# Signalling

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LSE

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# Introduction

Signalling is an alternative explanation for the schooling - earnings correlation

- Human capital
  - schooling –> productivity –> wage
- Signalling
  - productivity –> schooling
  - productivity –> wage

# Model

- Worker

$$\begin{aligned} U(W,S,A) &= W - C(S,A) \\ C(S,A) &= \text{ cost of schooling} \\ C_S(S,A) &> 0, C_{SS}(S,A) > 0 \\ C_{SA}(S,A) &< 0 \end{aligned}$$

The cost of schooling increases in the level of schooling but is lower for the more able.

- Production

$$\begin{aligned} Y(S,A) &= \text{ output} \\ Y_S(S,A) &\geq 0, Y_{SS}(S,A) \leq 0 \\ Y_A(S,A) &> 0 \end{aligned}$$

$A$ is private information of the worker.

# Structure of Equilibrium

Bayesian Nash Equilibrium

1. Worker hypothesizes a wage schedule $\widetilde{W}(S)$
   1. chooses $S^*(A)$
   2. If
   $$\frac{dS^*}{dA} > 0$$
   we can invert the relationship to get $A(S)$
2. Competition among firms leads to a market wage schedule
$$W(S) = Y(S, A(S))$$
3. BNE: Correct conjectures in equilibrium
$$\widetilde{W}(S) = W(S)$$

# Solving the Model

Worker's problem

$$\max_S W(S) - C(S, A)$$

$$\text{FOC:} \quad W'(S) - C_S(S, A) = 0$$

$$\text{SOC:} \quad W''(S) - C_{SS}(S, A) < 0$$

Implicitly differentiate FOC:

$$\begin{aligned} W''(S) - C_{SS} - C_{SA}\frac{dA}{dS} &= 0 \\ \frac{dA}{dS} &= \frac{W'' - C_{SS}}{C_{SA}} \\ W'' - C_{SS} &< 0 \quad \text{by SOC} \\ C_{SA} &< 0 \quad \text{by assumption} \\ \Rightarrow \quad \frac{dS}{dA} &> 0 \end{aligned}$$

# Keep Solving the Model

Zero profit condition

$$W(S) = Y(S, A(S))$$

Implicitly differentiate:

$$W'(S) = Y_S(S, A(S)) + Y_A(S, A(S))\frac{dA}{dS}$$

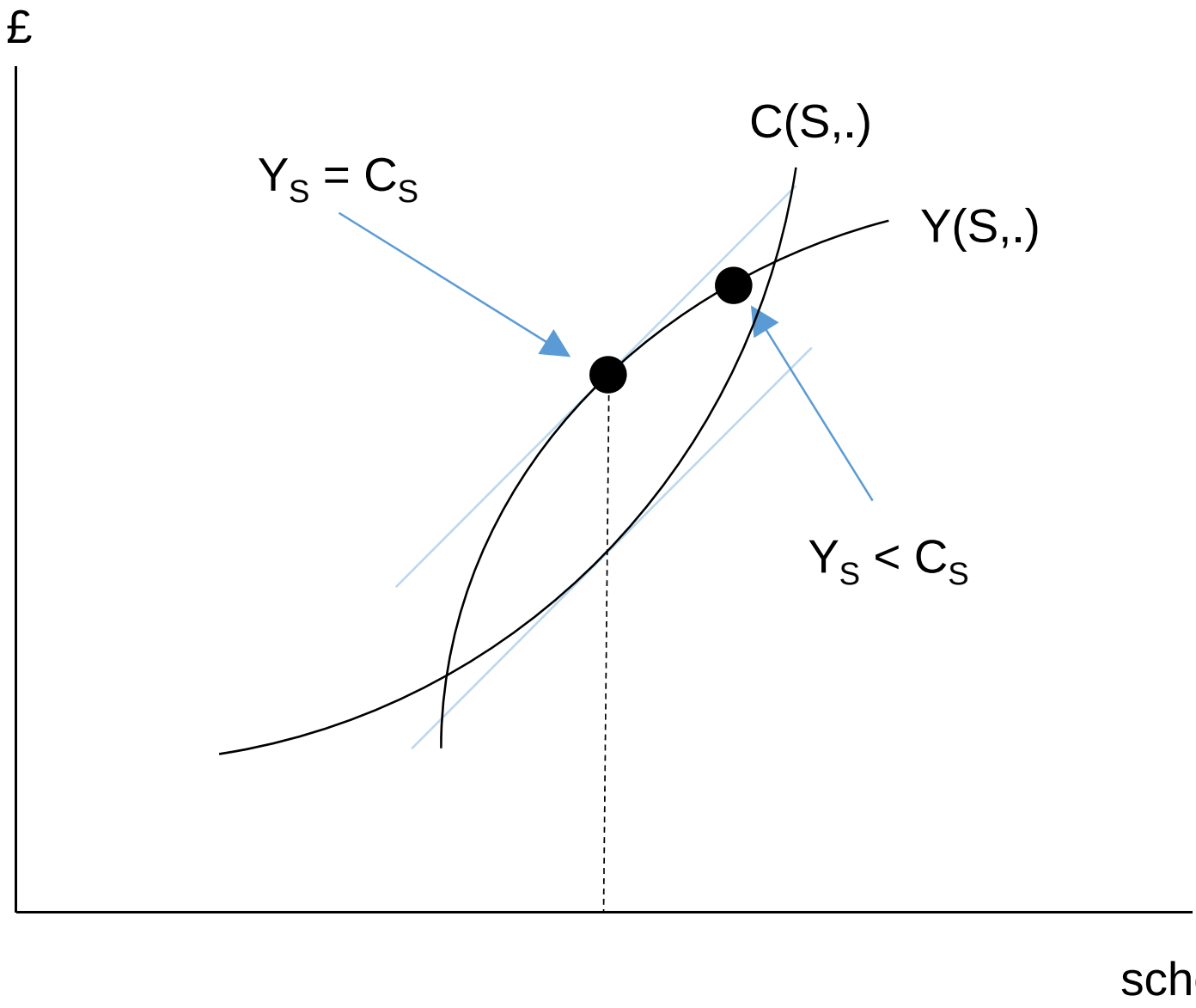
Combine with FOC

$$W'(S) = C_S(S, A)$$

to get

$$\begin{aligned} C_S &= Y_S + Y_A\frac{dA}{dS} \\ \underbrace{Y_S - C_S}_{\text{First Best} = 0} &= -Y_A\frac{dA}{dS} < 0 \end{aligned}$$

# Equilibrium in the Signalling Model



# How to think of this

The $C(S,.)$ function is an indifference curve in $W-S$ space.

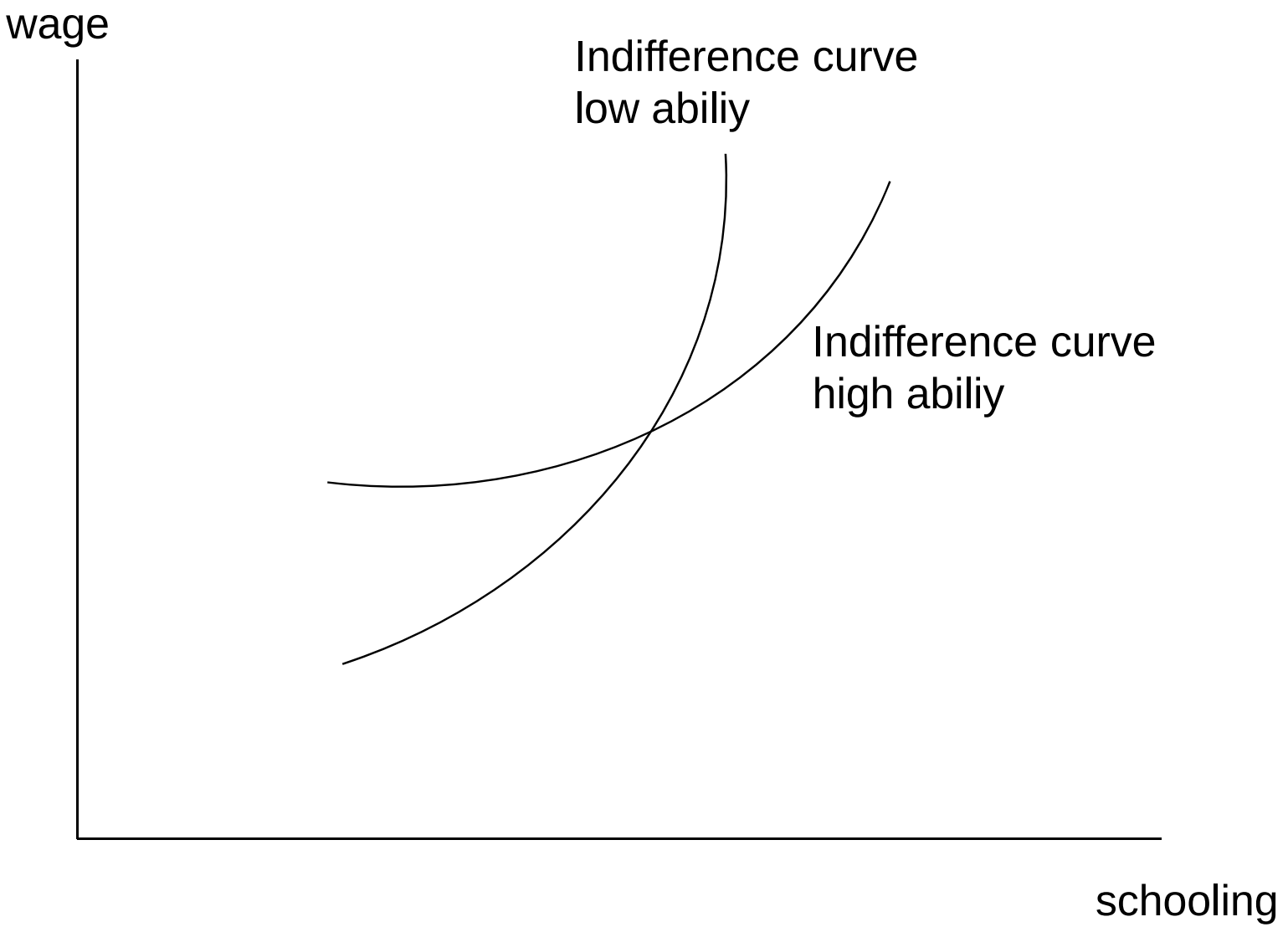
- Take $U = W - C$ and hold $U$ fixed:

$$\begin{aligned} 0 &= dW - C_S(S,.)dS \\ \frac{dW}{dS} &= C_S(S,.) > 0 \\ \frac{d^2W}{dS^2} &= C_{SS}(S,.) > 0 \end{aligned}$$

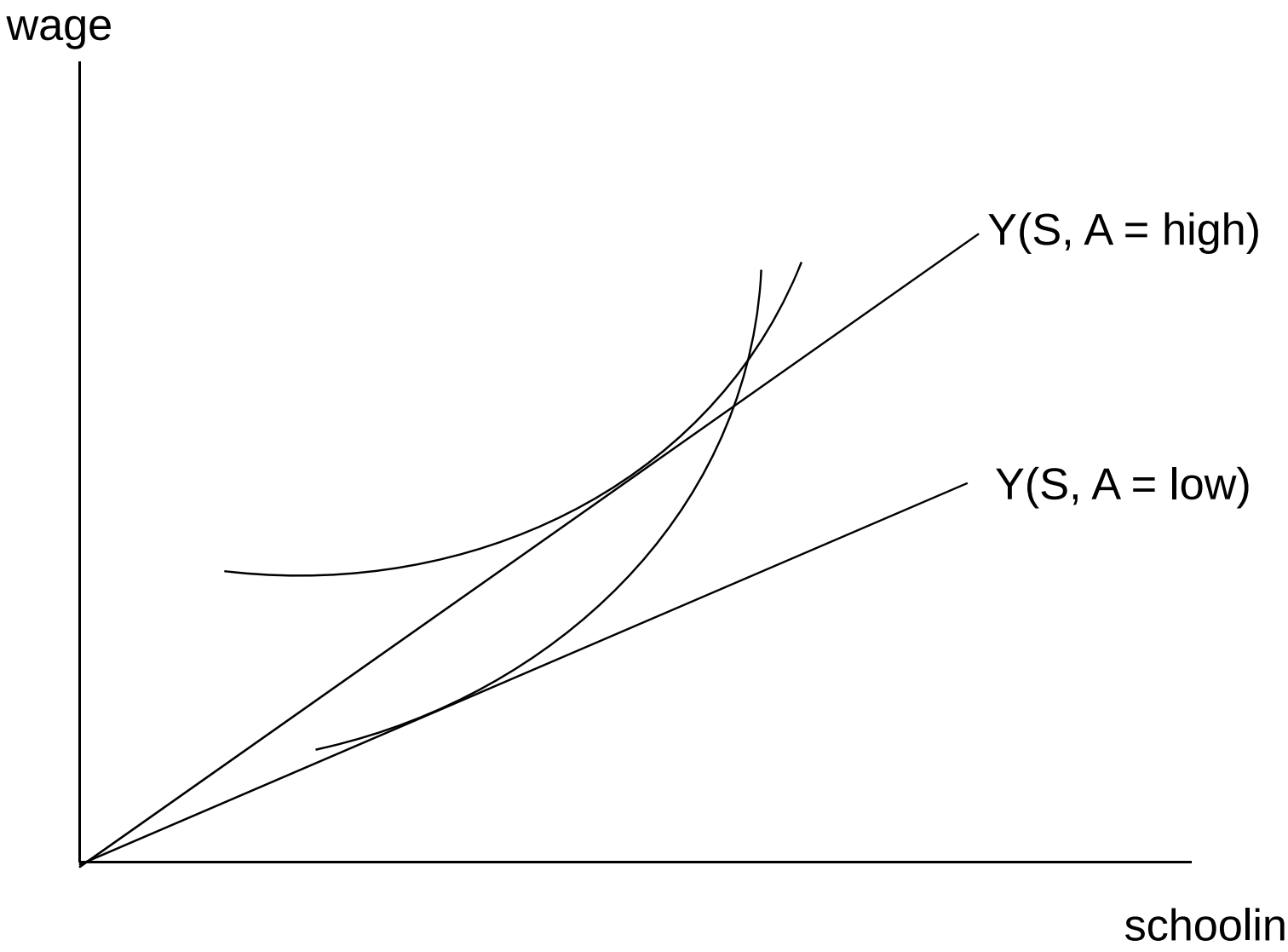
- Different abilities have indifference curves with different slopes:

$$\frac{d^2W}{dSdA} = C_{SA}(S,A) < 0$$

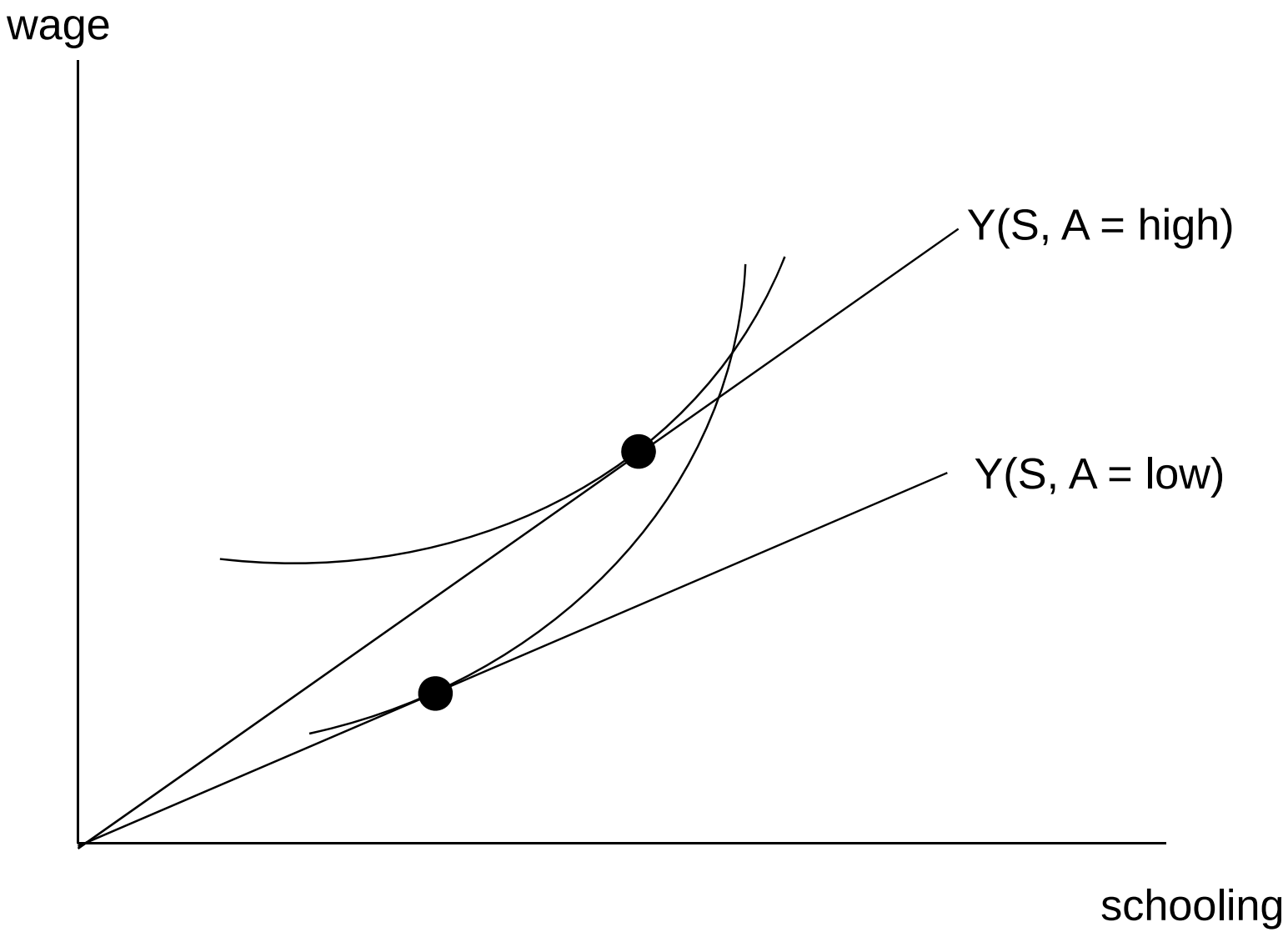
# Indifference Curves in the Signalling Model



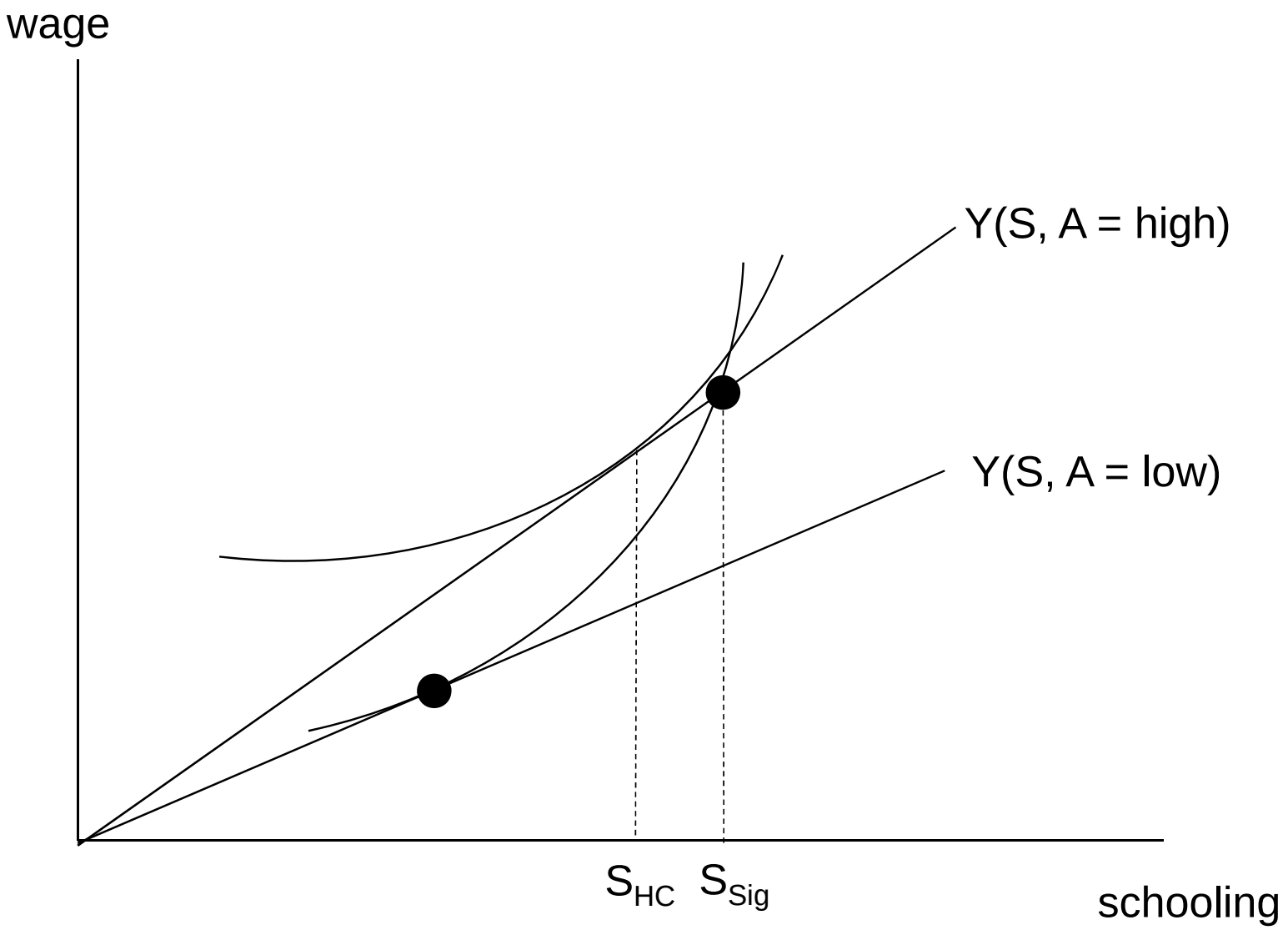
# Adding Output



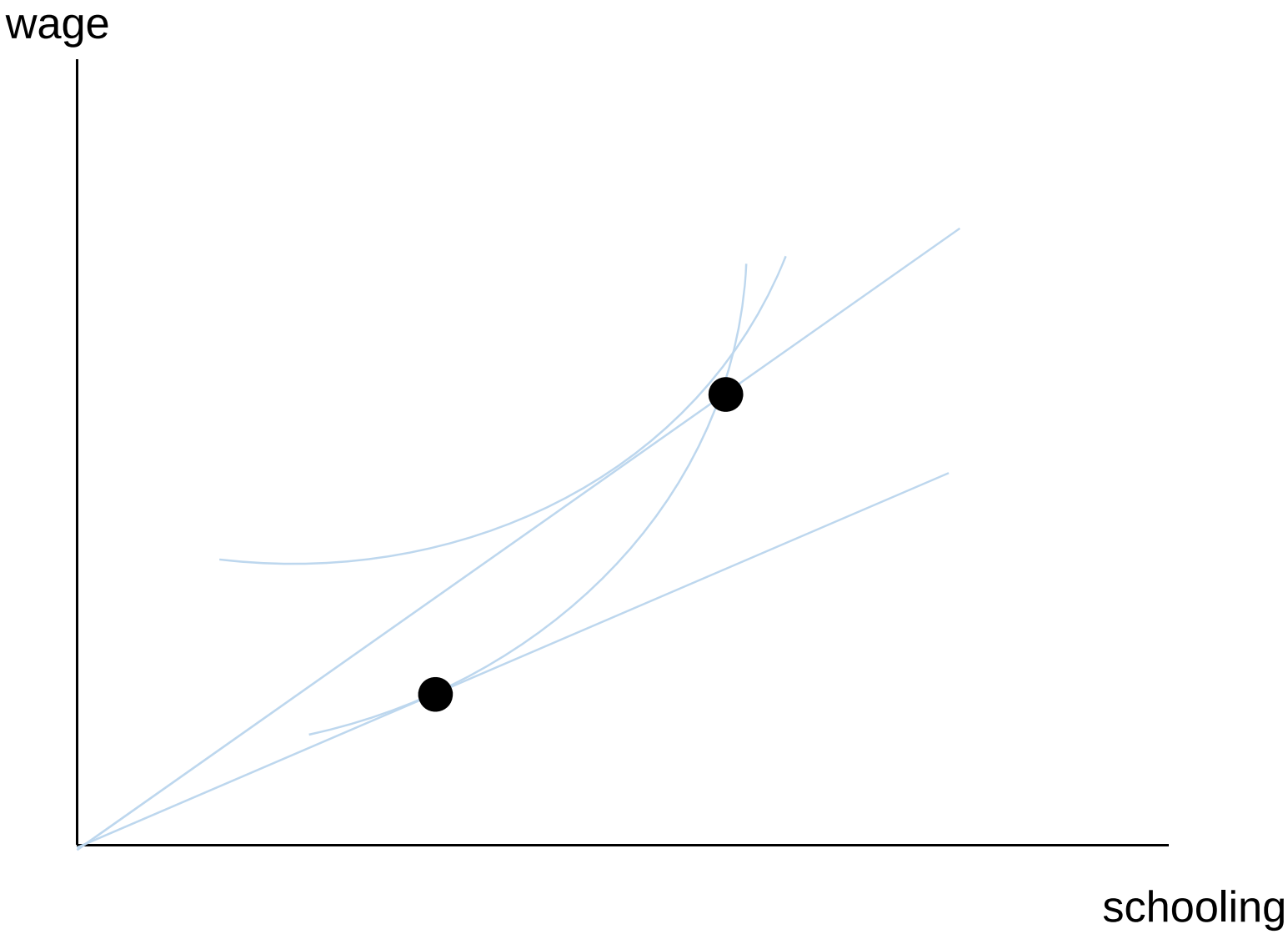
# Schooling in the Human Capital Model



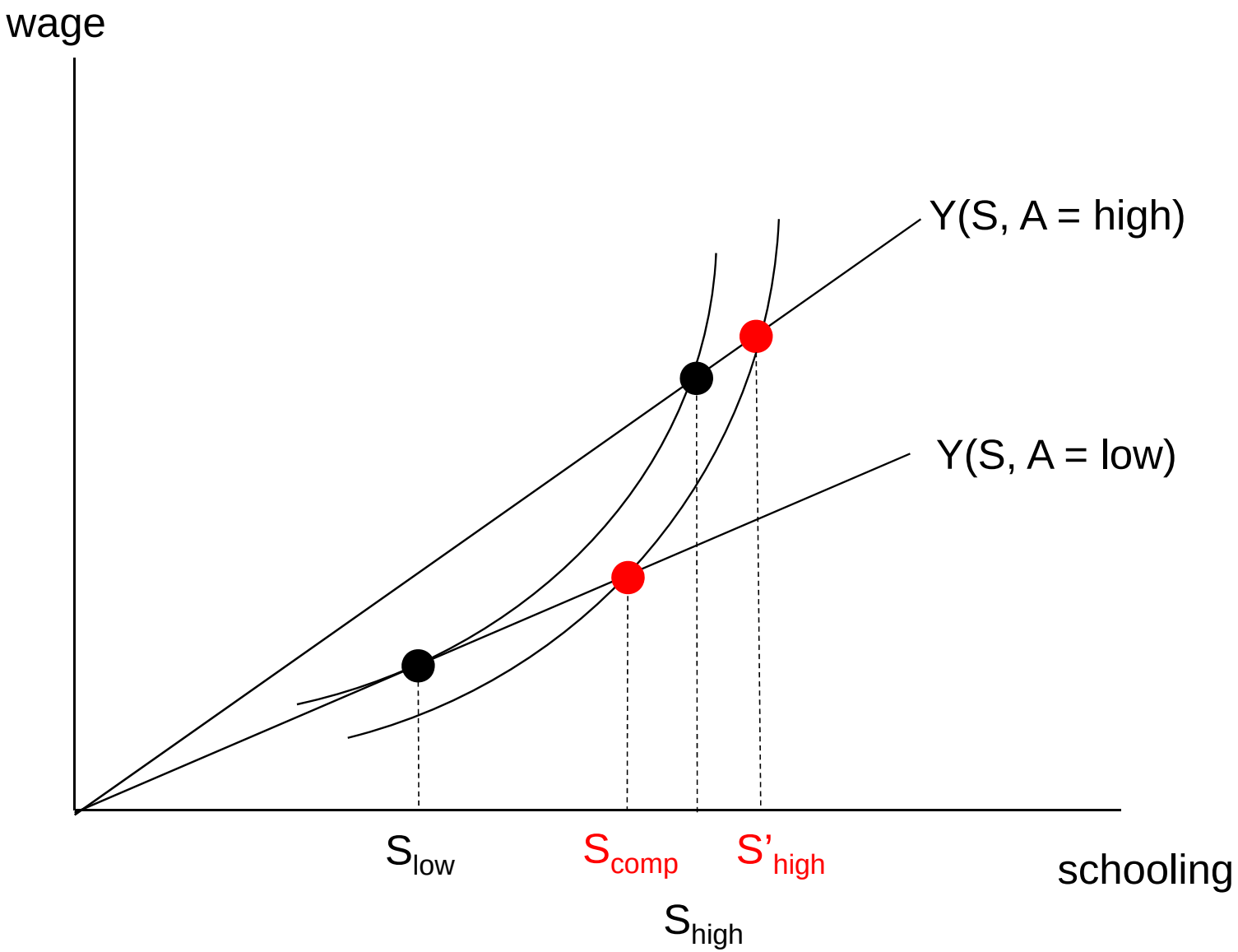
# Schooling in the Signalling Model



# What is the W(S) Function?



# Lang and Kropp (1986): Compulsory Schooling



# Lang and Kropp (1986): Evidence

Lang and Kropp (1986) suggest that the signalling model implies spillovers from compulsory schooling on those getting more schooling anyway.

- L&K find evidence for spillovers in a panel of US states over time
- Acemoglu and Angrist (2000) found some similar evidence
  - but we saw not robust to state trends
- Chevalier, Harmon, Walker, and Zhu (EJ 2004) find no spillovers for England

Conceptually: in general equilibrium, spillovers could also arise in a HC model because of relative supply changes or complementarities

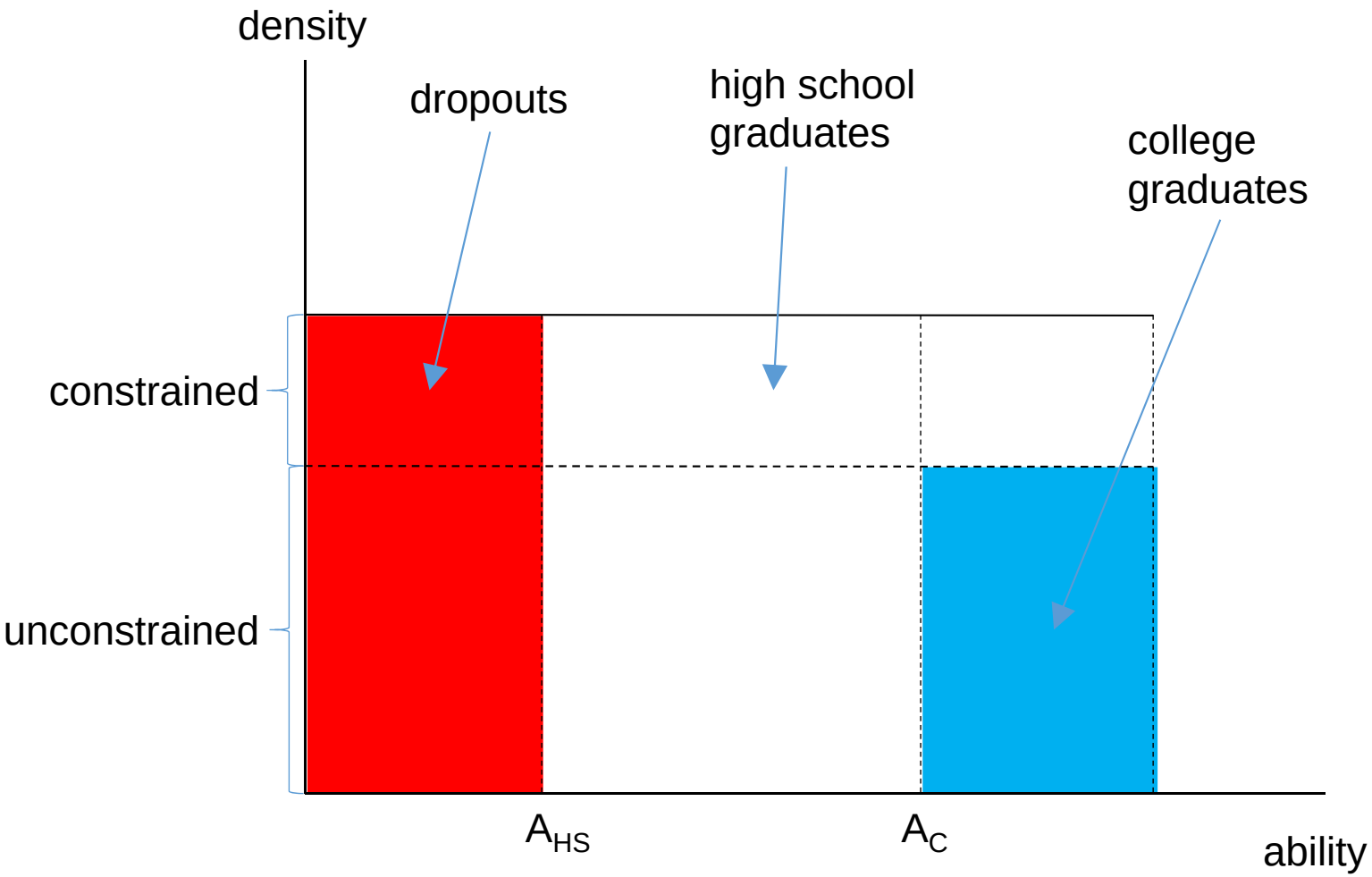
# Bedard (2001): Change in College Access

Like L&K: Look for a comparative statics implication of signalling not shared by the human capital model.

- Three schooling levels: dropouts, high school graduates, and college graduates
- Continuous ability types
- No return to schooling, wages are average productivities of types
- Constraint: not everybody who wants to go to college gets to go (e.g. credit constraint)

What happens to schooling choices when the constraint changes?

# The Bedard (2001) Model



# Bedard (2001): Implications

Remember wages are average productivities of types. What happens when we relax the constraint?

- Some previously constrained types now go to college
  - fewer high school grads
  - average ability of high school grads falls, high school wage falls
- $A_{HS}$ goes up, some high school grads now decide to drop out
  - $A_C$ goes down, some high school grads now decide to go to college (not interesting as college directly affected by constraint)
- Empirical Implementation
  - NLS Young Men and Women (1960s - 70s)
  - Measure of constraint: whether there is a college in the local labour market

# Bedard (2001): Basic Results

TABLE 1
DESCRIPTIVE STATISTICS

| | Entire Sample | | Men | | Women | |
|---|---|---|---|---|---|---|
| | Men (1) | Women (2) | Access (3) | No Access (4) | Access (5) | No Access (6) |
| Average score on KWW test (%): | | | | | | |
| High school dropouts | 50.4 | 57.0 | 51.3* | 48.8 | 58.2* | 54.9 |
| High school graduates | 55.3 | 70.2 | 55.7 | 54.7 | 70.5 | 70.0 |
| University enrollees | 61.8 | 79.1 | 62.4 | 60.8 | 80.0 | 78.1 |
| Mean years of education | 13.3 | 13.0 | 13.4 | 13.2 | 13.1 | 13.0 |
| Distribution of education choices (%): | | | | | | |
| High school dropouts | 21.6 | 19.6 | 22.3 | 20.5 | 21.3* | 17.3 |
| High school graduates | 30.9 | 47.8 | 28.5 | 34.6 | 44.5 | 52.2 |
| University enrollees | 47.6 | 32.6 | 49.2 | 44.9 | 34.2 | 30.5 |
| Sample size | 3,203 | 2,693 | 1,972 | 1,231 | 1,563 | 1,130 |

# Tyler, Murnane, and Willett (2000): GED taking

In 1996, about 10% of 18-24 year olds held a General Educational Development Certificate (GED) instead of a high school diploma.

- The GED is a uniform test throughout the US
- Passing standards differ by state
  - 40-44 is a passing score in Texas but not in New York or Florida
- Idea: compare GED holders and non-holders with the same scores
  - score: controls for human capital
  - GED: signal of completing educational credential
- Why might passing the GED be a signal?
  - Costs: $50 fee, a full day to take the exam, the average GED taker studies for 20 hours
  - not all high school dropouts attempt the GED
  - attempting is relatively cheap, passing might only be possible for higher ability dropouts

# Tyler, Murnane, and Willett (2000): Basic Results

| | Experiment 4 | | |
|---|---|---|---|
| | State passing standard is | | Low-High standard contrast |
| | Low | High | |
| **Panel A: Whites** | | | |
| Test score is | | | |
| Low | 9628 | 7849 | 1779 |
| | (361) | (565) | (670) |
| High | 9981 | 9676 | 305 |
| | (80) | (65) | (103) |
| Difference-in-differences for whites | | | 1473* (678) |

# Tyler, Murnane, and Willett (2000): Effects over Time

**Figure I: Experiment 4**

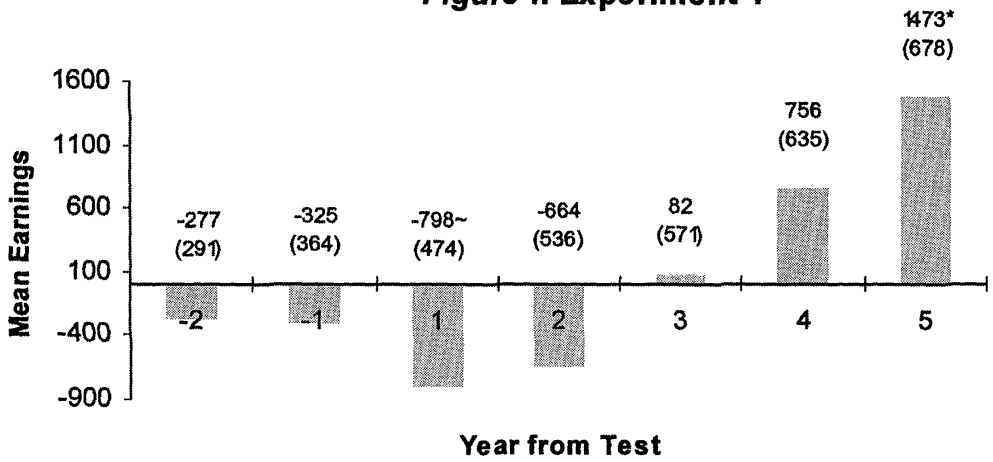
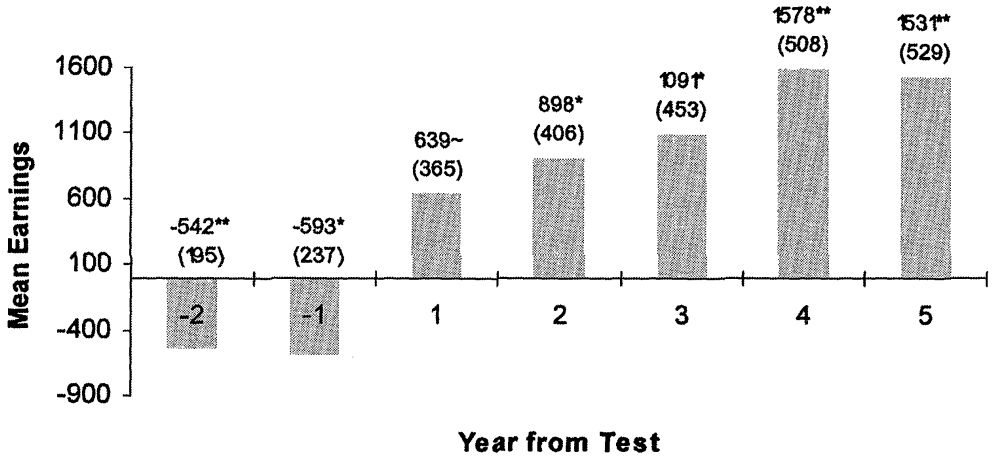



**Figure II: Experiment 3**



# Tyler, Murnane, and Willett (2000): Interpretation

- Returns for whites are \$1,000 to \$1,500 on baseline earnings around \$8,000, a 10-20% return
- OLS returns are in the order of 15%, suggesting that the entire return to the GED is that of a signal
- Zero effects on minorities
  - Many dropouts in prison are required to take the GED. Blacks are more likely to be in prison. Employers may infer a criminal record for them from a GED.
- Returns seem to build up over time
  - Not consistent with signalling (see Farber and Gibbons, *QJE*, 1996)
- Is the effect due to post-secondary schooling or training?
  - GED holders in Texas accumulate about 7 college credits or 0.2 of a year, at a 10 % return that is 2 percentage points