

# Economics of Human Capital

## Introduction

Philipp Eisenhauer

Human capital is defined as:

*The knowledge, skills, competencies and attributes embodied in individuals that facilitate the creation of personal, social and economic well-being.*

- OECD (2001)

## Tasks

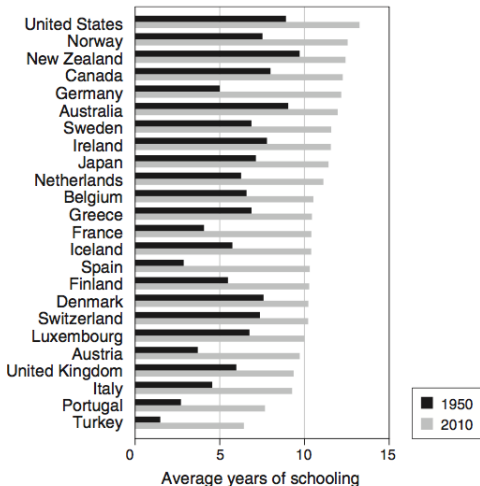
- ▶ definition and measurement of human capital
- ▶ determining the effect of human capital on a variety of personal, social and economic outcomes
- ▶ understanding the formation of human capital

## Tasks

- ▶ identifying the driving forces behind the observed heterogeneity across and within countries
- ▶ search for effective policies to ameliorate disparities
- ▶ ...

# Facts

Figure: Years of schooling

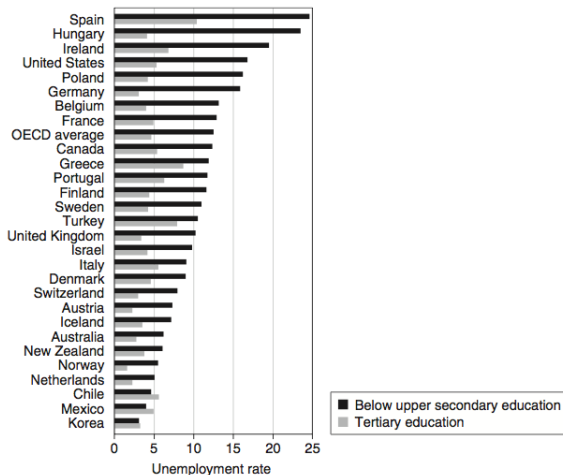


**FIGURE 4.4**

Years of schooling of the total population aged 25 and older.

Source: Barro and Lee (2010, education data set, available at [www.barrolee.com/data](http://www.barrolee.com/data)).

# Figure: Unemployment rates

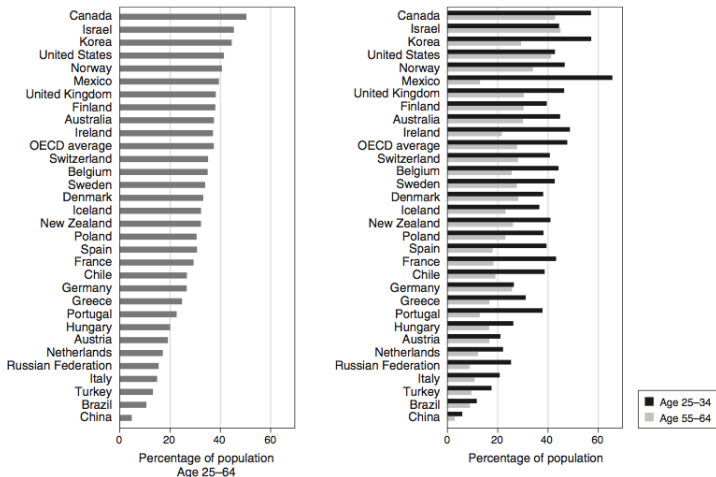


**FIGURE 4.6**

Unemployment rates by level of educational attainment for 25- to 64-year-olds, 2010. The OECD average is the nonweighted average of the 34 OECD countries, including those not represented on this figure. Data missing for non-OECD countries.

Source: OECD (2012, table A7.4a, p. 133).

# Figure: Tertiary education



**FIGURE 4.3**

Percentage of the population that has attained at least tertiary education or advanced research programs, by age group, 2010. The OECD average is the nonweighted average of the 34 OECD countries, including those not represented in this figure. Brazil, China, and the Russian Federation are not part of the OECD.

Source: OECD (2012, table A1.3a, p. 36).



# Figure: Secondary education



**FIGURE 4.2**

Percentage of the population that has attained at least upper secondary education, by age group, 2010. The OECD average is the nonweighted average of the 34 OECD countries, including those not represented in this figure. Brazil, China, and the Russian Federation are not part of the OECD.

Source: OECD (2012, table A1.2a, p. 35).

## Figure: Expenditures



**FIGURE 4.1**

Expenditure on educational institutions as a percentage of GDP, 2009. The OECD average is the nonweighted average of the 34 OECD countries, including those not represented in this figure. Brazil and the Russian Federation are not part of the OECD. Private expenditure is missing for Brazil, Hungary, Norway, and Switzerland. Data are missing for China, Greece and Turkey.

Source: OECD (2012, table B2.3, p. 246).

Figure: Relative earnings



FIGURE 4.5

Relative earnings from employment among 25- to 64-year-olds, by level of educational attainment (2010 or latest available year). Upper secondary and post-secondary nontertiary education = 100. The OECD average is the nonweighted average of the 34 OECD countries, including those not represented in this figure. Brazil is not part of the OECD. Data missing for Chile, China, Iceland, Mexico, and the Russian Federation.

Source: OECD (2012, chart A8.1, p. 140).

Figure: Unemployment rates



**FIGURE 4.7**

Unemployment rates by level of educational attainment for 25- to 64-year-olds, 2010. The OECD average is the nonweighted average of the 34 OECD countries.

Source: OECD (2012, table A7.4a, p. 133).

# **Economic models**

*All models are wrong, but some are useful.*

- Box (1987)

Economic models facilitate experiential learning.

- ▶ What question are they designed to address?
- ▶ What are the underlying economic mechanisms?
- ▶ How robust are the conclusions?
- ▶ What is missing?
- ▶ ...

Figure: Modeling process

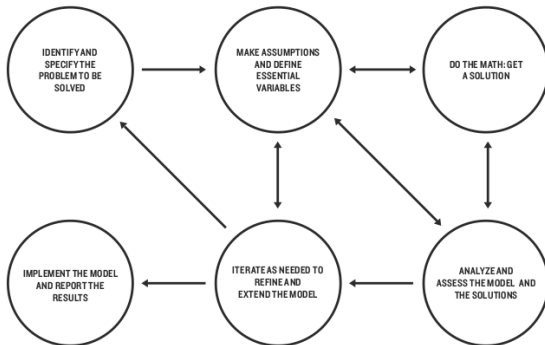


FIGURE 1.2: THE MATH MODELING PROCESS



## Famous examples

- ▶ **Lemons model (Akerlof, 1970)**, market unraveling in presence of asymmetric information
- ▶ **Roy model (Roy, 1951)**, static model of self-selection and comparative advantage
- ▶ **Career decisions model (Keane & Wolpin, 1997)**, dynamic model human capital investment with schooling and on-the-job training
- ▶ ...

# **Life-cycle of earnings**

## Stylized Facts

- ▶ Life-cycle earnings are increasing at early ages and decline towards the end.
- ▶ Wages tend to increase over the life-cycle with a weak tendency to decline at the end of working life.
- ▶ Hours of work increase at early ages and decline in old age, with the peak occurring earlier than in the wage profiles.

See Weiss (1986) for comprehensive modeling framework that allows to interpret all these facts.

Figure: Wage gains



**FIGURE 4.8**

Average wage gains for college and high school graduates in the United States in 1996.

Source: Ashenfelter and Rouse (1999).

We study a version of the seminal Ben-Porath Model (Ben-Porath, 1967) that relates human capital accumulation to life-cycle earnings.

## Basic Notation

$s(t)$       fraction devoted to training

$h(t)$       stock of human capital

$w(t)$       wage

$\delta$           depreciation of knowledge

The individual's objective is to maximize the discounted sum of wages over their life-cycle.

$$\Omega = \int_0^T w(t) e^{-rt} dt$$

Their economic environment is characterized by the production functions for wages and human capital.

$$w(t) = A[1 - s(t)]h(t)dt$$

$$\dot{h} = \theta g(s(t)h(t)) - \delta h(t) \quad g' > 0, g'' < 0$$



## Notable Features

- ▶ Individuals cannot work and learn at the same time.
- ▶ There is no individual heterogeneity.
- ▶ There is no direct cost of education but there are the opportunity cost of lost wages.
- ▶ ...

## Model Specification

We study the implementation in Cahuc and Zylberberg (2004).

$$g(h(t), s(t)) = (h(t)s(t))^{0.71}$$

$$A = 0.75 \quad \delta = 0.06 \quad r = 0.05$$

$$h_0 = 5 \quad T = 60 \quad \theta = 0.5$$

**Figure:** Contour plot of human capital production function

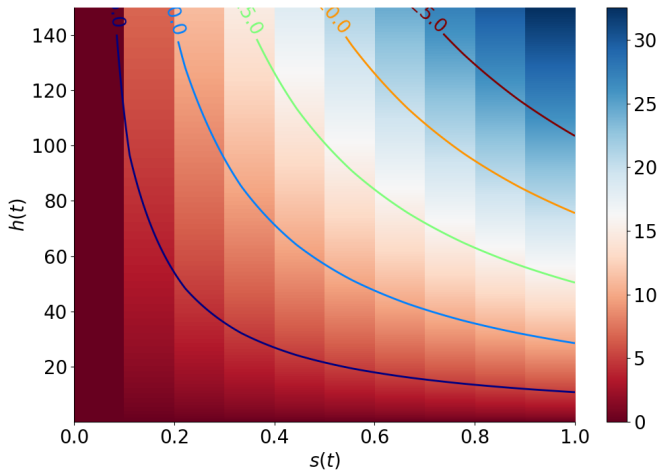


Figure: Surface plot of human capital production function

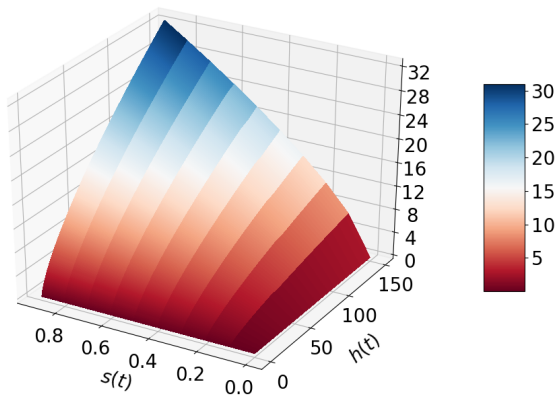


Figure: Wage production

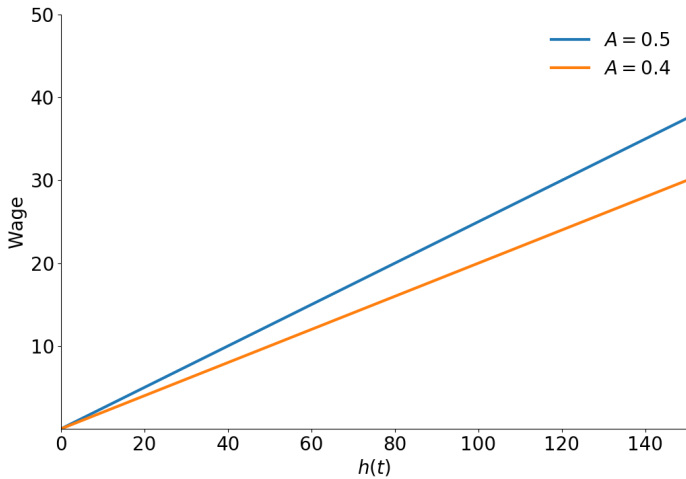


Figure: Wage over the life-cycle

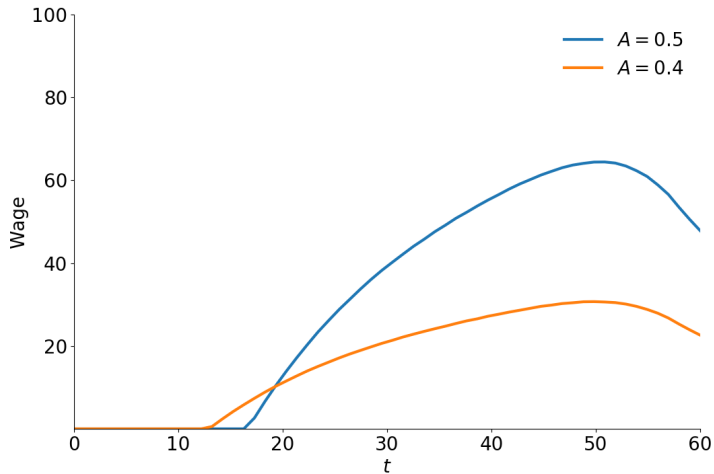


Figure: Stock of human capital over the life-cycle

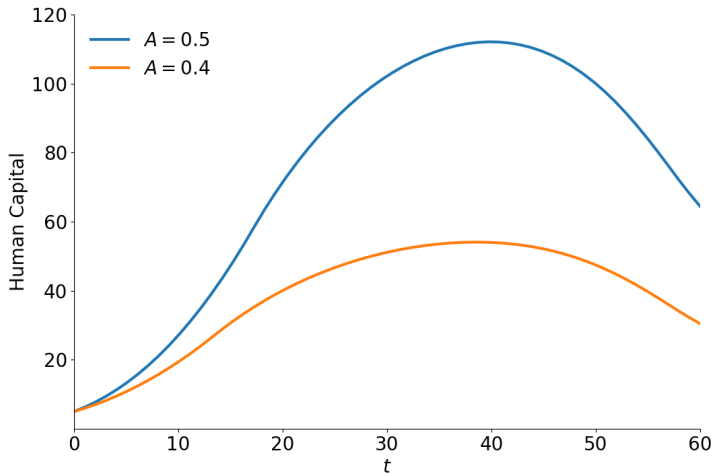
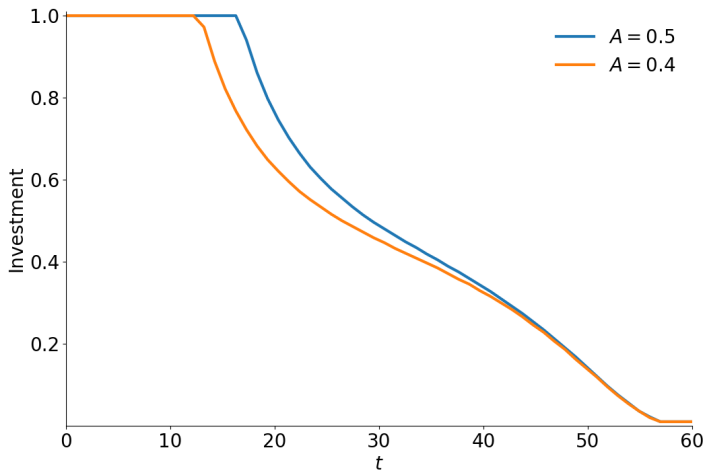


Figure: Human capital investment over the life-cycle





## Extensions

Weiss (1986) reviews a host of alternative extensions to the basic model.

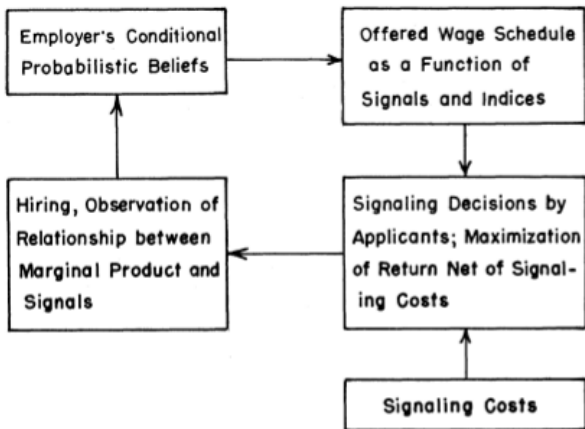
- ▶ general versus specific training
- ▶ hours worked
- ▶ uncertainty
- ▶ borrowing-constraints
- ▶ ...

# **Job market signaling**

We study the seminal model presented in Spence (1973).

- ▶ There are two groups  $j \in \{H, L\}$  in the population facing one employer, where  $h_{i \in \{L, H\}}$  denotes the respective level of productivity.
- ▶ Group  $H$  is a proportion  $q_H$  in the population.
- ▶ Education  $y$  is measured by an index  $y$  of level and achievement and is subject to individual choice.
- ▶ Education costs are both monetary and psychic and differ by group  $c_{i \in \{L, H\}}$ .

Figure: Informational feedback



We explore the following parameterized version.

$$h_L = 1 \quad h_H = 2$$

$$c_L = y \quad c_H = \frac{1}{2}y$$

Figure: Benefit of education

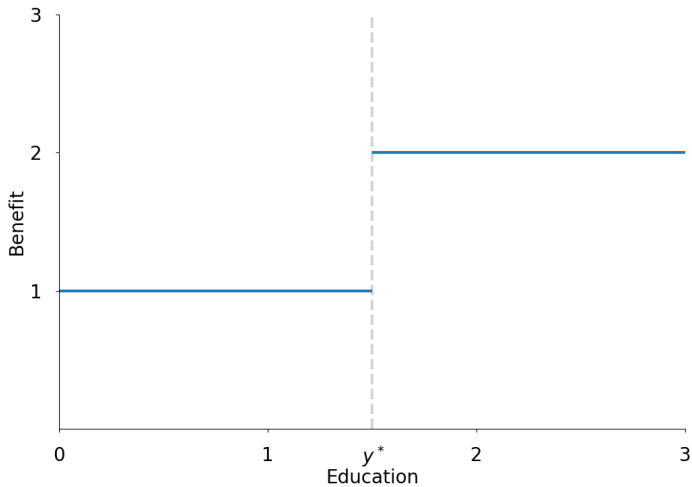


Figure: Cost of education

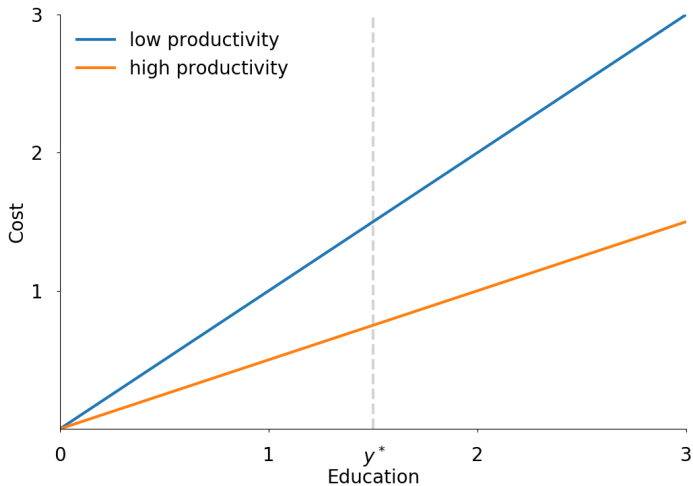
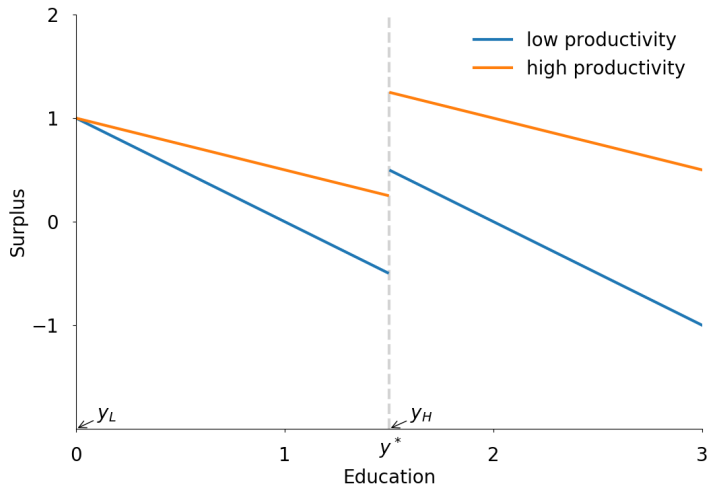


Figure: Surplus of education I





- ▶ For  $y^* = 1.5$  the employer's beliefs are confirmed. More generally,  $L$  chooses  $y_L = 0$  if  $1 > 2 - y^*$  and  $H$  acquires  $y_H = y^*$  provided that  $2 - 0.5y^* > 1$ .
- ▶ Beliefs are confirmed provided that the following holds:

$$1 < y^* < 2$$

Figure: Surplus of education II

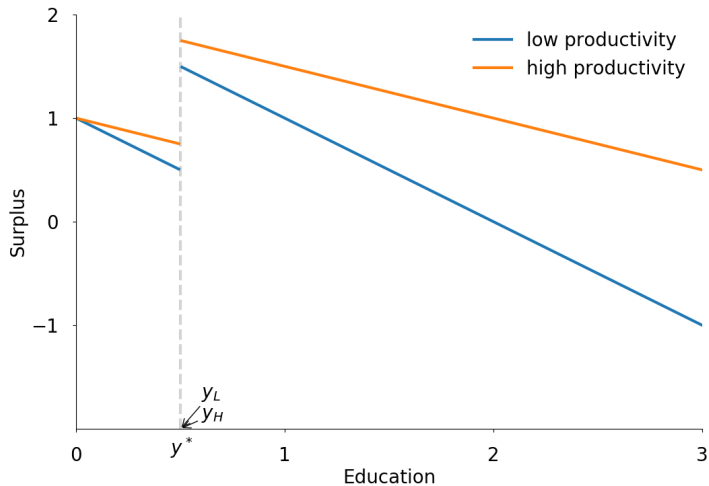
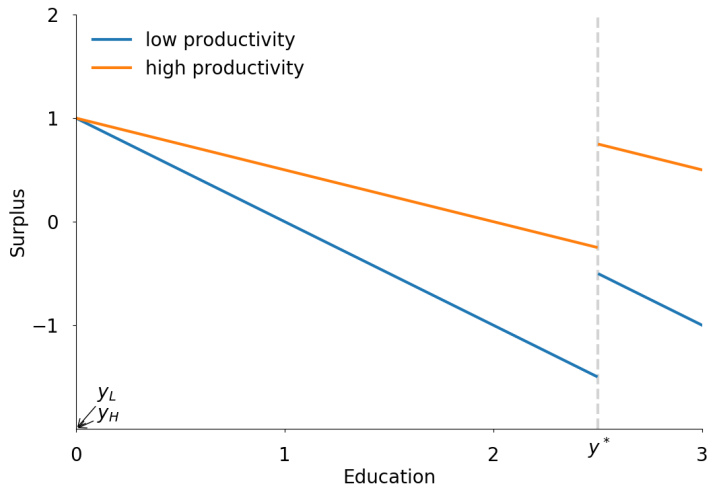


Figure: Surplus of education III



- ▶ From the outside, education appears to be productive and is for the individual. However, there is no real effect on the marginal product.

- ▶ In the absence of signaling, both groups are paid the unconditional expected marginal product.

$$q_L \times 1 + (1 - q_L) \times 2$$

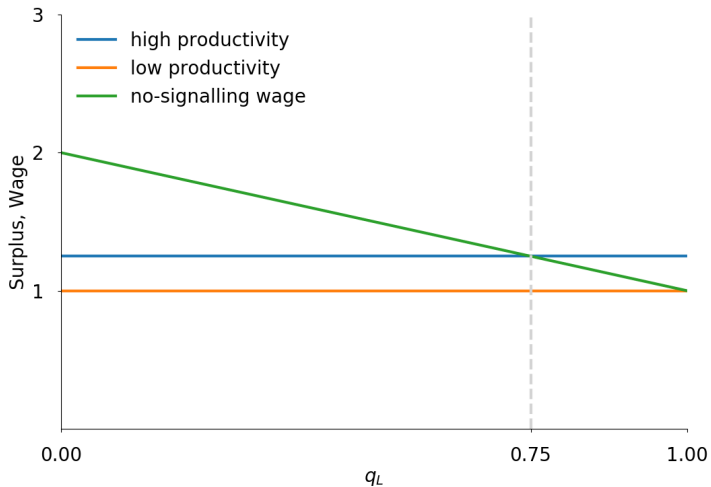
- ▶ It depends on the share of low ability individuals whether high ability individuals actually prefer a no-signaling case. The surplus is determined as follows:

$$\text{signaling} \quad 2 - \frac{1}{2}y^*$$

$$\text{no-signaling} \quad 2 - q_L$$

- ▶ High ability individual prefer the signaling case as long as  $y^* \geq 2q_L$ .

Figure: Market structure



- ▶ The ability to signal has a detrimental effect on low ability workers, while the consequences are ambiguous for high ability workers.
- ▶ High ability workers benefit from their ability to send a signal if their proportion is sufficiently small with respect to the ability gap to low ability individuals.



# Appendix

# *References*

- Akerlof, G. A. (1970). The market for "lemons": Quality uncertainty and the market mechanism. *Quarterly Journal of Economics*, 84(3), 488–500.
- Ben-Porath, Y. (1967). The production of human capital and the life cycle of earnings. *Journal of Political Economy*, 75(4), 352–365.
- Box, G. E. P., & Draper, N. R. (1987). *Empirical model-building and response surfaces*. Oxford, England: John Wiley & Sons.
- Cahuc, P., & Zylberberg, A. (2004). *Labor economics* (1st ed.). Cambridge, MA: MIT Press.

Heckman, J. J., & Vytlačil, E. J. (2007a). Econometric evaluation of social programs, part I: Causal effects, structural models and econometric policy evaluation. In J. J. Heckman & E. E. Leamer (Eds.), *Handbook of econometrics* (Vol. 6B, pp. 4779–4874). Amsterdam, Netherlands: Elsevier Science.

Heckman, J. J., & Vytlačil, E. J. (2007b). Econometric evaluation of social programs, part II: Using the marginal treatment effect to organize alternative economic estimators to evaluate social programs and to forecast their effects in new environments. In J. J. Heckman & E. E. Leamer (Eds.), *Handbook of econometrics* (Vol. 6B, pp. 4875–5144). Amsterdam, Netherlands: Elsevier Science.

- Keane, M. P., & Wolpin, K. I. (1997). The career decisions of young men. *Journal of Political Economy*, 105(3), 473–522.
- Roy, A. D. (1951). Some thoughts on the distribution of earnings. *Oxford Economic Papers*, 3(2), 135–146.
- Spence, M. (1973). Job market signaling. *The Quarterly Journal of Economics*, 87(3), 355–374.
- Weiss, Y. (1986). The determination of life cycle earnings: A survey. In O. C. Ashenfelter & R. Layard (Eds.), *Handbook of labor economics* (Vol. 1, pp. 603–640). Amsterdam, Netherlands: North-Holland Publishing Company.