Part IIIA: Human Capital Models

David A. Díaz

UNC Chapel Hill

Human Capital

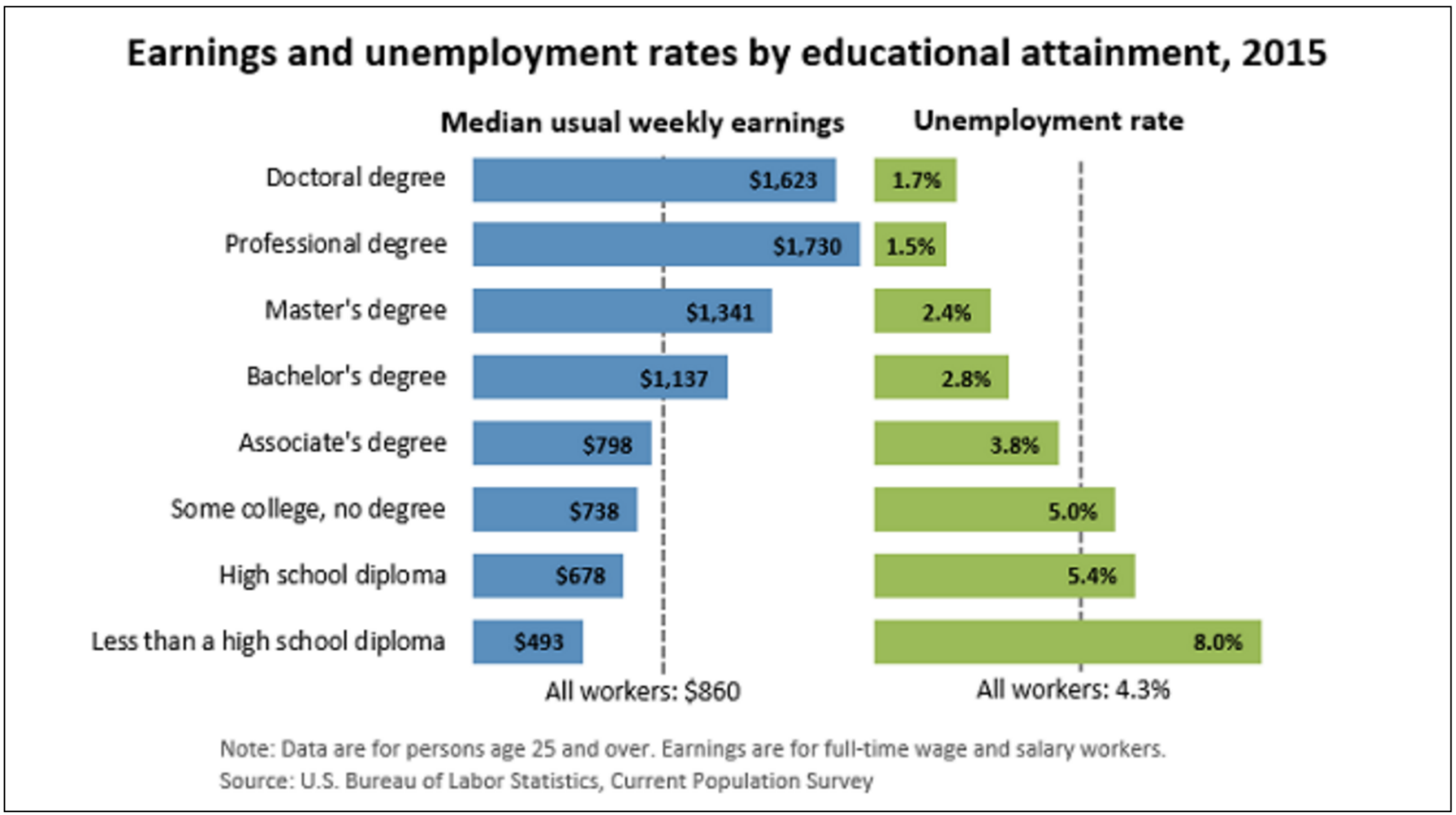
- So far, we have largely discussed competitive labor markets where there was a single equilibrium wage
  - Assumption: Homogeneous firms and workers
- Real-world labor markets: workers and jobs are different
  - Jobs differ in their characteristics
  - Workers differ in their skills
- Thus, wages will vary among workers

Human Capital Intro

- Human capital: The set of skills and abilities each individual brings to the workforce
- Basic idea: Through education, training, experience, we acquire knowledge and skills that increase our productivity
- Key questions:
  - Why do some workers obtain a lot of schooling?
  - Is the money spent on schooling a good investment?
  - How much are individuals compensated for schooling?
  - Why are they compensated for schooling?

Human Capital Intro

- Major topic in labor econ: Returns to skill
  - Education
  - Certification & training (CPA, RN, etc.)
  - Experience



Education in the U.S.

TABLE 6-1 **Educational Attainment of U.S. Population, 2013 (Persons Aged 25 and Over)**

Source: U.S. Bureau of Labor Statistics, *Annual Demographic Supplement of the Current Population Surveys*, March 2013.

	Highest Grade Completed (Percentage of Population in Education Category)					
Group:	**Less Than High School**	**High School Graduates**	**Some College**	**Associate Degree**	**Bachelor's Degree**	**Advanced Degree**
All Persons	10.6%	31.1%	16.8%	9.8%	20.1%	11.6%
Gender:						
Male	11.0	31.6	16.6	8.8	20.0	12.0
Female	10.2	30.6	17.0	10.8	20.2	11.2
Race/ethnicity:						
White	6.3	30.6	17.3	10.6	22.3	12.9
Black	12.0	35.9	20.4	9.7	14.2	7.8
Hispanic	31.0	33.2	13.6	7.1	10.7	4.3
Asian	8.7	20.4	9.9	7.2	30.9	23.0

Education in the U.S.

TABLE 6-2 Labor Market Characteristics, by Education Group, 2013 (Persons Aged 25 to 64)

Source: U.S. Bureau of Labor Statistics, *Annual Demographic Supplement of the Current Population Surveys*, March 2013.

		Less Than High School	High School Graduates	Some College	College Graduates
All workers:	Labor force participation rate	60.2	72.8	78.3	85.2
	Unemployment rate	12.5	8.9	6.4	3.7
	Annual earnings (in $1,000)	23.3	35.3	41.9	73.0
Gender:					
Men	Labor force participation rate	72.3	80.4	84.0	91.5
	Unemployment rate	11.8	9.3	6.4	3.7
	Annual earnings (in $1,000)	26.4	41.6	50.6	89.1
Women	Labor force participation rate	46.4	64.6	73.3	79.7
	Unemployment rate	14.0	8.3	6.4	3.8
	Annual earnings (in $1,000)	17.9	27.0	33.4	57.0

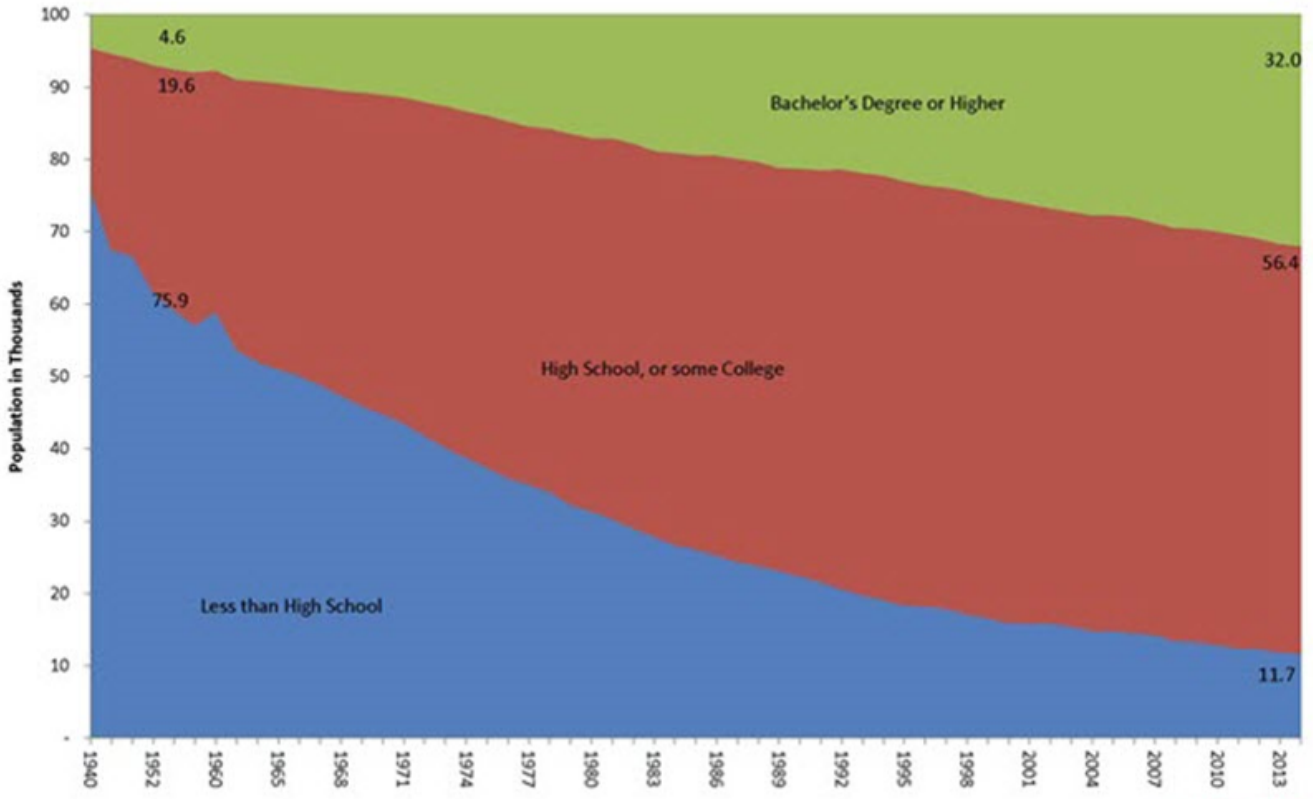
Education in the U.S.

Race/ethnicity:					
White	Labor force participation rate	52.1	73.3	78.6	85.8
	Unemployment rate	12.8	7.8	5.6	3.3
	Annual earnings (in $1,000)	26.3	38.5	44.2	75.7
Black	Labor force participation rate	47.0	68.1	77.8	84.4
	Unemployment rate	25.2	14.7	19.7	6.2
	Annual earnings (in $1,000)	21.1	28.1	35.7	57.5
Hispanic	Labor force participation rate	68.9	75.7	79.3	84.9
	Unemployment rate	10.4	8.3	6.5	5.3
	Annual earnings (in $1,000)	22.2	30.5	36.6	60.3
Asian	Labor force participation rate	62.0	72.6	75.7	82.1
	Unemployment rate	8.3	5.0	5.8	3.8
	Annual earnings (in $1,000)	23.1	30.9	40.1	76.5

Figure: Labor Market Characteristics by Education Group, 2013

Education in the U.S. - Trends

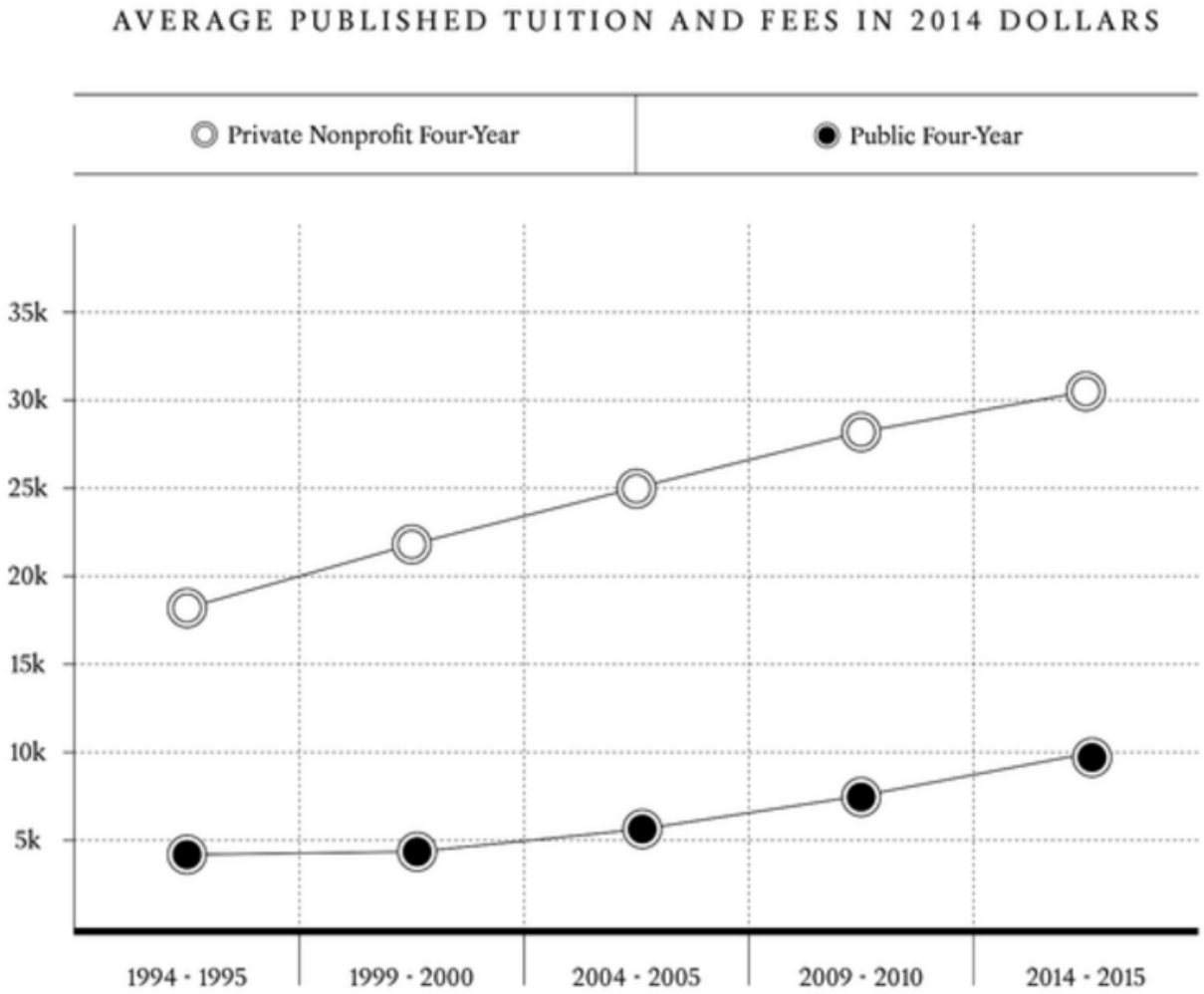
Figure 2: Percent of Population Age 25 and over by Educational Attainment: 1940-2014



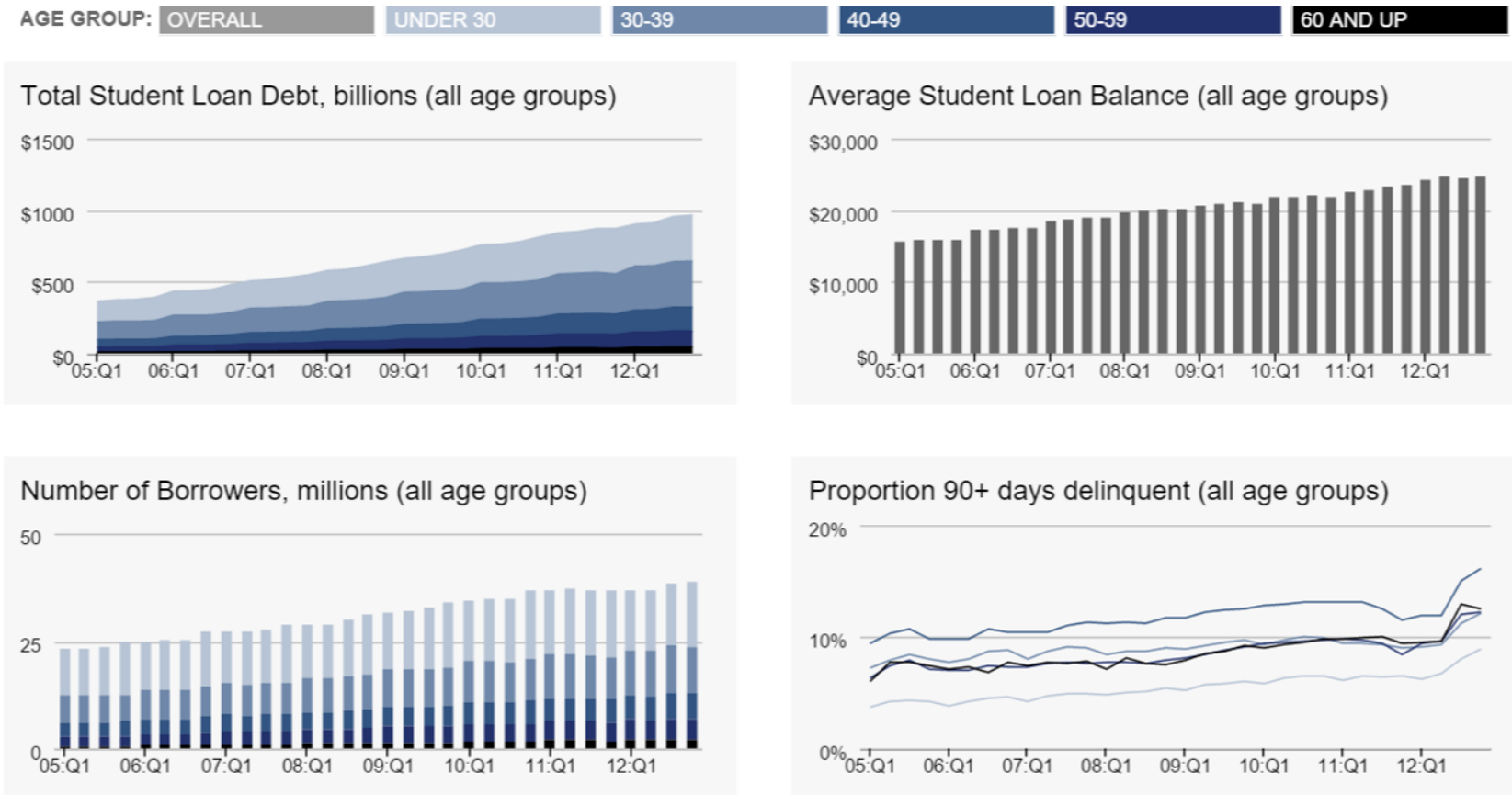
Sources: U.S. Census Bureau. 1947, 1952-2002 March Current Population Survey, 2003-2014 Annual Social and Economic Supplement to the Current Population Survey; 1940-1960 Census of Population.

United States Census Bureau

Education in the U.S. - Trends



Education in the U.S. - Trends



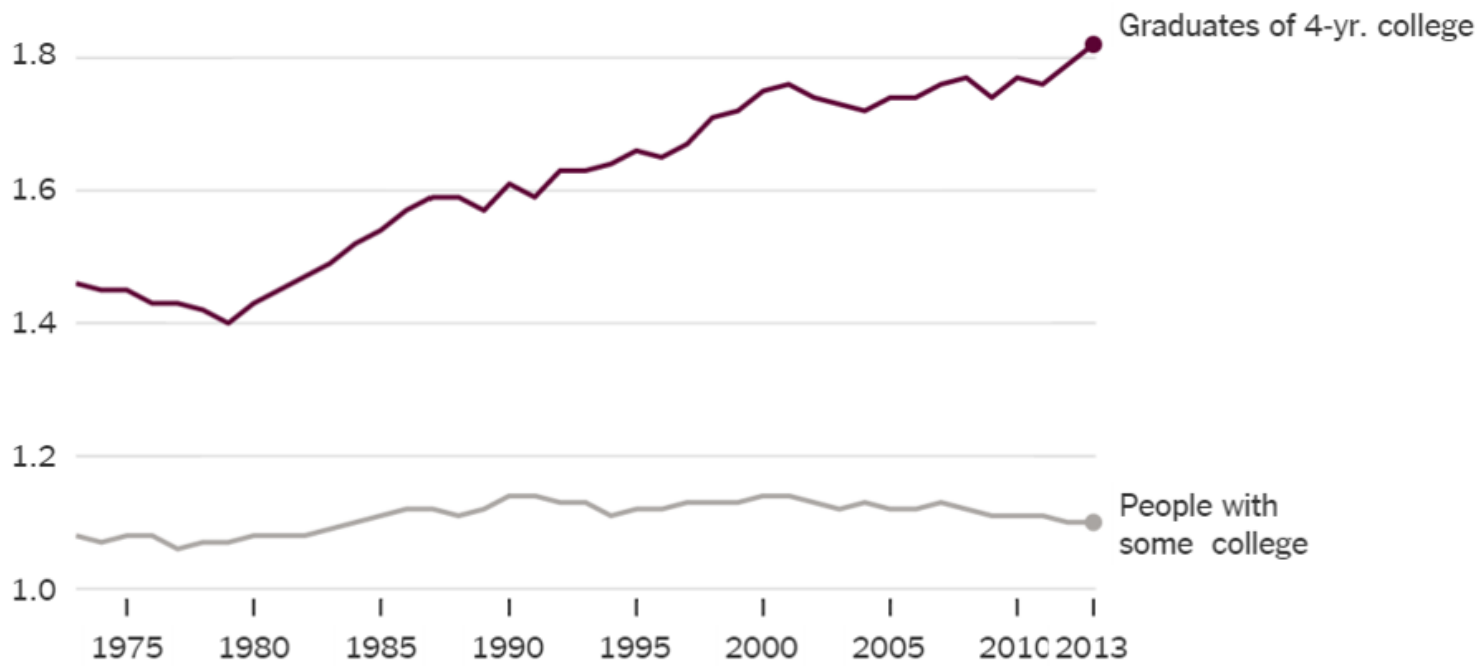
Source: FRBNY Consumer Credit Panel/Equifax

Education in the U.S. - Trends

Rising Value of a College Degree

The pay of people with a four-year college degree has risen compared to that of those with a high school degree but no college credit. The relative pay of people who attended college without earning a four-year degree has stayed flat.

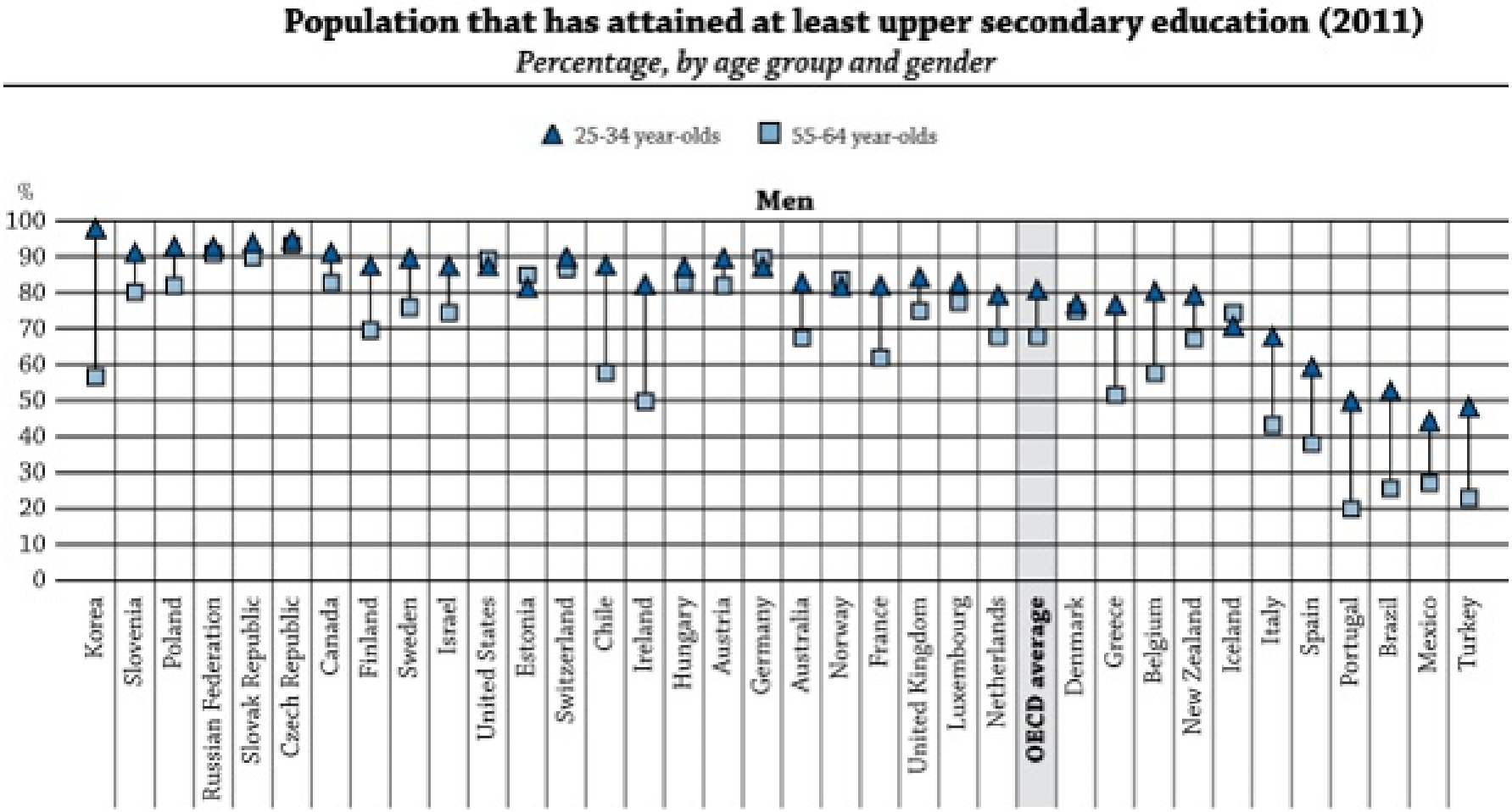
Ratio of average hourly pay, compared with pay of people with a high school degree



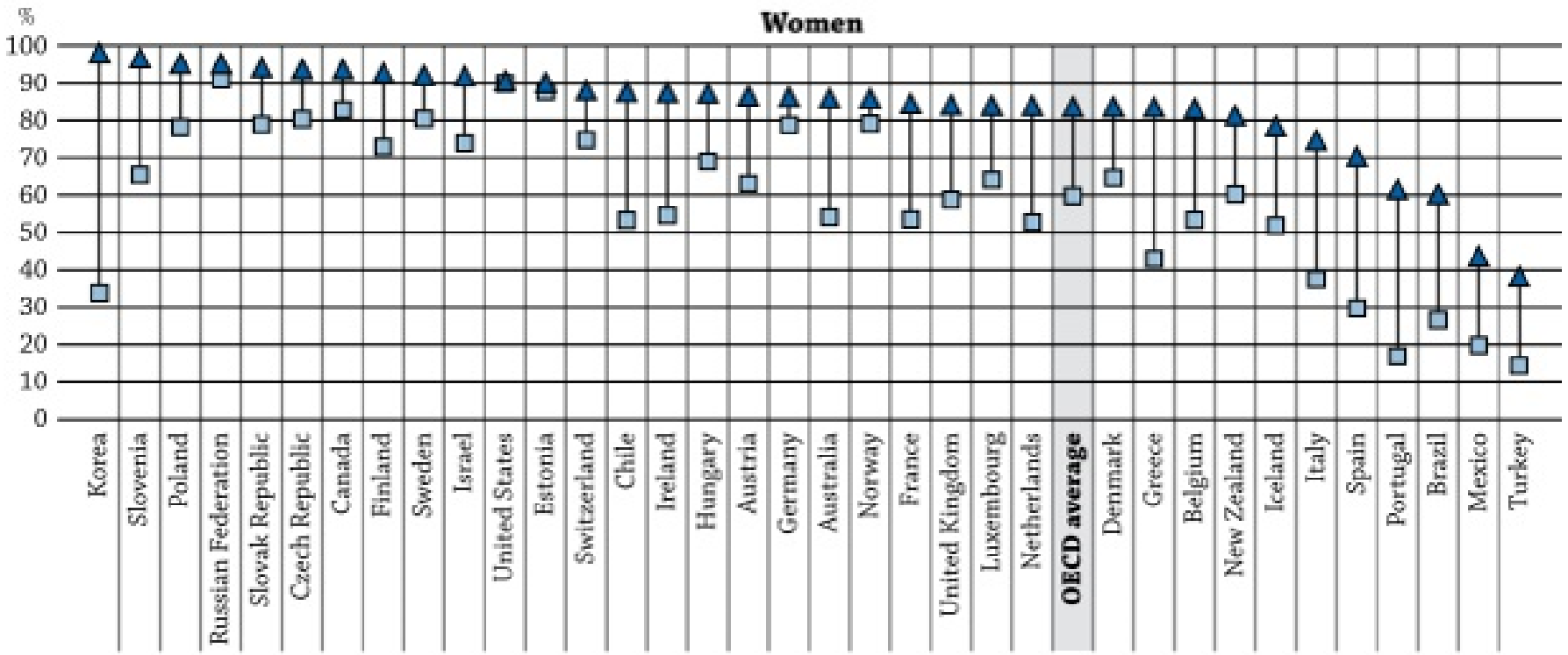
Labels reflect group's highest level of education. "Graduates of 4-year college," for instance, excludes people with graduate degrees.

Source: New York Times analysis of Economic Policy Institute data

Education in Other Developed Nations



Education in Other Developed Nations



Education Trends

- As economists, great interest in understanding
  - Why are individuals with college degrees paid more?
  - Why have tuition and debt have risen faster than inflation?
  - Why does attendance continue to rise, despite rising costs?

Human Capital Theory - Intro

- Gary Becker: Choose educational attainment based on long-term costs and benefits
- Investments often give payoffs far into the future
- Decisions must take account of "time-value" of money
- Example: Give up $1,000 today, get $1,100 next year. Good deal?
- Depends on individual's time-preference

Human Capital Theory - Intro

- Present-value of payment X received t years in the future:

$$PV_t = \frac{X}{(1+r)^t}$$

- Net present value of income "stream" with payouts at $t = 0, \ldots, T$

$$NPV_t = \sum_{t=0}^{T} \frac{X}{(1+r)^t}$$

- Important: t represents the number of periods we are discounting, not necessarily the period the payment is received.
- r is the "rate of return," "discount rate," or "interest rate"
- $\uparrow r \Rightarrow \downarrow PV/NPV$

Human Capital Theory - Intro

- Consider a simple two-period model:
  - Individuals can borrow/lend at rate $r \geq 0$
  - College educated workers are paid W_C at the beginning of each period they work
  - Non-college educated workers are paid W_N at the beginning of each period they work
  - Cost of college is $\$c$ and is paid at beginning of period before starting school

Human Capital Theory - Intro

- Value of attending college:

$$V(C) = -c + \frac{W_C}{(1+r)}$$

- Value of not attending college:

$$V(N) = W_N + \frac{W_N}{(1+r)}$$

- What would change if payments were made at the end of each period?
- Individual only attends college if $V(C) \geq V(N)$
- Relationship between r and college choice?

Human Capital Theory - Intro

Example

(Borjas 6.1) Debbie is about to choose a career path. She has narrowed her options to two alternatives. She can become either a marine biologist or a concert pianist. Debbie lives two periods. In the first, she gets an education. In the second, she works in the labor market. If Debbie becomes a marine biologist, she will spend $15,000 on education in the first period and earn $472,000 in the second period. If she becomes a concert pianist, she will spend $40,000 on education in the first period and then earn $500,000 in the second period. All payments are made at the beginning of each period.

1. *Suppose Debbie can lend and borrow money at a 5 percent rate of interest between the two periods. Which career will she pursue? What if she can lend and borrow money at a 15 percent rate of interest?*
2. *Suppose musical conservatories raise their tuition so that it now costs Debbie $60,000 to become a concert pianist. What career will Debbie pursue if the interest rate is 5 percent?*

Human Capital Theory - Intro

- What would change if payments were made at the end of each period?
- Relationship between r and college choice?

Readings

- Borjas 6.1-6.2

The Schooling Model

- If higher levels of education are associated with higher earnings, why don't all workers choose to get the highest level of education possible?
- Goal: Develop a model of lifetime schooling accumulation
  - When is the optimal stopping point?
  - How does ability affect optimal schooling attainment?
  - Assumption: Workers acquire education level that maximizes their utility from the present value of lifetime earnings

The Schooling Model

- Choice: How much time to spend in school
- Individuals have rational preferences over wages, $U(w)$, where $MU_w > 0$ (i.e., $\uparrow w \Rightarrow \uparrow U(w)$)
- Implication:
  - Individuals do not receive any utility from schooling outside of its effect on wages

The Schooling Model

- In reality, expected future wages are just one of the many determinants of our schooling path
- Other costs/benefits of schooling
  - "Nicer" occupations
  - Psychological costs of schooling
  - Social benefits
  - Etc.
- A more general approach would assume workers choose education/skill level to maximize lifetime utility
- For now, only focus on monetary rewards of school

The Schooling Model

- The market wage individuals receive is a function of an individual's ability level (A) and level of schooling (S)

$$w = w(S; A)$$

- S is an individual choice
- A is taken as given by each individual

The Schooling Model

- What is ability?
- Hard to define
- Generally, can be thought of as some uncontrollable stock of raw talent each individual is born with
- Key: Exogenously determined, so individuals take this as given

The Schooling Model

- Wage-schooling locus: Shows salary level employers are willing to pay a particular worker for every level of schooling
- Notice that this may vary across workers
- The slope of the locus tells us the wage increase associated with an additional year of schooling
- Properties:
  - Locus is upward sloping
  - Locus is concave (diminishing returns to education)

The Schooling Model

- Using wage-schooling locus, can define the marginal benefit from one additional year of schooling similar to a "return on investment"

$$MB \equiv MRR = \frac{\%\Delta w}{\Delta S} = \frac{\Delta w}{\Delta S} \times \frac{1}{w_0}$$

- Properties:
  - $MRR > 0$
  - MRR is decreasing

The Schooling Model

- What is the marginal cost of schooling?
- Harder to define in practice
- Suppose tuition is $20,000/year, and financed as follows:
  - $10,000/year paid by outside source (parents/college fund/etc.)
  - $1,000/year paid by work-study job
  - $9,000/year paid through student loans
- What is the cost borne by the student? When do they pay this?
  - Small amount ($1,000) paid through working during school.
  - Large amount ($9,000/year) paid throughout life after school.

The Schooling Model

- To simplify, suppose each worker has a constant rate of discount r:

$$MC \equiv r$$

- Intuition: Higher interest rate $\Rightarrow$ higher opportunity cost of delaying earnings
- For our purposes, we will assume the discount rate for individuals is equal to the market interest rate offered by financial institutions

The Schooling Model

- Decision rule: Continue schooling until $MRR = r$
- What if an individual stopped at a schooling level where $MRR > r$?
- What if an individual continued schooling at levels where $MRR < r$?

The Schooling Model

Example

(Borjas 6.6) Suppose Carl's wage-schooling locus is given by

Years of Schooling	*Earnings*
9	*$18,500*
10	*$20,350*
11	*$22,000*
12	*$23,100*
13	*$23,900*
14	*$24,000*

When will Carl quit school if his discount rate is 4 percent? What if the discount rate is 9 percent?

Readings

- Borjas 6.3

Schooling Model - Recap

- Recall the schooling model from last time:
  - Individuals choose their schooling level, S
  - Wages are a function of schooling and ability: $w = w(S; A)$, where ability is taken as given
  - Each particular individual continues to acquire schooling until their *MRR* (determined by *their own* wage-schooling locus) equals their discount rate r
- Implication: Individuals will differ in their school attainment due to differences in either their (i) discount rate or (ii) *MRR* schedules (and potentially both)

Differences in the Rate of Discount

- Consider two workers, A and B who face the same MRR curve, but differ in their rates of discount
- Without loss of generality, assume $r_A > r_B$
- Which individual will attain more schooling?

Differences in the Rate of Discount

- As we noted earlier, a higher rate of discount will decrease schooling years
  - Individuals with a higher discount rate do not value future earnings as highly and are more "present-oriented"
- Thinking about r as an interest rate, the intuition is:
  - Higher $r \Rightarrow$ higher cost of loans
  - Higher $r \Rightarrow$ greater cost of forgone interest income from earnings
- Standard price effect: $\uparrow r \Rightarrow \downarrow S$

Differences in the Rate of Discount

- Since we are assuming the two individuals face the same *MRR* schedule, this implies they have the same wage-schooling locus
- Thus, differences in r simply put the workers at two different points on their *common* locus

Differences in the Rate of Discount

- Individual B attains more schooling and ends up at a higher point on the locus, where she earns more
- Implication: We can estimate the rate of return to schooling from the observed (school choice, wage outcome) for each individual without bias
    - Predicted impacts of a given policy would be correct

Differences in Ability

- Now, suppose two individuals, C and D have the same rate of discount, but individual C has a higher ability level: $A^C > A^D$
- Assumption: Individuals with a higher ability level have higher returns on education

Differences in Ability

- In effect, the higher ability individual will have an *MRR* schedule to the right of a lower ability individual
  - Equivalently, we can say their wage-schooling locus is above that of a lower ability individual
- Implications for schooling decision?
  - Higher return, same discount rate $\Rightarrow$ High ability individual chooses more schooling
  - Lower return, same discount rate $\Rightarrow$ Low ability individual choose less schooling

Differences in Ability

- Recall that ability is seldom observed
- Data would show us (S_C, w_C) and (S_D, w_D), but not A^C or A^D
- Naive estimate of rate of return to schooling:

$$\widehat{MRR} = \frac{w_C - w_D}{s_C - s_D} \times \frac{1}{w_D}$$

Differences in Ability

- However, this assumes that both individuals are on the *same* wage-schooling locus, which we know is not true
- Thus, the observed data on earnings and schooling do not allow us to accurately estimate the rate of return to schooling (i.e., the estimate is biased)

Ability Bias

- The differences in the earnings of individuals C and D were due to
  1. Differences in schooling
  2. Differences in innate ability
- Because ability is unobserved, earnings differentials across workers do not accurately estimate the returns to education (**ability bias**)

Ability Bias

- Direction of bias?
  1. Higher ability individuals face lower costs of schooling (less effort) and obtain more schooling $\Rightarrow$ upward bias
  2. Higher ability individuals may be more productive and earn more independent of schooling $\Rightarrow$ downward bias

Estimating Returns to Schooling

- Raw premium for college: $\sim$80% for four-year degree in 2015
  - $\Rightarrow\sim$ 16% return on education per year (unrealistic)
- General empirical model used to estimate returns to education:

$$\log \textit{wage} = \beta_0 + \beta_1 S + \text{other variables}$$

- $\widehat{\beta_1}$ is the estimate of the returns to education
- Controlling for race, gender, industry, and other observable factors likely influencing wages, the estimate is around $\sim$11-12% per year

Estimating Returns to Schooling

- How to account for ability bias?
  - Including IQ, AFQT as proxy for ability. Good solution?
  - Twin or sibling studies to control for unobserved ability. Issues?
  - Instrumental variables for schooling
    - Need to find "instrument" (e.g., a policy) that is correlated with schooling, but uncorrelated with any unobserved characteristics that affect wages
    - Examples: Compulsory schooling laws, school construction initiatives, tuition changes, college proximity
    - Potential issues?
- Controlling for relevant factors *and* ability bias, estimate is around $\sim$9-11% per year

Estimating Returns to Schooling - Other Issues

- Variable choice: What should we include in "other variables"?
  - Typically included: Experience, experience squared, occupation, etc.
  - Potentially omitted: ability variable
- Measurement error
  - Earnings, schooling, and other variables may be measured with error
- Selection bias
  - Self-selection into schooling is not random
  - Self-selection into labor force is not random
- Reverse causality
  - School choice may respond to anticipated wages

Estimating Returns to Schooling - Other Issues

- Distributional effects
  - β_1 assumed constant in empirical model $\Rightarrow$ estimating the average return to college for all individuals
  - Do returns to schooling vary across the wage distribution?
- Time effects
  - Do returns to schooling vary over time and over the life cycle?
- Are we observing an individual's true optimal school choice?
  - Remember individuals choose S^* such that $MRR = r$ at S^*
  - This assumes individuals know the true MRR
  - Is this a reasonable assumption?
- What do returns to schooling measure?
  - Productivity effect of schooling?
  - Signaling value of schooling on the labor market?
  - Both?

Readings

- Borjas 6.4-6.5