

Next Week's Topic

"The Economics of Education: Teacher Quality and Pay for Performance"

- ▶ Next Week Professor Rothstein will discuss
 - ▶ Hanushek, Eric and Steven G. Rivkin, "Teacher Quality,"
 - ▶ Rockoff, Jonah and Douglas Staiger, "Searching for Effective Teachers with Imperfect Information,"
 - ▶ Measures of Effective Teaching Project, "Learning about Teaching: Initial Findings from the Measures of Effective Teaching Project,"
 - ▶ Rothstein, Jesse, "Review of Learning about Teaching: Initial Findings from the Measures of Effective Teaching Project."
- ▶ In two weeks Professor Eichengreen, John and I will lead the First Research Advisor Meeting

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- ▶ Today, I will motivate the topic and present a basic model of teacher selection from Rockoff and Staiger (2010)
- ▶ John will introduce you to the empirical part of the topic

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Motivation

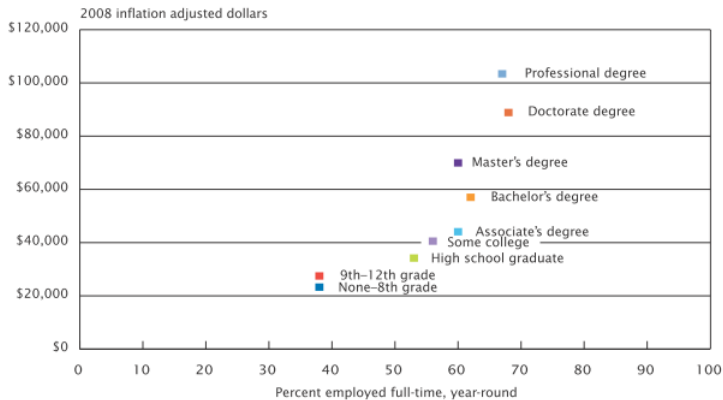
- ▶ Why should we care about Teacher Quality?

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Motivation: Education is Valuable

Figure 2.

Education, Work Status, and Median Annual Earnings



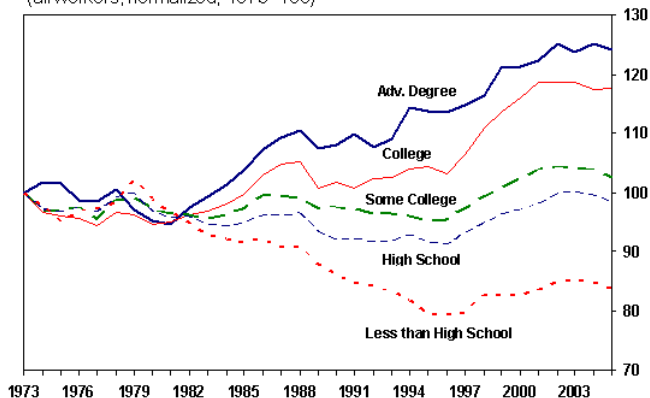
Source: U.S. Census Bureau, American Community Survey, 2006-2008.

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Motivation: Education is Valuable

Figure 2: Real Hourly Wages by Education

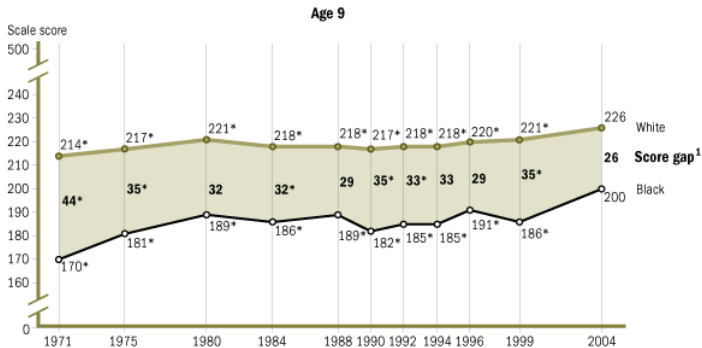
(all workers, normalized; 1973=100)



Source: Economic Policy Institute

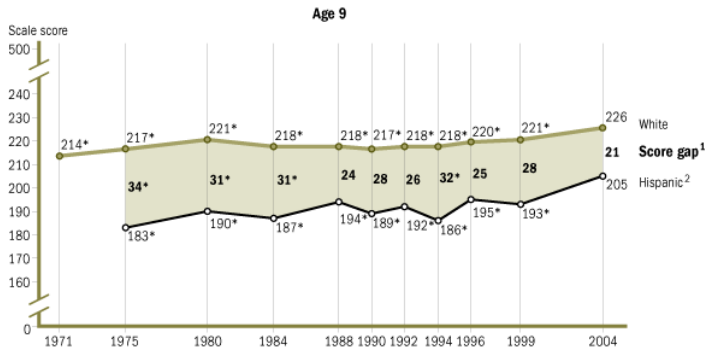
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Motivation: Educational Dispersion



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Motivation: Educational Dispersion



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Motivation

- ▶ Educational achievement gaps are observed by other individual characteristics as well (e.g. gender)
- ▶ Since these characteristics do not reflect individuals' intrinsic abilities (instead incomes, residence, etc), these differences are undesirable
- ▶ Perhaps, improvement in teacher quality is an answer

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Key Questions

- ▶ What are the determinants of teacher quality? How to measure them?
- ▶ What is the effect of teacher quality? How to measure it?

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Determinants of Teacher Quality

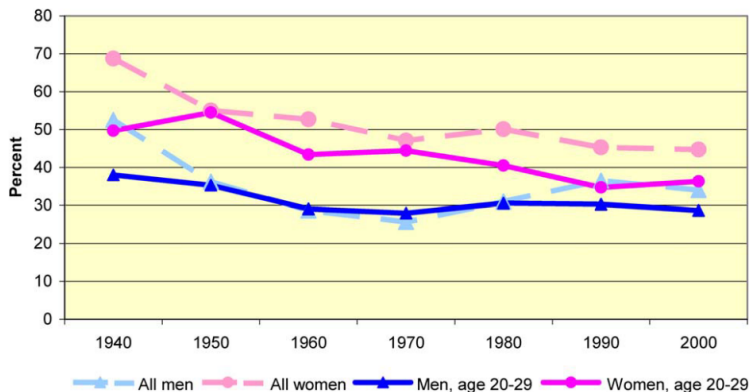
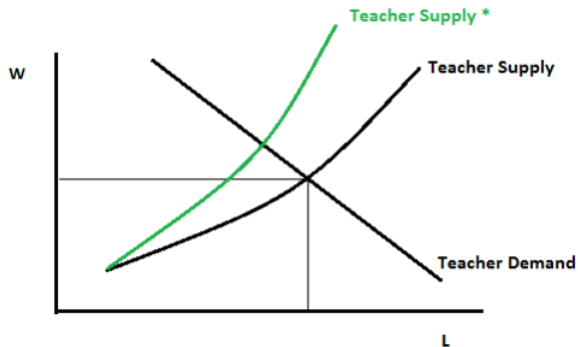


Figure 1. Percent college educated earning less than average teacher, by gender and age, 1940–2000.

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Determinants of Teacher Quality



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Measuring Teacher Effectiveness

- ▶ Value Added Approach

- ▶ A popular approach to identify the effect of teacher quality is to write a performance production function

$$Y = F(TQ, X)$$
$$= \alpha + \beta TQ + \delta X + \epsilon$$

- ▶ One can then run a regression to estimate the impact of TQ on Y

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Measuring Teacher Effectiveness

- ▶ Difficult to make causal inferences
 - ▶ Students of high ability may be sorted into good schools with high overall teacher quality (β likely to be biased upwards)
- ▶ Need exogenous variations in teacher quality TQ
 - ▶ Instrumental variables
 - ▶ Randomized experiments
- ▶ John will discuss these in more detail later tonight

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Motivating the Model

- ▶ Key Findings in the Literature
 - ▶ Teacher effect is heterogeneous
 - ▶ Estimates of teacher effect based on student achievement give noisy measures
 - ▶ Teacher effectiveness rises rapidly in the first one or two years and then rapidly levels off
 - ▶ The primary cost of teacher turnover is not from hiring and firing but is associated with students being taught by a novice teacher
 - ▶ It is difficult to identify the teachers who will be effective at the time of the hire

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Motivating the Model

- ▶ How do we utilize these findings in practice?
- ▶ What are the implications for school officials who are interested in maximizing the quality of education in schools
- ▶ Rockoff and Staiger construct a simple model of teacher selection and “calibrate” it to guide policy suggestions

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We then explore what these facts imply for how principals and school districts should act, using a simple model in which schools must search for teachers using noisy signals of teacher effectiveness. Due to a lack of information available at the time of hire, we will argue for a hiring process that is not highly selective—that is, while it might require evidence of general educational achievement like a college degree, it would not require individuals to make costly up-front specific investments before being permitted to teach. We then argue that, given the substantial observed heterogeneity of teacher effects, the modest rise in productivity with on-the-job experience, and the fact that tenure is a lifetime job, tenure protections should be limited to those who meet a very high bar. Even with the imprecise estimates of teacher effectiveness currently available, our simulations suggest that a strategy that would sample extensively from the pool of potential teachers but offer tenure only to a small percentage could yield substantial annual gains in student achievement.

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Model Description: Environment and Agents

- ▶ Economic Agents:
 - ▶ Principal
 - ▶ Teachers
- ▶ Environment
 - ▶ Teachers are of heterogeneous quality and passively accept the jobs they are offered
 - ▶ Principal has the choice to hire a given teacher or to let the teacher go before tenure
 - ▶ Principal's objective is to maximize the quality of the pool of teachers in school

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Model Description: Teachers

▶ Teacher Heterogeneity

- ▶ Teacher quality is distributed as $Q \sim N(\beta, \sigma^2)$, with $\beta < 0$ if teacher is a rookie and $\beta = 0$ if experienced
- ▶ Teacher classroom performance is not perfectly related to her quality and is given by $Y = Q + \epsilon$, $\epsilon \sim N(0, \sigma_\epsilon^2)$

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Model Description: Principal

- ▶ Principal
 - ▶ Principal receives applications from teachers and must decide whether to hire teacher or not
 - ▶ Principal does not observe the applicant's quality Q (Important!)
 - ▶ After a year of observing teacher performance Y , principal must decide whether to grant teacher a tenure

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Solving the Model

- ▶ Let $P = 1$ be the population of teachers at the schools
- ▶ At each date, principal encounters rookies, experienced teachers, and teachers who drop out from teaching
- ▶ The pool of teachers can be divided into a fraction π of rookies and a fraction $1 - \pi$ of experienced teachers
- ▶ We will need to determine π later

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Solving the Model

- ▶ Recall that principal's objective is to maximize the quality of the pool of teachers
- ▶ What is the quality of the pool of teachers at a given point in time?

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Solving the Model

- ▶ There are π rookies with average quality β and $1 - \pi$ experienced teachers with average quality γ (to be determined later)
- ▶ We can therefore write principal's objective as

$$\max \bar{Y} = \pi\beta + (1 - \pi)\gamma$$

by choosing some criterion for tenuring teachers (effectively choosing γ)

- ▶ What do you think are the tradeoffs that the principal faces?
- ▶ Hint: If you want to keep population of teachers fixed, what happens to π when you increase or decrease γ ?

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Solving the Model

- ▶ Intuitively
 - ▶ If γ is set too high, there will be too few experienced teachers
 - ▶ if γ is set too low, the quality of the pool will be too low
 - ▶ Optimal γ must tradeoff these two effects and choose an intermediate γ

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Solving the Model

- ▶ How is γ determined?
 - ▶ Let r denote the threshold that the principal sets on teacher classroom performance
 - ▶ The fraction of teachers granted tenure is then given by $Pr(Y > r)$
 - ▶ The average quality of these teachers is $\gamma = E\{Q|Y > r\}$ and of the entire pool

$$\bar{Y} = \pi\beta + (1 - \pi) E\{Q|Y > r\}$$

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Solving the Model

- ▶ How is π determined?
 - ▶ It is possible for the population of teachers to either grow over time (do not fire anyone) or decline over time (do not hire everyone)
 - ▶ We want a situation where the population of teachers stays stable over time (presumably there are limited vacancies opening at each date)
 - ▶ If P_t and P_{t+1} denote populations of teachers at time t and $t + 1$, we need to impose that $P_{t+1} = P_t$

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Solving the Model

- ▶ Population at time $t + 1$ is

$$P_{t+1} = \pi P_t + (1 - \pi) [Pr(Y > r)(1 - \delta) P_{t-1} - Pr(Y > r)(1 - \delta)^2 P_{t-2} - \dots - Pr(Y > r)(1 - \delta)^T P_{t-T}]$$

Imposing $P_{t+1} = P_t = P_{t-1} = \dots$, we get

$$\pi = \frac{1}{1 + Pr(Y > r) \sum_{t=1}^T (1 - \delta)^t}$$

- ▶ What happens to π when r or δ change?

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Solving the Model

- ▶ Finally, we can write the principal's objective as

$$\max_r \bar{Y} = \pi\beta + (1 - \pi) E \{Q|Y > r\}$$

where $\pi = \frac{1}{1 + \gamma \sum_{t=1}^T (1 - \delta)^t}$

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Solving the Model

- ▶ The first order condition to this problem is

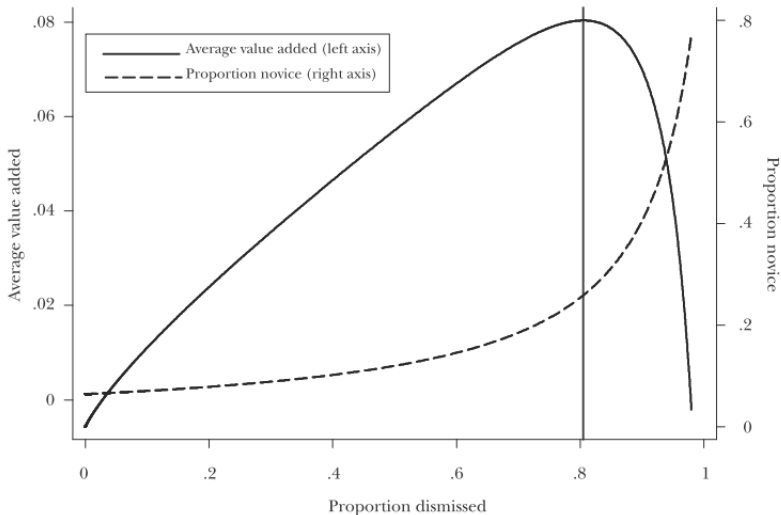
$$\bar{Y} = E \{Q|Y = r^*\}$$

- ▶ The threshold r is thus set so that the quality of the marginal tenured teacher is equal to the average quality of teachers

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Solution Graphically

Effect of Dismissing a Given Proportion of Novice Teachers Based on One Year of Data



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Comparative Statics

- ▶ The equilibrium is characterized by the set of equations

$$\bar{Y} = E \{Q|Y = r^*\}$$

$$\bar{Y} = \pi\beta + (1 - \pi) E \{Q|Y > r^*\}$$

$$\pi = \frac{1}{1 + P(Y > r^*) \sum_{t=1}^T (1 - \delta)^t}$$

- ▶ What happens to the optimal threshold r^* as δ , β , or σ^2 , σ_ϵ^2 change?

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Comparative Statics

- ▶ A more negative β lowers average quality of teachers and therefore the threshold r is lowered.
 - ▶ The value of experience raises the cost of dismissing experienced workers
- ▶ A larger turnover rate δ increases the fraction of rookies and reduce the quality of the pool. Thus r is again reduced.
 - ▶ There is lower benefit to selecting teachers if they are not going to stay for long
- ▶ Smaller variance in Q lowers the benefit of selection and higher variance in ϵ makes it difficult to select effective teachers. Both reduce the threshold r .
 - ▶ Little reason to be selective based on performance if performance is a poor measure of teacher quality

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Conclusion

The implications of our analysis are strikingly different from current practice. Schools and school districts attempt to screen at the point of hiring and require significant investment in education-specific coursework but then grant tenure status to teachers as a matter of course after two to three years on the job. Performance evaluation is typically a perfunctory exercise and, at least officially, very few teachers are considered ineffective (Weisberg, Sexton, Mulhern, and Keeling, 2009). Rather than screening at the time of hire, the evidence on heterogeneity of teacher performance suggests a better strategy would be identifying large differences between teachers by observing the first few years of teaching performance and retaining only the highest-performing teachers.