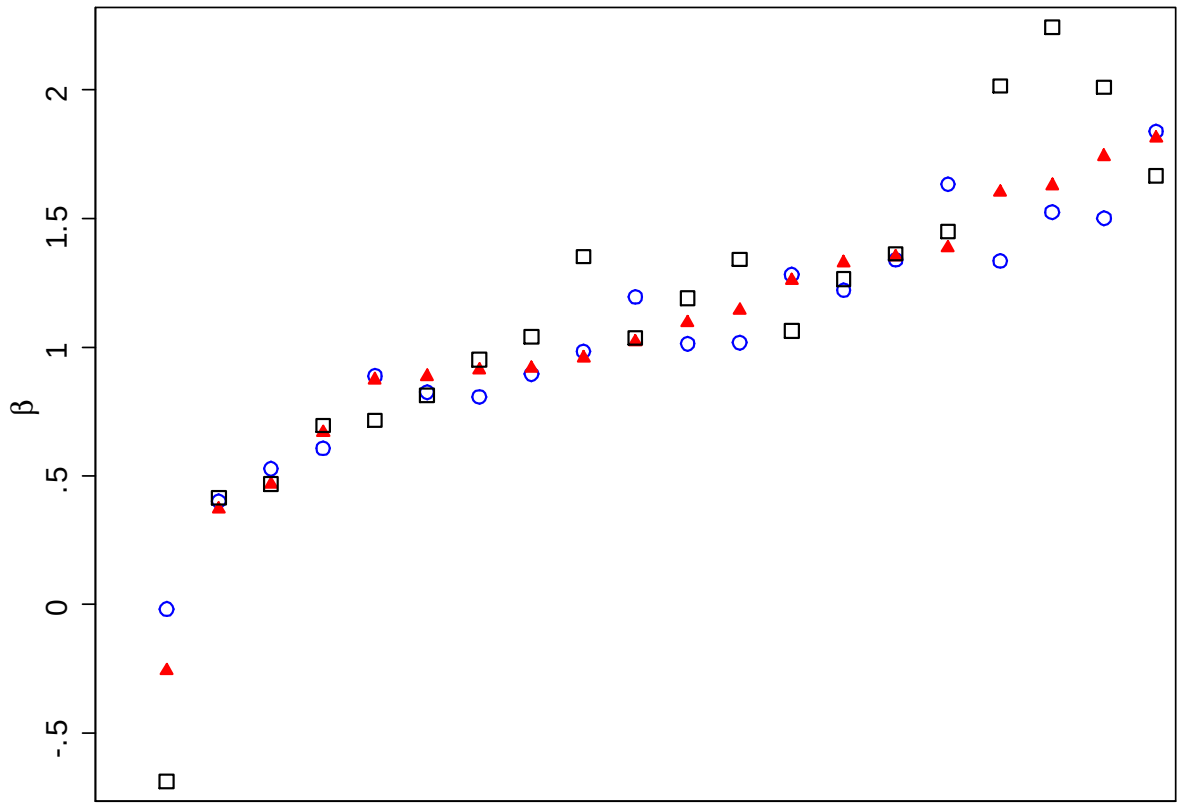


Income-group specific measurement error

$$\log x_{hjt} = \log x^*_{hjt} + \psi^j_t + \phi^i_t + \upsilon_{hjt}$$



Robustness: how much do the β_j vary by year?

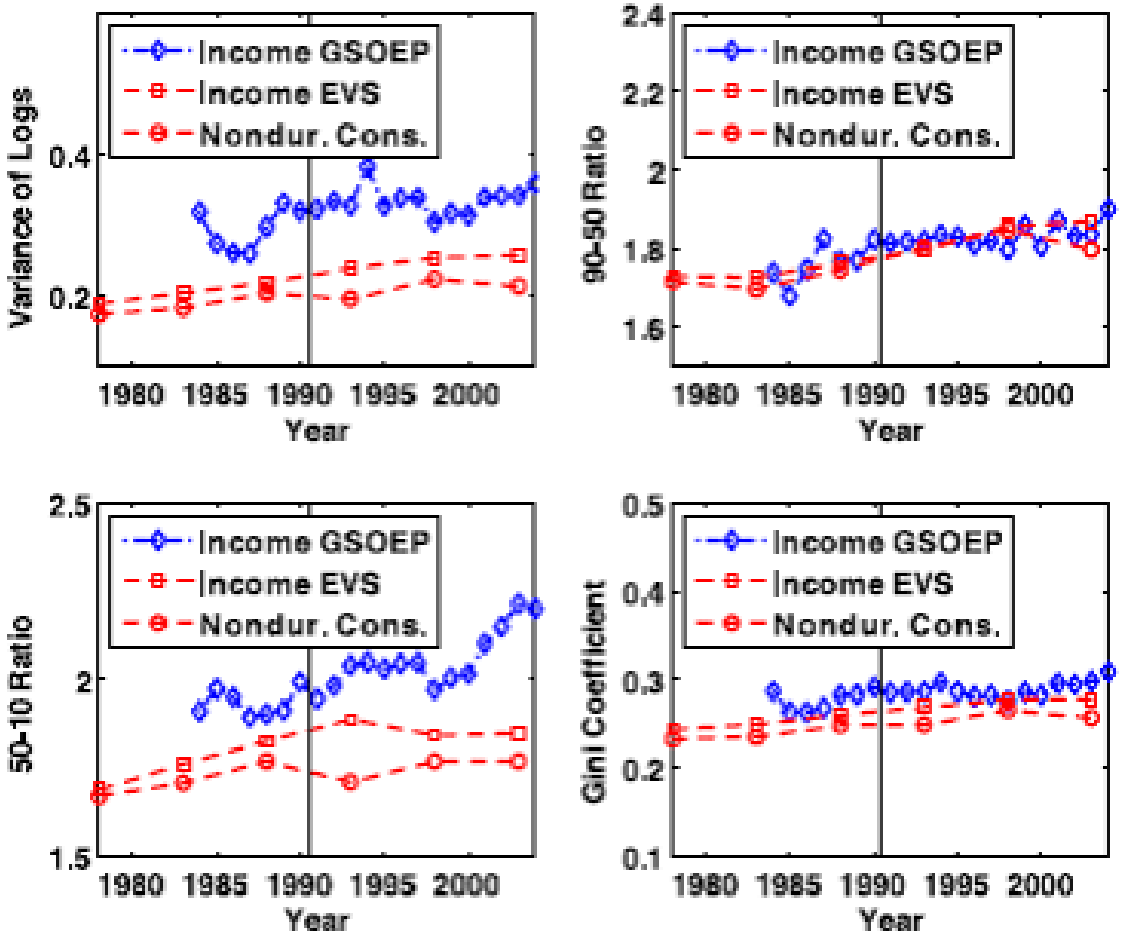


- Increase in 90-10 inequality is similar when using β estimated from 1980-82 (36 log points) or 2008-10 (43 log points).

Conclusion

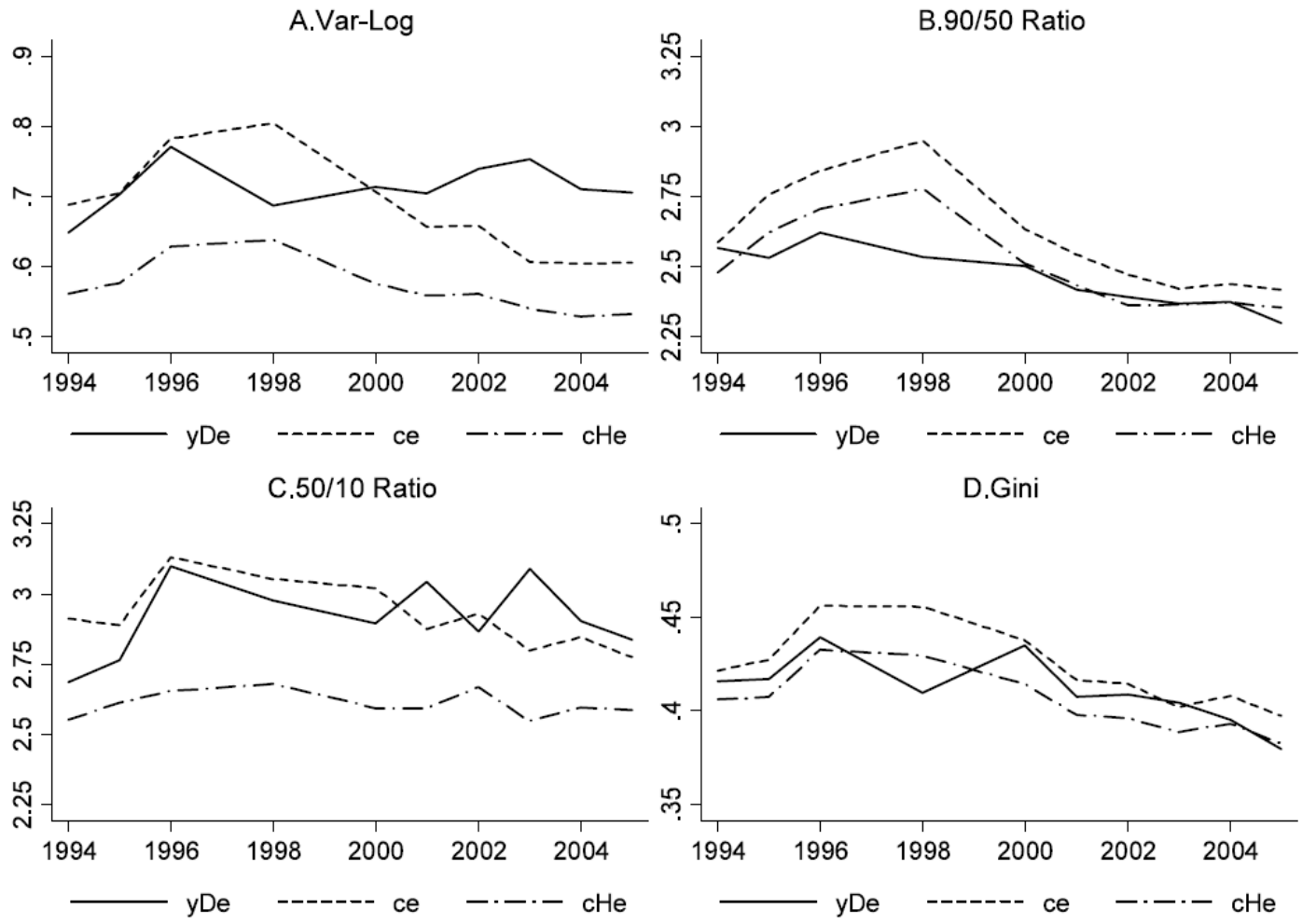
- Big income-group-specific measurement error$\Rightarrow$ Masks growing consumption inequality in the US.
- Other countries, where micro consumption datasets match better with aggregate consumption data...

Income and Consumption Inequality in Germany



Source: Fuchs-Schündeln, Krueger, Sommer (2010).

Income and Consumption Inequality in Russia



Source: Gorodnichenko, Peter, Stolyarov (2010).

Notes on Aguiar and Hurst (2007): "Measuring Trends in Leisure: The Allocation of Time over Five Decades"

The past one and a half lectures

- Heathcote et al. (2010)
  - Household earnings inequality has been increasing since the 1970s.
  - Most of the increase is in residual ("within group") inequality.
  - Consumption inequality is basically flat. The small increase is mostly between-group inequality.
- Aguiar and Bils (2013)
  - Consumption inequality actually increases at a rate similar to that of income inequality.

We care about utility from consumption expenditures...

...not consumption expenditures per se.

- During the last few lectures, we defined consumption $\equiv f(x_1, ..., x_n)$.
  - Relevant budget constraint:

$$\sum_i \underbrace{p_i \cdot x_i}_{\text{expenditures on good i}} = \underbrace{W \cdot t_W}_{\text{labor income}} + \underbrace{V}_{\text{other income}}$$

- Becker (1965): Consumption consists of a bundle of commodities $c_1, ..., c_i, ..., c_n$
  - Commodities are a combination of market goods (x_i) and time inputs (t_i): $c_i = \phi^i(x_i, t_i)$
  - Extra budget constraint:

$$\sum_i \underbrace{t_i}_{\text{time spent on commodity } i} = T - t_W$$

Research question and method

- Data on the evolution of t_W have been readily available (in the PSID, CPS, NLSY, etc...) for awhile. Not so for the components of $T - t_W$.
- How have the components of $T - t_W$ (time spent not working in the market) changed over time
  - ... on average?
  - ... for men vs. women?
  - ... for individuals in different income groups?
- Method: Combine time-use surveys from 1965 to 2003 (some results extended to 2013).

Data Sources

- Use only retrospective diaries. Individuals badly estimate time use without time diaries.
  - Robinson and Godbey (1997): Someone with a diary showing 38 (55) hours/wk reports, in a retrospective interview, working 40 (70+) hours/wk
- Americans Use of Time (1965-1966), Time Use in Economic and Social Accounts (1975-1976), Americans' Use of Time (1985), National Human Activity Pattern Survey (1992-1994).
  - 2K-9K individuals per dataset.
- American Time Use Survey
  - Annual, beginning in 2003.
  - 20K in 2003, somewhat fewer in other years
  - Can be linked to the CPS.

Main results and their implications

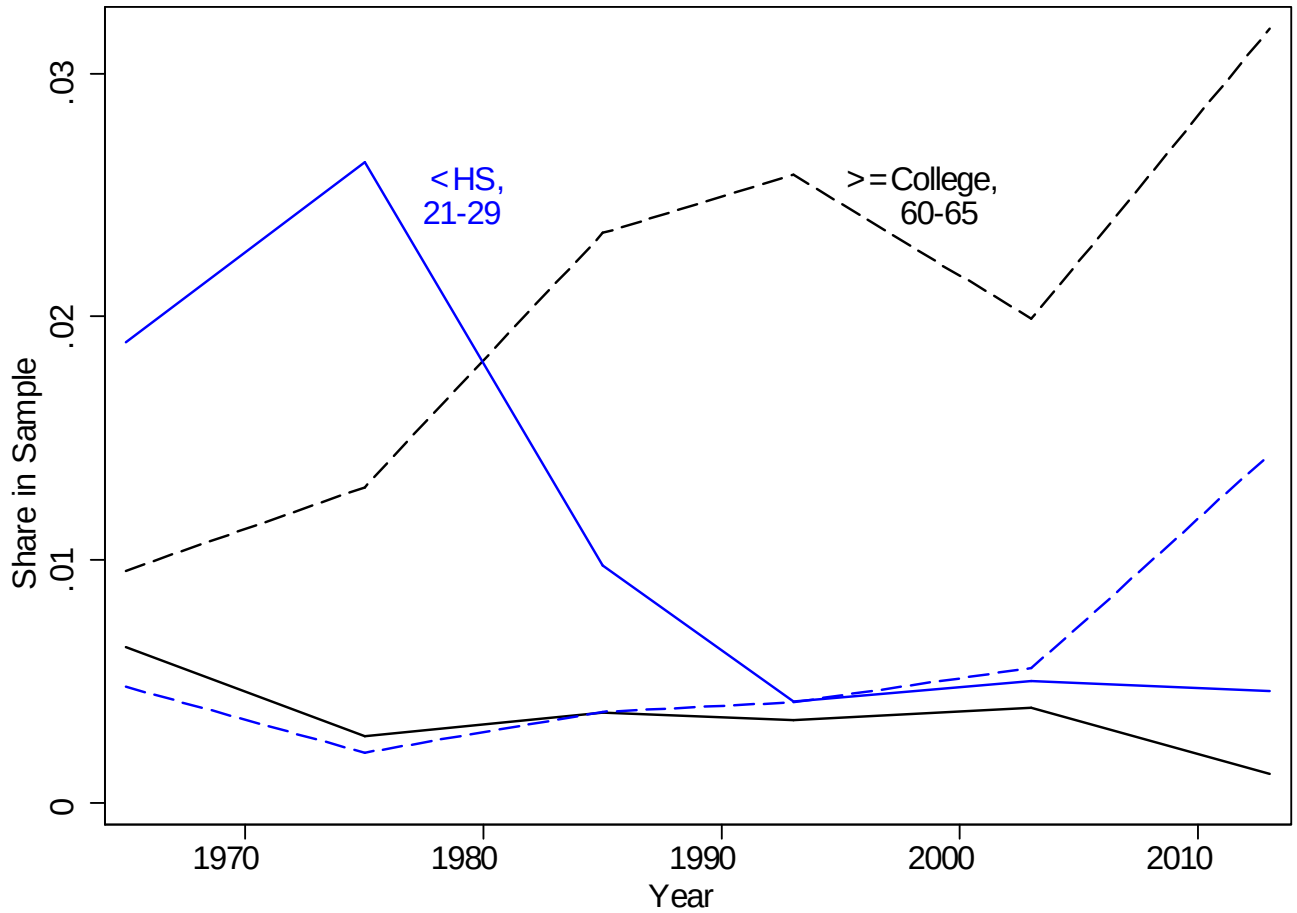
Two main findings:

1. Average time spent on leisure has gone up, by roughly 4 to 8 hours
2. Dispersion in leisure time also increasing
   - 2.1 90-10 difference in leisure time increases by 14 hours
   - 2.2 Less educated increase their leisure time more.

Implications:

- GDP growth may understate welfare growth
- Looking at consumption expenditures may overstate the growth of inequality in the past few decades.

Demographic Change



- Most calculations "fix" demographic weights when computing averages.

Time Categories

1. Market work
   - "Core": Main and second jobs, telecommuting work
   - "Total": Core + Commuting + Lunch Breaks at Work.
2. Non market work
   - Meal preparation, house cleaning, laundry
   - Shopping: obtaining gods and services
   - Home and vehicle maintenance, pet care.
3. Time with children
4. Leisure
   - Leisure 1: Entertainment, social and recreational activities, relaxing, gardening
   - Leisure 2: "1" + Eating, sleeping, personal care
   - Leisure 3: "2" + child care
   - Leisure 4: "3" + civic activities, caring for other adults, education, medical care

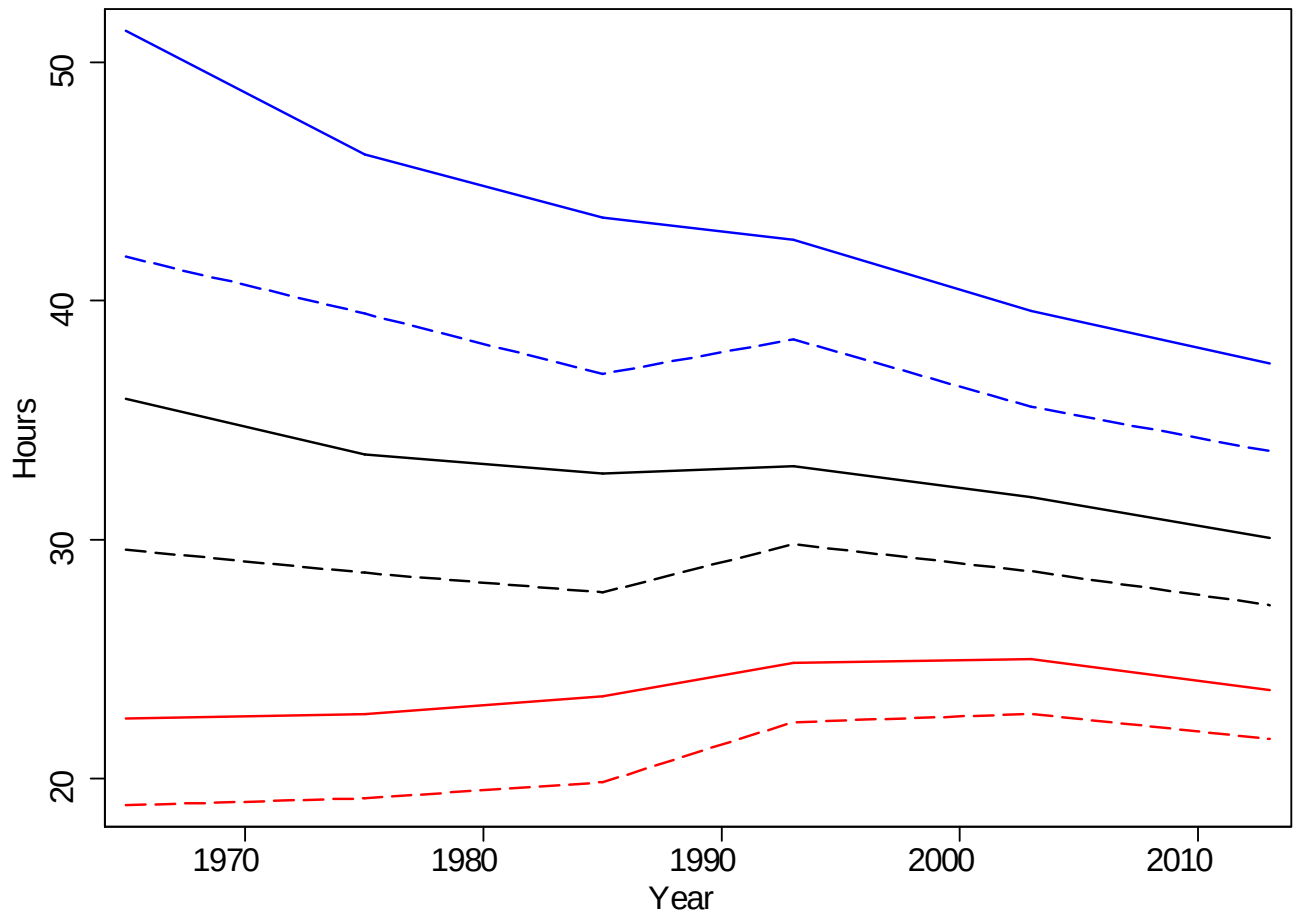
What activities are leisure?

- Robinson and Godbey: activities that have high enjoyment
  - 1985 Time Use Survey rate activities from 0 to 10

Activity	Index	Activity	Index
Sex	9.3	Market work	7.0
Play sports	9.2	Help adults	6.4
Play with kids	8.8	Child care	6.4
Talk/read to kids	8.6	Commute	6.3
Church	8.5	Pet care	6.0
Sleep	8.5	Homework	5.3
TV	7.8	Yardwork	5.0
Baby care	7.2	Child health	4.7
Gardening	7.1	Car repair shop	4.6

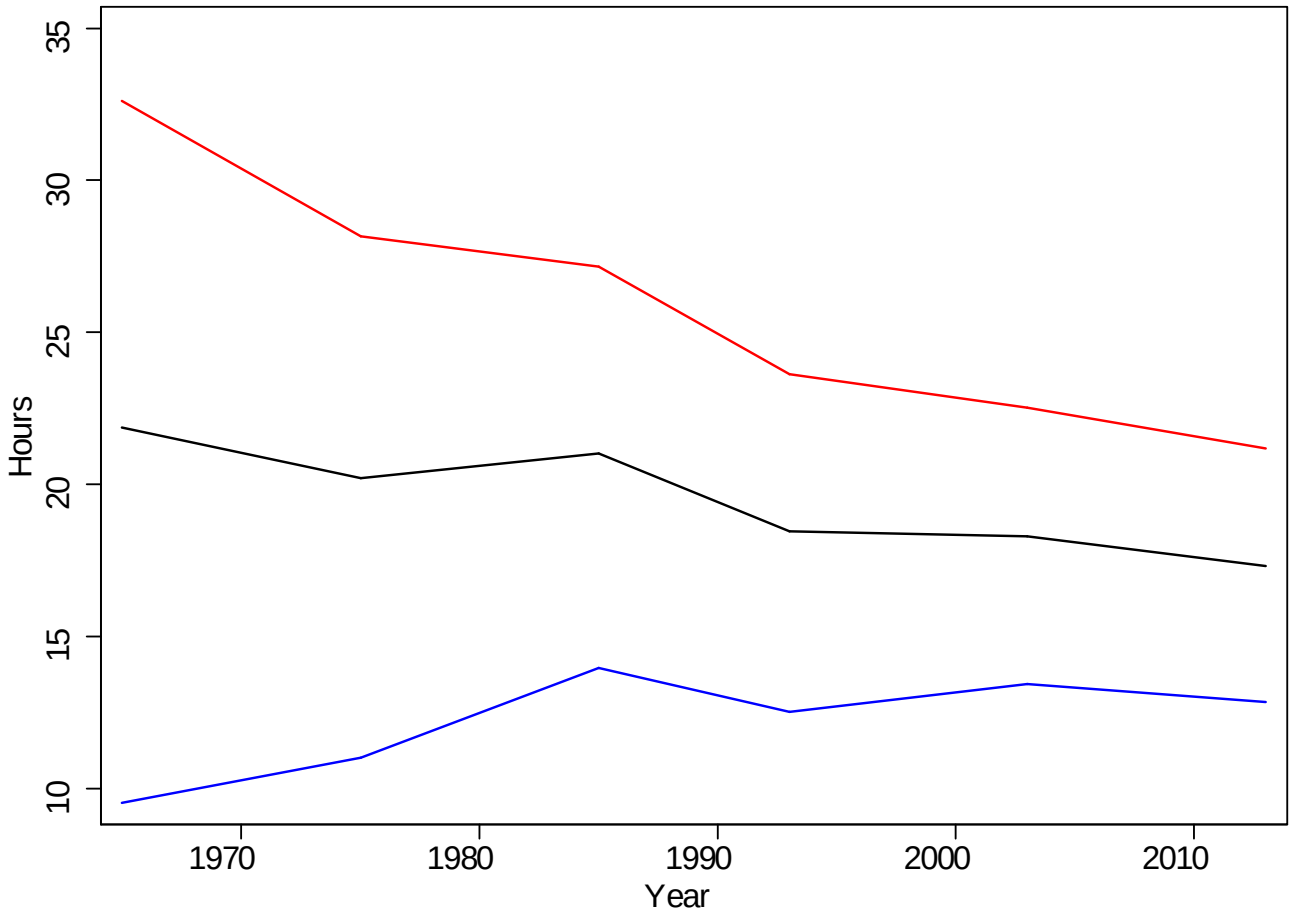
- Margaret Reid (1934): Home production is time spent in activities for which a market substitute could potentially exist.
  - gaden + pet care, child care, care of others

Time Spent in Market Work



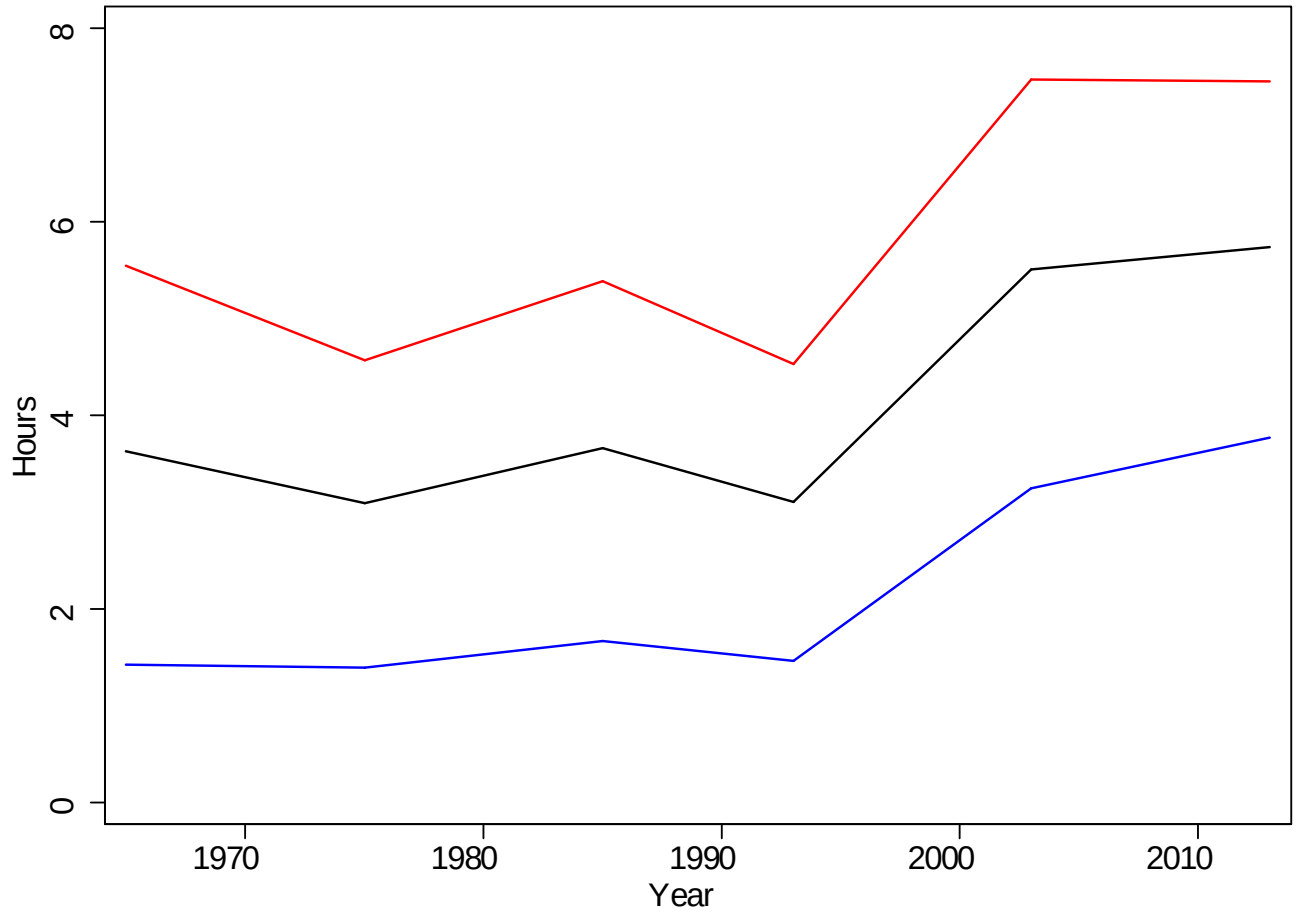
- Core work declines 8 hours for men, up 3 hours for women
- "Non-core" market work declines 6 hours for men, 2 for women.

Time Spent in Home Production



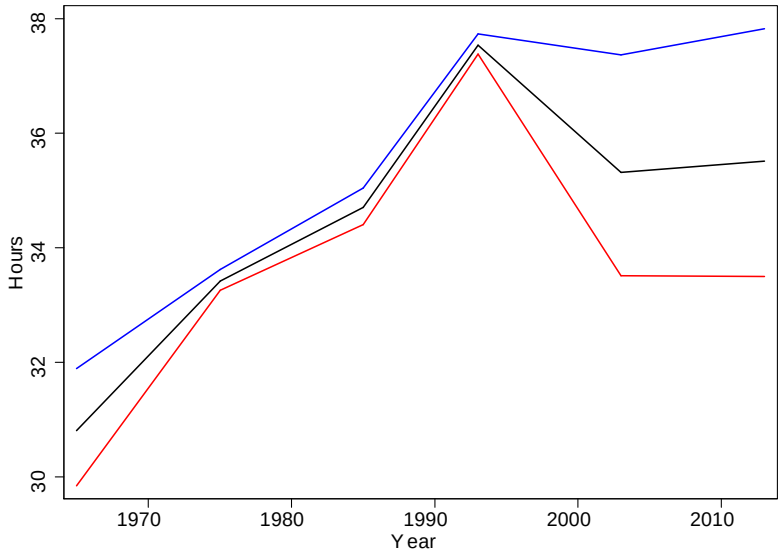
- Declines 11 hours for women, up 3 hours for men.

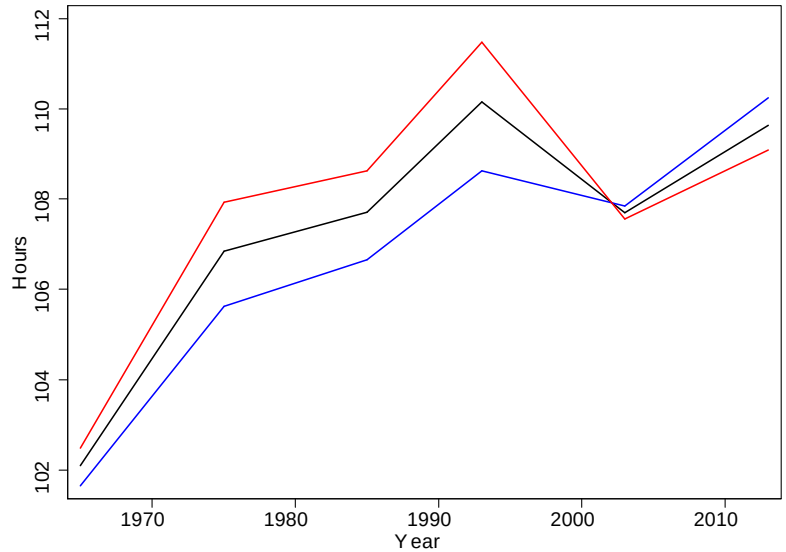
Time Spent with Children



- Increases 2 hours for both men and women.

Leisure Time



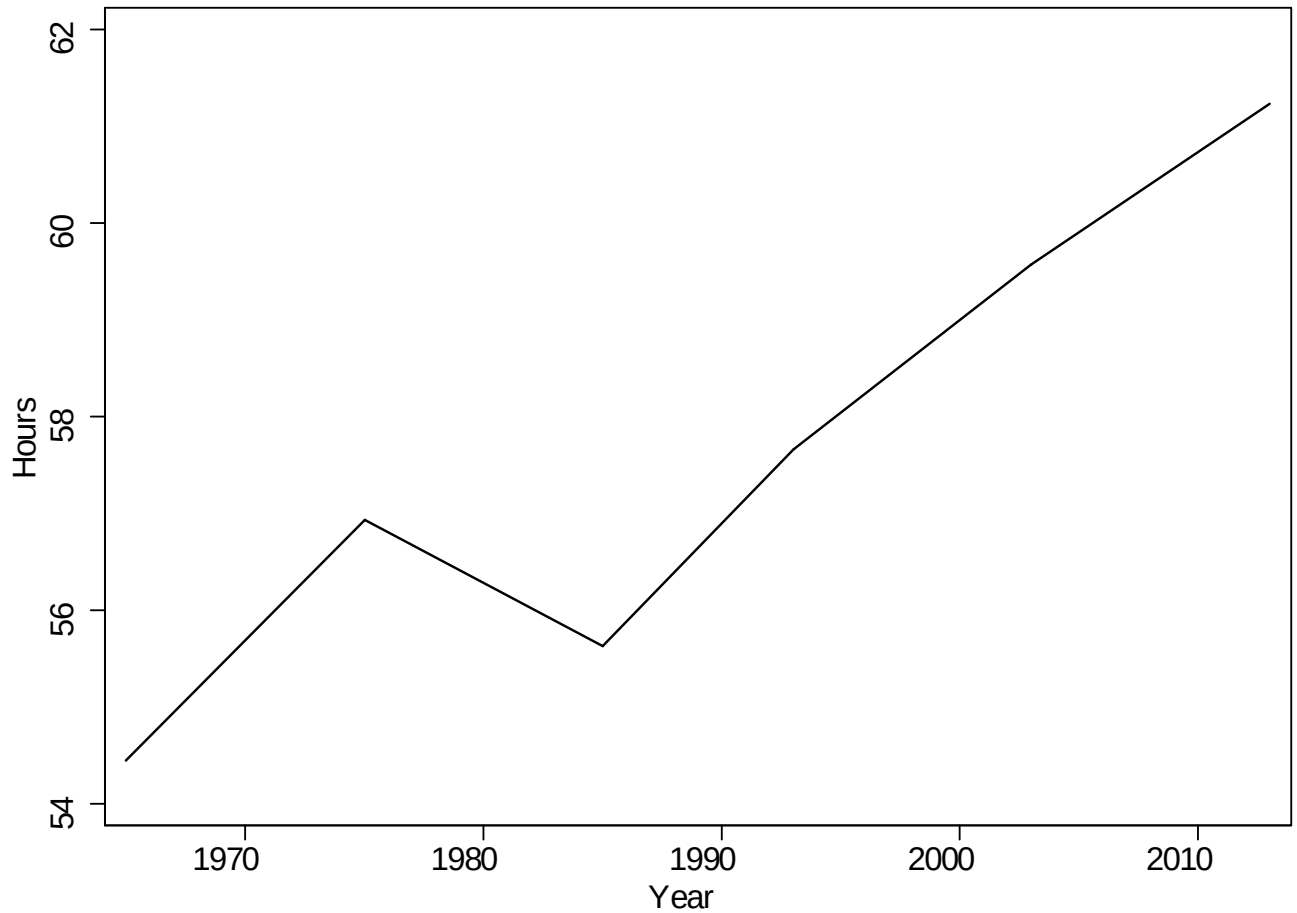


- "Leisure 2 measure" increases roughly by 6 hours for men, 5 for women.

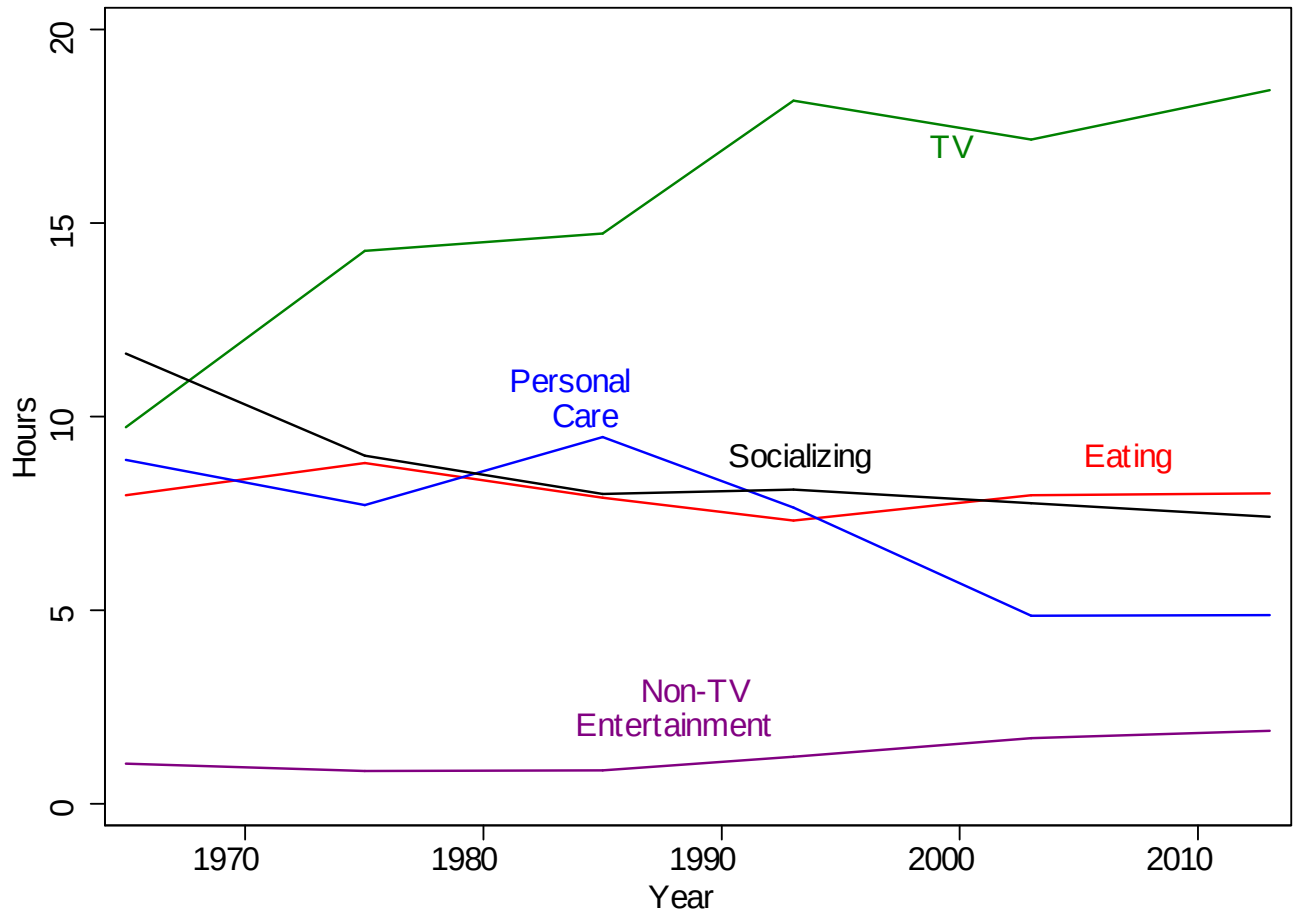
Leisure Time: Changing Demographic Weights

- Slightly larger increase in leisure-2 time, with changing demographic weights.

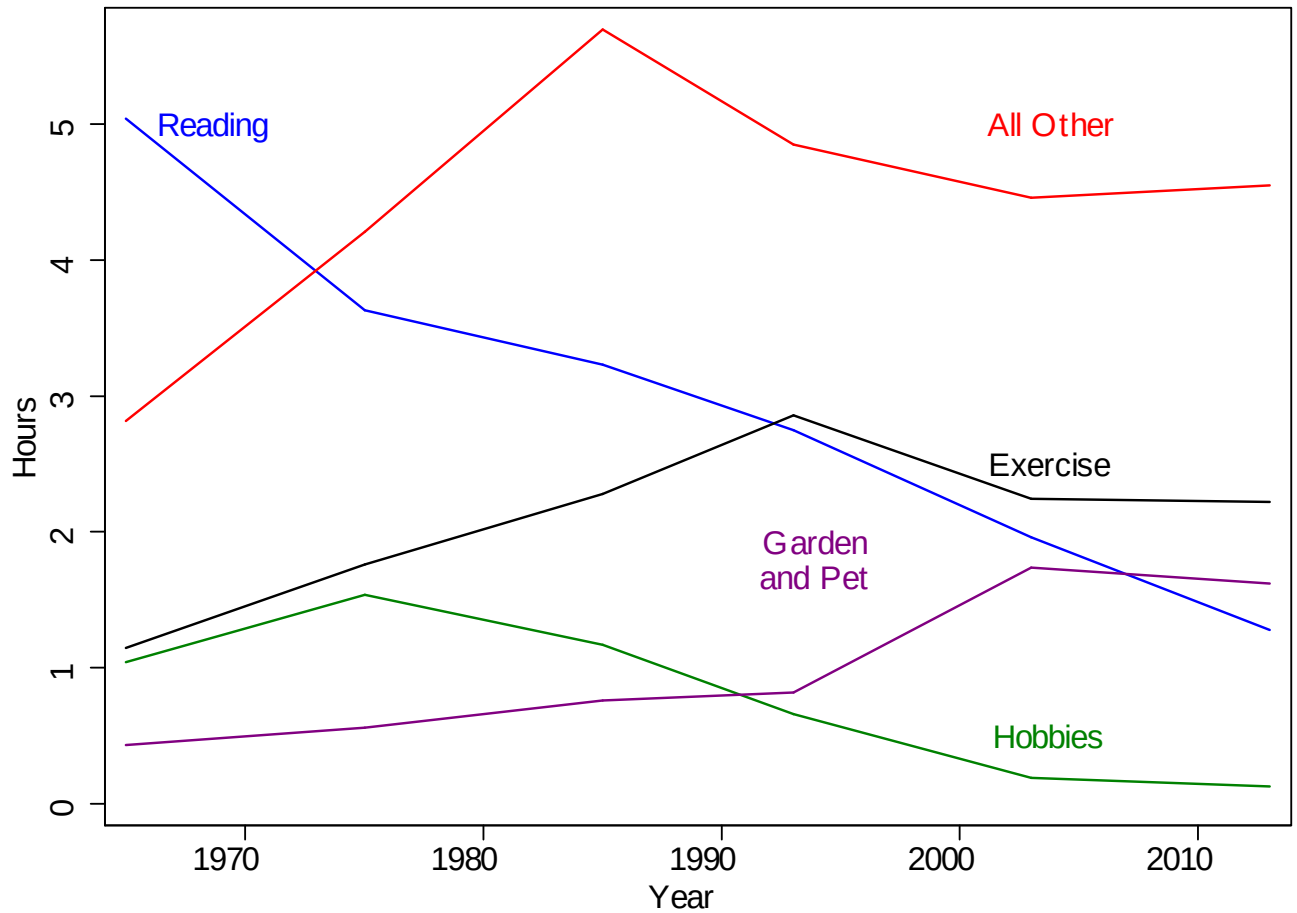
Leisure: Sleep has increased by 7 hours/wk



Leisure: TV has increased by 9 hours/wk



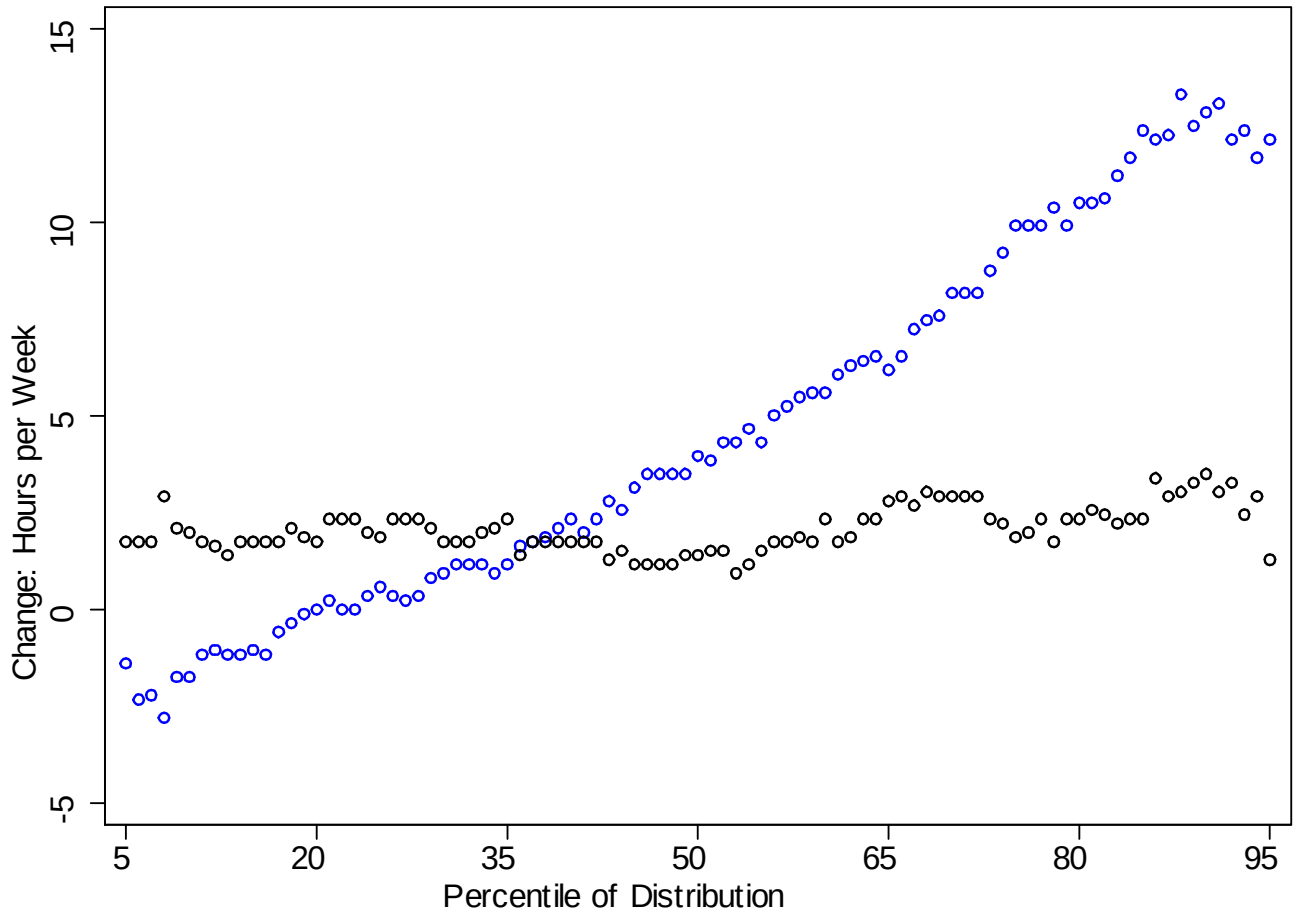
Leisure: Reading has decreased by 4 hours/wk



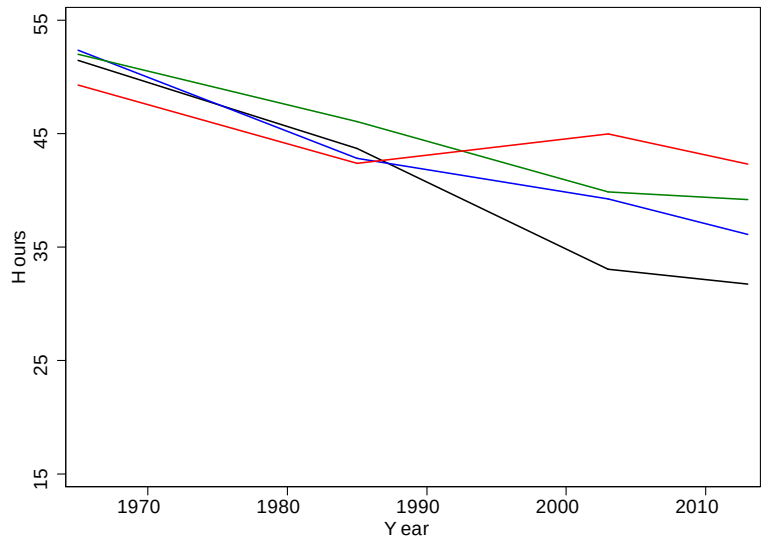
Distribution of leisure time

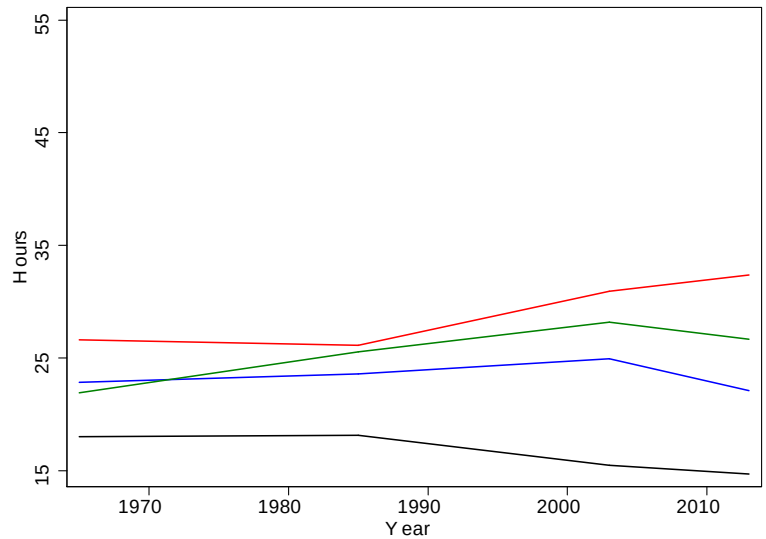
Percentile	1965	1975	1985	1993	2003	2013
10	74.7	77.4	77.0	75.5	72.9	74.1
25	85.2	88.1	88.4	87.5	85.8	86.3
50	98.1	102.1	102.7	103.3	102.1	101.5
75	117.3	126	127.2	130.4	127.2	125.4
90	136.5	146.1	147.5	154.0	149.3	148.8
Mean	102.0	107.0	107.5	110.8	110.2	109.2

Changes in the distribution of leisure time, 1965 to 2003 and 2003 to 2013



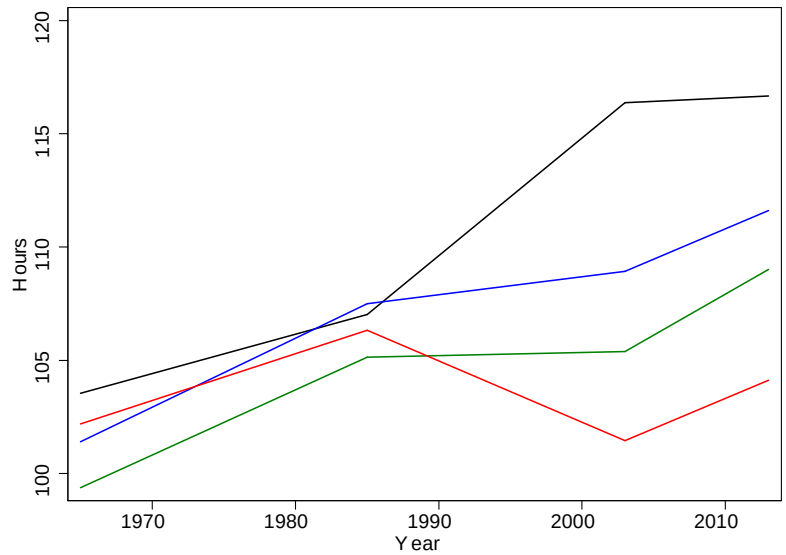
Changes in market time by education category

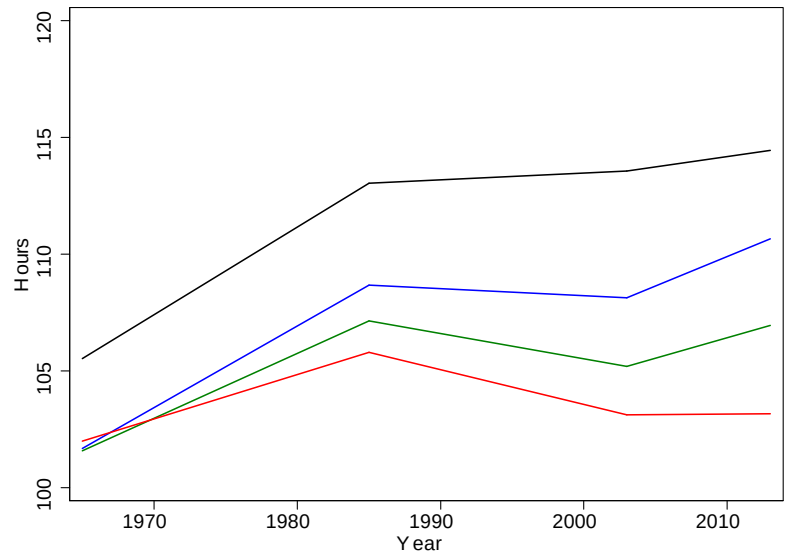




- Market time decreases most for less educated men.

Changes in leisure time by education category





- Leisure time increases most for less educated men.

Changes in leisure time by education category

Change: '65-'13	Whole Sample	< High School	High School	Some College	> College
Eating	−0.64	−1.43	−0.62	−0.85	0.18
Sleeping	6.78	8.17	7.98	6.84	3.57
Pers. Care	−4.10	−4.42	−4.40	3.52	−3.82
TV	8.70	9.66	9.74	8.35	6.46
Non-TV Ent.	0.84	0.98	0.95	0.82	0.57
Socializing	−4.96	−3.89	−4.95	−4.77	−6.06
Hobbies	−0.91	−0.89	−1.05	−0.77	−0.79
Reading	−3.75	−3.38	−3.75	−3.55	−4.23
Exercise	0.77	0.47	0.48	0.58	1.66
Garden	1.19	1.17	1.34	1.12	1.04
All Other	1.33	3.05	1.35	0.92	0.18

Conclusion

- Average leisure increases by approx. 5 hours.
- 90^{th} percentile in leisure distribution increases from 137 to 149 hours per week; 10^{th} percentile is flat at 74-75 hours.
- Leisure increases are concentrated in high school graduates, dropouts.
- Is it possible to estimate the functions, ϕ^i, f from the beginning of the presentation (where, again,

$$c = f\left(\phi^1\left(x_1, t_1\right), ..., \phi^i\left(x_i, t_i\right), ..., \phi^n\left(x_n, t_n\right)\right) \quad)$$

  How does inequality in $\sum x_i$ compare to inequality in c?

Today's lecture

- Benhabib, Rogerson, Wright (1991)
  - Some problems with the most basic RBC model
  - One solution: include home production
    - Need high elasticity of substitution between market and nonmarket commodities
- Aguiar, Hurst, Karabarbounis (2013)
  - How have time use patterns changed (across states) over the Great Recession?
  - Use this variation to identify the EoS between market and nonmarket commodities

Notes on Benhabib et al. (1991): "Homework in Macroeconomics: Household Production and Aggregate Fluctuations"

Motivation

- Standard RBC model.
  - Representative consumer maximizing:

$$\mathbb{E}\sum \beta^t \left[\log c_t + v\left(1 - h_t\right)\right]$$

  - Production:

$$\begin{aligned} y_t &= s_t\left(h_t, k_t\right) \\ \log s_t &= \rho \log s_{t-1} + \varepsilon_t \\ k_{t+1} &= \left(1-\delta\right) k_t + i_t \end{aligned}$$

- Some predictions of model are not borne out by the data:
  - Correlation between (market) hours, investment, and output is almost equal to 1.
  - Strong negative correlation between hours employed to produce investment goods (h_{it}) and hours employed to produce consumption goods (h_{ct}).
  - Relative to output, volatility of hours and consumption is less than in the data.

Motivation

Some predictions of the RBC model are not borne out by the data

- Correlation between (market) hours, investment, and output is almost equal to 1.
- Relative to output, volatility of hours and consumption is less than in the data.

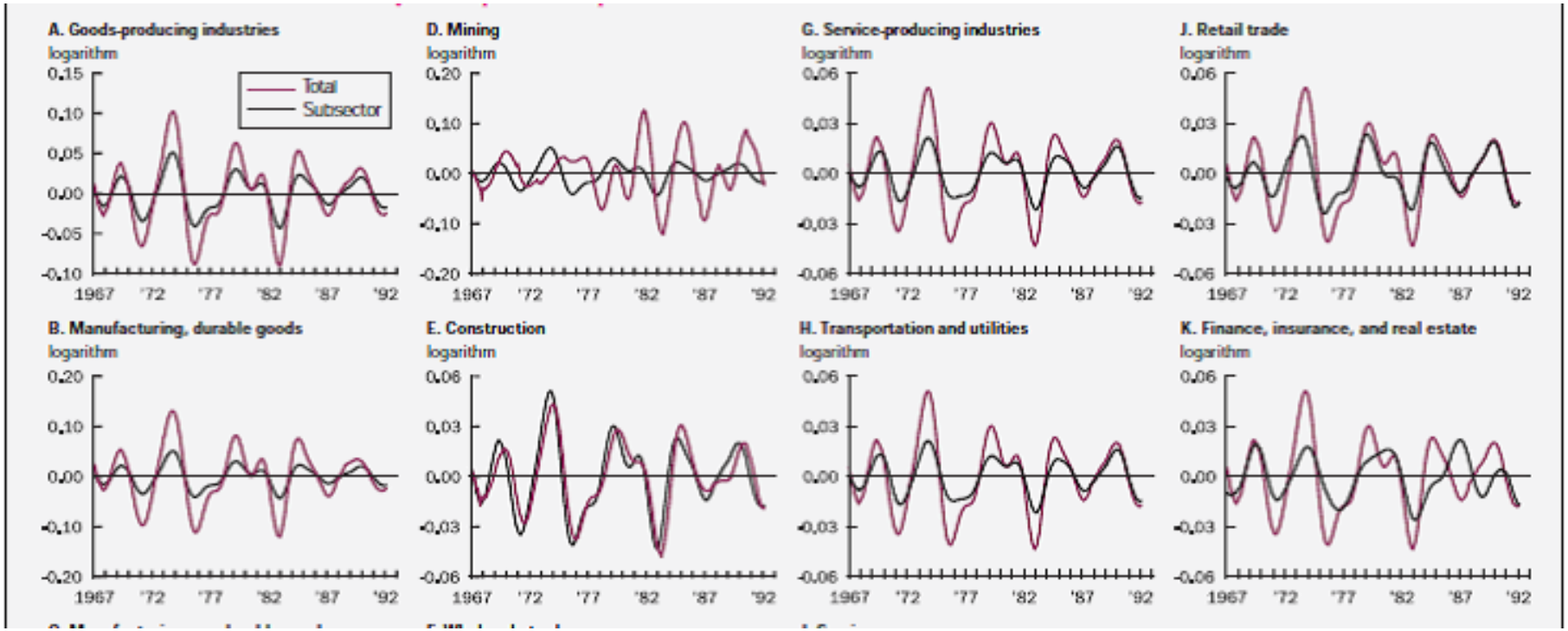
	RBC Model		Data	
	Relative Std.	Corr(with y)	Relative Std.	Corr(with y)
c_m	0.44	0.94	0.74	0.88
i	2.95	0.99	2.93	0.80
h_m	0.48	0.97	0.99	0.88
y/h_m	0.54	0.98	0.56	0.55
s	0.68	1.00	0.54	0.78

- Source: King and Rebelo (1999)

Motivation

Some predictions of the RBC model are not borne out by the data

- Strong negative correlation between hours employed to produce investment goods (h_{it}) and hours employed to produce consumption goods (h_{ct})

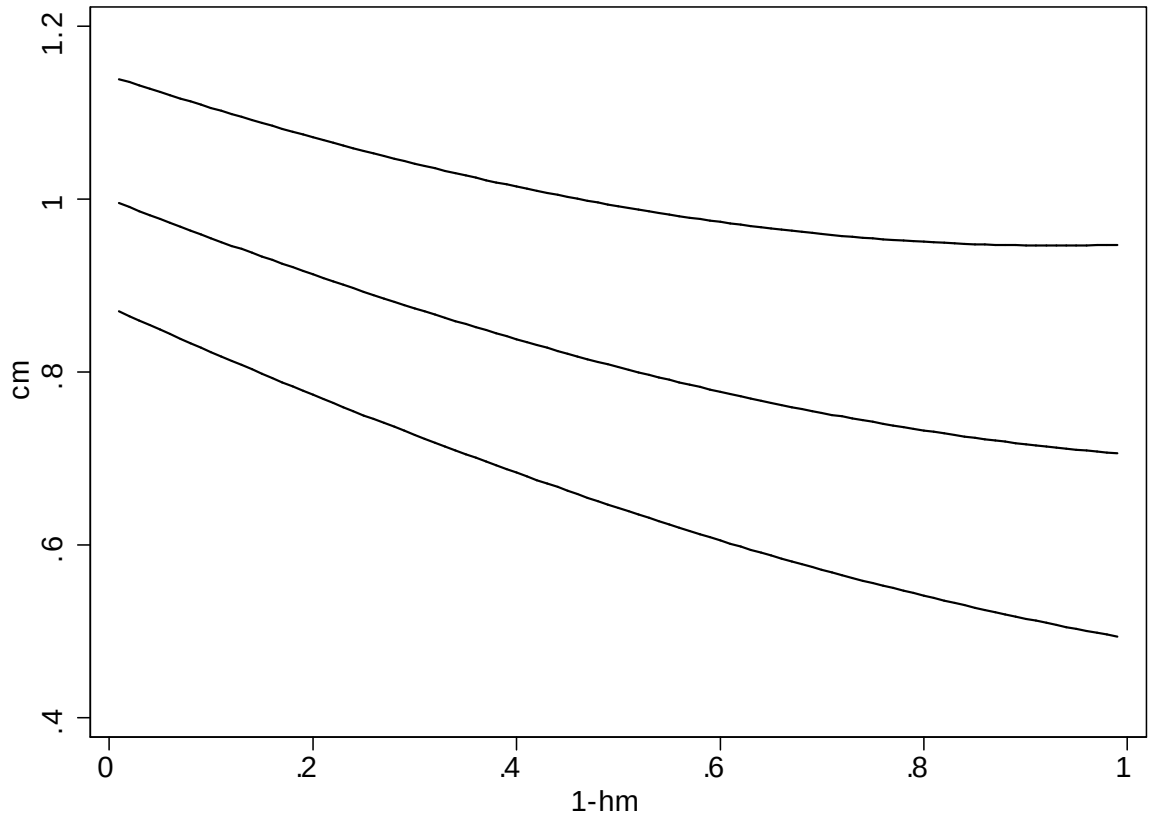


- Source: Christiano and Fitzgerald (1998)
- Basic NK models share this deficiency.

Contribution

- Amend RBC model to include home production.
  - Inputs into home production (household durable goods, time spent at home cooking, cleaning) are large.
  - The extra margin of substitution (between working on home production vs. working in the market) tempers some of the strong predictions of Hansen's model.
- Main results:
  - Model with home production nests the standard model when $\sigma \equiv$elasticity of substitution between market and non-market goods equals 1.
  - Performance of RBC is much improved as long as preference σ is large ($=$ approximately 5).

Indifference curves of the reduced form utility function



- $1 - h_m$ is an inferior good in the $V(c_m, h_m)$ utility function.

Dynamic Model

- Representative consumer now maximizing:

$$\mathbb{E}\sum \beta^t \left[\frac{b}{e}\log\left[ac_{mt}^e + (1-a)\,c_{nt}^e\right] + (1-b)\log\left(1-h_{mt}-h_{nt}\right)\right]$$

  - $e \equiv \frac{\sigma-1}{\sigma}$ related to elasticity of sub.

- Production in home and market sectors (m ="market" ; n="nonmarket") and market-clearing conditions:

$$\begin{aligned} y_m &= s_m k_m^{\theta} h_m^{1-\theta} \\ y_n &= s_n k_n^{\eta} h_n^{1-\eta} \\ y_m &= c_m + \underbrace{i_m}_{=k'-(1-\delta)k} \\ y_n &= c_n \\ k &= k_n + k_m \end{aligned}$$

Dynamic Model

Notation and Productivity Processes

- Evolution of productivity:

$$\log s_{mt} = \rho \log s_{m,t-1} + \varepsilon_{mt}$$
$$\log s_{nt} = \rho \log s_{n,t-1} + \varepsilon_{nt}$$

  - $\gamma \equiv$ correlation between ε_{mt} and ε_{nt}

- h_{mt} is made up of h_{it} (hours of market work making the investment good) h_{ct} (hours of market work making the consumption good).

A special case: e=η=$log(s_{nt})$=0

- Period utility function now:

$$U = ab \log c_{mt} + (1-a)\, b \log c_{nt} + (1-b) \log (1 - h_{mt} - h_{nt}) \tag{5}$$

- Production function for home production (with $\eta = 0$):

$$y_{nt} = c_{nt} = h_{nt} \tag{6}$$

- Plugging Equation (6) into (5) and taking FOC wrt h_n:

$$(1-a)\, b = \frac{1-b}{1 - h_{mt} - h_{nt}} \Rightarrow h_{nt} = (1 - h_{mt}) \frac{1-b}{(1-a)\, b}$$

- And, finally, plug the FOC back into (5):

$$\begin{aligned} U &= ab \log c_{mt} + (1-a)\, b \log \left[(1 - h_{mt}) \frac{1-b}{(1-a)\, b} \right] \\ &\quad + (1-b) \log \left(\left(1 - \frac{1-b}{(1-a)\, b} \right) (1 - h_{mt}) \right) \\ &= ab \log c_{mt} + \kappa \log (1 - h_{mt}) \end{aligned}$$

A special case: e=η=$log(s_{nt})$=0

- From the previous slide

$$U = ab \log c_{mt} + \kappa \log(1 - h_{mt})$$

- Punchline:
  - When $e = \eta = 0$, home production technology shocks, look like a model without home production, but with preference shocks.
  - When also $s_{nt} = 1$ for all t, the home production model is equivalent to a model without home production.

Calibration

- a, b are chosen so that the steady-state time spent in market and nonmarket production are 0.33 and 0.28.
- Standard parameters for capital depreciation, capital share in market production: $\delta = 0.025$; $\theta = 0.36$.
- Capital share in home production $\eta = 0.08 \iff \frac{k_n}{k_m} = 0.14$ value of furniture and household equipment vs. value of capital in market production
- s_{mt}, s_{nt} has persistence of 0.95, standard deviation of productivity shocks $= 0.007$
- e , γ, and s_{nt} processes are the most difficult to pin down.
  - $\gamma = \frac{2}{3}$; s_{nt} has same volatility, persistence as s_{mt}.

Effects of a shock to s_m

- In the standard business cycle model:
  - Intratemporal FOC, multiplied by h_{ct}

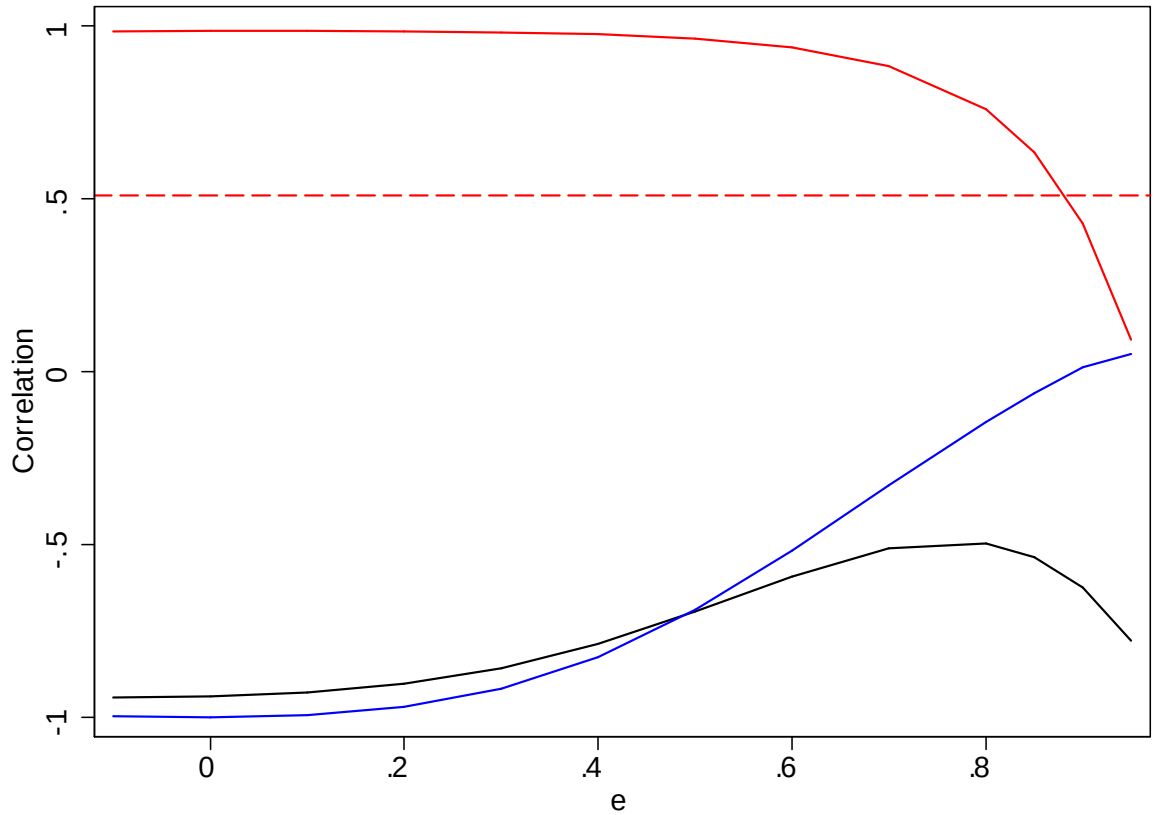
$$\underbrace{b\frac{MPL_t}{c_t}h_{ct}}_{\text{labor's share in the consumption sector}} = (1-b)\frac{1}{1-h_{mt}}\cdot h_{ct}$$

  - Left-hand side is constant$\Rightarrow$ corr(h_{mt},h_{ct}) is negative
  - ε_{mt} is positive $\Rightarrow$ h_{ct} has to decrease.
- In the home work model:

$$b\frac{MPL_t}{c_t}h_{ct} = (1-b)\frac{1}{1-h_{mt}-h_{nt}}\cdot h_{ct}$$

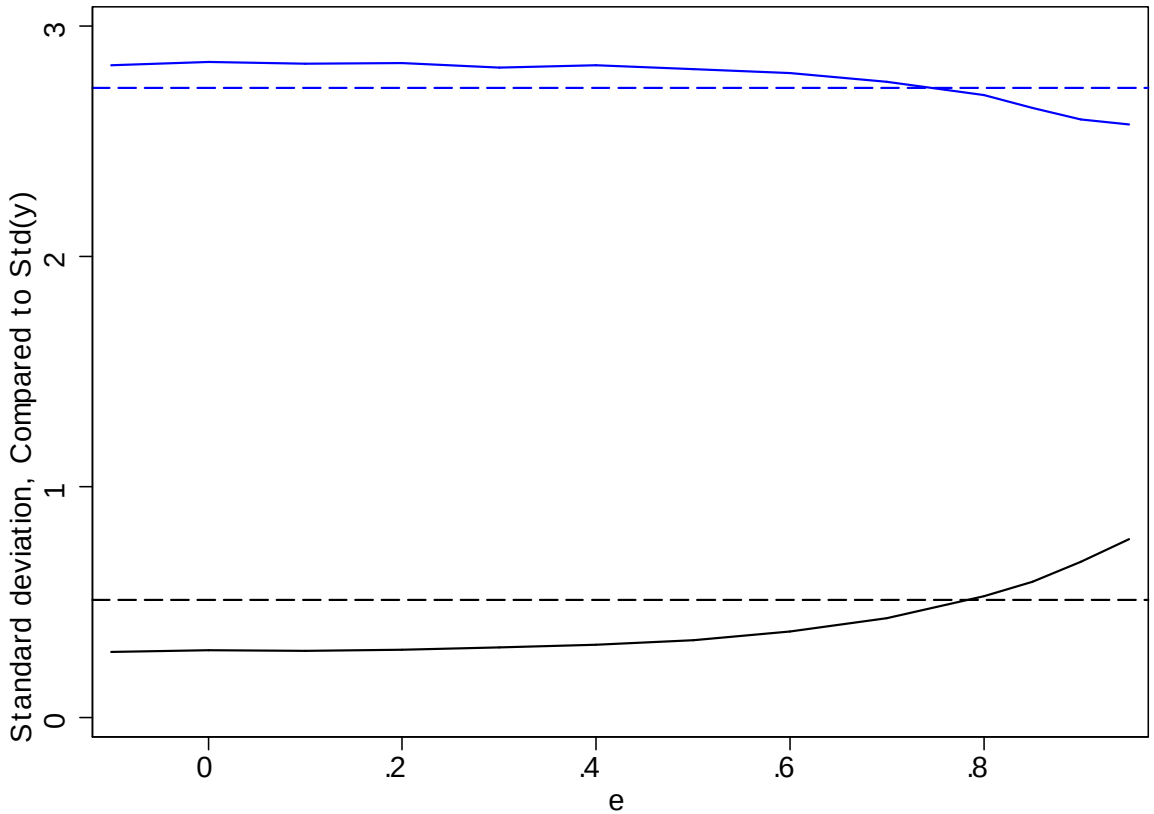
  - ε_{mt} is positive $\Rightarrow$ If h_{nt} decreases sufficiently, both h_{it} and h_{ct} can go up.
  - For h_{nt} to "decrease sufficiently," e needs to be high.

Correlations among y/h_m, y, h_m, and h_i



- Correlation between h_c and h_i is increasing in e
- Correlation between y and labor productivity is decreasing in e.

Relative Volatilities



- Relative standard deviation of c_m is increasing in e
- Relative standard deviation of i is decreasing in e

Summary

- Standard RBC model: Resulting from a productivity shock:
  - h_{ct} goes down and h_{it} goes up.
  - $\Rightarrow$ negative co-movement.
  - $\Rightarrow$ c_m is not so volatile,
- Inclusion of home production provides an extra margin of adjustment.
  - If h_{nt} decreases sufficiently (only possible if e is close to 1), h_{ct} and h_{it} can both go up.
  - $\Rightarrow$ positive co-movement.
  - $\Rightarrow$ c_m is more volatile, compared to the no-home-production model

Notes on Aguiar et al. (2013): "Time Use During the Great Recession"

Introduction

- Main Question: How does leisure and home production time vary over the business cycle?
- Because of data limitations, this question has been (up to now) difficult to answer.
  - ATUS begins in 2003. Now have dataset spanning only one recession.
  - Challenge to separate trend from cycle, draw inference from 1 recession.
  - Strategy: Use geographic (cross-state) variation on changes in market hours. Many more observations.

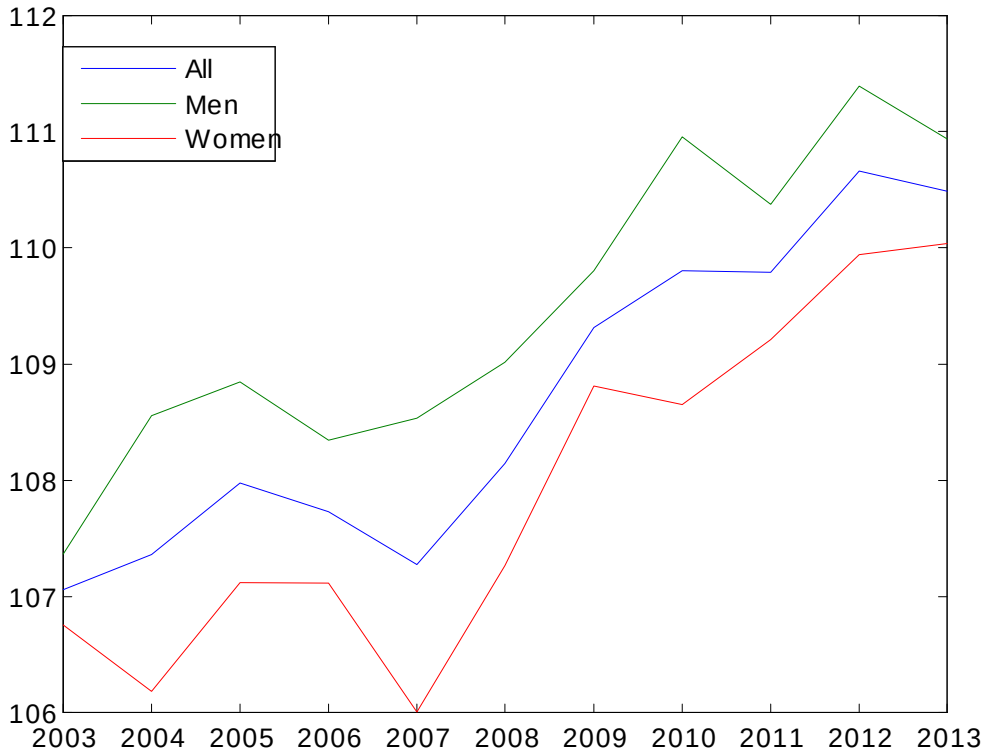
Outline

- Data.
- Aggregate results.
- Cross-state results.
- Implications for Benhabib et al (1991).

Data

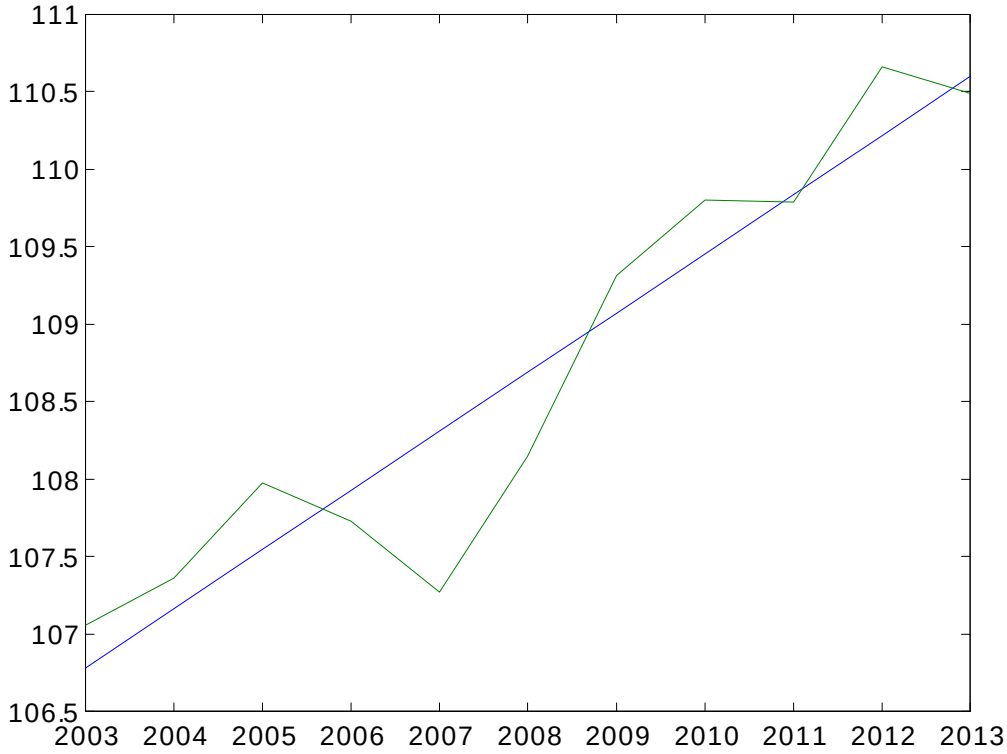
- American Time Use Survey: 2003 to 2013 (2010 in the paper).
- Similar categorization to Aguiar and Hurst (2007), with a few extra categories
  - Market work. Approx 32 hours
  - Other income generating activities. 10 minutes
  - Job search. 15 minutes;
  - Nonmarket work. 18 hours
  - Leisure: TV, Socializing, Sleeping, Eating & Personal Care. 108 hours.
  - Child care. 4.5 hours.
  - Other: Education, Religion activities, Own medical care. 5 hours.

Leisure has increased by roughly 3 hours

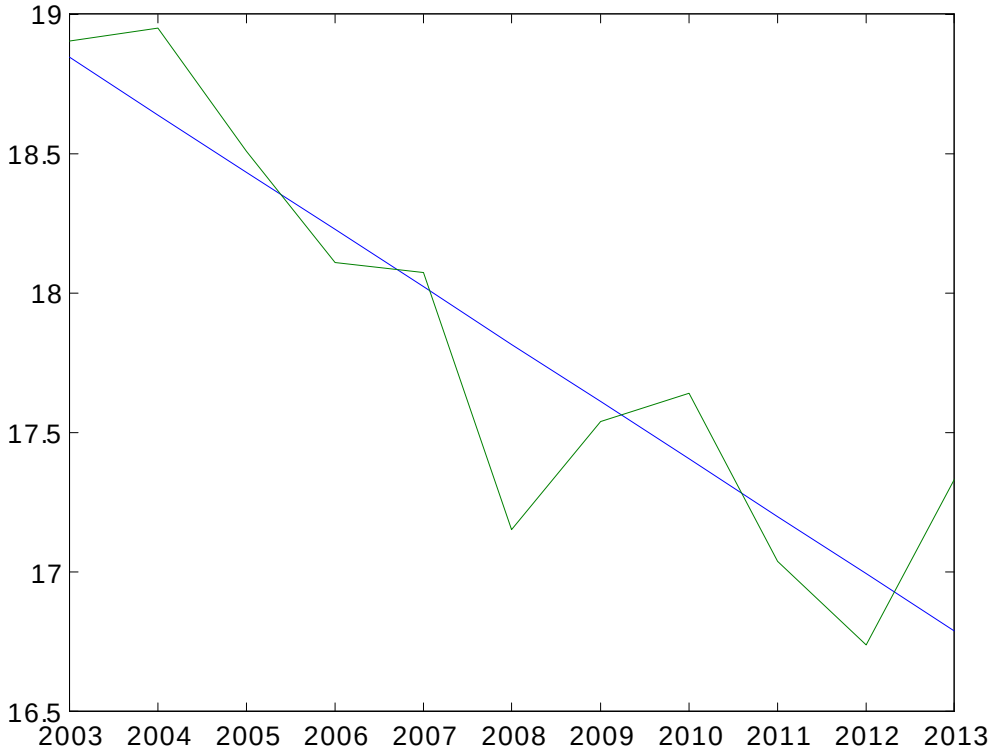


- About half of the increase from sleeping, the other half from TV watching.

Leisure roughly 25 minutes above trend in the GR

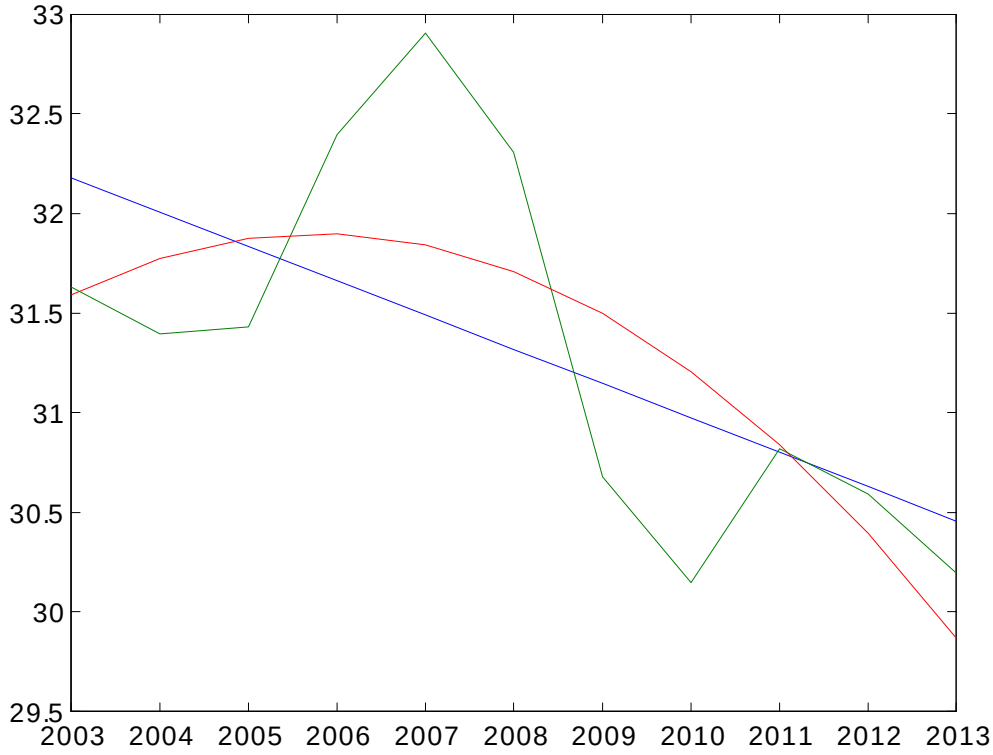


Homework 15 minutes above trend in the GR



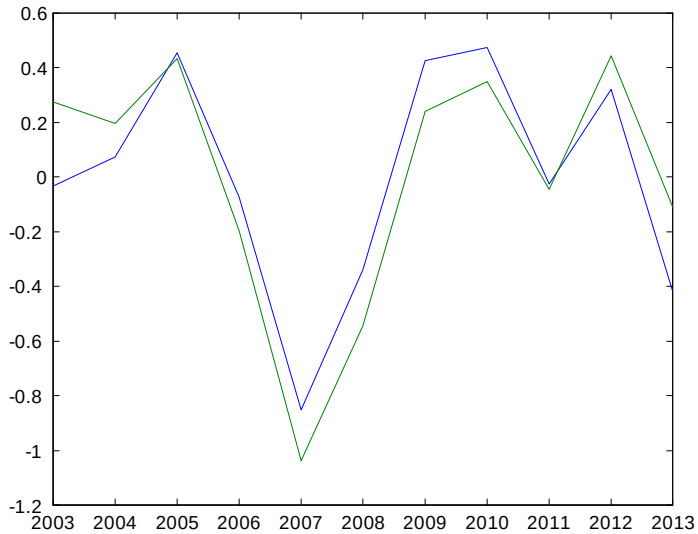
Market time 40 minutes above trend in the GR

The method of de-trending matters



The method of de-trending matters

Homework-Dev. from trend



Leisure-Dev. from trend

- Deviation roughly 3× as large for homework, 40% higher for leisure, when using a quadratic trend.
- Not enough power from aggregate data ⇒ Use cross-state variation.

Identification via cross-state variation

- Object of interest, τ_{st}^{j} (s=state, t=period, j=activity)
  - average over two-years to mitigate measurement error.
  - $t \in$ {2003-2004, 2005-2006, 2007-2008, 2009-2010, 2011-2012, 2013}
- Run **descriptive** regressions of the form

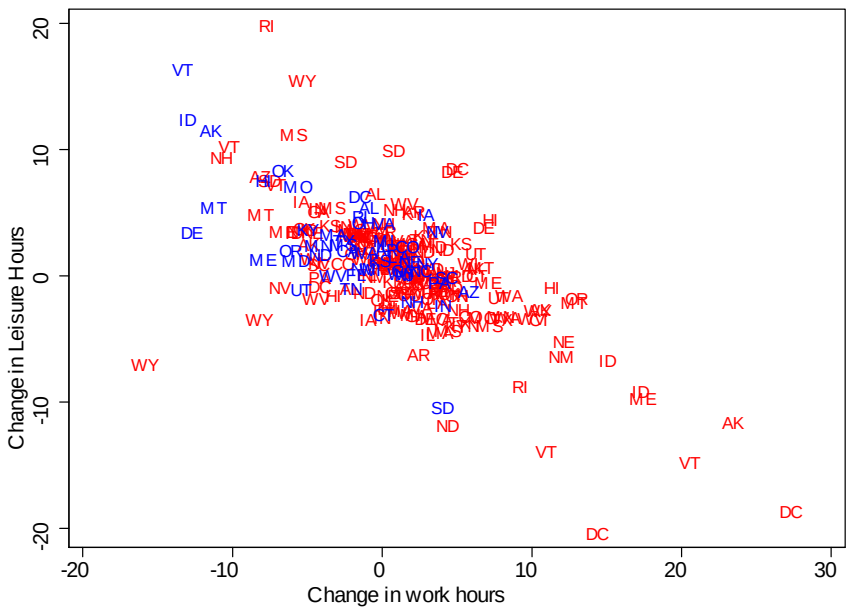
$$\Delta\tau_{st}^{j} = \alpha^{j} - \beta^{j}\Delta\tau_{st}^{market} + \varepsilon_{st}^{j}$$

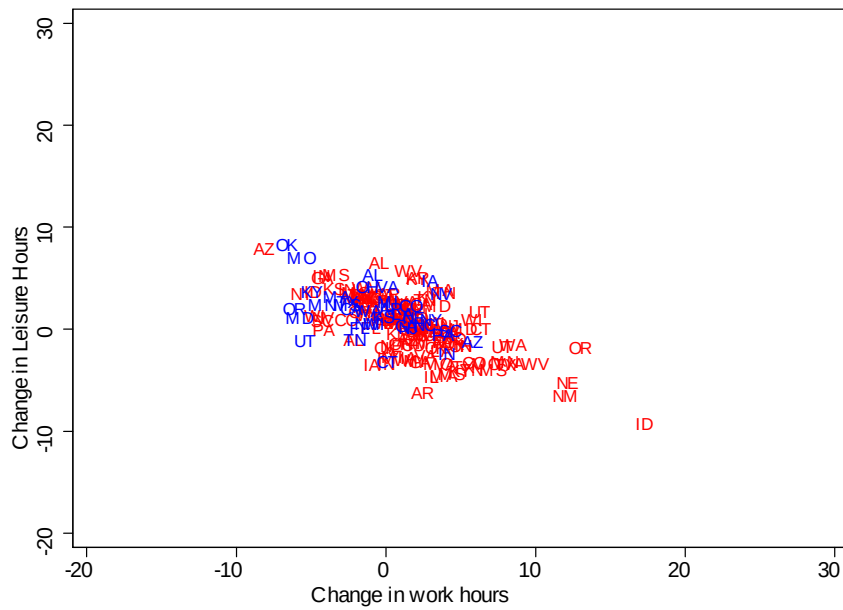
- Main assumption: There are no state-specific low frequency trends in time usage. (National trends are picked up by the α^{j} term.)
  - We can weaken this assumption by allowing fpr state-specific *linear* trends, by including α_{s}^{j}, state-activity specific fixed effects, in the regression.

Compare states with different market hours

$$\Delta\tau_{st}^{j} = \alpha^{j} - \beta^{j}\Delta\tau_{st}^{market} + \varepsilon_{st}^{j}$$

s = state, t = period, j = activity



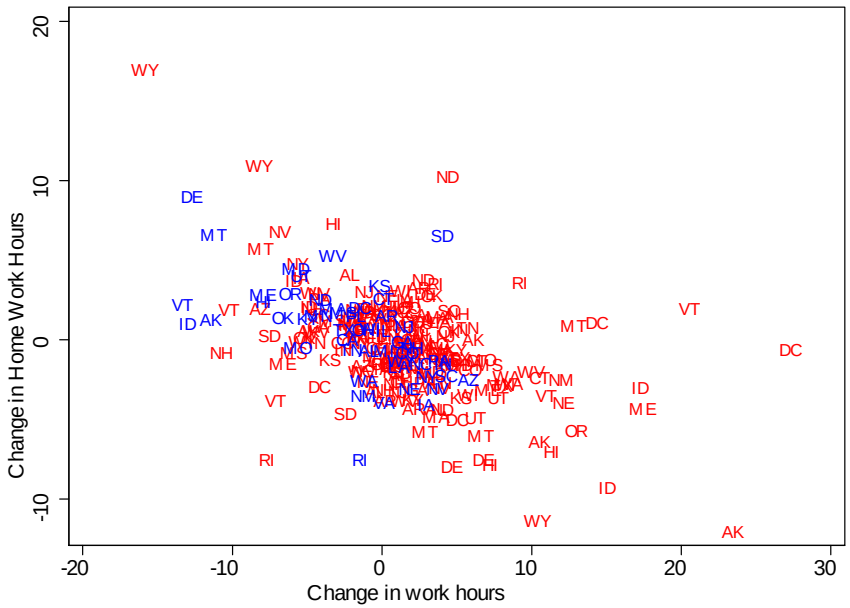


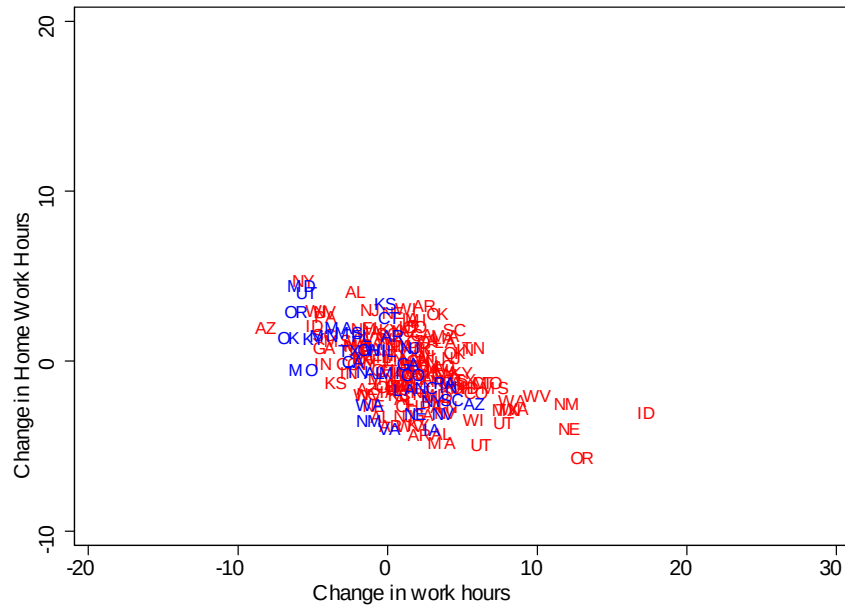
$\beta^{\text{leisure}} \approx 0.55$

Compare states with different market hours

$$\Delta \tau_{st}^{j} = \alpha^{j} - \beta^{j} \Delta \tau_{st}^{market} + \varepsilon_{st}^{j}$$

s = state, t = period, j = activity





$\beta^{\text{home work}} \approx 0.30$

More Comparisons

	Sample Mean	$\hat{\beta}$ unweighted	$\hat{\beta}$ weighted
Other income-generating activities	0.14	7.9	0.9
Job search	0.23	2.8	1.5
Child care	3.36	1.6	4.2
Nonmarket work	13.03	29.1	31.8
Core home production	6.91	13.2	13.3
Home ownership activities	1.57	4.4	5.8
Leisure	79.52	55.6	52.7
TV watching	13.07	12.4	13.2
Socializing	5.61	8.5	7.2
Sleeping	43.85	14.8	17.9
Eating and personal care	9.75	0.5	-0.1
Other leisure	7.23	19.5	14.4
Other	3.72	10.1	8.9

How to identify e from cross-state data?

- Simulate Benhabib, Rogerson, Wright model; 51 "states" and 58 years of data (discard first 50 years).
- From the simulated data, regress

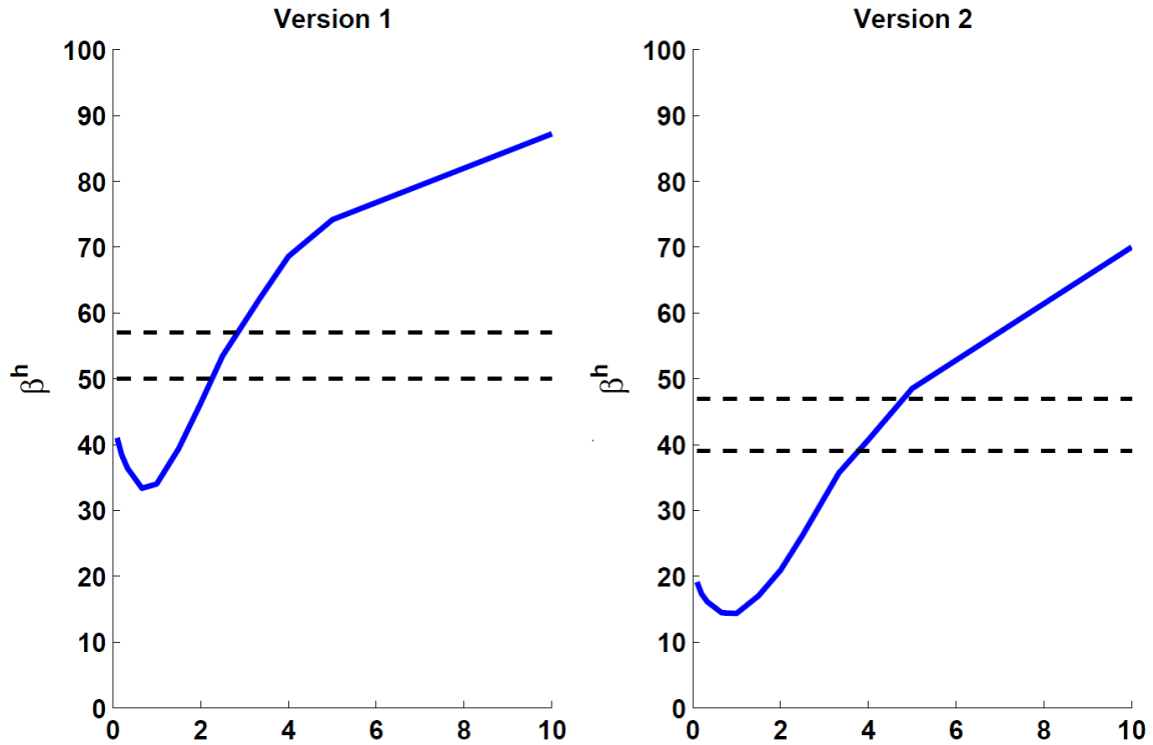
$$\Delta\tau_{st}^{\text{home}} = \alpha^j - \beta^j \Delta\tau_{st}^{\text{market}} + \epsilon_{st}^j$$

- Version 1 (2): Leisure includes (excludes) sleep.
- Now try different values of e

Version	Model $e = 0.8$	Model $e = 0.5$	Data Full Sample	Data Recession
1	0.74	0.46	0.50	0.57
2	0.48	0.20	0.39	0.47

How to identify "e" from cross-state data?

$$\Delta\tau_{st}^{\text{home}} = \alpha^j - \beta^j \Delta\tau_{st}^{\text{market}} + \epsilon_{st}^j$$



- $\sigma \in [2.5, 4] \iff e \in [0.6, 0.75]$

Takeaways (1)

- Two examples in which time use data have been useful
  1. Re-examining the growth in inequality over time.
  2. Identifying a preference parameter important to certain macro models.
- A third example: Babcock and Marks (2010) examine time diaries of college students. Hours spent studying declines by a third between 1961 and 2003 $\Rightarrow$ Declining production of human capital.
- Data from other countries are also readily available: Multinational Time Use Survey (MTUS) is a harmonized dataset of approximately 20 (mainly developed) countries.
- Survey of Unemployed Workers in New Jersey: Individual-level panel of time use.

Takeaways (2)

- Cross-market variation in business cycle variables can help identify macro models' parameters.
- Other examples of this strategy:
  - Mian and Sufi (2013, 2014): next class.
  - Nakamura and Steinsson (2014): "What is the government spending multiplier?"
- Care must be taken in interpreting these "open economy" parameter estimates