Labor Supply in the Past, Present, and Future:

Who and how much?

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Motivation

- Mounting evidence: as productivity rises, hours fall
  - Well-known historically in macro (Keynes, 1930, ...); however
  - "forgotten" in modern macro (Prescott, 1986, King, Plosser, and Rebelo, 1988, entire BC literature...)
  - but new support from cross-section and time series (Bick, Fuchs-Schündeln, and Lagakos, 2017, Boppart and Krusell, 2017).
- Interpretation: income effect exceeds substitution effect
- Can be rationalized under balanced growth with new preference class: BK preferences, with

$$\frac{h_{t+1}}{h_t} = \gamma^{-\nu} < 1$$

- Quantitatively data from a large set of countries suggests $\gamma = 1.02$, $\frac{h_{t+1}}{h_t} = 0.996$ and $\nu \approx 0.2$

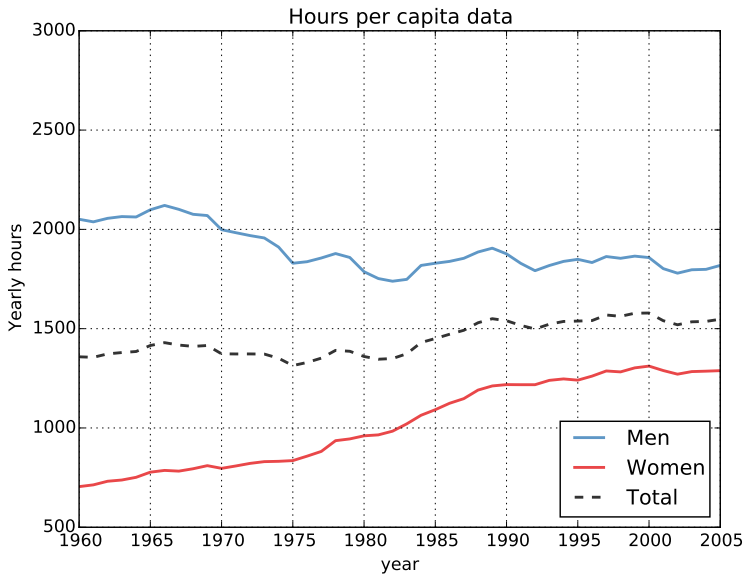
Post-war U.S. data

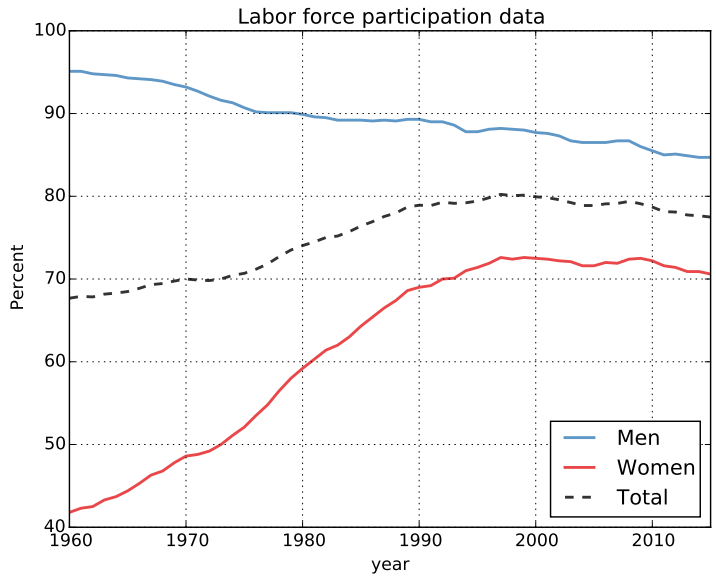
Hours per working aged overall stable – an exception internationally

- Decreasing *intensive margin* (hours worked per worker)
  - Male hours have gone down
  - Female hours have gone up
- Increase along the *extensive margin* (participation rate)
  - Falling labor force participation males
  - Increasing labor force participation females
- Significant demographic changes

Post-war U.S. data

Population 25-64:[1] ▸ Details





Source hours per capita: Ramey (2009)
Sources labor force participation: BLS (labor force participation 25-54 by gender), OECD, "Main Economic Indicators - complete database" (activity rate 55-64 by gender), Ramey (2009) (population by age group and gender)

[1] Throughout this presentation we will use the adult population 25-64 as population of interest, both in data and model.

This paper

Purpose

- See if a straightforward theory of labor supply can account for the facts on both margins
- If yes, project forward

Setup

- Neoclassical economy with steady labor productivity growth
- Heterogeneity in age, assets, disutility of work, gender, parenthood, skill/productivity (and complete markets)
- Allows us to study exogenous changes in demographics, gender wage/disutility gap, inequality, taxes and transfers

Quantitative method

- Calibrate model to cross-sectional facts of the U.S.
- Evaluate model performance in the time dimension

Preview of main results – understanding the history

- The model accounts surprisingly well (to us) for the U.S. post-war experience, both the intensive and extensive margin and for men as well as for women
- A trend of decreasing disutility of work for women is necessary for understanding the female labor supply (and puts pressure on further work to understand its deeper roots)
- Other factors (demographics, taxes, rising inequality, closing of gender wage gap) adds to the complete picture, but none stands out

Preview of main results – project into the future

- For the future, we consider (so far) one main scenario
  - Continuing productivity growth
  - Trend of decreasing disutility of work among women stops
  - Demographics according to U.N. projections
- Income effect dominates the substitution effect and we will see a decrease in hours
  - Women with young children will be the ones leaving the labor force first
- We could imagine a range of other scenarios, e.g.,
  - Secular stagnation
  - Continuation of the trend of falling disutility of work among women
- This paper provides a toolbox for analyzing these type of questions, with virtually unlimited heterogeneity

Household utility

All households have identical lifetime preferences:

$$\mathcal{U}_0 = \sum_{t=0}^{\infty} \beta^t u(c_t, h_t)$$

We use

$$u(c,h) = \frac{c^{1-\sigma} - 1}{1-\sigma} - \psi \frac{h^{1+\frac{1}{\theta}}}{1+\frac{1}{\theta}}$$

where $\sigma > 1$ and $\theta > 0$

- MaCurdy preferences widely used in, e.g., business cycle analysis
- Belongs to the BK preference class, consistent with long run facts
- $\sigma > 1$ means that income effect dominates substitution effect
- Hours will be restricted: $h \in \{0\} \cup [\underline{h}, 1] = \mathcal{H}$

Heterogeneity

s_t denotes the individual's type at time t in terms of

- Gender
- Age
- Parenthood
- Individual permanent productivity component $\overline{\omega} \in \Omega$
  - Constant over the life span, between generations the permanent component changes according to an AR(1) process capturing estimate of intergenerational income mobility
- Individual permanent disutility component $\overline{\psi} \in \Psi$
  - Permanent for the dynasty

$s_t \in \{\text{man, woman}\} \times \{\text{5 age brackets}\} \times \{\text{kids, no kids}\} \times \Omega \times \Psi$

s^t is defined as $\{s_0, s_1, ..., s_t\}$

Markov chain for life-cycle transitions

- Average number of years spent in each state equals size of age bracket
- Household either stays in current state or transitions to the natural "next" state:
  - Example: Man aged 25-29 w/o kids in this period either stays in same state next period, or transitions to man 30-39, with or w/o kids
- Old individuals are reborn again as either men or women
  - Example: Woman aged 60-64 either stays in the same state next period, or is "reborn" as young man or woman
- Markov chain adjusted to capture demographic change

The household problem

Maximize $\mathcal{U}_0$ with respect to $\{c_t(s^t), h_t(s^t), e_t(s^t)\}$:

$$\mathcal{U}_0 = \sum_{t=0}^{\infty} \sum_{s^t} \beta^t \left[\frac{c_t(s^t)^{1-\sigma} - 1}{1-\sigma} - e_t(s^t)\psi_t(s_t) \frac{h_t(s^t)^{1+1/\theta}}{1+1/\theta} \right] \pi_t(s^t)$$

s.t.

$$h_t \in [\underline{h}, 1]$$

$$0 \leq e_t \leq 1, \quad \forall t$$

$$a(1+r_0) + \sum_{t=0}^{\infty} \sum_{s^t} q_t(s^t) \Big[w_t \omega_t(s_t) e_t(s^t) h_t(s^t)(1-\tau_t) + T_t(s^t) \Big]$$

$$= \sum_{t=0}^{\infty} \sum_{s^t} q_t(s^t) c_t(s^t),$$

where $\psi_t(s_t) = \zeta_{t\psi}(s_t)$ and $\omega_t(s_t) = \zeta_{t\omega}(s_t)$

Equilibrium: some theoretical results

- **Result**: Work is front-loaded (retire from labor force forever in finite time)
  - Intuition: as in the planner's problem (welfare theorems)
  - Mechanism: interest rate will adjust
  - Intertemporal shifts due to temporary low productivity add to complete picture
- **Result**: the rich, "lazy", and low-productive quit sooner
  - Rich: wealth effect
  - "Lazy": more costly to work
  - Low-productive: intertemporal substitution
- **Result**: in equilibrium, lotteries are almost never used

Calibration of distributions and profiles

We calibrate to year 2008 and back-cast the model to 1960

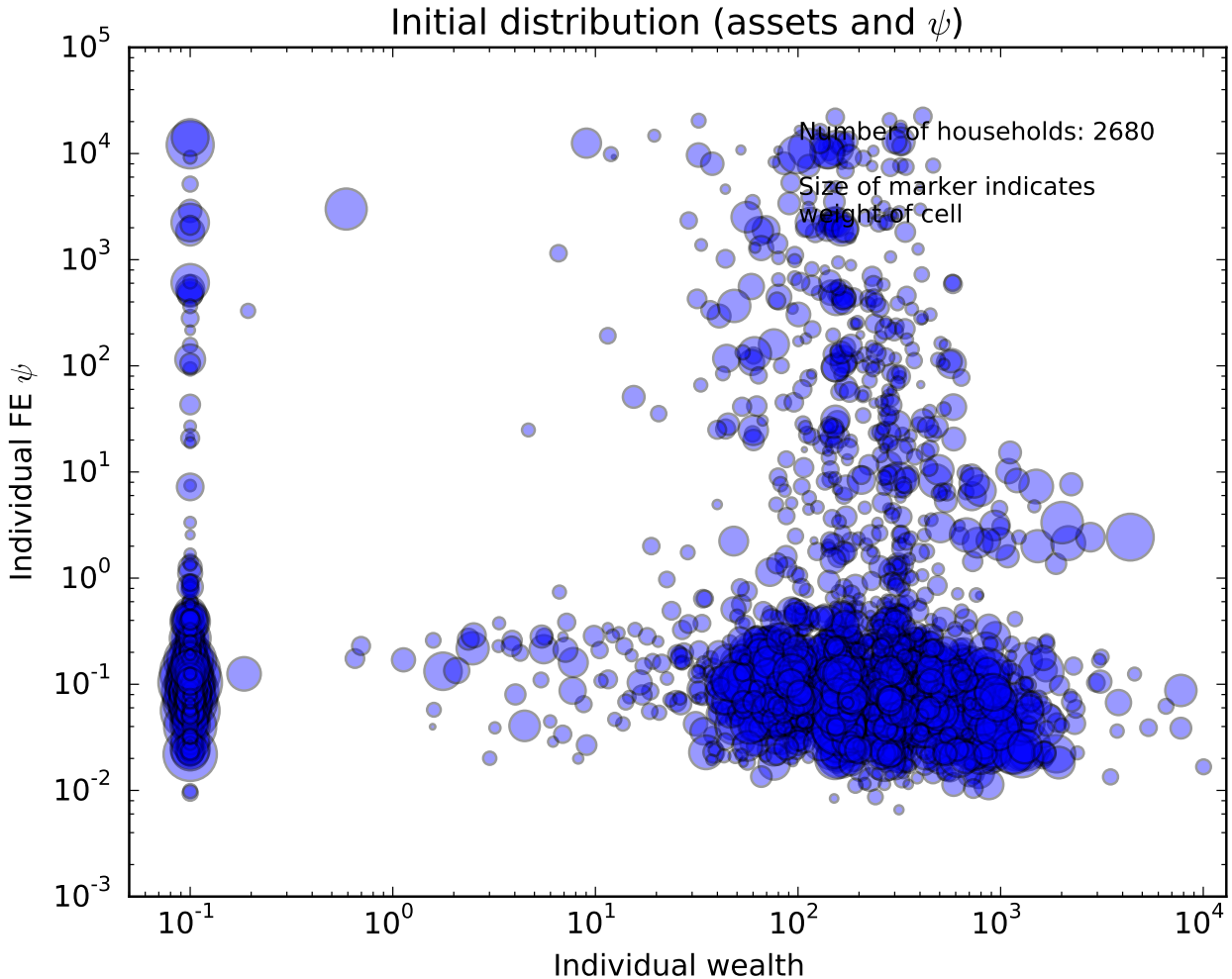
- Joint distribution of assets and permanent disutility component ($\overline{\psi}$):
  - Source: PSID
  - Assets directly available
  - Back out disutility from intratemporal cons.-leisure FOC:

$$w_t c_t^{-\sigma} = \psi h_t^{1/\theta}$$

    and use the individual fixed effect from a panel regression 1998-2008 controlling for age, gender and parenthood
- Life-cycle profiles for productivity and disutility
  - Estimated from regressions including individual FE from PSID 1998-2008
- We calibrate the model to the core working population 25-64

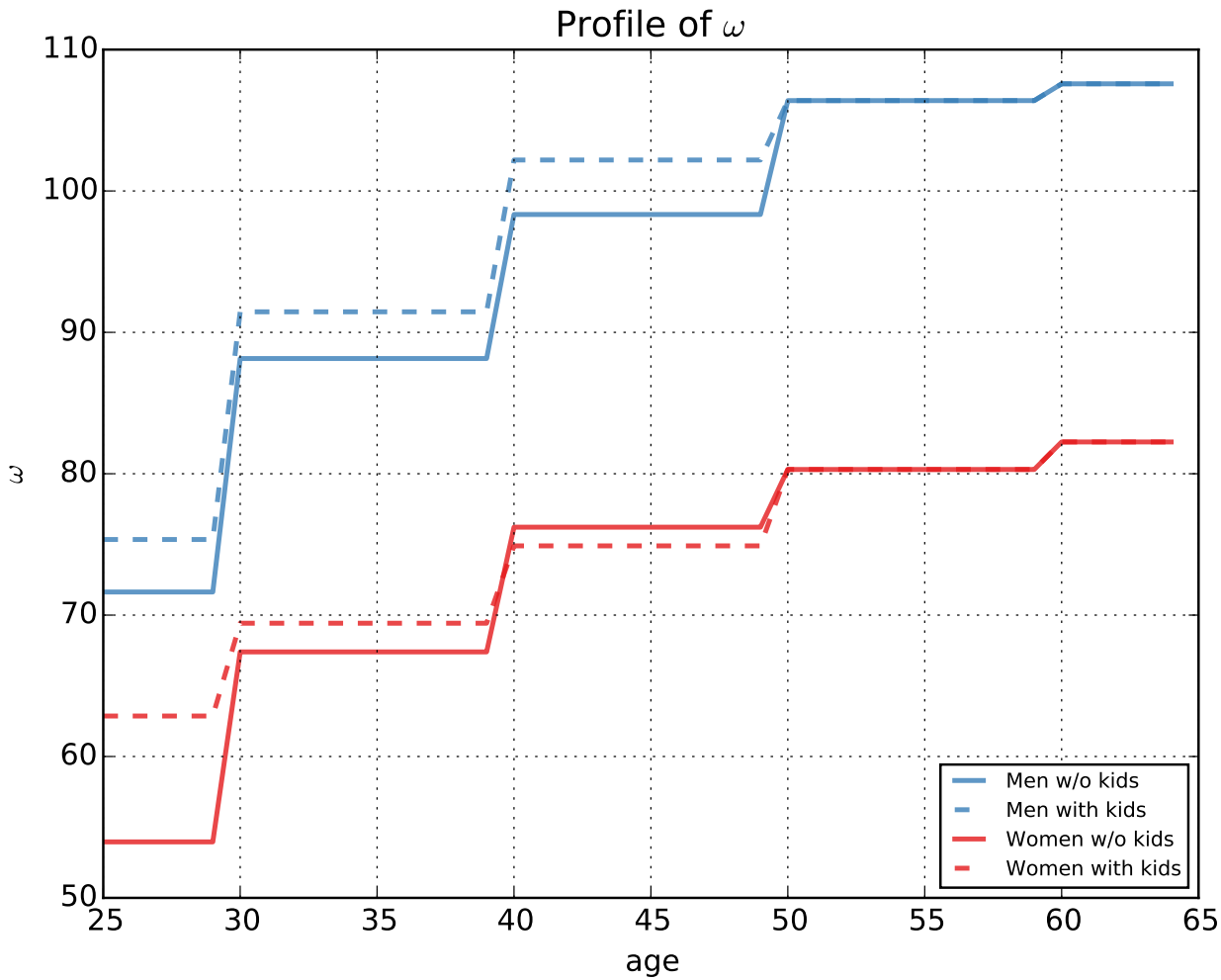
▸ Details

Initial distribution of wealth and disutility of work



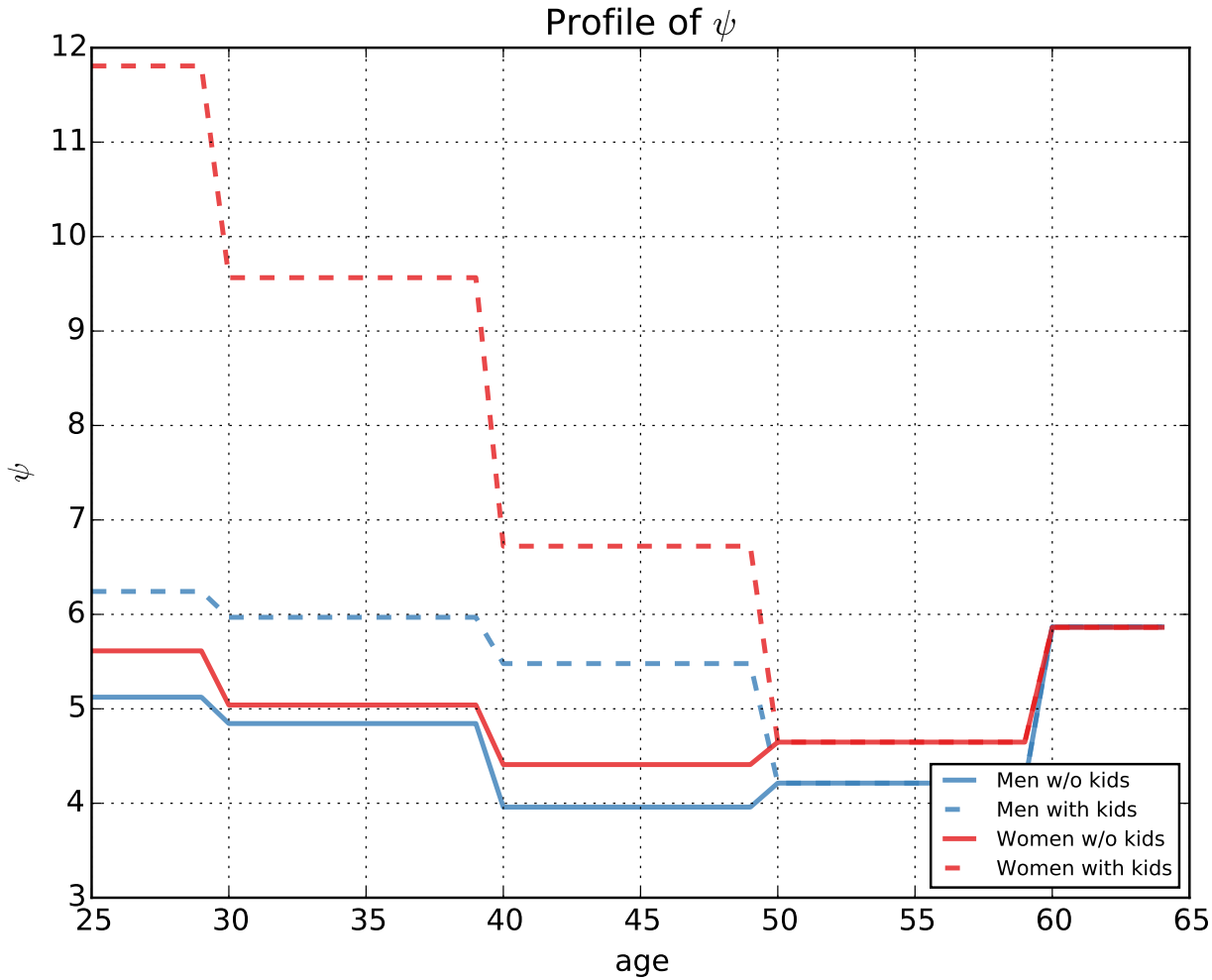
Source: PSID 1998-2008. Households created by dividing cross-sectional sample 2008 in asset quantiles, ω individual FE quantiles, ψ individual FE quantiles, men/women, kids/no-kids, age. In this graph assets are capped from below at 0.1 due to the log scale of the x-axis (i.e., negative assets visible as the lump to the left).

Life-cycle profiles of measured productivity ω



Source: PSID 1998-2008. Results from regression including individual FE.

Life-cycle profiles of measured disutility of work ψ



Source: PSID 1998-2008. Results from regression including individual FE. Disutility of work calculated from the consumption-leisure FOC for each individual and year. $\left(\psi = \frac{\omega}{c^{\sigma} h^{1/\theta}}\right)$

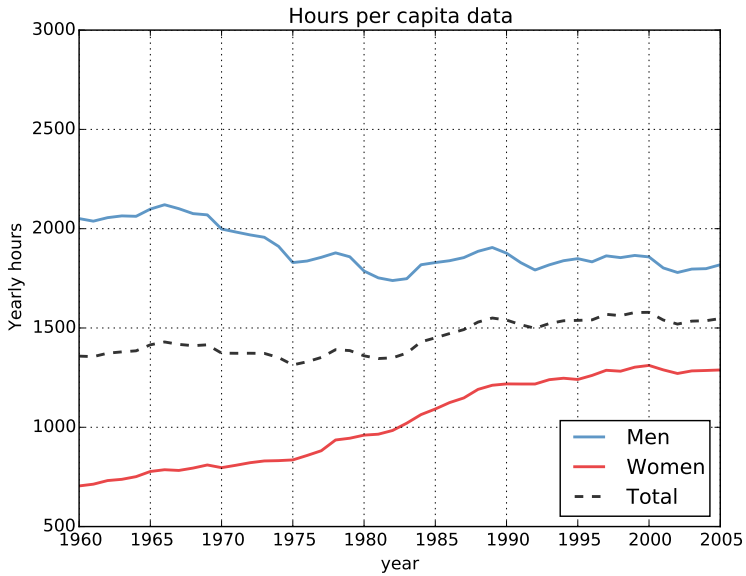
Historical drivers

Exogenous time series 1960-2008 fed into the model

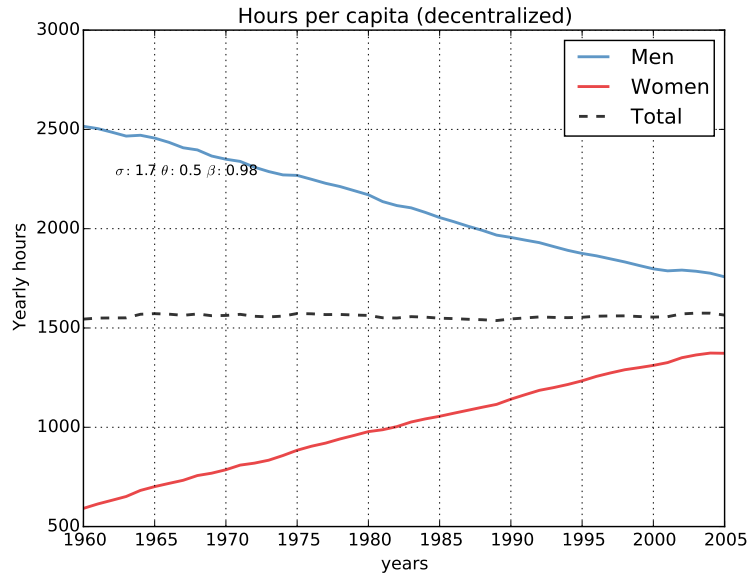
1. Changes in taxes and transfers ▸ Details
   - Use historical average effective tax rates on labor income
2. Demographic change ▸ Details
   - Use UN data on demographic growth by age group and gender
3. Increasing income inequality ▸ Details
   - Use historical increase in variance in (log) productivity
4. Changes particular to female labor force conditions ▸ Details
   a) Incorporate historically observed trend in female wage gap
   b) Assume that the cost of working / disutility for women was even larger in the 1960s than now, and that it has been decreasing until today's level

Comparing data and model output historically

Hours per capita, by gender



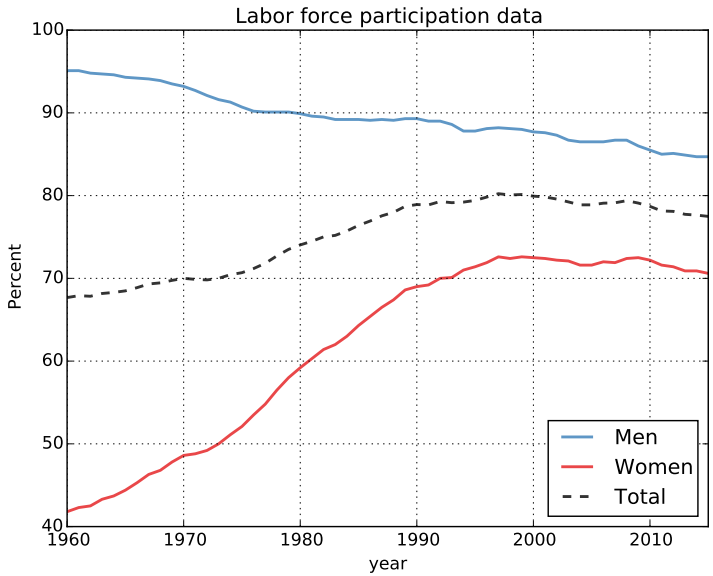
(a) Data



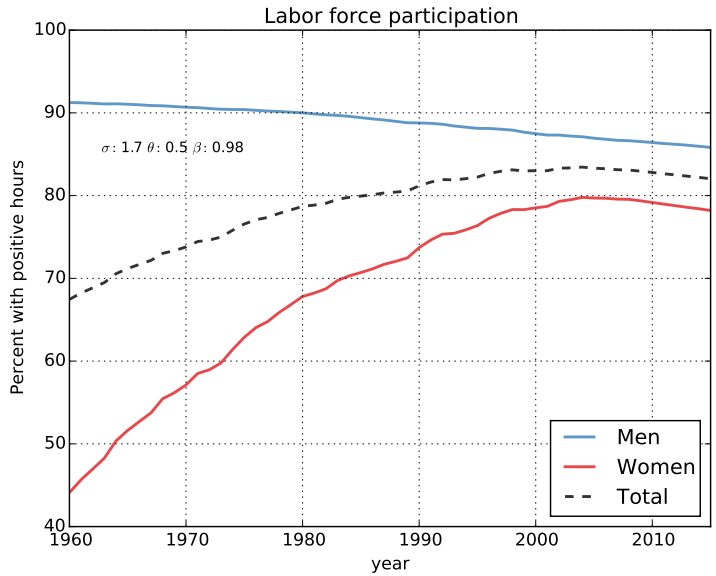
(b) Model output

Comparing data and model output historically

Labor force participation, by gender



(a) Data



(b) Model output

▸ Other model results

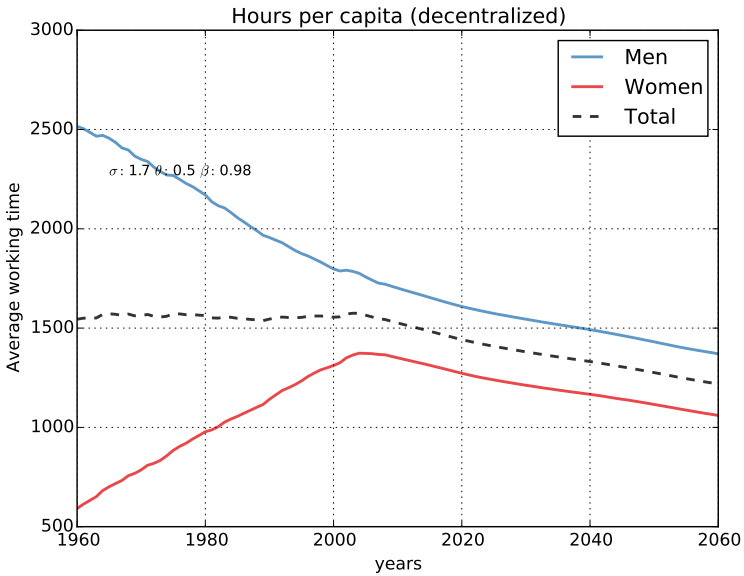
Projecting forward

A straightforward theory of labor supply seems to account for the main trends on both margins reasonably well

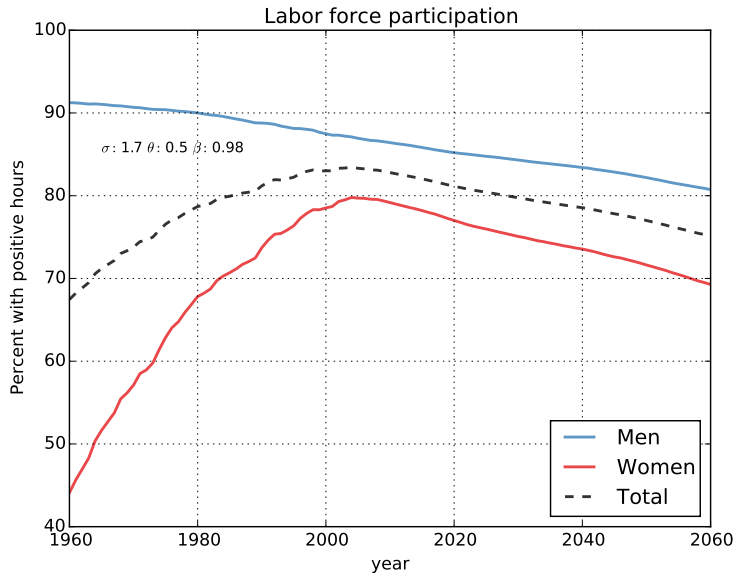
Next step: project forward

- Using UN demographic projections
- Keeping other drivers constant at the 2008 level
  - No secular stagnation (i.e. assuming continuing productivity growth)
  - No further decrease in the gender wage gap
  - No further decrease in women's relative disutility of work

Projecting forward – broad aggregates



(a) Hours per capita

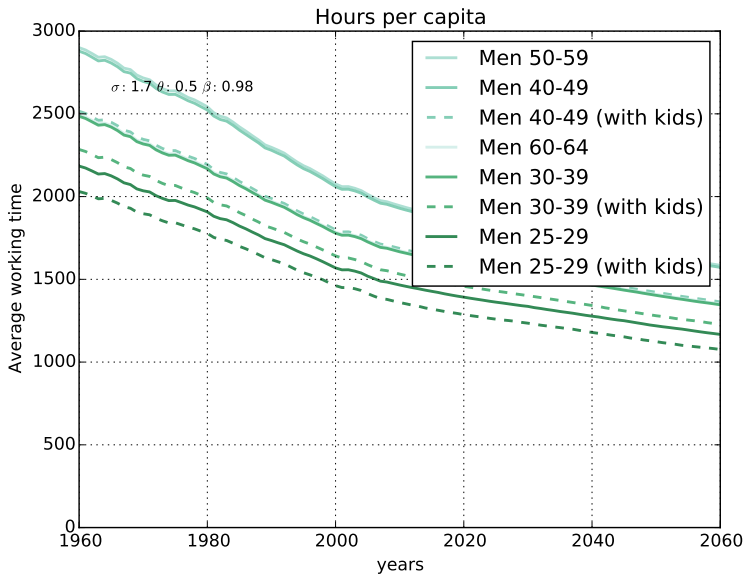


(b) Labor force participation

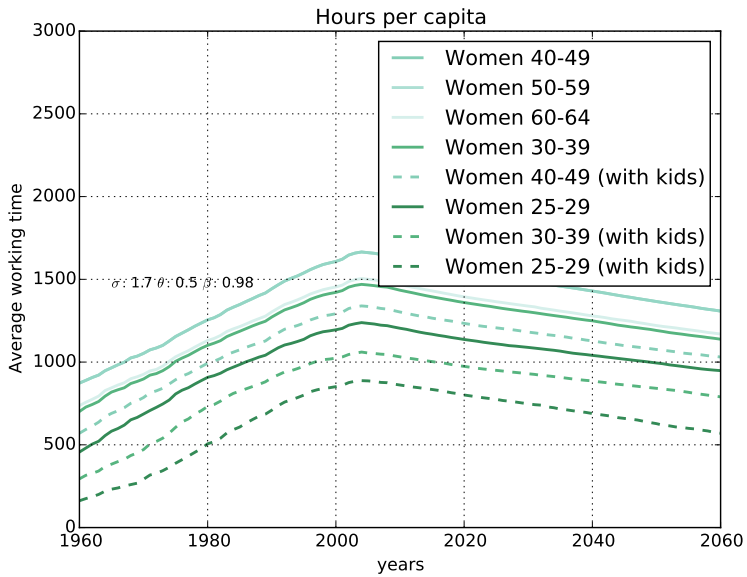
- Income effect dominates the substitution effect and we will see a decrease in hours

Projecting forward – who and when?

Hours per capita, by gender, age, and parenthood



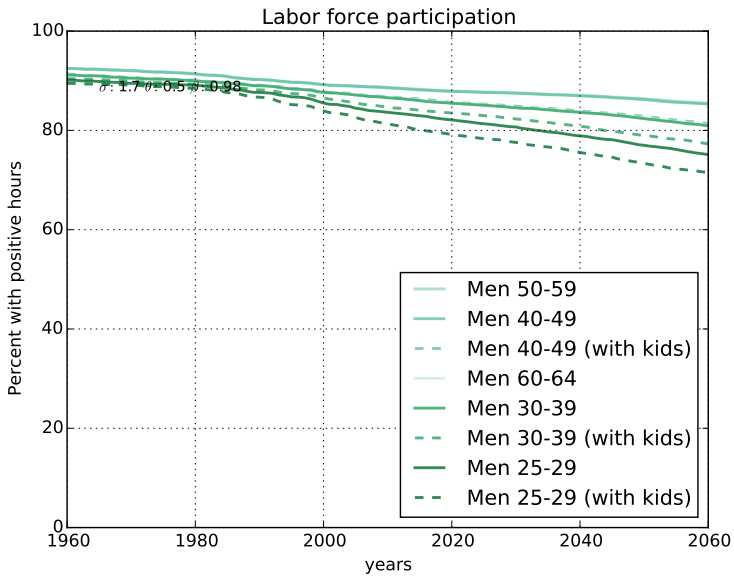
(a) Men



(b) Women

Projecting forward – who and when?

Labor force participation, by gender, age, and parenthood



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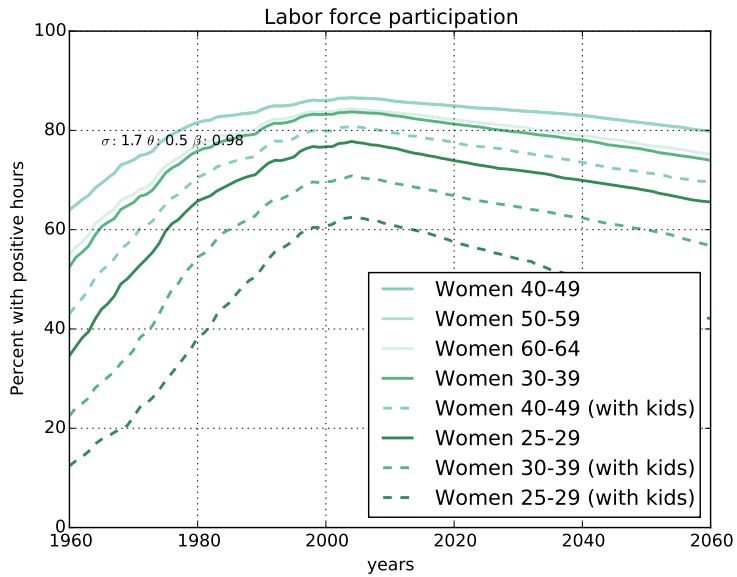

(b) Women

Alternative scenarios (future work)

- Underlying the predictions for who will work in the future is the productivity to disutility (ω/ψ) ratio for each group
  - Assumed to be constant 2008 and onwards
- With other assumptions about the development of either productivity (ω) or disutility of work (ψ) for one or more different subgroups, conclusions about who will work and who will drop out of the labor force might change
  - Increased access to daycare
  - Less discrimination in the workplace
  - More widespread paternity leave
  - Healthier old age
  - ...

Post-view of main results – understanding the history

- The model accounts surprisingly well (to us) for the U.S. post-war experience, both the intensive and extensive margin and for men as well as for women
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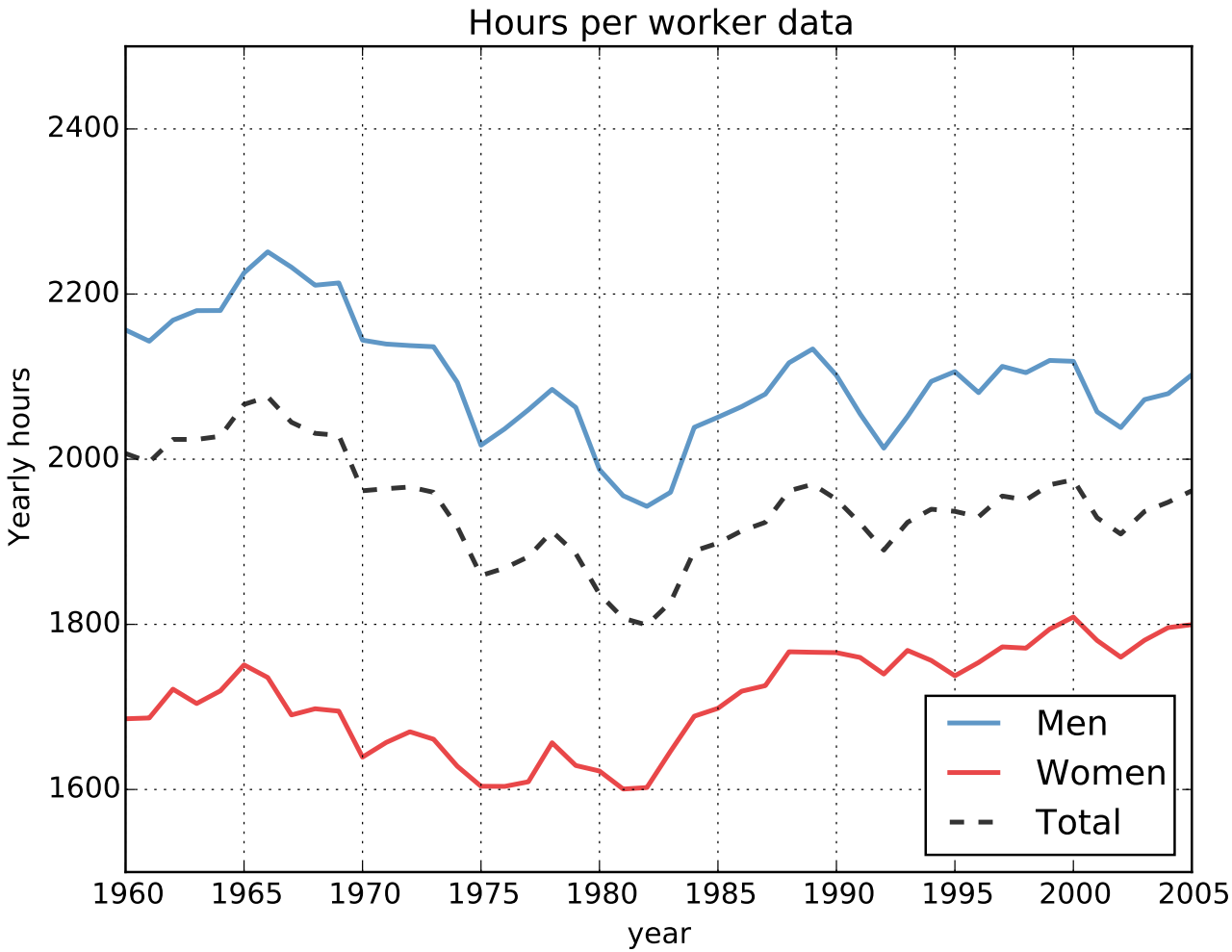
- We could imagine a range of other scenarios, e.g.,
  - Secular stagnation
  - Continuation of the trend of falling disutility of work among women
- This paper provides a toolbox for analyzing these type of questions, with virtually unlimited heterogeneity
- Opens up for many new interesting extensions, e.g.,:
  - Here: technological change is neutral. What if not?
  - More frictions, such as uninsurable shocks

APPENDIX: HOURS PER WORKER, DATA AND MODEL

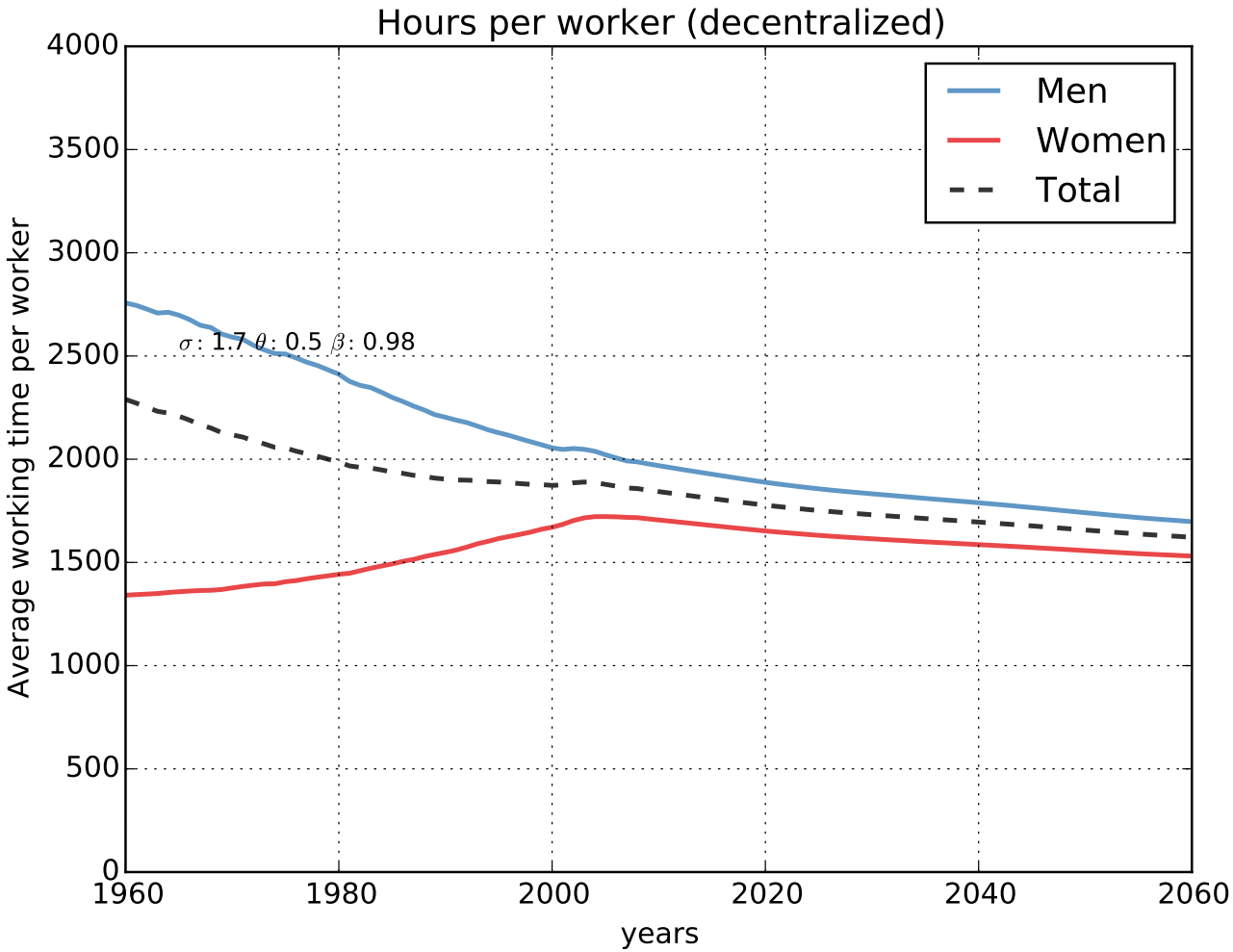
◂ Back

Hours per worker (data)



Source: Ramey (2009), BLS, OECD.

Hours per worker (model)

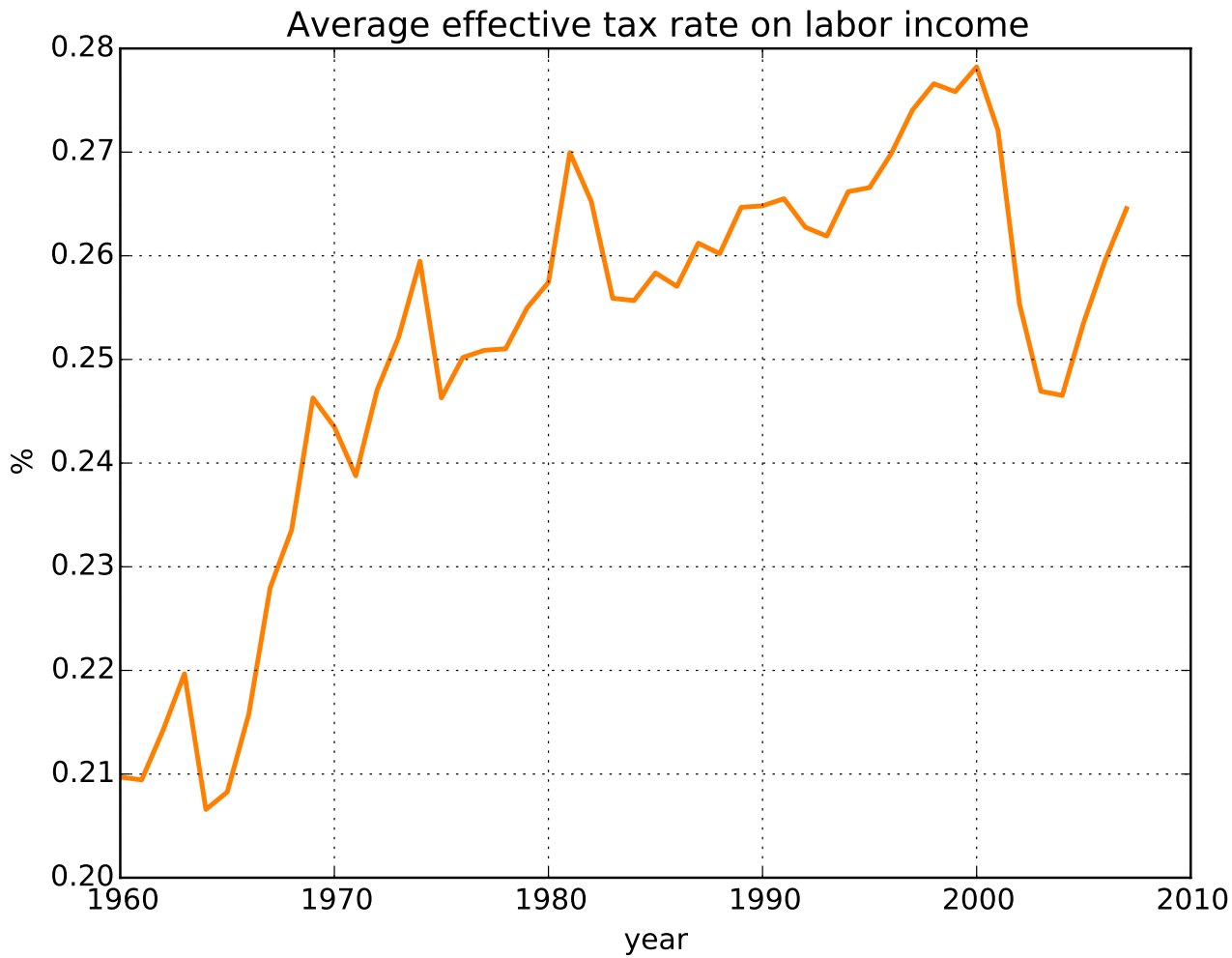


Source: Ramey (2009), BLS, OECD.

APPENDIX: CHANGES IN TAXES

◂ Back

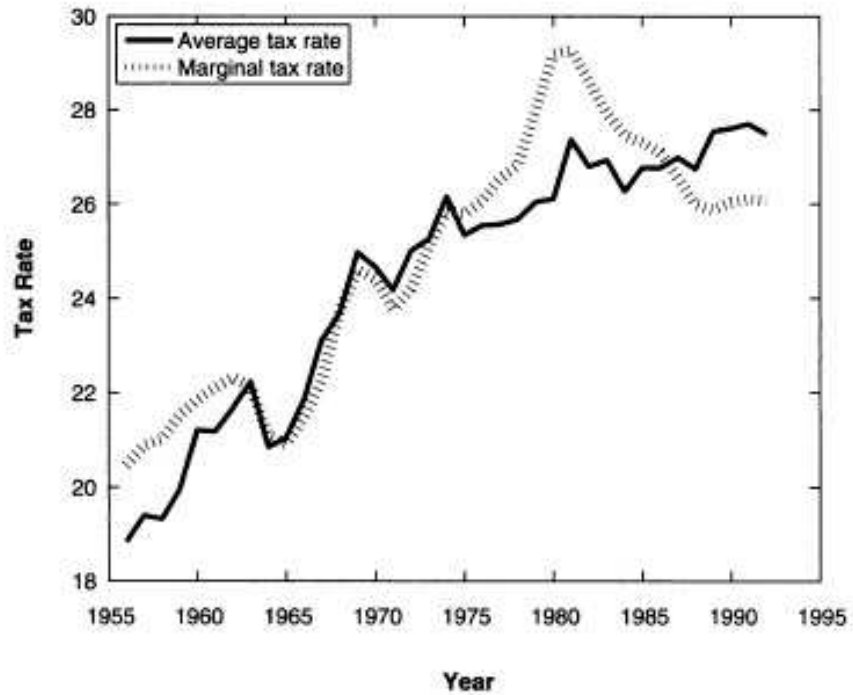
Average U.S. effective tax rate on labor income



Source: Based on McDaniel (2006), updated with the most recent data from her website. See next slide for exact definition.

Comparing average and marginal tax rates

FIGURE 3-2
AVERAGE AND MARGINAL U.S. TAX RATES ON LABOR, 1956–1992



SOURCES: McDaniel 2006 (for average tax rate); McGrattan, Rogerson, and Wright 1997 (for marginal tax rate).

Taken from Rogerson, *The Impact of Labor Taxes on Labor Supply* (2010).

Calculation of average U.S. effective tax on labor

- Use tax rates computed by McDaniel (2006), who uses Prescott's (2004) modification of the procedure originally used by Mendoza, Razin, and Tesar (1994):
  - Take all tax revenues collected by governments (at all three levels – local, state, and federal)
  - Allocate them according to which source they are derived from (e.g., labor income, capital income, consumption expenditures, or investment expenditures)
  - Compute the appropriate base for each revenue source
  - Find average effective tax rate as the ratio of tax revenue divided by corresponding tax base

Definition of the effective tax on labor

Effective tax on labor, denoted by τ, is defined by:

$$1 - \tau = \frac{1 - \tau_h}{(1 + \tau_c)(1 + \tau_p)}$$

- τ_h labor income tax levied on workers
- τ_c consumption tax levied on consumers
- τ_p payroll tax levied on firms

Using our data set and following suggestion by the author, τ_h is approximated by $\tau_{inc} + \tau_{ss}$ where

- τ_{inc} average tax rate on household (non-capital) income
- τ_{ss} average payroll tax rate (both what is paid by employer and employee)

while we set $\tau_p = 0$.

Assumptions about transfers and government budget

- Balanced government budget
- The amount collected by the government in taxes are given back as transfers
- Every dynasty receives in transfers exactly what was paid in taxes by that dynasty

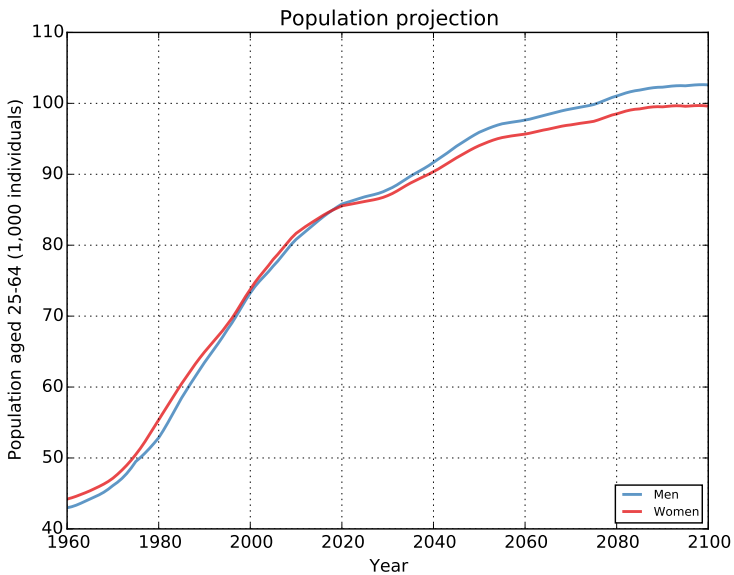
APPENDIX: DEMOGRAPHIC CHANGE

◂ Back

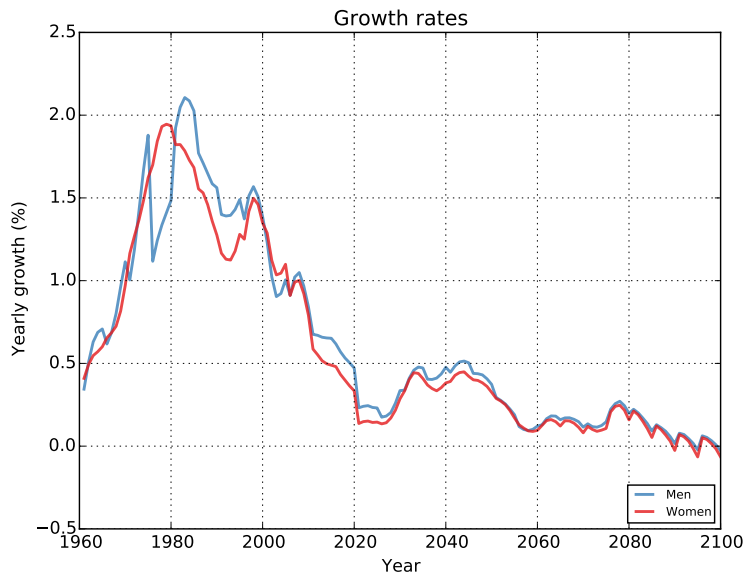
Data about demographic growth

- Demographic projections by gender and age group until 2100 available from the UN, Department of Economic and Social Affairs, Population division
- Estimated to be consistent with the 2010 census
- Based on estimates of fertility, mortality and life expectancy from 2011, and immigration from 2014

Population projection (age 25-64), by gender



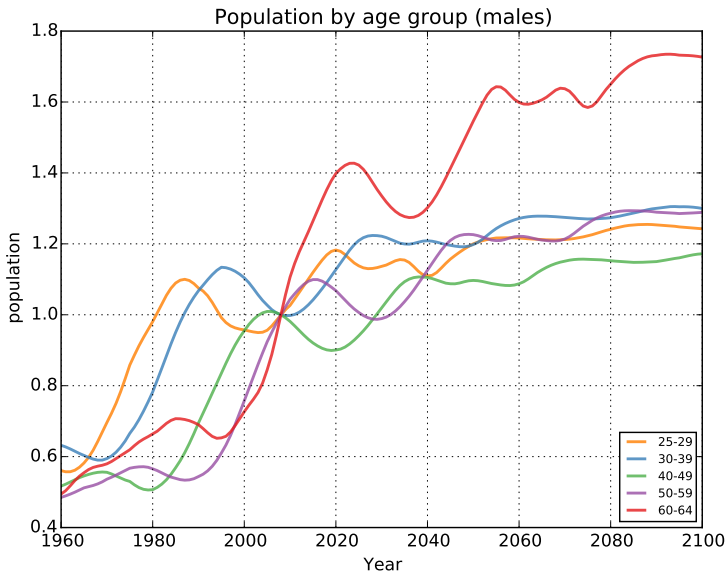
(a) Population



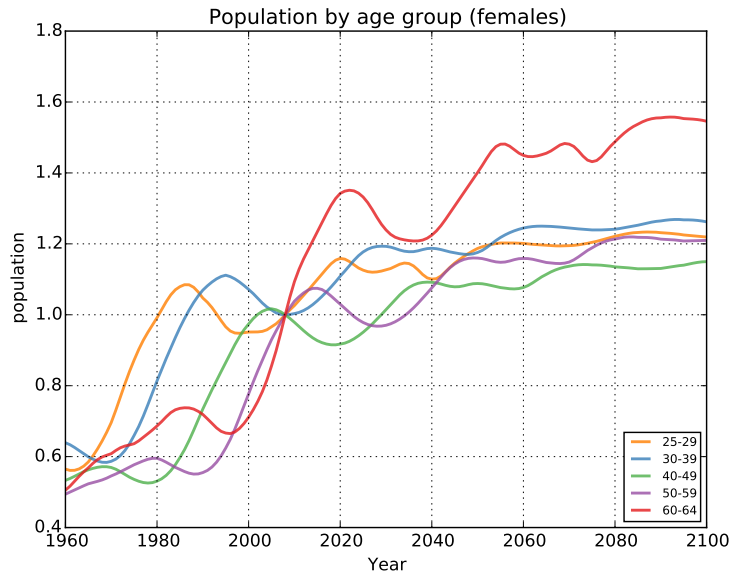
(b) Growth

Source: UN, Department of Economic and Social Affairs, Population division (https://esa.un.org/unpd/wpp/).

Population by age group and gender



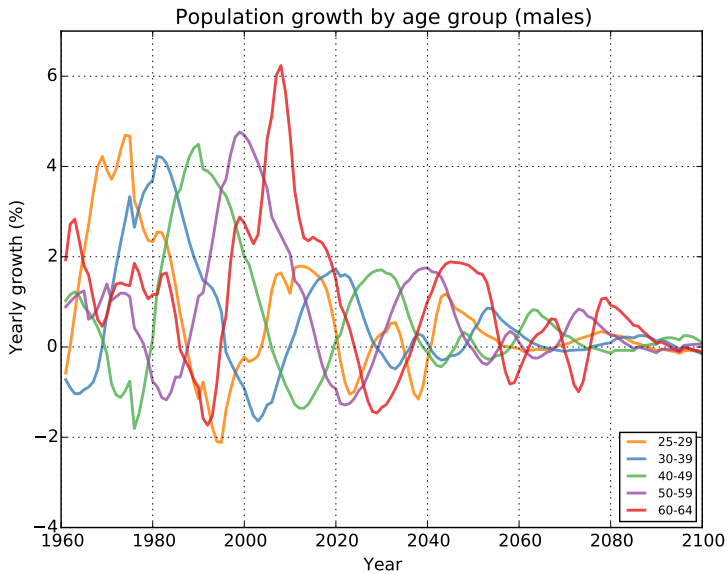
(a) Men



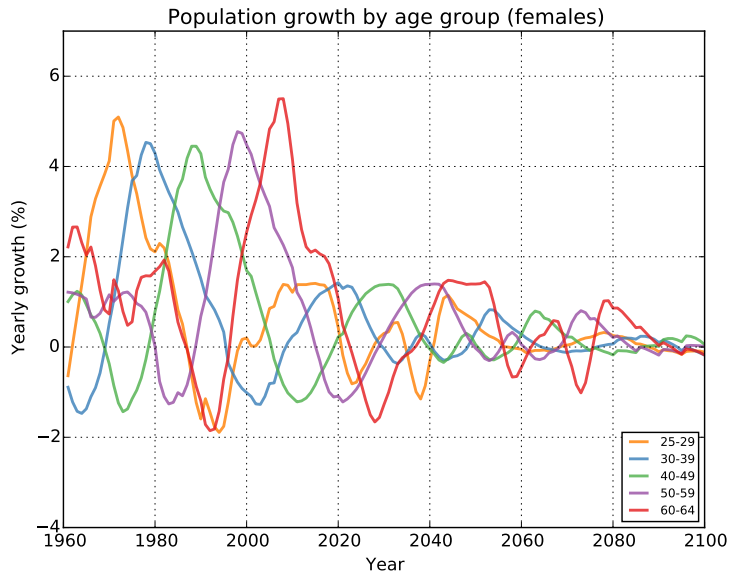
(b) Women

Figures are normalized to 1 for year 2008 (year 0 in the model).

Population growth rates by age group and gender



(a) Men



(b) Women

After year 2100 growth rate is set to 0

Introducing demographic growth in the model

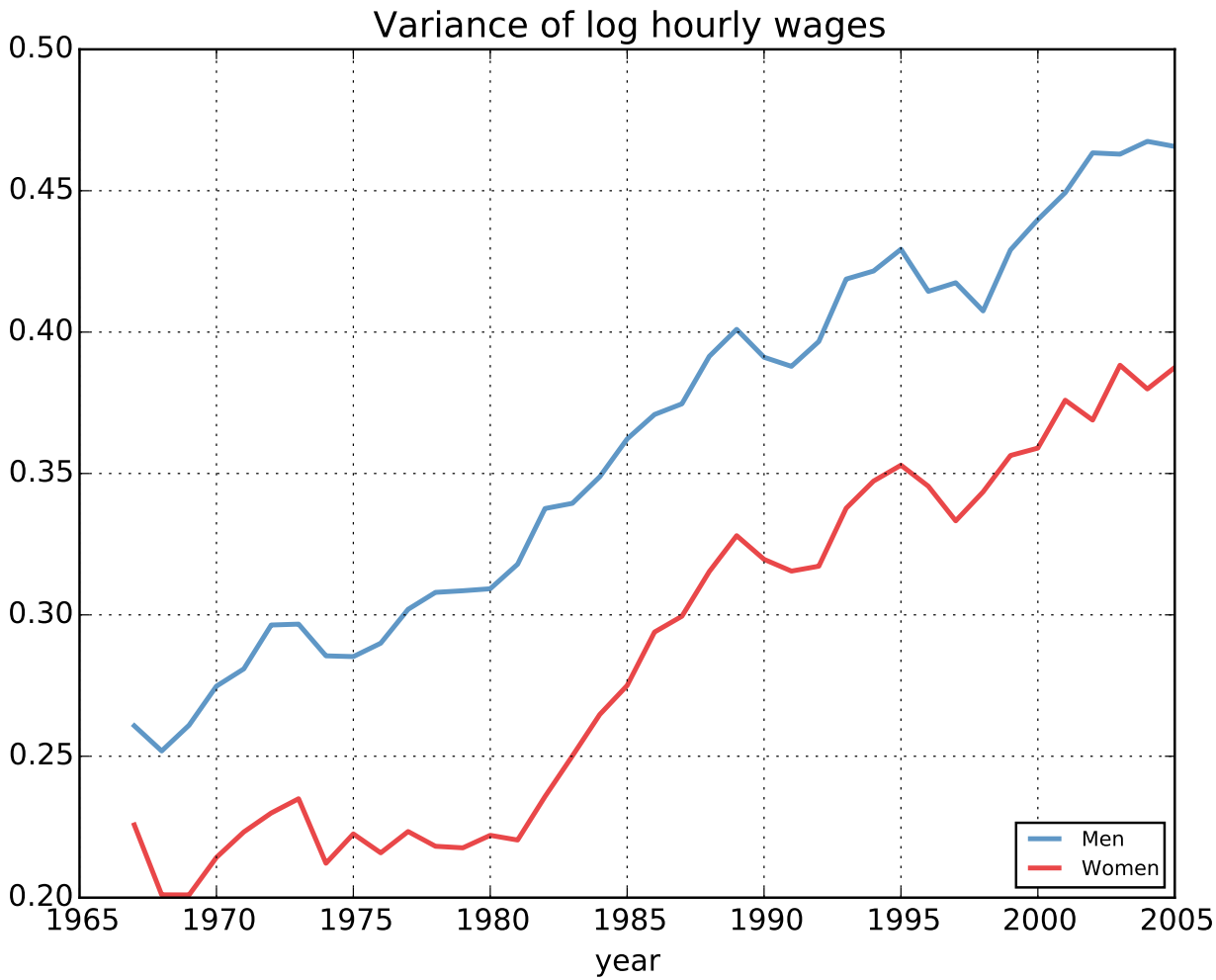
- Assume that growth, conditional on age and gender, is evenly spread in the population (i.e., *not* faster growth for e.g., certain income or wealth levels)
- Assume that dynasties have perfect foresight about future growth when solving their maximization problem
- No "new" families enter the model (i.e., not a model of immigration)

◂ Back to list of exogenous factors ◂ Back to role of demograpics

APPENDIX: INCREASING INEQUALITY

◂ Back

Variance of log hourly wages



Source: Heathcote et al (2010).
Note: The average of the variance for men and women is fed into the model, then the distribution is shifted so that the average productivity in the economy is kept constant.

APPENDIX: CHANGES PARTICULAR TO FEMALE LABOR FORCE CONDITIONS

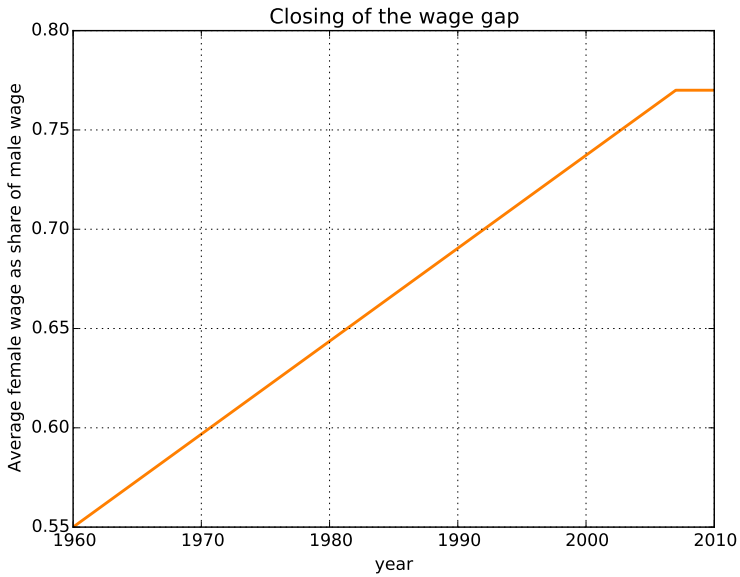
◂ Back

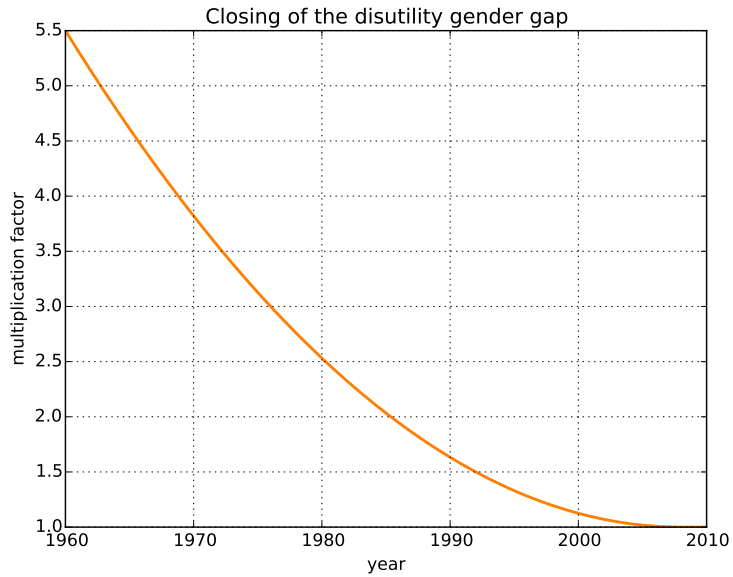
A "what-if" scenario

What if we feed in the following:

- Gender wage gap (source IWPR):
  - In 1960, women's median earnings as percent of men's median earnings was around 55%
  - In 2008, corresponding figure around 77% (corresponds well to the wage gap profile we have estimated)
  - Assume linear development
- Gender ψ gap:
  - Assume it was approximately 5.5 times as costly for women to work in the 1960s as compared to now
  - Assume smooth decline until today's figures
- Assume no further change from now (i.e., 2008) and onwards

Closing of the wage and disutility gap



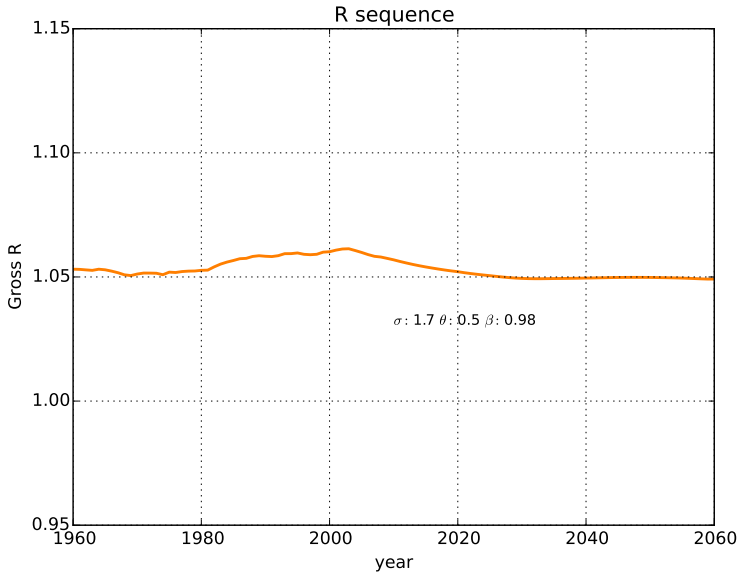


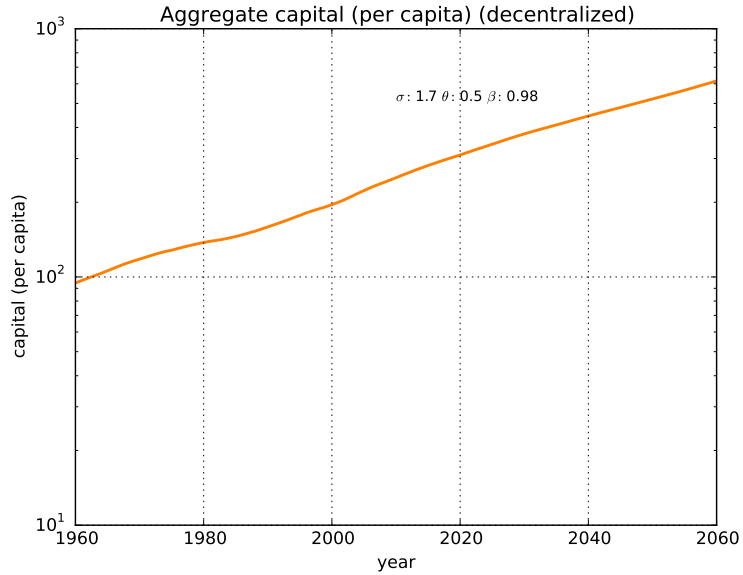
Source wage gap: Institute for Women's Policy Research (IWPR)
Source psi gap: Modelled as a second order polynomial with the restriction that the derivative should be 0 in 2008.

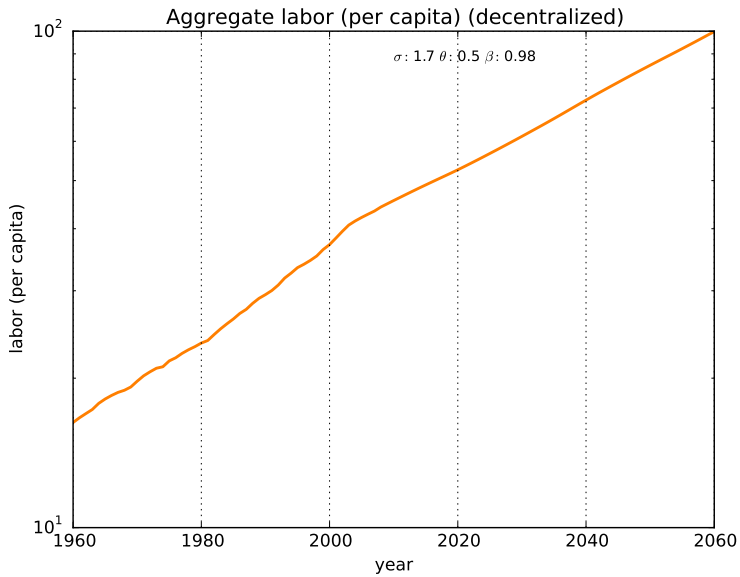
APPENDIX: OTHER MODEL RESULTS

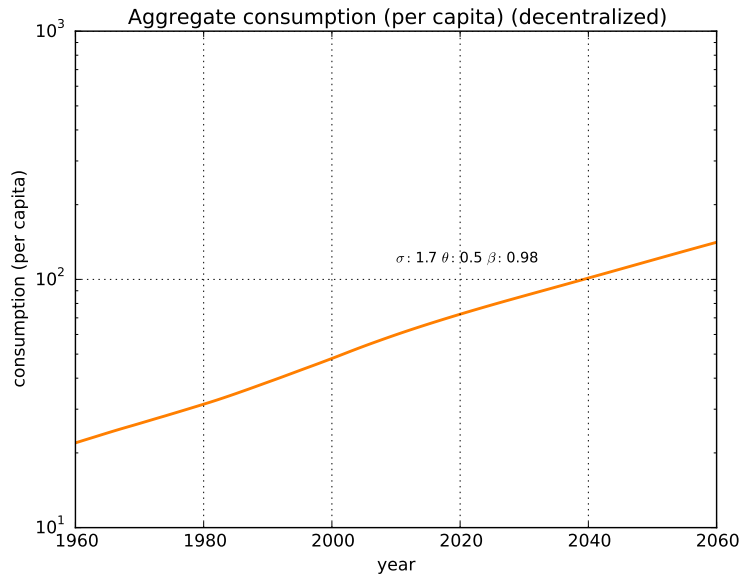
◂ Back

Results aggregate variables





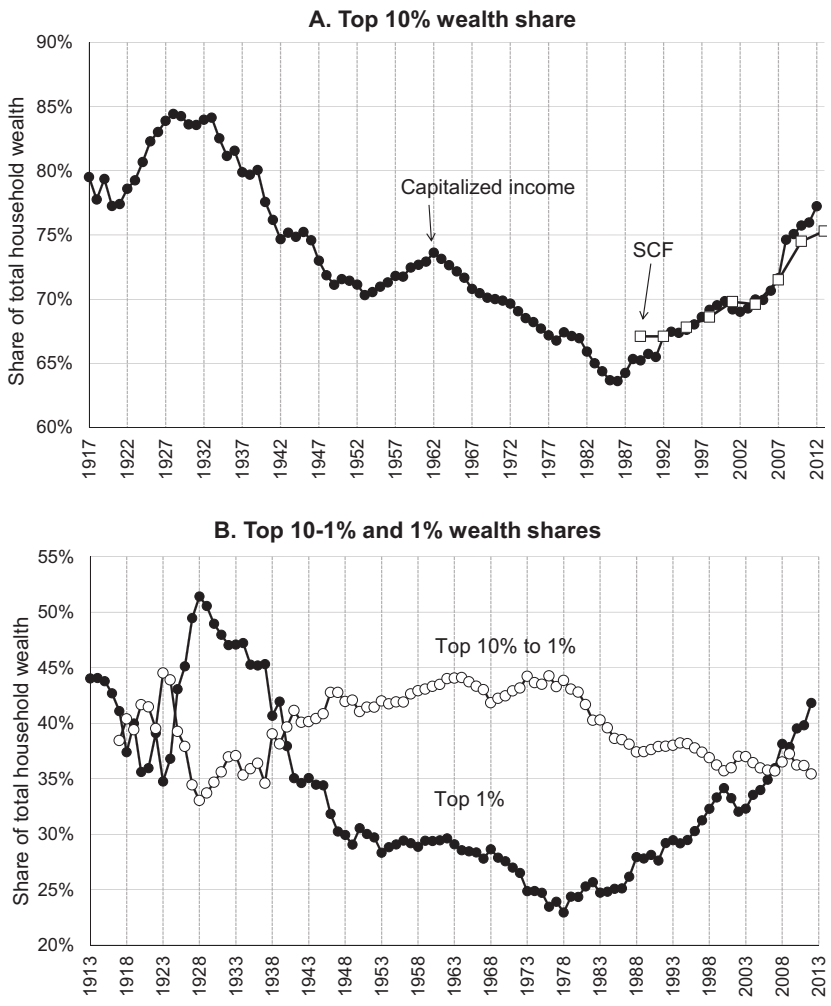


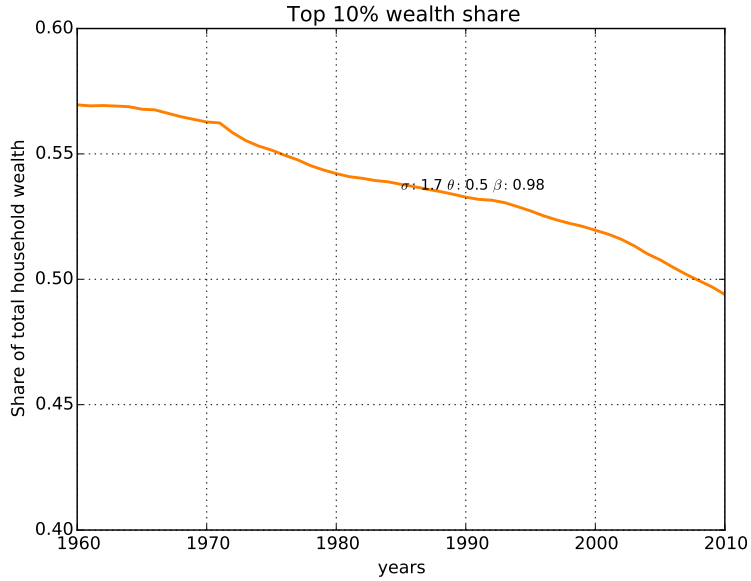


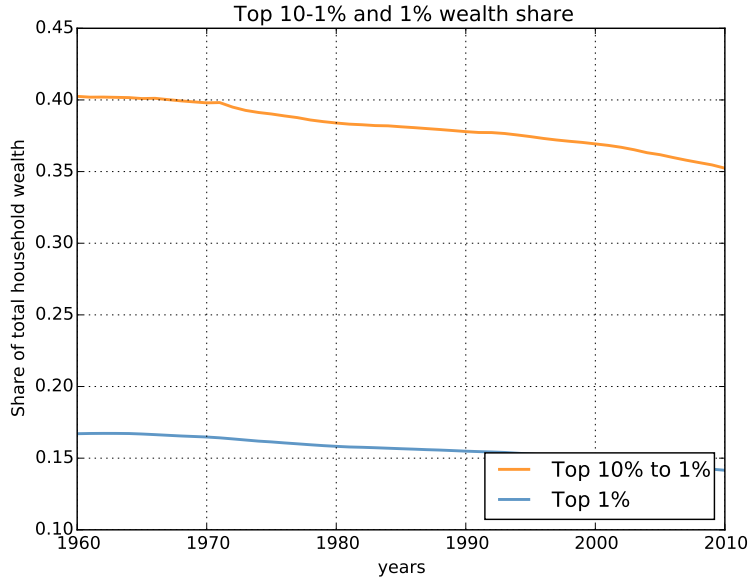
Model predictions re wealth inequality

- Model predicts a falling wealth inequality historically (and rising inequality in the future)
- In the data, wealth inequality has been first falling, and then rising since the 1960s
- However, if we look at model predictions in more detail, we see that what we miss is the top 1%, otherwise the model is reasonably close to data
- See next slide for comparison data vs. model

Wealth inequality data vs. model







Source: Saez and Zucman (2016).

APPENDIX: POPULATION OF INTEREST

◂ Back to post-war data

◂ Back to calibration

Defining working population as 25-64

- Want to be able to compare with as many other sources as possible (BLS, GGDC, OECD, ATUS, ...)
- Lower bound of 25: excludes the part of the population where the main trade-off between work and school is (and where the not so clear-cut categorization of schooling is most important)
- Upper bound of 64: fraction of the population working above 64 is small, changes in hours worked in this age group hardly affects the aggregate
- For both groups (just below or just above the working population definition): difficult to estimate credible productivity and disutility figures (selection effect is severe)