# Heterogeneous agents and inequality

## Session 1

## **Introduction and Inequality facts**

Karl Walentin, Sveriges Riksbank

Macroeconomics II.2

Stockholm Doctoral Program in Economics 2017

# Intro

- 1st year PhD macro so far
  - Aggregate Economic Behaviour: Growth, Cons, Inv, Business cycles
  - Microfounded models, using optimising behaviour by representative agents: 1 firm, 1 household, 1 government
- Now:
  - Introduce "Heterogeneity" of agents: Many households, many firms

# Inequality vs. Heterogeneity vs. idiosyncratic risk

- Inequality: Dispersion in economic outcomes (wage, income, wealth, consumption)
- Heterogeneity: Dispersion in **Household**/Firm-level characteristics of an economic model more generally
- Risk: Uncertainty about future values of variables
- Idiosyncratic risk: Uncertainty about individual-specific variables conditional on aggregate variables
- Vs. aggregate risk
- Realisations of idiosyncratic risk lead to inequality in exogenous variables (but other factors than risk also generate inequality)
    - depending on the structure of financial markets also endogenous variables

# Dimensions of Heterogeneity

1. How do agents differ?
   - Income, wealth, consumption
   - Preferences
   - Endowments
   - Technology/individual productivity/wages
   - Age
   - Information
   - Beliefs about the future (optimist and pessimists)
2. Where / when do differences arise?
   - Exogenous (parental education) vs endogenously chosen (own education)
   - Ex ante heterogeneity vs. ex post heterogeneity (due to realisation of risk)

# Heterogeneity: Why do we care (in Macro)?

- Realism: Heterogeneity is 'A fact of life'
- Welfare: Inequality and risk are bad

# The welfare impact of inequality

Jones and Klenow, "Beyond GDP? Welfare Across Countries and Time", 2016, forthcoming, *American Economic Review*

Considers the welfare flow for someone arriving to country X, from an *ex ante* perspective (not knowing individual characteristics)

# The welfare impact of inequality

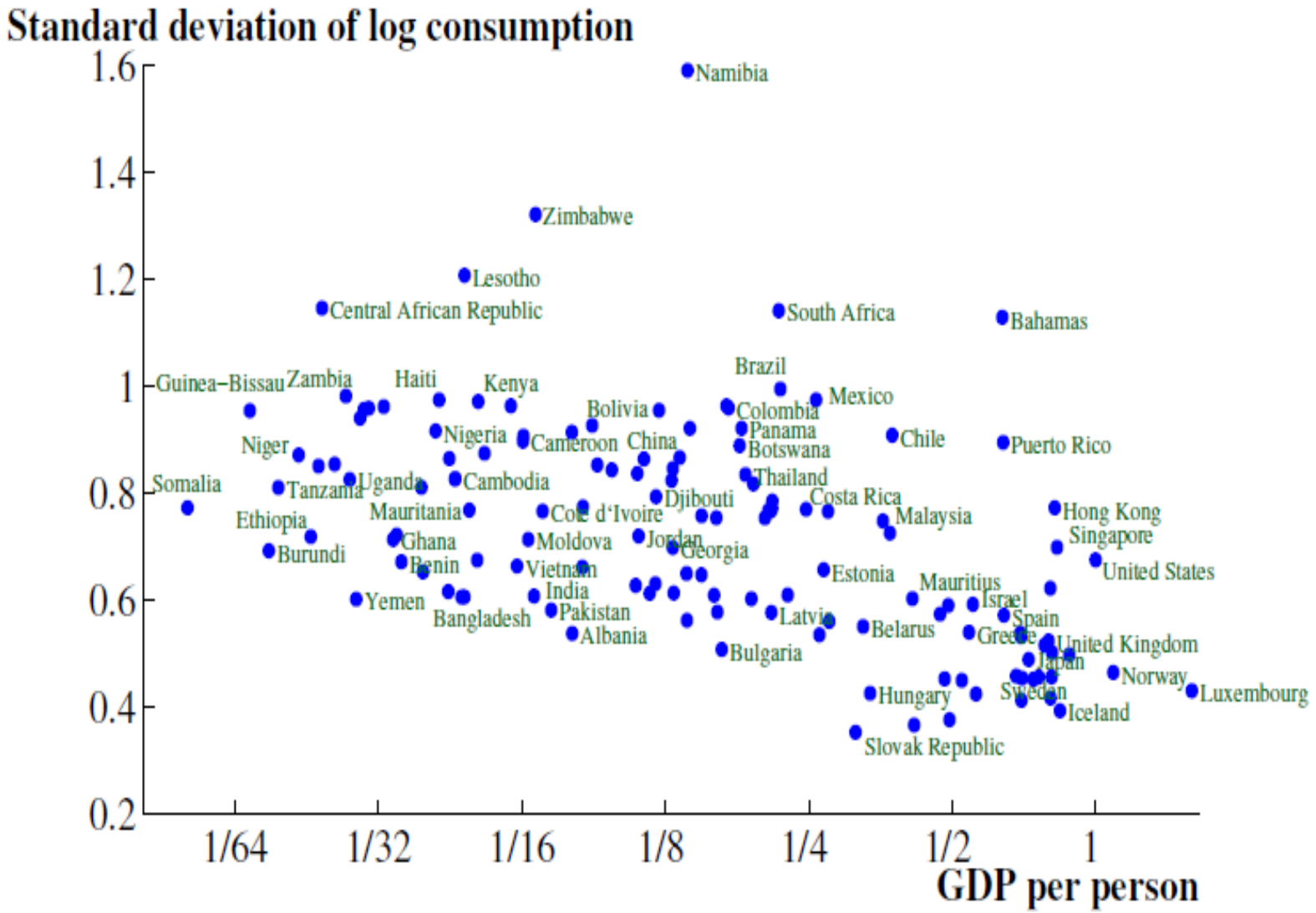
$$\log \lambda_i^{\text{simple}} = \frac{e_i - e_{us}}{e_{us}}(\bar{u} + \log c_i + v(\ell_i) - \tfrac{1}{2}\sigma_i^2) \quad \text{Life expectancy}$$

$$+ \log c_i - \log c_{us} \quad \text{Consumption}$$

$$+ v(\ell_i) - v(\ell_{us}) \quad \text{Leisure}$$

$$- \tfrac{1}{2}(\sigma_i^2 - \sigma_{us}^2). \quad \text{Inequality}$$

# The welfare impact of inequality




Source: Jones and Klenow 2010

# The welfare impact of inequality

Table 1: Welfare and Income Summary Statistics, 2000

| Country | Welfare $\lambda$ | Per capita Income | Log Ratio | Decomposition: Life Exp. | Decomposition: $C/Y$ | Decomposition: Leisure | Decomposition: Inequality |
|---|---|---|---|---|---|---|---|
| Average, unweighted | 24.8 | 27.3 | -0.659 | -0.646 | 0.071 | -0.026 | -0.058 |
| Average, pop-weighted | 19.7 | 22.2 | -0.611 | -0.530 | 0.034 | -0.065 | -0.050 |
| Median absolute dev. | ... | ... | 0.458 | 0.390 | 0.175 | 0.076 | 0.101 |
| Standard deviation | 32.6 | 29.4 | 0.790 | 0.720 | 0.219 | 0.124 | 0.170 |
| *Regional Averages* | | | | | | | |
| United States | 100.0 | 100.0 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Western Europe | 90.1 | 71.0 | 0.235 | 0.086 | -0.073 | 0.119 | 0.103 |
| Eastern Europe | 14.8 | 21.7 | -0.473 | -0.499 | -0.020 | 0.041 | 0.006 |
| Latin America | 13.1 | 21.4 | -0.518 | -0.322 | 0.054 | -0.031 | -0.219 |
| N. Africa, Middle East | 11.1 | 15.9 | -0.439 | -0.464 | -0.053 | 0.084 | -0.006 |
| Coastal Asia | 9.3 | 13.2 | -0.631 | -0.467 | 0.010 | -0.127 | -0.047 |
| Sub-Saharan Africa | 1.1 | 5.3 | -1.781 | -1.707 | 0.217 | -0.114 | -0.177 |

Note: Log Ratio denotes the log of the ratio of $\lambda$ to per capita GDP (US=100). The decomposition applies to this ratio; that is, it is based on equation (7) and its compensating variation analogue. The log Ratio is the sum of the last four terms in the table: the life expectancy effect, the consumption share of GDP, leisure, and inequality. (Of course, the sum does not hold for the median absolute deviation or the standard deviation.) Sample size is 134 countries, and regional averages are population weighted.

Source: Jones and Klenow

# Heterogeneity: Why do we care (in Macro)?

- Realism: Heterogeneity is 'A fact of life'
- Welfare: Inequality and risk are bad
- Heterogenity fundamental to generate role of financial aspects for macro
  - Empirical: Mian and Sufi (2014), "What explains high unemployment? The aggregate demand channel"
  - **Guerrieri and Lorenzoni (2016)**, Aggregate effects of transitioning from loose to tight credit constraints

# Heterogeneity: Why do we care (in Macro)?

- Realism: Heterogeneity is 'A fact of life'
- Welfare: Inequality and risk are bad
- Heterogenity fundamental to generate role of financial aspects for macro
- Heterogeneity and inequality may affect equilibrium values of aggregate variables
  - Recent and promising literature regarding business cycles:
    - Oh and Mankiw (2013)
    - Krueger, Mitman and Perri (2015)
    - Summers (2015): Increased inequality, decreased AD, decreased GDP
  - Hetereogeneity and monetary policy - HANK models

# Heterogeneity: Why do we care (in Macro)?

- Realism: Heterogeneity is 'A fact of life'
- Welfare: Inequality and risk are bad
- Heterogenity fundamental to generate role of financial aspects for macro
- Heterogeneity and inequality may affect equilibrium prices and values of aggregate variables
  - Business cycles
  - Absolute and relative asset prices
    - Increased wealth inequality (actually increased idiosyncratic risk) yielding lower real interest rate
  - Level / trend growth of output
  - ...

# This session: Outline of 'Inequality definitions and facts'

1. Variable Definitions
2. Inequality measures
3. US Facts
   - Inequality across Households / individuals in wages, income, wealth
4. Evolution over time, across countries

# Definitions

- Income
  - Hourly wage
  - $\times$ hours = Individual labour earnings
  - Summed over HH members = HH earnings
  - + private transfers + financial income = Pre-government income
  - + public transfers = Pre-tax income
  - - net taxes = Disposable income
- Assets
  - Financial Assets
  - + Real assets - financial liabilities = HH Net Worth

# Data sources and problems

- Survey vs. **administrative data**
- Individual vs HH level
- Panel vs. repeated cross-section
- Sampling error, attrition and undersampling of the rich

# What is a good measure of inequality?

- Overall goals
  - Summarise welfare-differences
  - Matter for economic dynamics
- Attractive properties
  - Scale invariance: Invariant to homogeneous growth across the distribution, nominal price inflation, etc.
  - Captures the part of the distribution we are interested in - right marginal effect

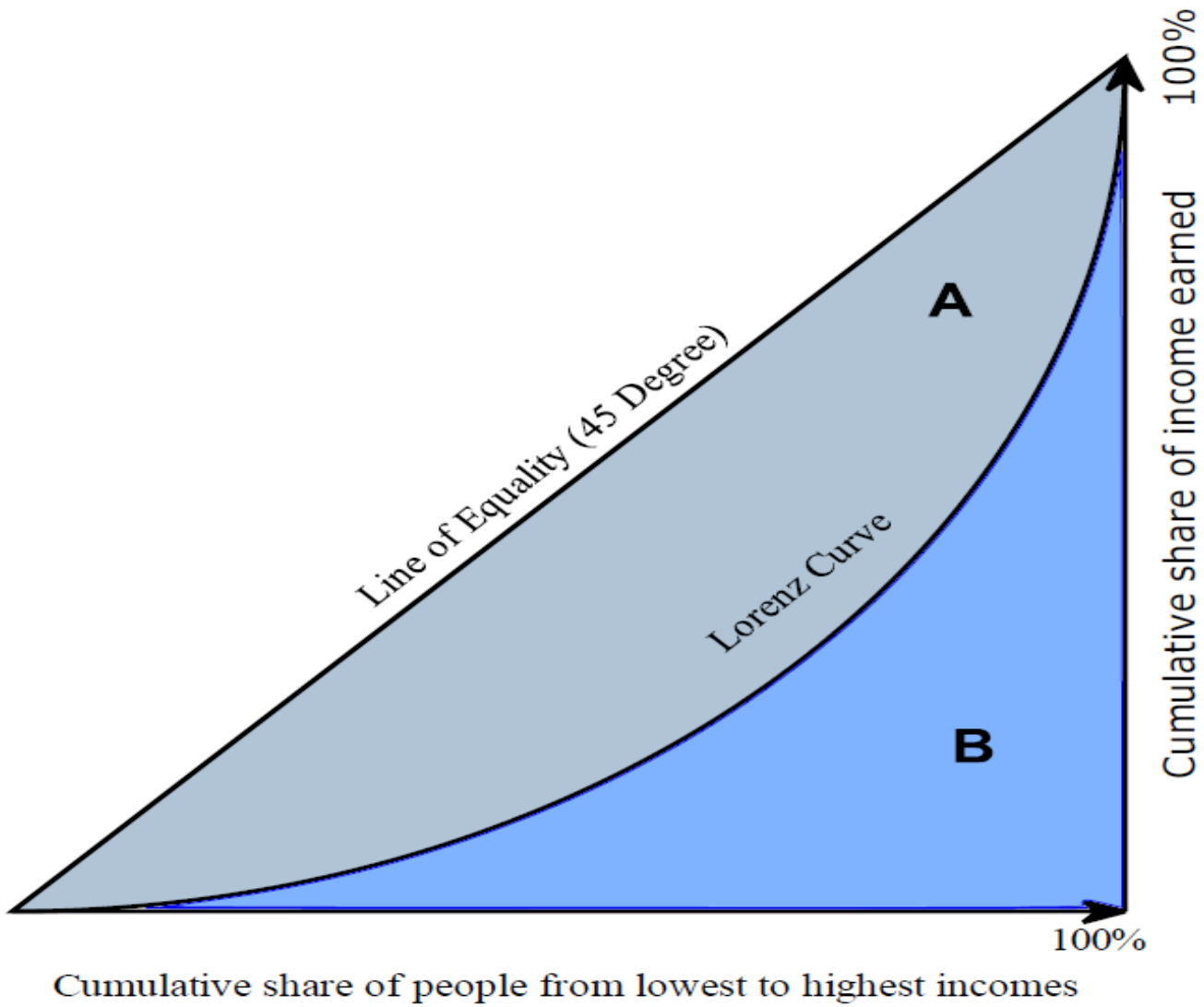
# Measuring inequality: Different dispersion measures

Suppose $y_{it} = A_t x_{it}$ where $A_t$ reflects a number of aggregate time varying variables (GDP level, price level, etc); $A$, $\{x\}$ unobserved

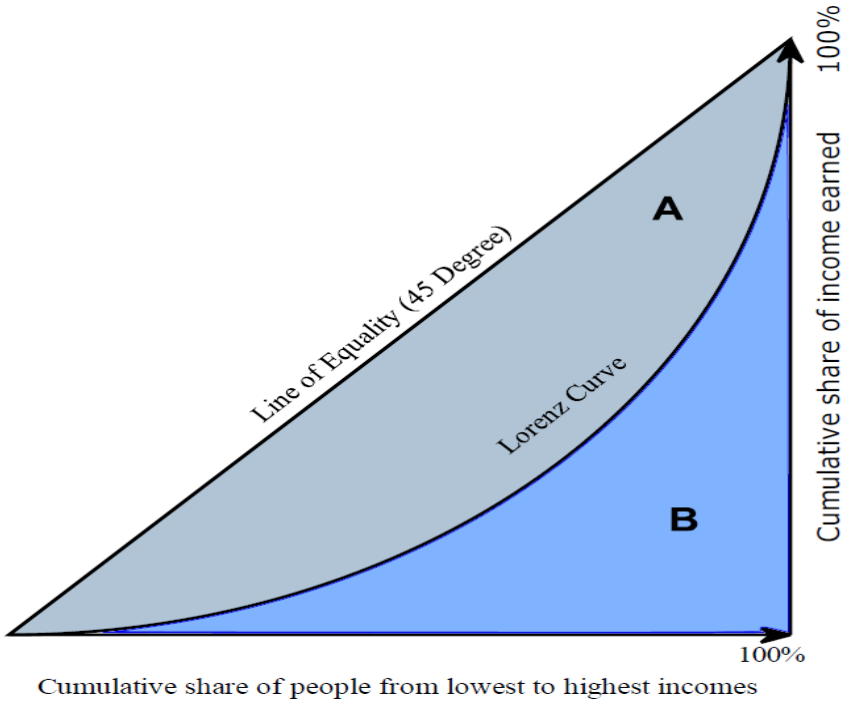
All below are scale invariant (independent of $A_t$), raw variance is not

- Variance of logs $V_t(\widehat{y}) = V_t(\widehat{x})$
  - Marginal effects $\frac{dV}{dx_i} = \frac{2(\widehat{x_i} - \overline{\widehat{x_i}})}{x_i N}$ decreases with $x_i$
- Share accruing to percentile/decentile
  - Marginal effects $\frac{dV}{dx_i} \in \{-\frac{x_i}{N}, \frac{x_i}{N}\}$
- Quantile ratios e.g. $P_{y,90,50} = P_{x,90,50}$
  - Marginal effects $\frac{dV}{dx_i} \in \{-\frac{1}{x_i^2}, 0, 1\}$ as $P$ is independent of changes in other quantiles
- Gini coefficient (details below)

# Lorenz-Curve and Gini Coefficient



# Lorenz-Curve and Gini Coefficient




- Lorenz Curve $L(x) = \frac{\int_{-\infty}^{x} x(fx)dx}{\int_{-\infty}^{\infty} x(fx)dx}$ "Cumulative share of total x"
- $Gini = A/(A+B) = 1 - 2B \in [0,1]$ as $A + B = 0.5$
  - 0 [1] implies total [in-]equality

# Lorenz-Curve and Gini Coefficient

- Lorenz Curve $L(x) = \frac{\int_{-\infty}^{x} x(fx)dx}{\int_{-\infty}^{\infty} x(fx)dx}$ "Cumulative share of total x"
- $Gini = A/(A+B) = 1 - 2B$ as $A + B = 0.5$
- Discrete Population
  $Gini = \frac{1\Sigma_{i=1}^{N} iy_i}{\Sigma_{i=1}^{N} x_i} - \frac{N+1}{N} = \frac{\Sigma_{i=1}^{N}\Sigma_{j=1}^{N}|y_i - y_j|}{2\mu} = 2\frac{cov(y_i,i)}{n\mu}$
- Continuous Distribution
  $Gini = 1 - \frac{1}{\mu}\int_0^{\infty}(1 - F(x))^2 dy = \frac{E|y_i - y_j|}{2\mu}$
- Independent of $A_t$
- Marginal Effects increasing in $x_i$

# Within and across group inequality

- Suppose individual income depends on group-specific mean $\alpha_j$ (gender, college vs non-college) and individual-specific variable $z$ (years of experience) in $y_i = \alpha_j + \beta z_i + \epsilon_i$
- Can decompose total dispersion into:
  - dispersion in means, $\alpha$
  - dispersion due to variation in individual characteristics, $z$
  - "within group"-dispersion in residual, $\epsilon$
- Implicit assumption: no heterogeneity in $\beta$ or distribution of $\epsilon$
- Beware of causal interpretation (due to omitted variables etc)

# US Facts

# Main US data sources

- IRS tax data - Piketty et al
- Social security - Guvenen et al (panel, labor income)
- PSID (long panel, original HH and offspins, detailed income and food consumption, more recently non-durables)
- CPS (main unemployment statistic, annual supplement on income etc)
- SCF (repeated cross-section, detailed wealth and income data)
- *(CEX (short panel, large detail on cons, not income))*

# A summary look at US Income and Wealth Inequality

Table 2

**Concentration and Skewness of the Distributions**

| | Earnings | Income | Wealth |
|---|---|---|---|
| Coefficient of variation | 3.60 | 4.32 | 6.02 |
| Variance of the logs | 1.29 | 0.99 | 4.53 |
| Gini index | 0.64 | 0.58 | 0.82 |
| Top 1% / lowest 40% | 183 | 88 | 1,526 |
| Location of mean (%) | 69 | 74 | 80 |
| Mean / median | 1.72 | 1.77 | 4.61 |

Source: Diaz-Gimenez et al 2011 (SCF)

- Earnings (=labor income) include share of entrepreneurial earnings
- (pre-tax) Income = Earnings + capital income + **gov. transfers**

# A summary look at US Income and Wealth Inequality

Table 2

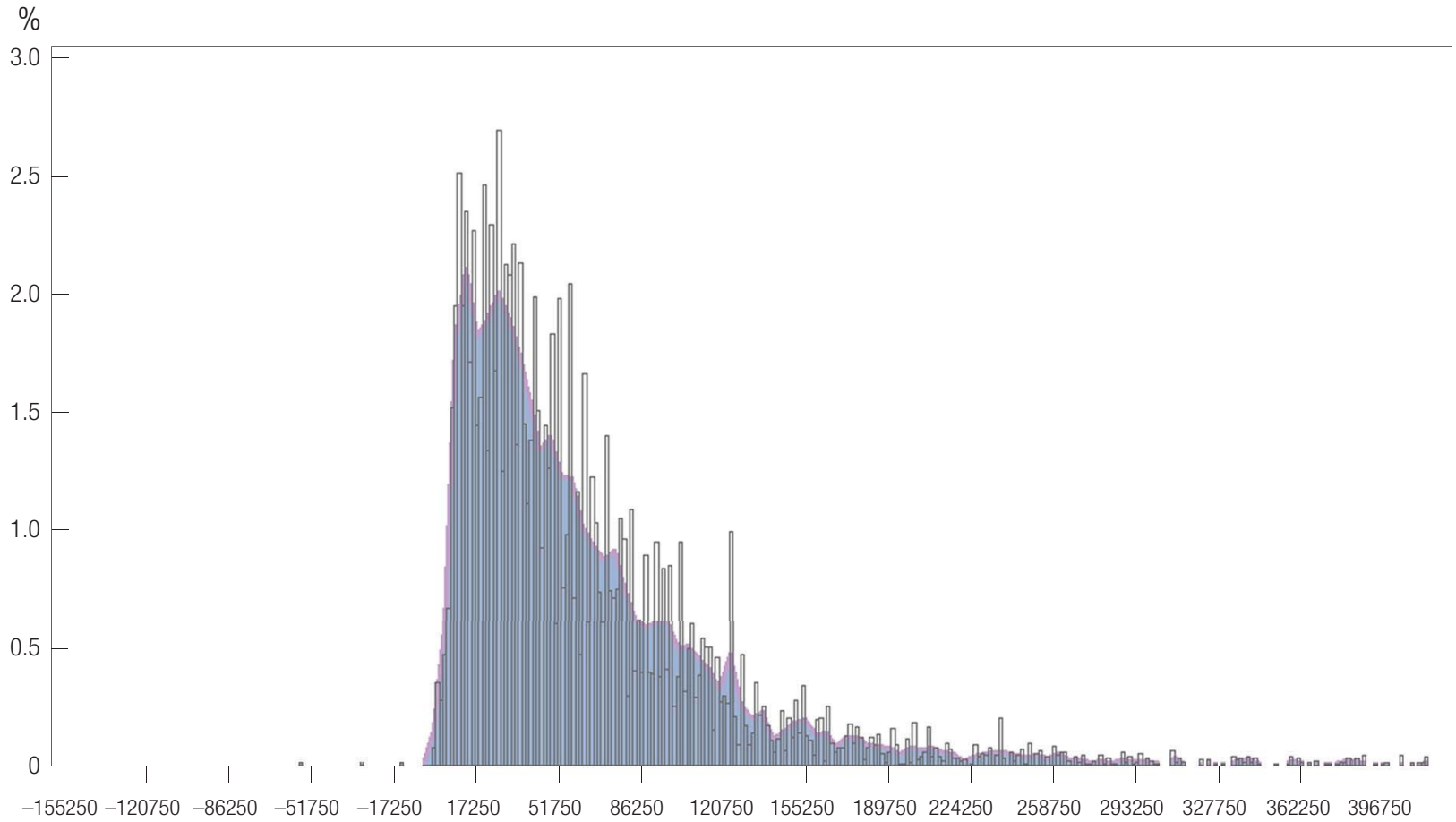
**Concentration and Skewness of the Distributions**

| | Earnings | Income | Wealth |
|---|---|---|---|
| Coefficient of variation | 3.60 | 4.32 | 6.02 |
| Variance of the logs | 1.29 | 0.99 | 4.53 |
| Gini index | 0.64 | 0.58 | 0.82 |
| Top 1% / lowest 40% | 183 | 88 | 1,526 |
| Location of mean (%) | 69 | 74 | 80 |
| Mean / median | 1.72 | 1.77 | 4.61 |

Source: Diaz-Gimenez et al 2011 (SCF)

- Wealth is much more concentrated than income, which is less concentrated than earnings
- The wealth distribution has a strong right-skew

# US Income Inequality



# US Wage Inequality since 1970

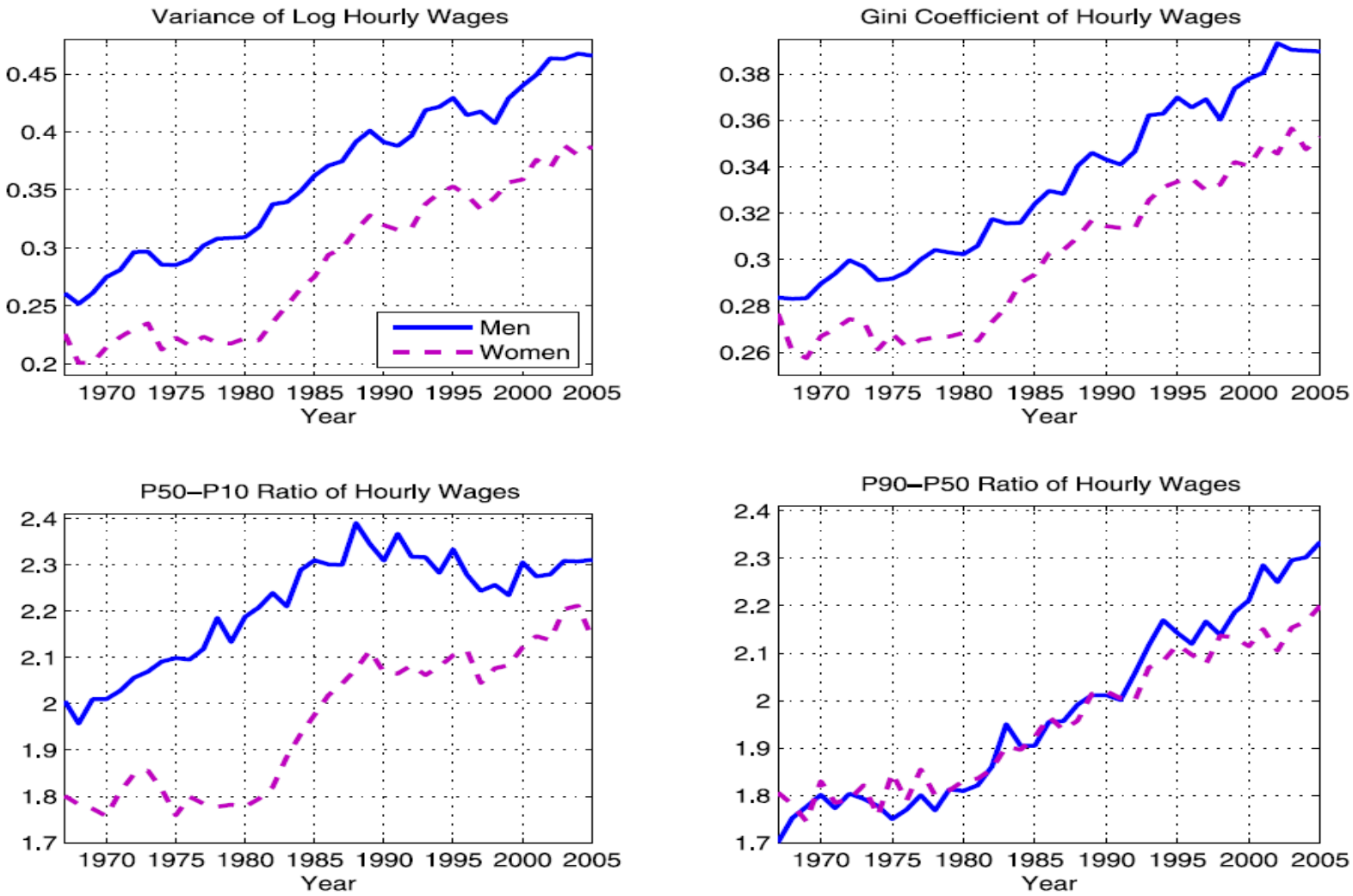



**Fig. 4.** Wage inequality for men and women (CPS).

Source: Heathcote et al 2010, CPS data

# US Wage premia since 1970

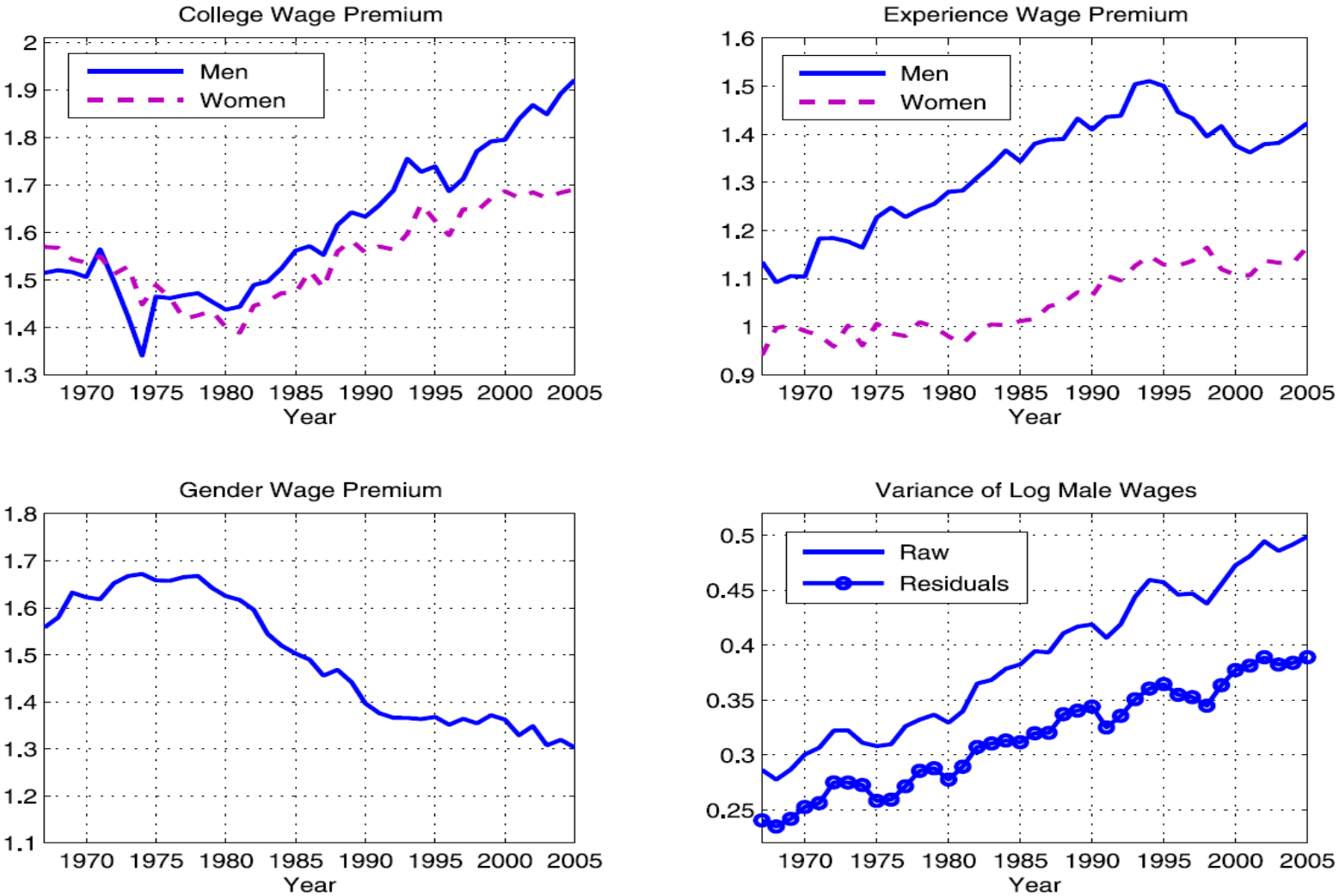



**Fig. 5.** Education, experience, gender wage premia, and residual wage inequality (CPS).

Source: Heathcote et al 2010, CPS data

# US earnings and labour supply since 1970

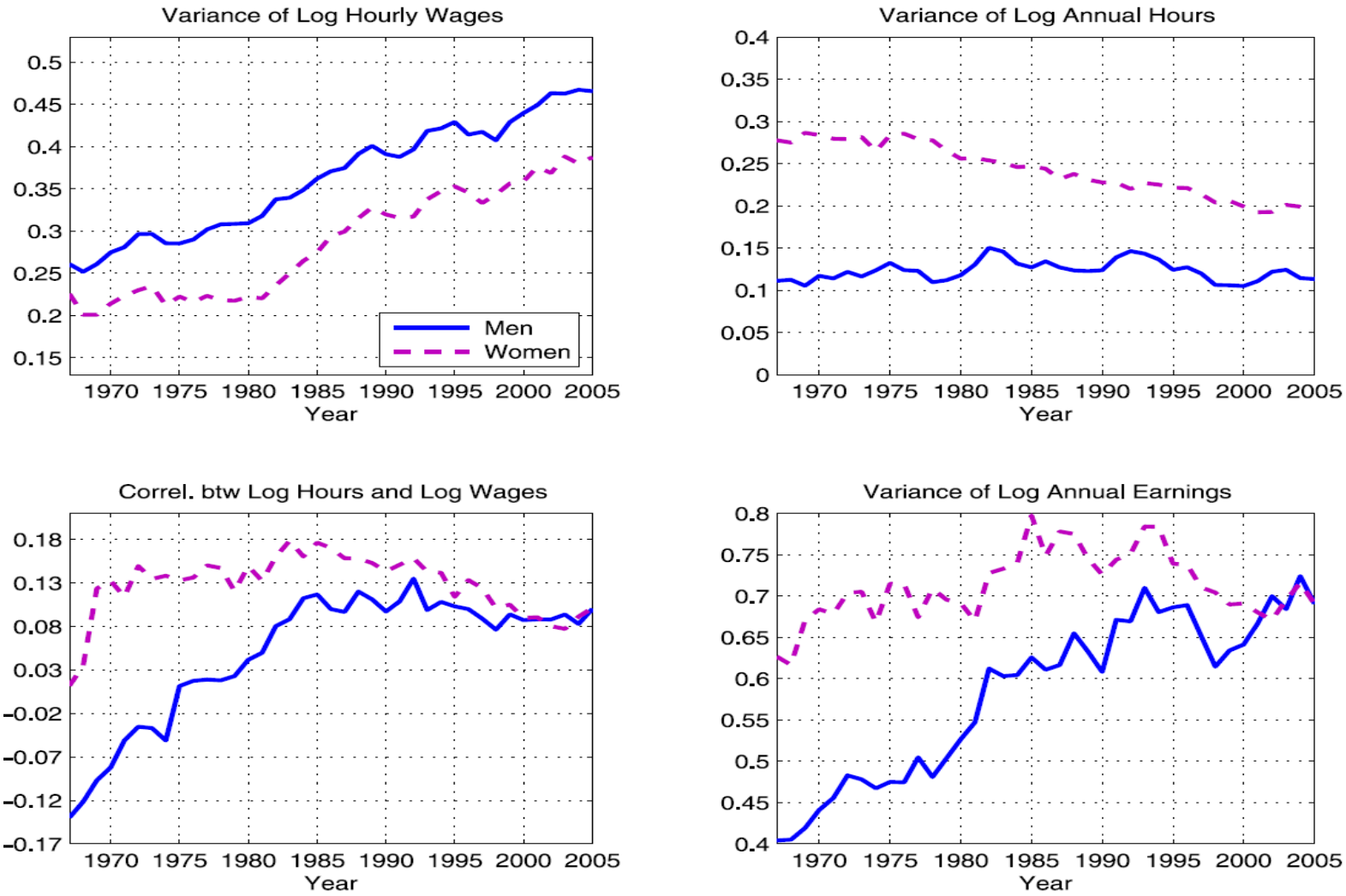


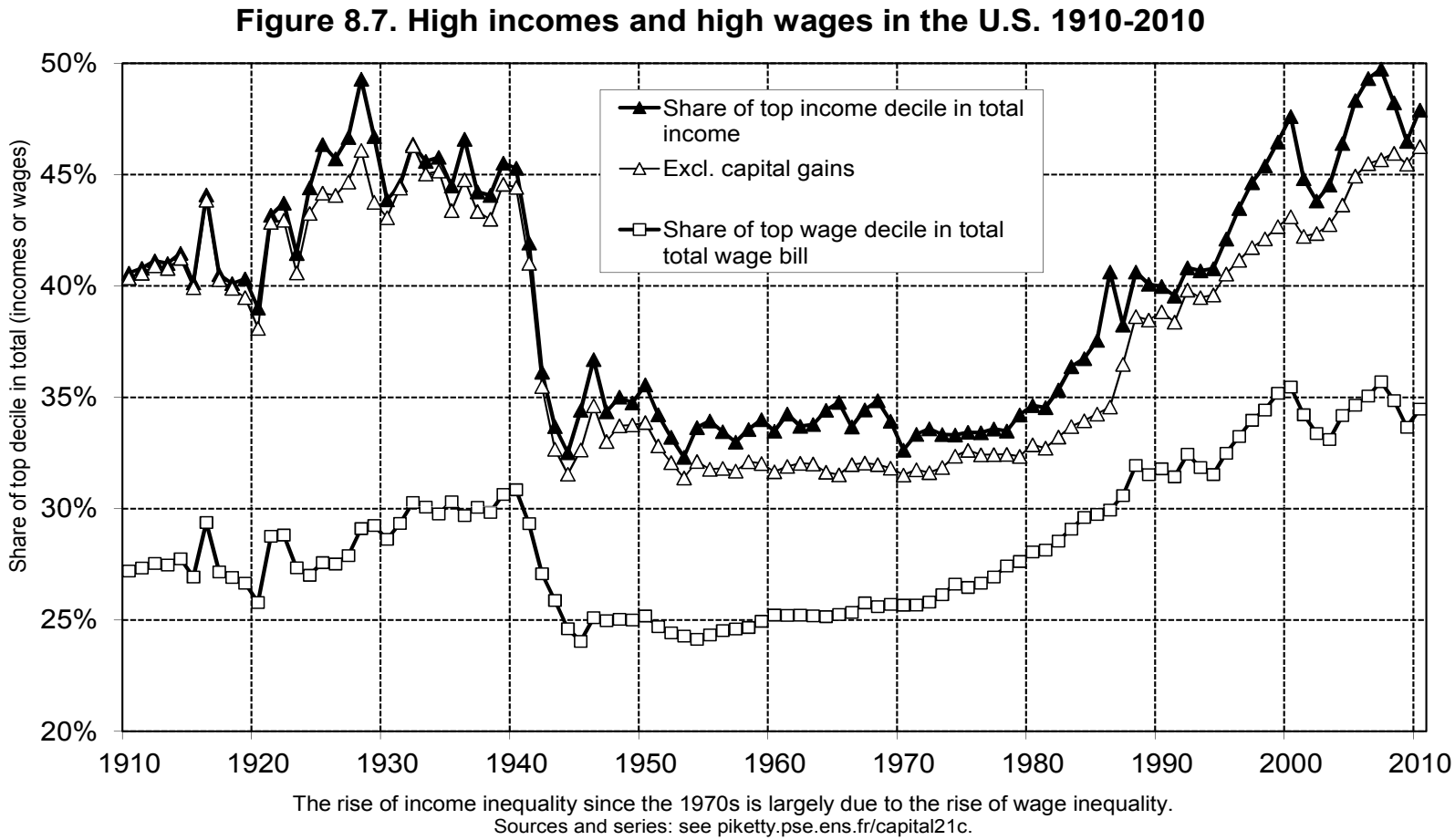

**Fig. 6.** Inequality in labor supply and earnings of men and women (CPS).

Source: Heathcote et al 2010, CPS data

# Piketty

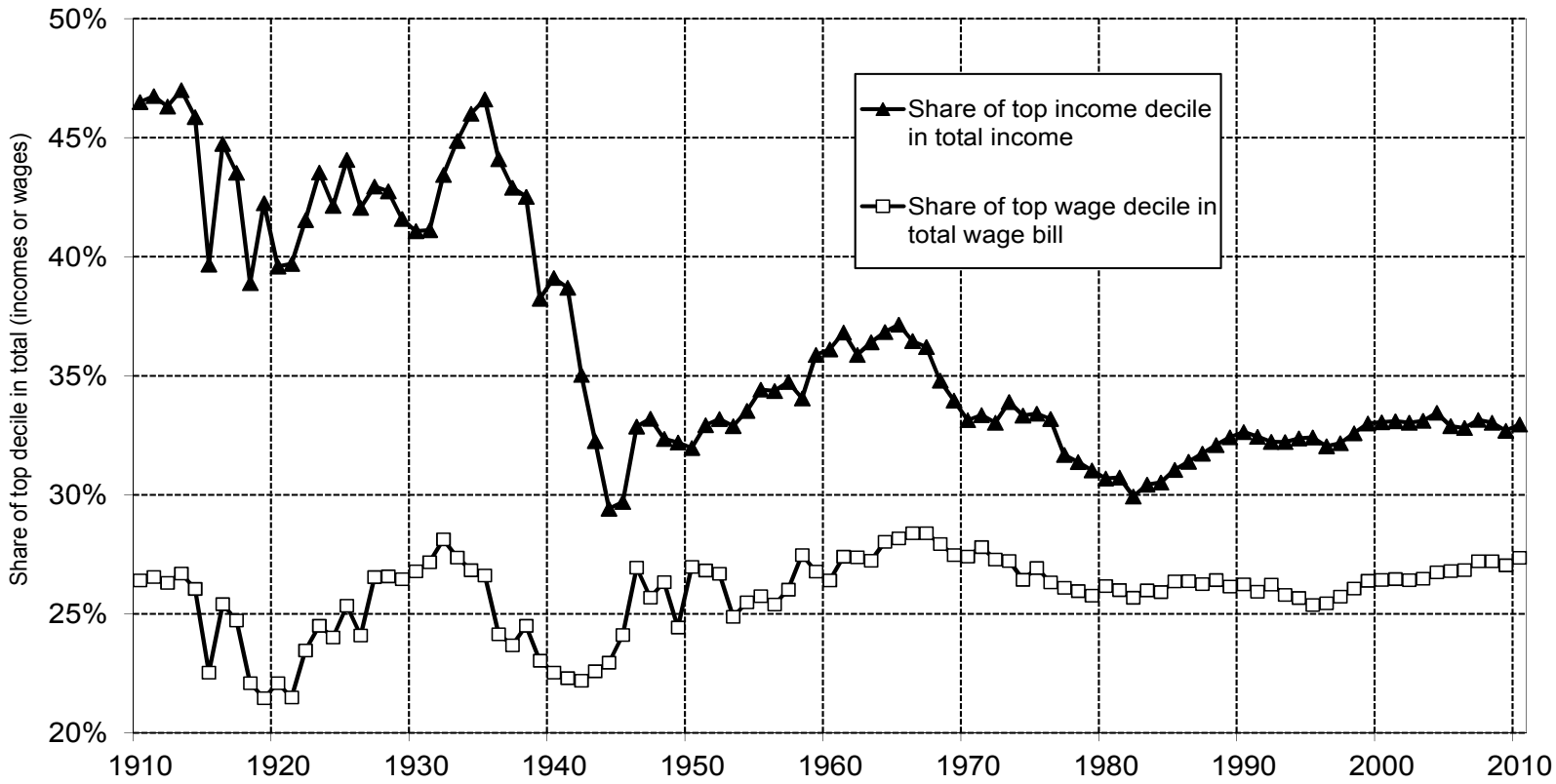
- Piketty's book 'Capital in the 21st century' (2013)
  - Received enourmous amount of public attention
  - Controversial within the economics profession
  - We will cover the purely empirical part:
  - Documented/Summarized facts on income, earnings and wealth distributions over **long** time horizons
  - Several countries
  - Income tax / Estate tax data
  - Decomposed income:
    - labor income
    - capital income

# Income inequality and earnings inequality - US



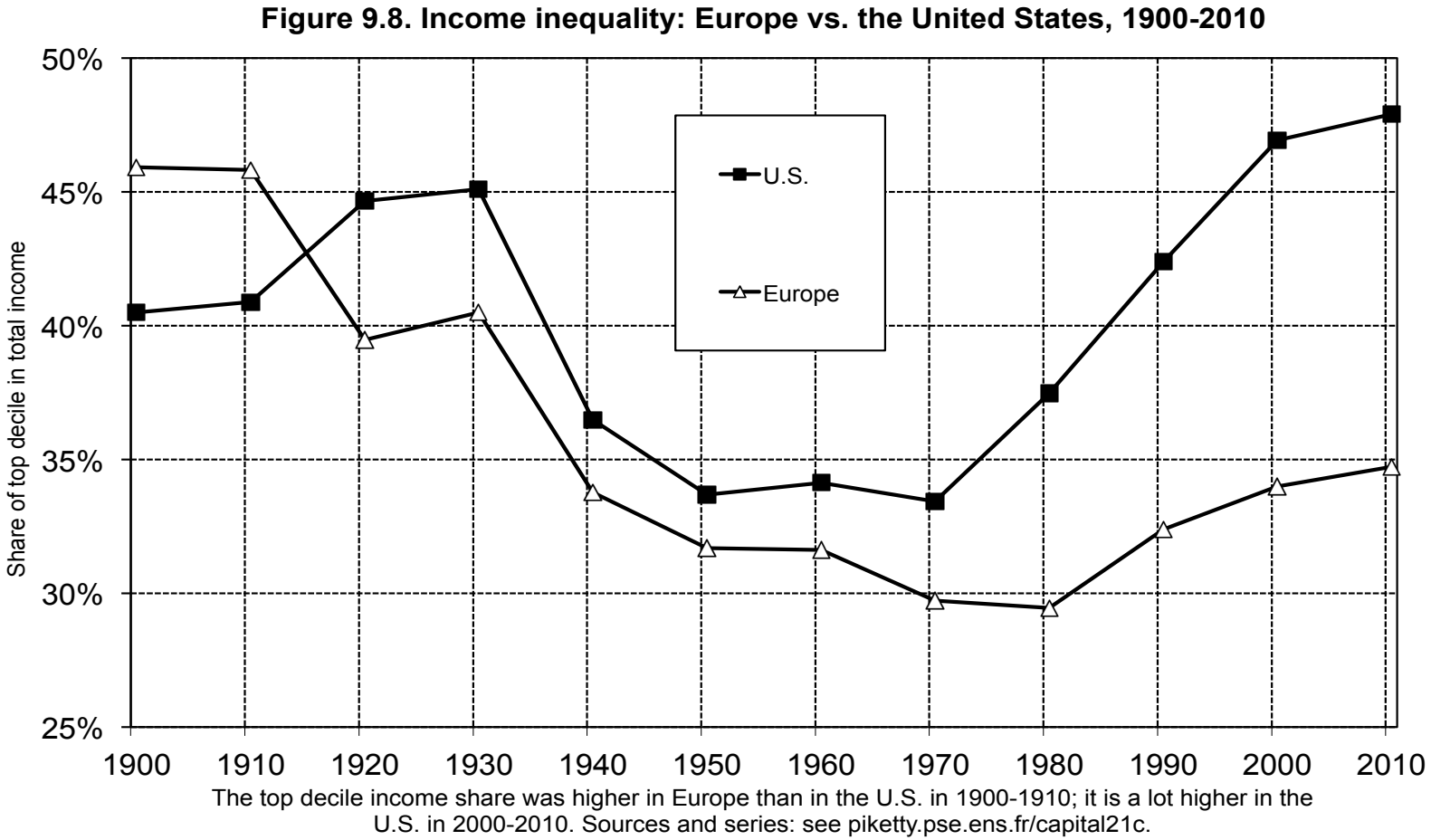
# Income inequality and earnings inequality - France

**Figure 8.1. Income inequality in France, 1910-2010**



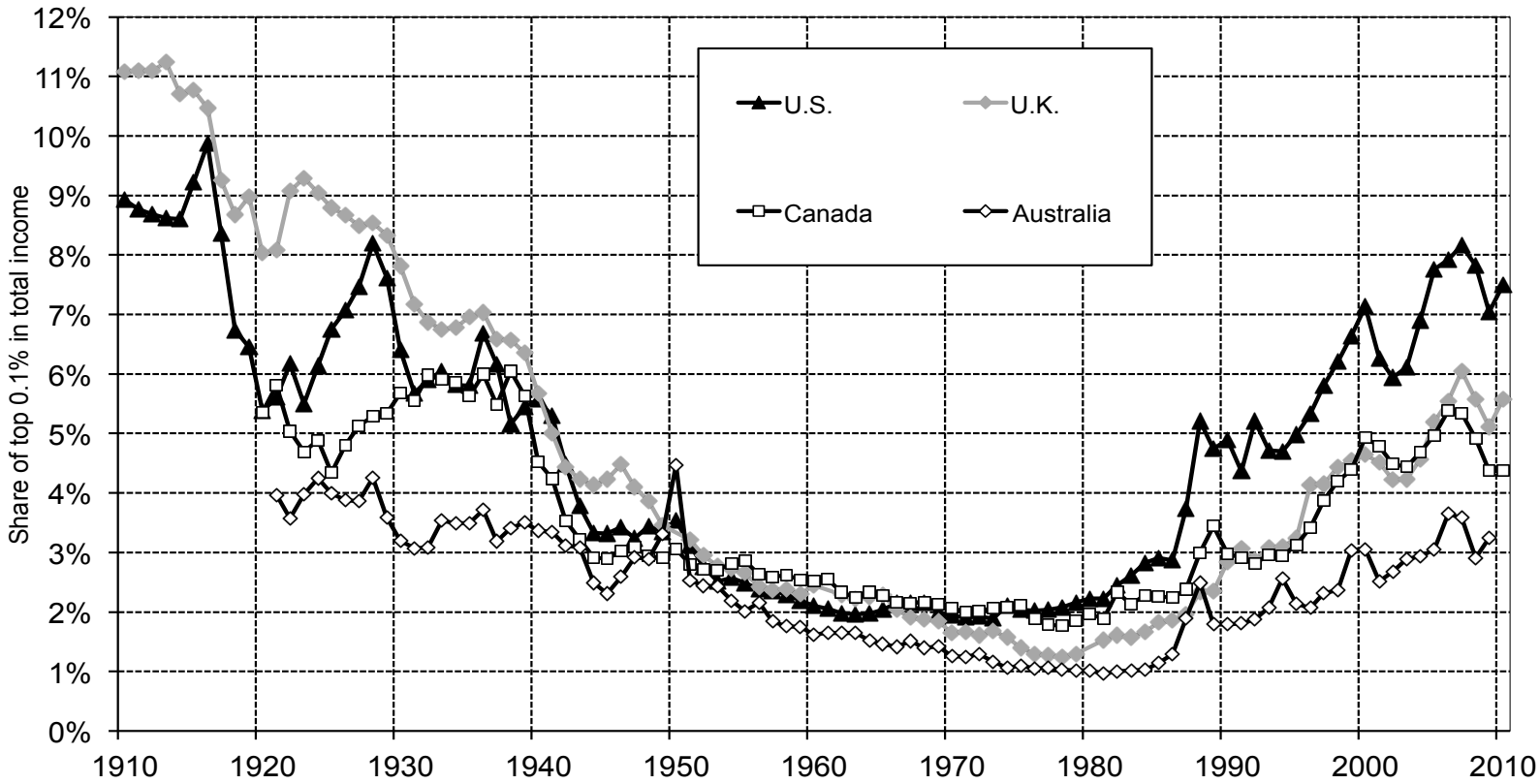

Inequality of total income (labor and capital) has dropped in France during the 20th century, while wage inequality has remained the same. Sources and series: see piketty.pse.ens.fr/capital21c.

# Income inequality - country comparison



# Income inequality - very top

**Figure 9.5. The top 0.1% income share in Anglo-saxon countries, 1910-2010**




The share of the top 0.1% highest incomes in total income rose sharply since the 1970s in all Anglo-saxon countries, but with varying magnitudes. Sources and series: see piketty.pse.ens.fr/capital21c.

# Intergenerational Earnings Mobility

- Jantti et al, 2006, "American Exceptionalism in a New Light"
- Study connection between (lifetime) earnings of children and parents

$$log(y_{si}) = \alpha + \beta log(y_{fi}) + \epsilon_i \tag{1}$$

- Regression coefficient $\beta$ is the intergenerational elasticity
- Correlation obtained by adjusting for difference in variance across generations
- Alternative persued by Chetty et al (2014) is to rank individuals within cohort.

# Intergenerational Earnings Mobility

**A. Men**

**Elasticity $\beta$**

| | Estimate | Fi | No | Sw | UK | US |
|---|---|---|---|---|---|---|
| De | 0.071 [0.064,0.079] | $<$ (0.0) | $<$ (0.0) | $<$ (0.0) | $<$ (0.0) | $<$ (0.0) |
| Fi | 0.173 [0.135,0.211] | . | $>_{ol}$ (21.9) | $<$ (0.0) | $<$ (0.0) | $<$ (0.0) |
| No | 0.155 [0.137,0.174] | . | . | $<$ (0.0) | $<$ (0.0) | $<$ (0.0) |
| Sw | 0.258 [0.234,0.281] | . | . | . | $<_{ol}$ (8.4) | $<$ (0.0) |
| UK | 0.306 [0.242,0.370] | . | . | . | . | $<$ (0.0) |
| US | 0.517 [0.444,0.590] | . | . | . | . | . |

**Correlation $\beta\sigma_P/\sigma_O$**

| | Estimate | Fi | No | Sw | UK | US |
|---|---|---|---|---|---|---|
| De | 0.089 [0.079,0.099] | $<$ (0.0) | $<$ (0.0) | $<$ (0.0) | $<$ (0.0) | $<$ (0.0) |
| Fi | 0.157 [0.128,0.186] | . | $>_{ol}$ (12.7) | $>_{ol}$ (15.9) | $<_{ol}$ (5.9) | $<$ (0.0) |
| No | 0.138 [0.123,0.152] | . | . | $<_{ol}$ (38.7) | $<$ (0.4) | $<$ (0.0) |
| Sw | 0.141 [0.129,0.152] | . | . | . | $<$ (0.4) | $<$ (0.0) |
| UK | 0.198 [0.156,0.240] | . | . | . | . | $<$ (0.0) |
| US | 0.357 [0.306,0.409] | . | . | . | . | . |

**B. Women**

**Elasticity $\beta$**

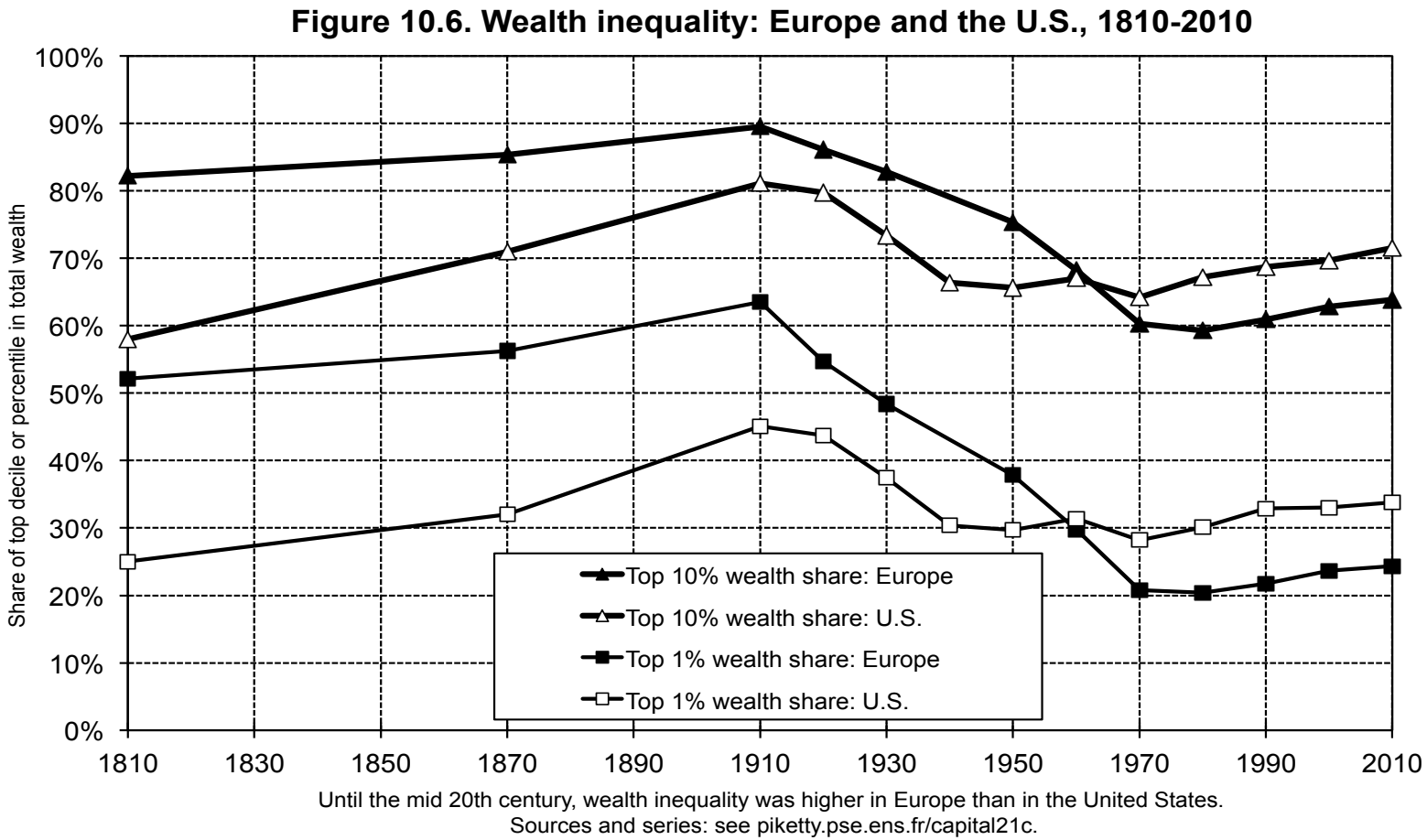
| | Estimate | Fi | No | Sw | UK | US |
|---|---|---|---|---|---|---|
| De | 0.034 [0.027,0.041] | $<$ (1.1) | $<$ (0.0) | $<$ (0.0) | $<$ (0.0) | $<$ (0.0) |
| Fi | 0.080 [0.042,0.118] | . | $<_{ol}$ (7.4) | $<$ (0.0) | $<$ (0.0) | $<$ (0.0) |
| No | 0.114 [0.090,0.137] | . | . | $<$ (0.0) | $<$ (0.0) | $<$ (0.1) |
| Sw | 0.191 [0.166,0.216] | . | . | . | $<$ (1.0) | $<_{ol}$ (4.4) |
| UK | 0.331 [0.223,0.440] | . | . | . | . | $>_{ol}$ (27.1) |
| US | 0.283 [0.181,0.385] | . | . | . | . | . |

**Correlation $\beta\sigma_P/\sigma_O$**

| | Estimate | Fi | No | Sw | UK | US |
|---|---|---|---|---|---|---|
| De | 0.045 [0.036,0.054] | $<_{ol}$ (3.9) | $<$ (0.0) | $<$ (0.0) | $<$ (0.0) | $<$ (0.0) |
| Fi | 0.074 [0.045,0.103] | . | $<_{ol}$ (28.0) | $<_{ol}$ (3.6) | $<_{ol}$ (0.6) | $<$ (0.4) |
| No | 0.084 [0.070,0.099] | . | . | $<_{ol}$ (3.6) | $<$ (0.9) | $<$ (0.5) |
| Sw | 0.102 [0.090,0.113] | . | . | . | $<_{ol}$ (4.3) | $<_{ol}$ (2.2) |
| UK | 0.141 [0.099,0.183] | . | . | . | . | $<_{ol}$ (30.3) |
| US | 0.160 [0.105,0.215] | . | . | . | . | . |

Source: Jantti et al, 2006

# Wealth inequality



# Summary of inequality facts

1. Different inequality measures can tell different stories
2. $ineq(wealth) >> ineq(earnings) > ineq(disposable) > ineq(c)$
3. Wealth holdings are extremely concentrated
   - ...and wealth inequality has increased slightly since 1970
4. Over time income (and earnings) inequality is roughly U-shaped in the US, less so in Europe
   - US: Increase since 1970 mainly driven by increased top earnings inequality (half is top 1%)
   - Europe: Differs across countries, but increase in capital income inequality important
5. *(Consumption inequality has increased less)*

# Heterogeneous agents and inequality

## Session 1

## **Introduction and Inequality facts**

Karl Walentin, Sveriges Riksbank

Macroeconomics II.2

Stockholm Doctoral Program in Economics 2017