On schooling and risk

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education is a decision under uncertainty:

the requirements of the school curriculum

occupations available after graduation

abilities and preferences

returns

Immediate questions:

1. how much risk in the investment stage?
2. how much risk in the returns?
3. does risk affect individual choice?
4. how does risk affect educational policies?

Outline:

1. risky returns
2. risk and educational choice
3. compensation and pay-off
4. selectivity: what do students know?
5. educational policy: what curriculum?

Risky returns

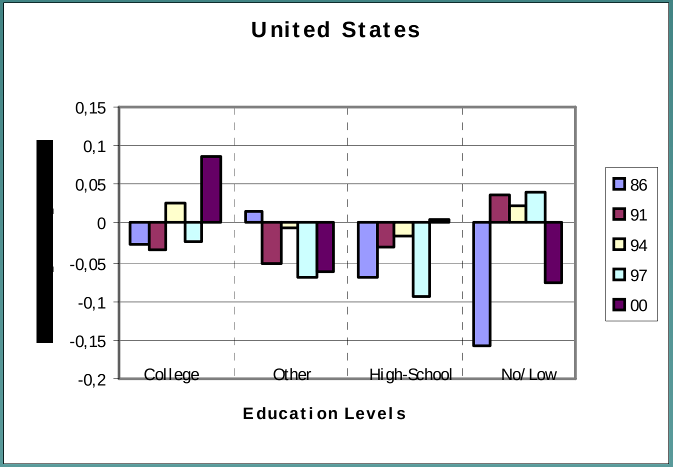
earnings variance by education: no standard pattern

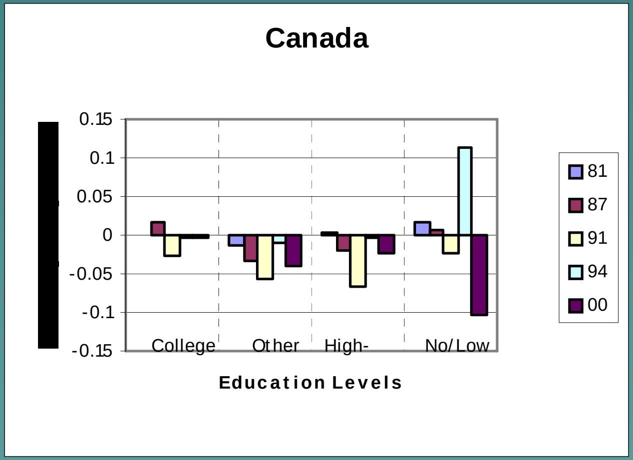
Residual variance by education, LIS data

(schooling, age):

$$\sigma_i^2 = \gamma_0 + \gamma_1 s_i + \gamma_2 s_i^2 + \gamma_3 s_i a_i + \gamma_4 a_i + \gamma_5 a_i^2 + u_i$$

Figure 1. Earnings Dispersion by Levels of Education





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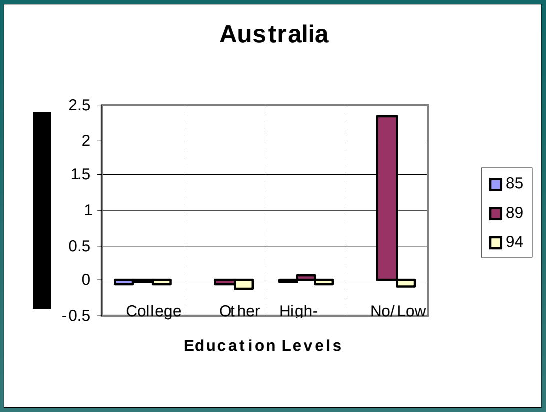

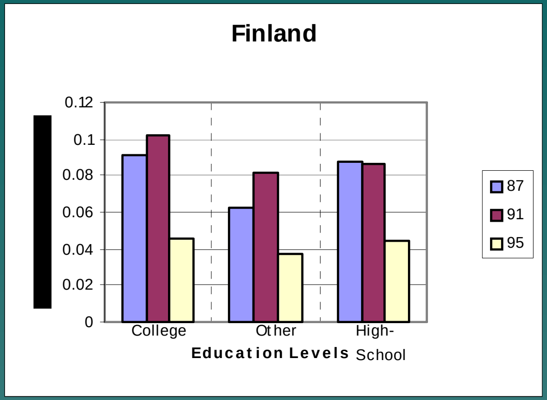

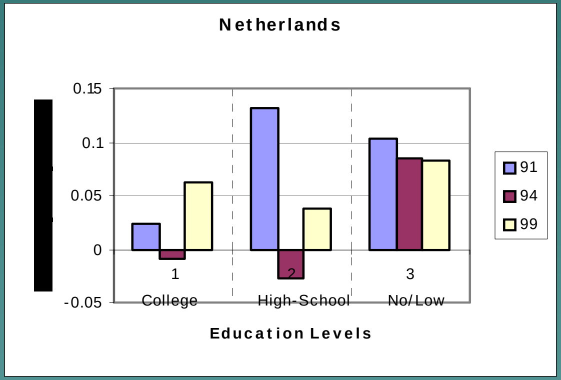

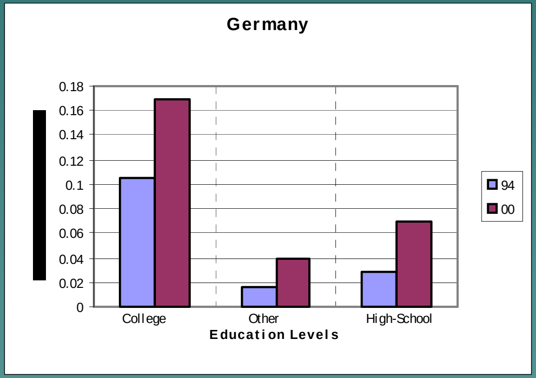

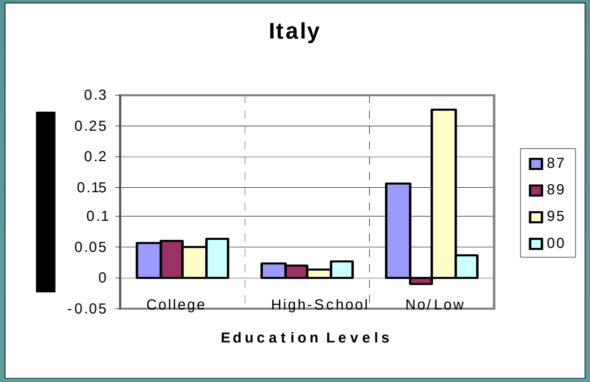

Chen and Khan (2005):

residual standard deviation

OLS:	high school:	0.370	college	0.397
Heckman two-stage		0.445		0.455

Cunha, Heckman and Navarro (2005):

60% of variability in returns to education is forecastable at the individual level (heterogeneity), 40% is risk

Palacios-Huerta, AER (2003):

mean-variance frontier does not improve if returns from financial assets are added to returns from human capital, adding human capital to financial assets does improve

Simulation: Hartog, van Ophem, Bajdechi (2007)

Simulation ex ante CV 0.3:

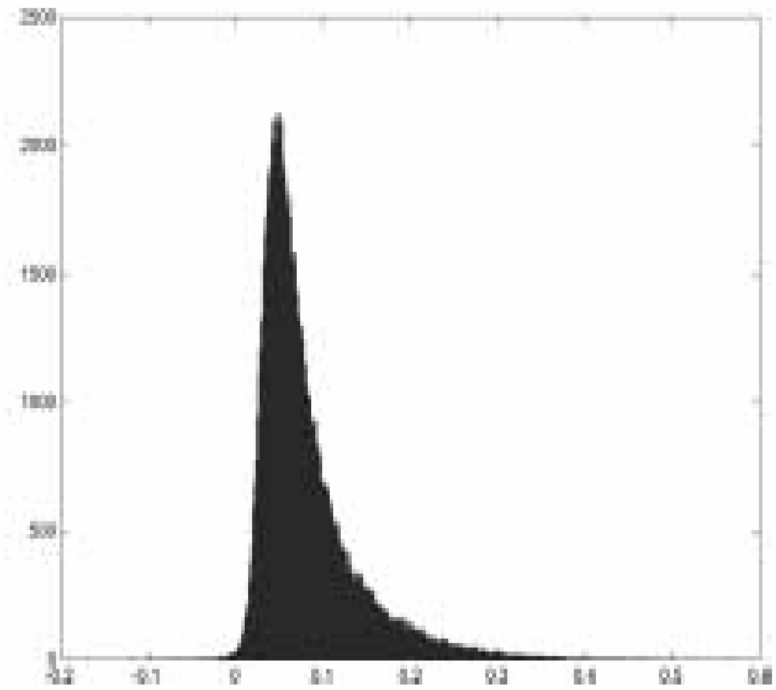

Figure 1. Distribution of internal rates of return. (a) $\rho = 0.5$, $\sigma_{u\mathrm{HS}} = \sigma_{u\mathrm{C}} = 0.45$, $\gamma_{\mathrm{HS}} = \gamma_{\mathrm{C}} = 0.6$; $\beta_{1,\mathrm{HS}} = \beta_{1,\mathrm{C}} = 0.065$, $\beta_{2,\mathrm{HS}} = \beta_{2,\mathrm{C}} = 0.05$, $\beta_{3,\mathrm{HS}} = \beta_{3,\mathrm{C}} = -0.001$. (b) $\rho = -1$, $\sigma_{u\mathrm{HS}} = \sigma_{u\mathrm{C}} = 0.45$, $\gamma_{\mathrm{HS}} = \gamma_{\mathrm{C}} = 0.6$; $\beta_{1,\mathrm{HS}} = \beta_{1,\mathrm{C}} = 0.065$, $\beta_{2,\mathrm{HS}} = \beta_{2,\mathrm{C}} = 0.05$, $\beta_{3,\mathrm{HS}} = \beta_{3,\mathrm{C}} = -0.001$.

Educational choice

Levhari and Weiss, AER (1974)

Increasing risk (variance pay-off to school time) reduces investment if good states of the world generate higher marginal returns to education.

Hogan and Walker, *Labour economics special* 14 (6), 2007

Option value model: risk up,longer in school

Jacobs, *Labour economics special* 14 (6), 2007

Option value model: risk up, shorter in school

Hartog and Diaz- Serrano (2007) *Journal of Applied Economics* X (1)

$$Y_{st} = \theta_{st} Y_s$$

$$E(\theta_s) = 1$$

$$E\{\theta_s - E(\theta_s)\}^2 = \sigma_s^2$$

θ_s stochastic shock around Y_s single lifetime realisation,

variance dependent on schooling length *s*.
Max lifetime expected utility:

$$W = E \int_s^{\infty} U\{\theta_s Y_s\} e^{-\rho t} dt$$

$$= \frac{1}{\rho} e^{-\rho s} E\left[U(\theta_s Y_s)\right]$$

Solve:

$$\varepsilon_s \left\{ \mu_s - \alpha_s \sigma_s^2 \left(\mu_s + \gamma_s - \frac{1}{2}\rho \right) \right\} - \rho = 0$$

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with

$$\mu_s = \frac{\partial Y_s}{\partial s}\frac{1}{Y_s} \geq 0$$

$$\gamma_s = \frac{\partial \sigma_s}{\partial s}\frac{1}{\sigma_s}$$

$$\alpha_s = \frac{U''(Y_s)}{-U'(Y_s)} Y_s$$

$$\varepsilon_s = \frac{\partial U}{\partial Y_s}\frac{Y_s}{U(Y_s)} > 0$$

$$\left(\mu_s + \gamma_s > \frac{1}{2}\rho\right)$$

increase in risk decreases optimum schooling for risk averters $\left(\alpha_s > 0\right)$

increase in risk increases optimum schooling for risk lovers $\left(\alpha_s > 0\right)$ negative

if risk strongly falls with education : $\left(\gamma_s < \frac{1}{2}\rho - \mu_s\right)$ Conclusion reversed

increase in risk gradient reduces optimum schooling length for risk averters increases it for risk lovers.

Table 7 Probit estimation for demand for higher education with Gambling

	Model 1			Model 2		
	Coef.	M.E.	Z-stat	Coef.	M.E.	Z-stat
Return	0.6919	0.2608	3.45	0.3724	0.1404	2.89
Risk	-0.2234	-0.0842	-2.73	-0.1402	-0.0528	-2.22
Risk*Lottery (1%)	0.2089	0.0787	1.89	0.1267	0.0477	1.45
Return	0.6940	0.2616	3.45	0.3839	0.1448	3.00
Risk	-0.2035	-0.0767	-2.82	-0.1304	-0.0492	-2.38
Risk*Lottery (2%)	0.2532	0.0955	1.96	0.1584	0.0597	1.58
Return	0.6783	0.2557	3.38	0.3760	0.1418	2.91
Risk	-0.1907	-0.0719	-2.64	-0.1261	-0.0475	-2.29
Risk*Lottery (3%)	0.3290	0.1240	2.38	0.2416	0.0911	2.26
Return	0.6738	0.2540	3.36	0.3745	0.1412	2.90
Risk	-0.1830	-0.0690	-2.60	-0.1212	-0.0457	-2.26
Risk*Lottery (4%)	0.3200	0.1206	2.19	0.2424	0.0914	2.15

Notes: Probit estimates include dummies for region and for lottery shares. Simulations are based on the estimated coefficients of model B and D in table 3.

Risk: does it pay-off?

Shaw (1996)

$$W_t = (1 - s_t) k_t$$

observed wage equals value of human capital stock, net of new investment cost

$$k_t = k_{t-1} + \gamma_t s_{t-1} k_{t-1}$$

where γt equals the productivity of the investment,

$$W_{t-1} = (1 - s_{t-1}) k_{t-1}$$

it is straightforward to derive

$$\Delta lnw_t = \gamma_t s_{t-1}$$

$$s = \frac{\mu_h - \eta}{\sigma_h^2 R}$$

$$\Delta \ln w_i = (\beta_0 \text{Riskattitude}_i) X_i A + \gamma' H_i + e_i$$

Table 1 Shaw's original results, SCF 83-86 Ln(hourly wage change 1986-1983)

	Asset		Risk dummies	
	Coef	t	Coef	t
Asset	1.04	2.39		
Risk aversion weak (risk 3)			-0.465	-4.37
Risk aversion strong (risk4)			-0.508	-4.54
Change years tenure	0.032	6.08	0.045	5.08
(Change years tenure)^2	-0.0006	-3.07	-0.0007	-2.23
(Change years experience)^2	-0.0007	-3.49	-0.0007	-4.69
Years of education	0.0071	2.42	-.0068	1.79
Number of Observations				
R^2	0.0559		0.0586	
Sum squared error/sum weights	22.25		22.05	

Source: Shaw (1996), Table 1

Replication (Budria, Ferrer Carbonel, Hartog, EALE Meetings 2008):

US: fair amount of support

Spain: weak support

Germany: no support

Italy: ?

Compensation for risk?

1. A simple formal model

$$\int_0^T U(Y_f)e^{-\rho t}dt = E\int_0^T U(Y_r+\varepsilon)e^{-\rho t}dt \qquad (1)$$

Left-hand side

$$\int_0^T U(Y_f)e^{-\rho t}dt = \frac{1}{\rho}\left(1-e^{-\rho T}\right)U(Y_f) \qquad (2)$$

third-order Taylor expansion

$$\int_0^T U(Y_r+\varepsilon)e^{-\rho t}dt = \frac{1}{\rho}\left(1-e^{-\rho T}\right)\left[U(Y_r)+\frac{1}{2}U''(Y_r)\sigma_p^2+\frac{1}{6}U'''(Y_r)\kappa_p^3\right] \qquad (3)$$

$$\frac{Y_r-Y_f}{Y_r} = -\frac{1}{2}\frac{\sigma_p^2}{Y_r^2}\frac{U''}{U'}Y_r - \frac{1}{6}\frac{\kappa_p^3}{Y_r^3}\frac{U'''}{U''}Y_r\frac{U''}{U'}Y_r = \frac{1}{2}\frac{\sigma_p^2}{Y_r^2}V_r - \frac{1}{6}\frac{\kappa_p^3}{Y_r^3}V_sV_r \qquad (4)$$

2. Empirical specifications

CRRA : $U(Y)=\frac{1}{1-\rho}Y^{1-\rho}$ implying $V_r=\rho$ and $F_r=\rho+1$

Risk Augmented Mincer equation (RAM):

$$E(\ln Y_s)=\ln Y_o+\frac{\delta}{1-\rho}s+\frac{1}{2}\rho\frac{m_{2s}}{\mu_s^2}-\frac{1}{6}\rho(\rho+1)\frac{m_{3s}}{\mu_s^3} \qquad (5)$$

McGoldrick (1995)

$$\ln Y_{ij} = X_i \beta + \sum_j \alpha_j d_j + \varepsilon_{ij} \tag{6}$$

$$R_j^{(1)} = \frac{1}{N_j} \sum_i \left(e_{ij} - \bar{e}_j\right)^2 \qquad K_j^{(1)} = \frac{1}{N_j} \sum_i \left(e_{ij} - \bar{e}_j\right)^3 \tag{7}$$

where e_{ij} is the exponential of the estimated residuals ε_{ij} in equation (6).

$$\ln Y_{ij} = X_i \beta + \gamma_R R_j + \gamma_K K_j + \varepsilon_{ij} \tag{8}$$

Conclusion from 15 studies, 8 countries

Elasticity risk (variance): positive, 0.1 – 0.2

Elasticity skew: negative, -0.1 - 0.0

Survey in Hartog (2007), A Risk Augmented Mincer Earnings Equation? Taking stock

Denmark: alternative measures, panel data 1984-2000

Table 5: Panel estimation of eq. (9) using *R* and *K* of the transitory and permanent shocks

	Model 1	**Model 2**	**Model 3**
Permanent shocks			
Risk (R^p)	0.4216		0.3322
	(29.8)		(17.90)
	0.0495		*0.0390*
Skewness (K^p)	-0.0362		-0.0481
	(-20.73)		(-17.84)
	-0.0078		*-0.0104*
Transitory shocks			
Risk (R^t)		4.6619	1.5727
		(14.55)	(6.00)
		0.1398	*0.0472*
Skewness (K^t)		-0.4023	4.1831
		(-1.65)	(8.74)
		-0.0012	*0.0128*

Note: Estimates include years of education, age, age squared, and dummies for year, 14 industries and 8 occupations. Each cell contains coefficient, t-value in parentheses and elasticity in italics.

Diaz Serrano, Hartog, Nielsen, *Scandinavian Journal of Economics*, forthcoming

Estimating underlying parameters (Hartog and Vijverberg)

i) CRRA, lognormal

$$E(\ln Y_j) = \ln Y_o + \frac{\delta}{1-\rho} s_j + 0.5\rho\sigma_j^2$$

ii) CRRA, non-normal

$$E(\ln Y_j) = \ln Y_o + \frac{\delta}{1-\rho} s_j + \frac{1}{2}\rho\frac{m_{2j}}{\mu_j^2} - \frac{1}{6}\rho(\rho+1)\frac{m_{3j}}{\mu_j^3}$$

iii) TLMU, non normal

$$\Pi_j = -\frac{1}{2}\frac{m_{2j}}{\mu_j^2}(\rho_1 - \rho_2 \ln\mu_j) - \frac{1}{6}\frac{m_{3j}}{\mu_j^3}\{(\rho_1 - \rho_2\ln\mu_j)^2 - \rho_1 - \rho_2 + \rho_2\ln\mu_j\}$$

utility function (10) TLMU $\ln U' = \rho_1 \ln Y - 0.5\rho_2 (\ln Y)^2$

iv) TLMU log-normal

If we assume log-normality, we can write the moments of the earnings distribution as a function of the parameters of the log normal distribution.

$$\frac{m_{2j}}{\mu_j^2} = R_j = e^{\sigma_j^2} - 1$$

$$\frac{m_{3j}}{\mu_j^3} = K_j = e^{3\sigma_j^2} - 3e^{\sigma_j^2} + 2$$

Table 3. Estimated relative risk aversion and relative skewness affection in four models

	Unrestricted TLMU, non-normal		Restricted TLMU, non-normal	
	V_r	F_r	V_r	F_r
men	-1.60	2.63	0.64	1.03
women	-0.81	3.66	0.46	2.18

Ability bias?

only ability differs (individuals know, researcher does not).

observed wage gap is overestimate of the wage premium (risky wage includes ability in risky job.

observed wage variance is overestimate of risk (includes ability variance)

sign of bias cannot be predicted

simulation does not help (but suggests underestimate of risk aversion) individual ability $w_n^r = \overline{w}^r + a_n + \varepsilon$

$\sigma_a^2 \quad \sigma^2$ independent

selection: $\overline{w}^r + a \geq w^s + \frac{1}{2}\rho\sigma^2$

$$\rho = \frac{\overline{w}^r + a_m - w^s}{\frac{1}{2}\sigma^2} \qquad a_m = \text{marginal ability}$$

$$V\left(w^r \mid a > a_m\right) = \sigma^2 + V\left(a \mid a > a_m\right)$$

$$\hat{\rho} = \frac{\overline{w}^r + \mathrm{E}\left(a \mid a > a_m\right) - w^s}{\frac{1}{2}\left[\sigma^2 + V\left(a \mid a > a_m\right)\right]}$$

4.4 Selectivity: What do students know?

Dominitz and Manski (1996), expected benefits from education.

Widely divergent anticipations.
Male high school students, expected median earnings at age 30, bachelor degree:

10th decile expects 25 000 dollars, the 90th decile expects 56 000 dollars.

Own dispersion: interquartile ranges of 28 000 and 58 000 dollars

Perceived returns: 10th percentile expects gain from college of 10 000 dollars,
90th percentile they expect a gain of 30 000 dollars.

Actual dispersion of earnings by education overestimated

Predictions of their own median expected salary correlate positively with their perception of the actual median:

“Respondents who believe current median earnings to be high (low) tend also to expect their own earnings to be high (low)” (o.c., p 25).

Brunello, Lucifora and Winter-Ebmer (2004)

Expected wage premium over high school graduates in ten European countries (business and economics) unrelated to any variable except age: not to parental background, not to channel of information about future earnings (university publication, career center, special reports, press, personal communication), not to reason for choosing their selected university, not to self-assessed relative ability.

Expectations Swiss students, economics, U of Applied Sciences
Dominitz and Manski method
Schweri, Hartog, Wolter (2008)

Figures and Tables

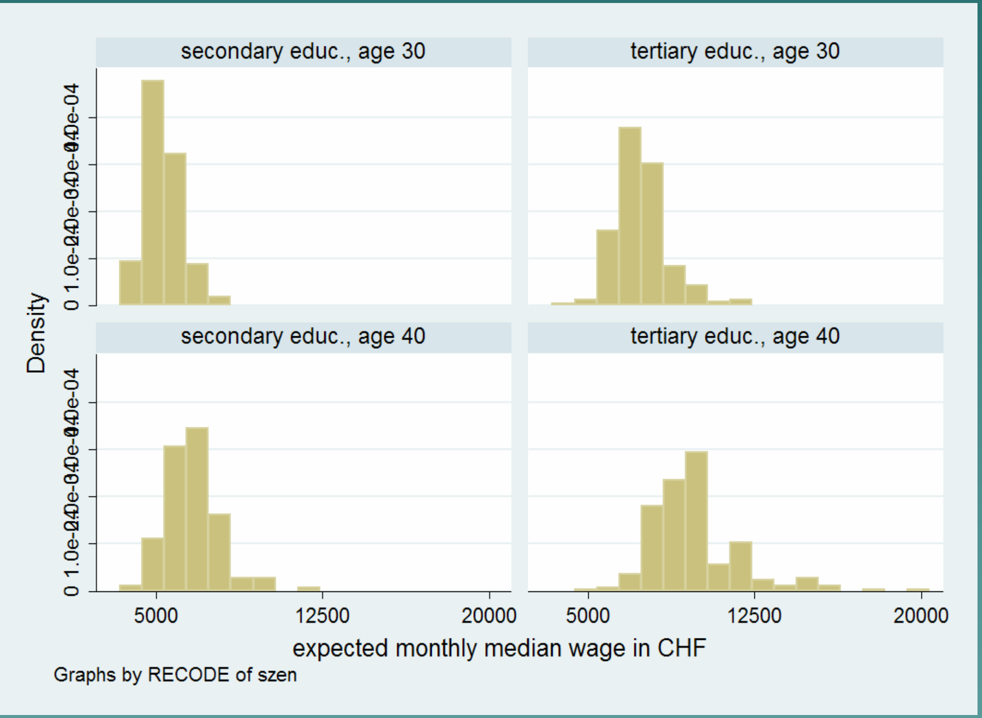

Figure 1: distribution of median of students' expected wage distributions

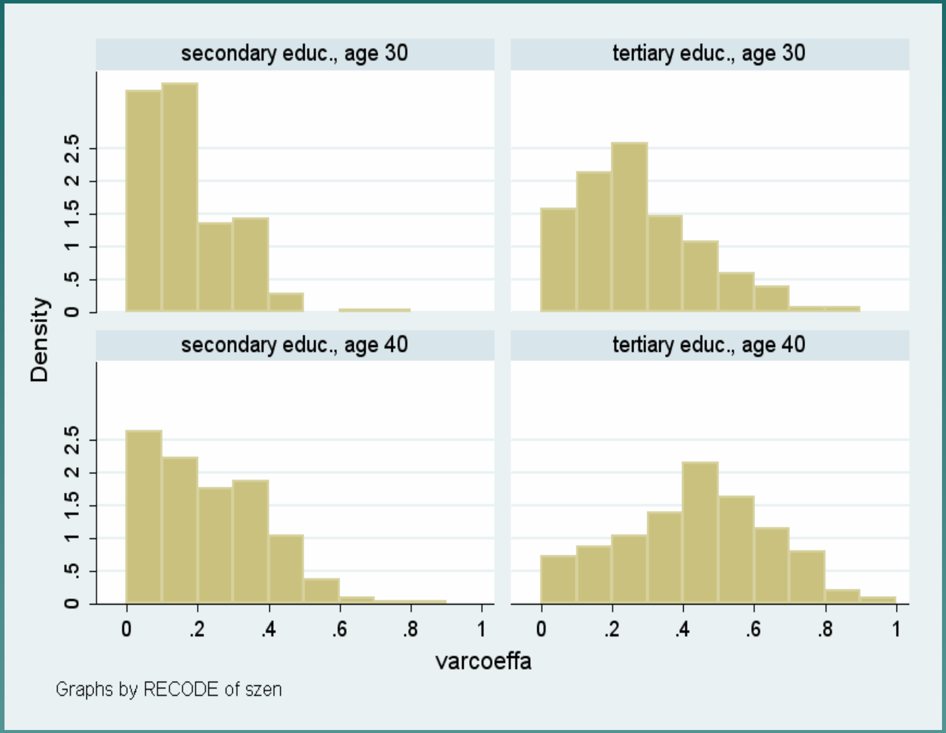

Figure 2: distribution of variance coefficients of students' expected wage distributions

Educational policies: curriculum choice

Woessman: effects of tracking
Brunello: early or late selection? Classification risk versus learning efficiency

Curriculum as portfolio, mean-risk by course:

Hartog and Vijverberg, *Economics of Education Review* (2007)

Curriculum: specialisation or generalisation?

Specific areas	Middle ground	General areas
Agriculture	Art	Language arts
	Health and physical	
Business	Education	Foreign language
Health occupatins	Music	Mathematics
Home economics	ROTC	Science
Industrial arts		Social Studies
Office occupations		Philosopy and religion
Technical education		Study skills
Trade and industry		

Residual variance smaller for specific areas NLSY1979, 20 years, AFQT inclined

A research agenda:

1. How much risk?
   Wages, job quality, unemployment

2. What do students know?
   Heterogeneity, risk, ignorance

3. Is risk relevant or negligible for educational choice?
   - school type
   - curriculum
   - differences M/F, ethnicity

4. How can school/curriculum reduce labour market risk?

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DP 3026: Starting Wages Respond to Employer's Risk, with P. Berkhout

Working paper

A Risk Augmented Mincer Earnings Equation? Taking stock",