Educational Attainment, Field of Study and Labor Market Outcomes

Preliminary and incomplete

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- "Mismatch" is not necessarily bad

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- Rich model in education choices:

  - Closely follow the institutional framework of the Finnish education system

  - Counterfactual policy evaluation e.g. labor market consequences of policies aimed at increasing the number of (STEM) students.

Related literature

- Determinants and labor market consequences of mismatch:

  - Over/undereducation:

    Clark, Joubert and Maurel, 2017; McGuinness, Bergin, Wheelan, 2018; Domnisoru, 2019; Leuven and Oosterbeek, 2011 for a survey.

  - Mismatch between field of study and occupations:

    Kinsler and Pavan, 2015; Liu, Salvanes and Sorensen, 2016; Altonji, Kahn and Speer, 2016; Eckardt, 2021.

- Dynamic models of schooling and occupational choice

  - Keane and Wolpin, 1997, 2001; Lee, 2005; Todd and Zhang, 2020; Arcidiacono, Aucejo, Maurel and Ransom (forthcoming).

- Search models with endogenous schooling/training choices

  - Flinn, Gemici and Laufer, 2017; Shephard and Sidibé, 2019; Bobba, Flabbi and Levy, 2021.

Data

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- 1988-2020 FOLK register data
  - Demographics, level and field of education
  - Employment histories, annual income
  - Annual occupation codes from 2010 to 2020

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  - Annual occupation codes from 2010 to 2020
- Linked Quality of Work Life Surveys (1990, 1997, 2003, 2008, 2013, 2018)
- Education information (Not today)
  - Matriculation exam subjects and scores
  - Secondary school outcomes
  - University courses and GPA

Education system in Finland

- All universities are public and free.

- Those who get into academic-track bachelor's programs are automatically enrolled in master's.

  - 3 years bachelor's $+$ 2 years master's
  - Most ($\sim$ 80%) academic bachelors continue on to master's
  - Those that stop at bachelor's degree are typically in polytechnic/vocational track

- Today: focus on men with master's degrees, born 1965-1990

Definition of mismatch

- Vertical mismatch:
  - Classify each 4-digit occupational code as **MA, BA**, or **HS or below** based on the majority (scaled mode).
  - Scale the number of MA, BA and HS students in each occupation:
    - Master's: 19.68%
    - Bachelor's ($=$ vocational track): 23.6%
    - High school and below: 56.73%

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    - ⋆ Bachelor's (= vocational track): 23.6%
    - ⋆ High school and below: 56.73%

- Horizontal mismatch:
  - ▸ Classify MA occupations as **Liberal arts, Business**, or **STEM** based on the scaled majority.
  - ▸ Scale the number of Liberal arts, Business and STEM students in each MA occupation:
    - ⋆ Liberal arts and education: 22.09%
    - ⋆ Business, law and administration: 20.61 %
    - ⋆ STEM and health: 57.29 %

Majors

Share of majors in various occupations

Education/major:	Occupations			
	BA & below	Liberal arts	Business	STEM
BA & below (%)	**86.29**	1.95	3.46	8.3
Liberal arts MA (%)	17.35	**61.67**	16.01	4.97
Business MA (%)	24.91	7.44	**59.04**	8.62
STEM-H MA (%)	30.56	7.14	10.84	**51.47**

Notes: FOLK data for men, 2010-2018.

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Summary of earnings by major and occupation

| | Occupations | | | |
Education/major:	BA & below	Liberal arts	Business	STEM
BA & below	**24,241**	25,509	50,196	41,027
Liberal arts MA	29,116	**33,001**	60,766	50,501
Business MA	48,770	44,803	**67,510**	68,621
STEM-H MA	45,364	40,203	72,049	**57,110**

Notes: FOLK annual earnings (in 2023 euros) for men, 2010-2018. Each number is the coefficient on the (major, occupation) cell indicator in a regression (without a constant) of annual earnings on potential experience and nationality.

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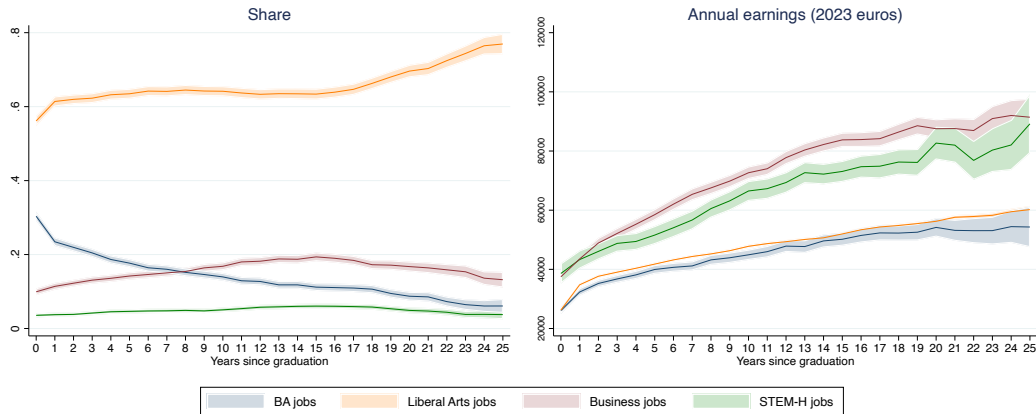
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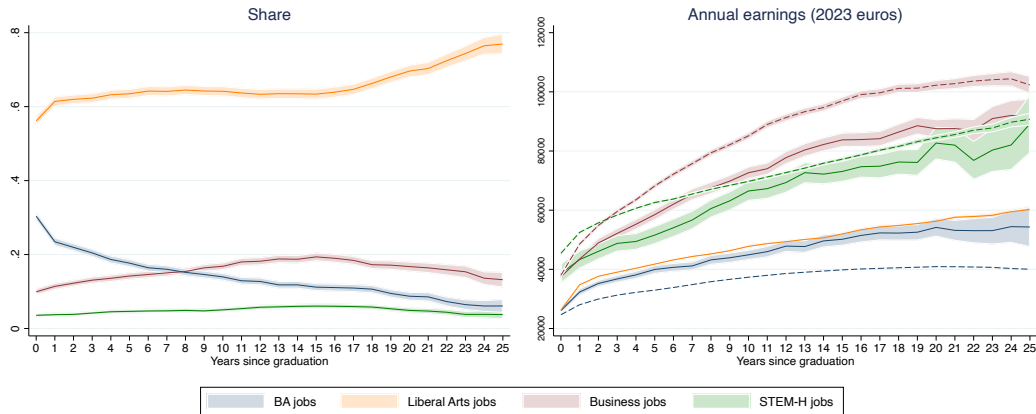
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Share of MA Liberal Arts majors across occupations and their earnings
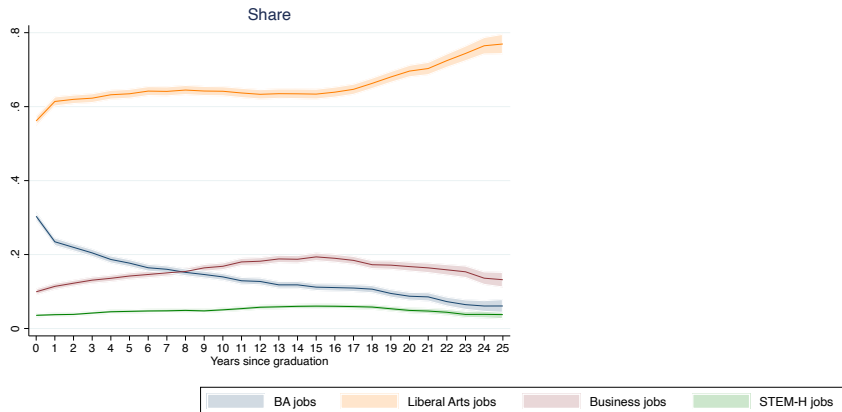
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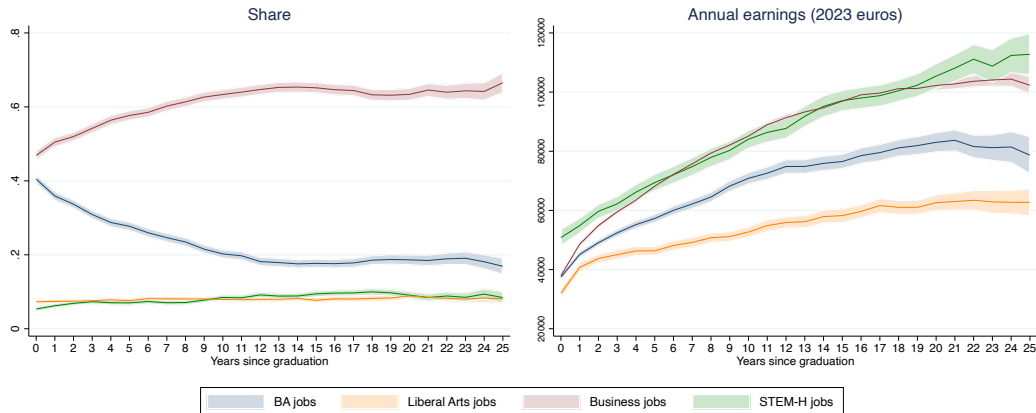
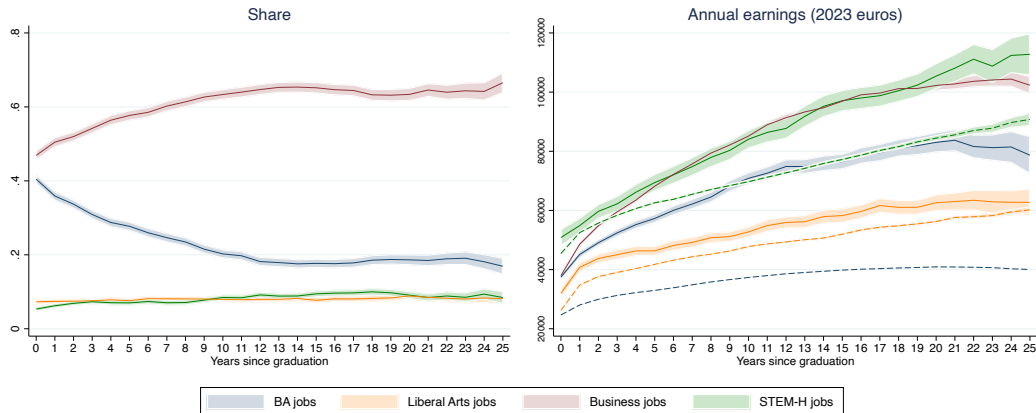# Share of MA Liberal Arts majors across occupations and their earnings

Share of MA Business majors across occupations and their earnings
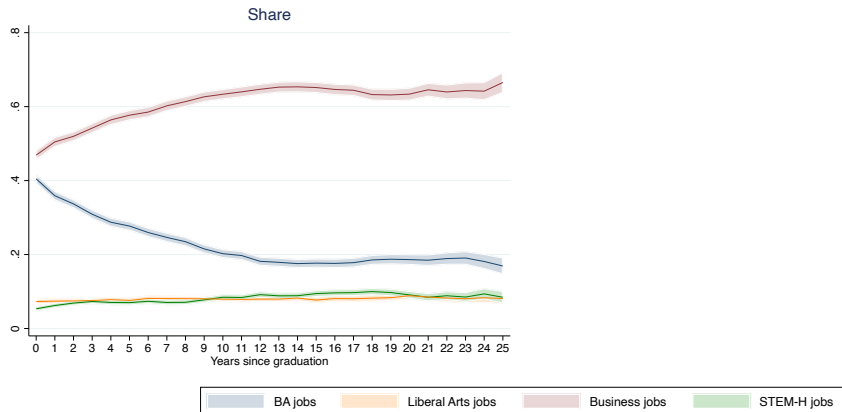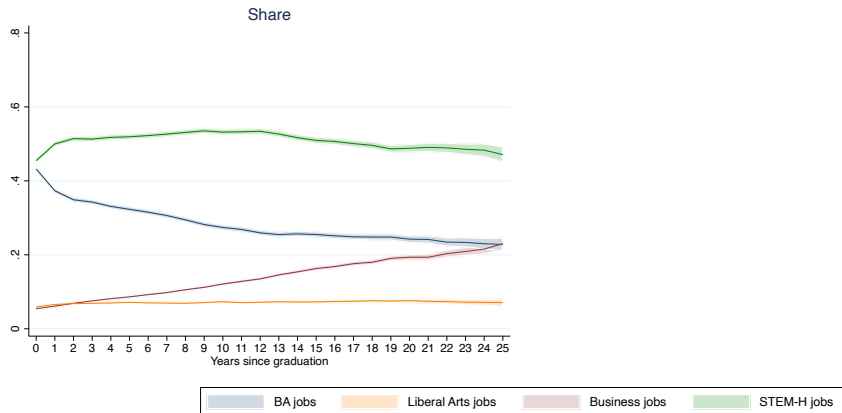
Share of MA Business majors across occupations and their earnings
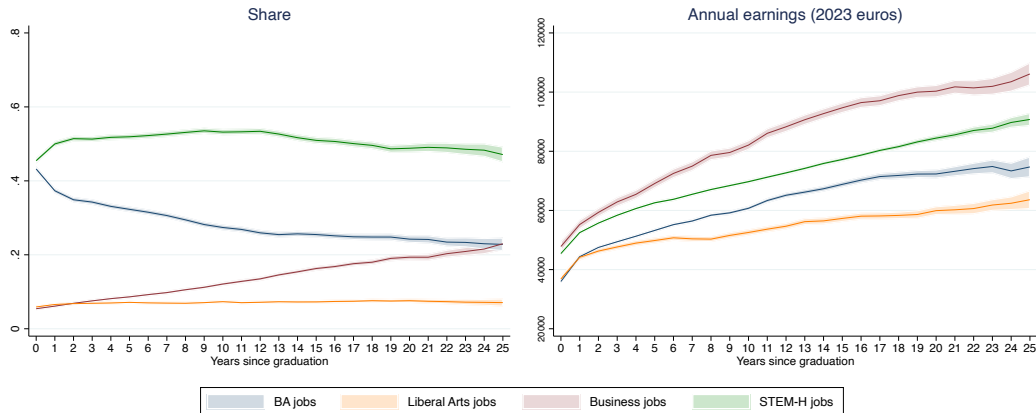
Share of MA Business majors across occupations and their earnings
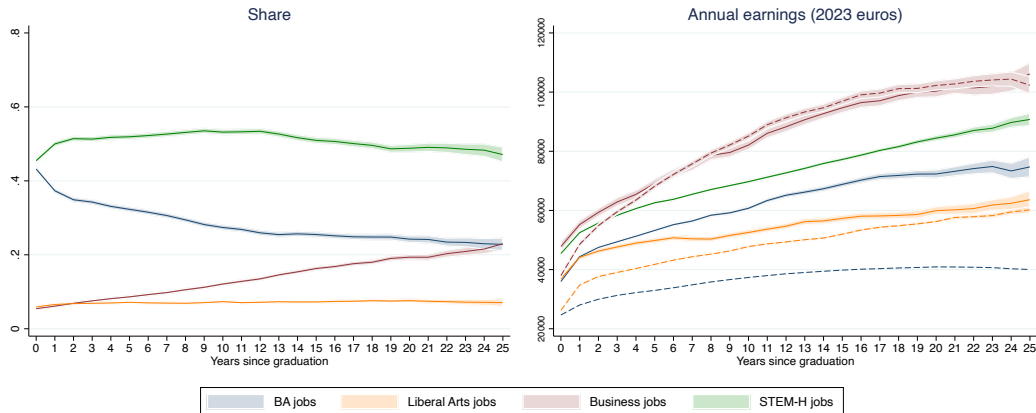
Share of MA STEM majors across occupations and their earnings

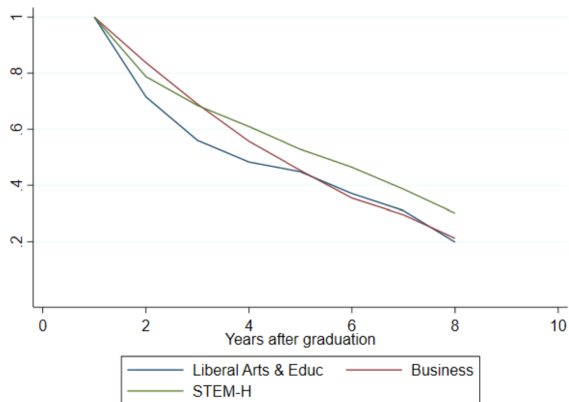# Share of MA STEM majors across occupations and their earnings

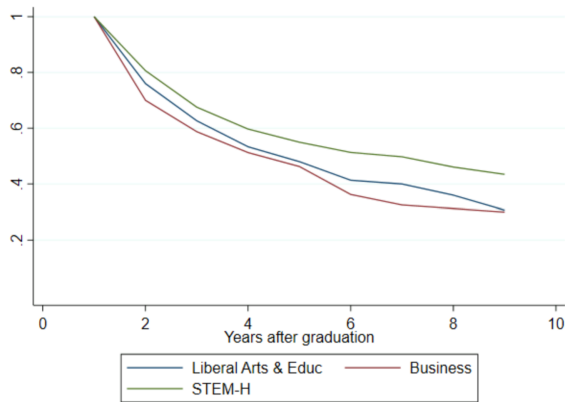# Share of MA STEM majors across occupations and their earnings

Persistence of vertical and horizontal "mismatch"

For 2010 master's who are "mismatched" in year 1, what proportion are still "mismatched" 8 years after graduation?

(A) Vertical

(B) Horizontal

Model

Model summary

- Education and labor market stages

- The labor market stage yields worker value functions, which serve as terminal value functions for the purposes of the education stage.

- Model explains the observed wage mismatch penalties/rewards: search frictions, ability, preferences.

- Human capital dynamics
  - Workers accumulate general and sector-specific HC while employed
  - Workers' multi-dimensional HC is valued differently in different sectors
  - Potential complementarities between workers' HC and job productivity

Model: Labor market stage

The labor market stage is an equilibrium job search model with on-the-job search, wage bargaining and sequential auctions (Cahuc, Postel-Vinay and Robin, 2006).

Worker heterogeneity $\mathbf{x} = (\alpha, h, \mathbf{k})$:

- α, time-invariant worker characteristics (ability and preferences)
- h, education level and field (BA, MA STEM, MA Business, MA Liberal arts)
- $\mathbf{k}$, accumulated experience in dimension $s \in \{\underline{G}\text{eneral}, \underline{S}\text{TEM}, \underline{B}\text{usiness}, \underline{L}\text{iberal arts}\}$

Job heterogeneity $\mathbf{y} = (p, q)$:

- p, job productivity.
- q, occupation sector (or education requirement), with the same categories as h.

Production function

When worker **x** matches with job **y**, they enjoy flow utility:

$$f(\mathbf{x}, \mathbf{y}) + g(\alpha, q)$$

An example of production function technology:

$$f(\boldsymbol{\alpha}, h, \mathbf{k}, p, q) = \ell(\boldsymbol{\alpha}) \times \left[\Gamma(h, q) + \sum_j \gamma(j, q) \; k_j + \rho_1(q) \; k_g \, p + \rho_2(q) \; k_q \, p + \psi \; p \right]$$

- Γ is a matrix of match values that flexibly specifies the relationship between worker's education and job requirements.
- γ is a matrix of the returns to work experience $[k_g, k_s, k_b, k_l]$ in occupation q.
- ρ_1, ρ_2 allow for complementarity between worker's HC and job productivity.
- ψ scales job productivity $p \in [0, 1]$.

This production function can be easily extended to allow for further complementarities.

Value functions

Joint value of a match:

$$(r + \phi + \delta + \eta^e)\, P(\boldsymbol{x}, \boldsymbol{y}) = f(\boldsymbol{x}, \boldsymbol{y}) + g(\alpha, q) + \delta\Big(U(\boldsymbol{x}) + J(\boldsymbol{y})\Big) + \eta^e\, P(\boldsymbol{x}^+, \boldsymbol{y})$$
$$+ \int_{S' > S} \kappa_1\, v(\boldsymbol{y}')\, \sigma\Big(S(\boldsymbol{x}, \boldsymbol{y}') - S(\boldsymbol{x}, \boldsymbol{y})\Big) d\boldsymbol{y}'$$

The worker's value of unemployment:

$$(r + \phi + \eta^u)\, U(\boldsymbol{x}) = b(\boldsymbol{x}) + \int_{S > 0} \kappa_0\, v(\boldsymbol{y})\, \sigma\, S(\boldsymbol{x}, \boldsymbol{y})\, d\boldsymbol{y} + \eta^u\, U(\boldsymbol{x}^+)$$

The value of a vacancy:

$$r\, J(\boldsymbol{y}) = -c(\boldsymbol{y}) + \int_{S > 0} \kappa_0\, u(\boldsymbol{x})\, (1 - \sigma) S(\boldsymbol{x}, \boldsymbol{y})\, d\boldsymbol{x}$$
$$+ \int_{S > S'} \kappa_1\, m(\boldsymbol{x}, \boldsymbol{y}')\, (1 - \sigma)[S(\boldsymbol{x}, \boldsymbol{y}) - S(\boldsymbol{x}, \boldsymbol{y}')]\, d\boldsymbol{x}\, d\boldsymbol{y}'$$

Equilibrium definition

A stationary equilibrium is defined by a tuple of values $\{U(\mathbf{x}), J(\mathbf{y}), S(\mathbf{x}, \mathbf{y})\}$, distributions of vacancies and workers $\{u(\mathbf{x}), v(\mathbf{y}), m(\mathbf{x}, \mathbf{y})\}$, and a total measure of jobs μ such that:

1. Given the distributions of workers and jobs, the equilibrium values satisfy the Bellman equations.

2. Given the transitions implied by the value functions, the distributions are stationary.

3. There is free entry of jobs until the worst job in the economy earns zero profit.

Model: Education stage

- Individuals have multi-dimensional abilities α and other characteristics z.
- They choose an education $j \in \{\varnothing, \text{BA}, \text{MA Stem}, \text{MA Business}, \text{MA Non-stem}\}$ based on expected values of each major and preference shocks.
- Students may not be immediately admitted (admission shocks).
  If not admitted, can re-apply up to T_A times.
- The value function when applying for a university program j at time t is:

$$V_t^j(\alpha, \mathbf{z}) = \text{Admit}_t(j|\alpha, \mathbf{z}) \widetilde{V}_t^j(0, \alpha, \mathbf{z})$$
$$+ \left[1 - \text{Admit}_t(j|\alpha, \mathbf{z})\right] \left((1 - e^{-rt})\frac{\overline{u}(\alpha)}{r} + e^{-r}\overline{V}_{t+1}(\alpha, \mathbf{z})\right)$$

  - $V_t^j(.)$ and $\widetilde{V}_t^j(.)$ are value functions before and after the realization of admission shocks.
  - $\overline{u}(\alpha)$ is the flow utility of the outside option.
  - $\text{Admit}_t(j|\alpha, \mathbf{z})$ is the admit probability.

Model: Education stage

- If an individual is admitted to university, there will be a drop-out probability.

$$\widetilde{V}_t^j(s, \alpha, \mathbf{z}) = \int_t^{t+1} e^{-rt} C^j(\alpha, \mathbf{z}) dt$$
$$+ e^{-r} \left[\text{Drop}_t(j|\alpha, \mathbf{z}) U(\alpha, h(s,j), \underline{\mathbf{k}}) + (1 - \text{Drop}_t(j|\alpha, \mathbf{z})) \widetilde{V}_t^j(s+1, \alpha, \mathbf{z}) \right]$$

   ▸ s keeps track of degree duration
   ▸ $C^j(.)$ is the utility cost/benefits while enrolled in a program

- When the individual drops out at $s < 3$, they enter the labour market without BA degree.

- If the individual is in an MA program and drops out after 3 years, they will enter the labour market with a BA.

- Given the worker value functions from the labor market stage, solve the initial education problem using backward induction.

Estimation

Production Function Parameters

Recall production function:

$$f(\boldsymbol{\alpha}, h, \boldsymbol{k}, p, q) = \ell(\boldsymbol{\alpha}) \times \left[\Gamma(h, q) + \sum_j \gamma(j, q) \ k_j + \psi \ p + \rho_1(q) \ k_g \ p + \rho_2(q) \ k_q \ p \right]$$

We estimate a restricted set of parameters in a preliminary round of estimation:

Γ 4×4 parameters where $\Gamma(h, q)$ is the flow value of production of major h in occupation q

γ 4×4 parameters where $\gamma(j, q)$ is the occupation q-specific returns to work experience k_j, $j \in \{g, s, b, l\}$

ψ Scalar on job productivity

ρ_1 4 parameters: complementarity between general HC and job productivity in $q = \{BA, \text{Liberal Arts, Business, STEM}\}$

ρ_2 3 parameters: complementarity between q-specific HC and job productivity in $q = \{\text{Liberal Arts, Business, STEM}\}$

Estimation – simplified version

- Estimated parameters:

Ω	Production function parameters $\Omega = \{\Gamma, \gamma, \psi, \boldsymbol{\rho}\}$
δ	Job destruction rate
κ_0, κ_1	Job arrival rates in unemployment and employment
$\boldsymbol{\xi}$	Measure of jobs in each sector q: ξ_q

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- Targeted moments:

  ▶ The share of each major in the four occupations in 5-year windows

  ▶ The earnings of each major in the four occupations in 5-year windows

  ▶ One-year transition rates between the four occupations and unemployment (averages in 5-year windows)

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- Estimate by Simulated Method of Moments:
  - Weighting: identify matrix (for now)

Parameter estimates (Preliminary)

Parameters		Estimates			
		Occupation sectors			
		$\leq$ BA	STEM	Business	Lib. Arts
	Majors				
Match values	BA	15.0	8.4	2.0	2.0
Γ	ST	20.2	28.2	15.0	14.5
	BU	21.3	20.2	31.0	16.3
	LA	10.8	6.9	11.7	15.4

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	HC				
Returns to experience	General	1.1	0.7	10.0	3.9
γ	ST exper	21.6	1.1	34.3	1.8
	BU exper	38.2	43.4	11.4	13.2
	LA exper	0.0	4.3	0.2	7.6
Complementarity with p	General	0.1	25.6	3.8	4.5
ρ	q-specific		10.9	40.3	0.0

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Model fit: Sorting patterns (Preliminary)
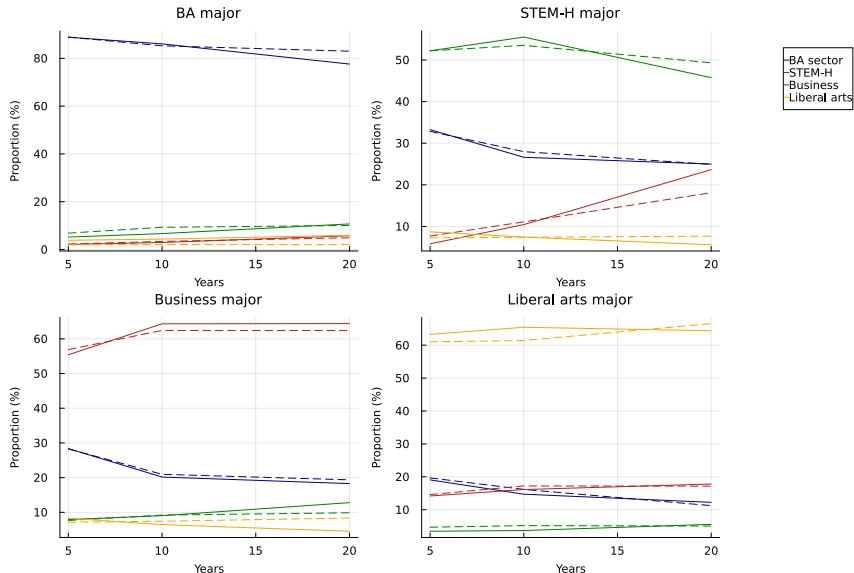
Solid lines = model; dotted lines = data

Model fit: Earnings profiles (Preliminary)
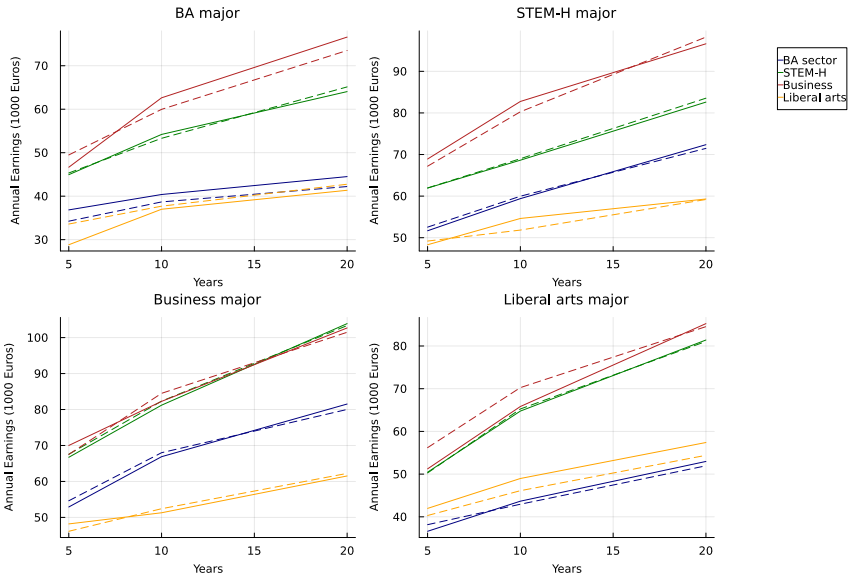
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Conclusions / next steps

- Descriptive patterns indicate significant earnings implications of working in different occupations; these implications differ across majors.

- There are transitory and persistent components of "mismatch"; important to quantify the role of frictions vs. other channels.

- Model allows us to study various policy counterfactuals

  ▶ Decompose the 3 channels of "mismatch"

  ▶ Returns to education (Oaxaca-Blinder): frictions/match probabilities vs. wages conditional on getting into an occupation

  ▶ General vs. specific human capital in different career tracks

  ▶ Effects of degree/program quotas

  ▶ Tradeoffs between unemployment and employed in mismatched jobs

  ▶ Effects of business cycles

Appendix

Fields of study in MA degrees

Field of study	% of total	Liberal arts and education	Business, Law and Administration	STEM-H
Education	12.94	X		
Arts	15.50	X		
Social sciences	11.18	X		
Business[a]	17.37		X	
Nat sciences, math	6.73			X
ICT	6.87			X
Engineering	16.76			X
Agriculture	2.25			X
Health	8.83			X
Services	1.37		X	
Missing field	0.19			
Total		39.62	18.74	41.44

Notes: FOLK data, 2010-2018. a) Economics included in Business field.

Back

Detailed fields of study in each education category

BA majors	STEM-H majors
Interdiscipl. studies in business & administration	Interdiscipl. studies in ICTs
Interdiscipl. studies in ICTs	Electricity and energy
Mechanics and metal trades	Mechanics and metal trades
Building and civil engineering	Interdiscipl. studies in engineering & engineering trades
Electricity and energy	Medicine
Electronics and automation	Building and civil engineering
Nursing and midwifery	Chemical engineering and processes
Interdiscipl. studies in engineering & engineering trades	Electronics and automation
Motor vehicles, ships and aircraft	Architecture and town planning
Forestry	Mathematics
Business majors	**Liberal Arts majors**
Interdiscipl. studies in business & administration	Teacher training without subject specialization
Law	Political sciences and civics
Economics	Interdiscipl. studies in social & behavioural sciences
Sports	Music and performing arts
Hotel, restaurants and catering	Language acquisition
Protection of persons and property	Sociology and cultural studies
Broad studies in business & administration	Religion and theology
Travel, tourism and leisure	Interdiscipl. studies in arts
Transport services	Teacher training with subject specialization
Broad studies in personal services	Literature and linguistics

Top 10 occupations in each occupation sector

BA sector	STEM-H sector
Commercial sales rep.	Software developers
Mechanical engineers	System analysts
Mechanical engineering technicians	Electrical engineers
Physical and engineering science technicians n.e.c.	Electronics engineers
Civil engineers	Manufacturing managers
ICT user support technicians	Engineering professionals n.e.c.
Civil engineering technicians	Telecommunications engineers
Technical and medical sales prof. (excluding. ICT)	ICT service managers
Construction managers	Software and app. developers and analysts n.e.c.
Social work assoc. professionals	Specialist medical practitioners
Business sector	**Liberal Arts sector**
Advertising and marketing professionals	Secondary education teachers
Accountants	Primary school teachers
Management and organization analysts	Vocational education teachers
Policy administration professionals	University and higher education teachers
Sales and marketing managers	Journalists
Lawyers	Teaching professionals n.e.c.
Financial and investment advisors	Education methods specialists
Business services and administration managers n.e.c.	Education managers
Financial managers	Special needs teachers
Managing directors and chief executives	Social work and counselling professionals

International comparison-field of study mismatch-OECD
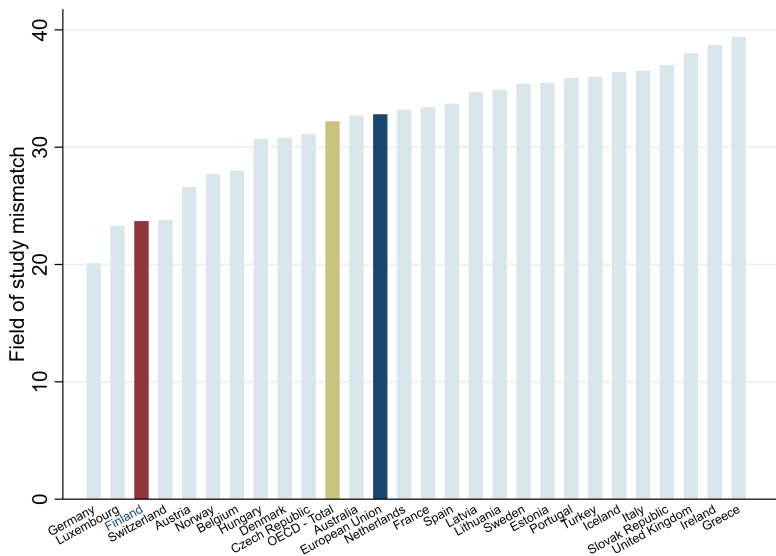
Summary of mismatch measures

	All	Men	Women	Private sector
Overeducation	30.21	31.33	29.40	45.66
Field of study mismatch	27.39	29.89	25.63	29.91
Field of study mismatch (OECD)	33.10	34.55	32.05	35.87
N^a	2,436,118	1,022,670	1,413,445	1,196,319

Notes: [a]Mismatch indicator defined only for individuals who are not overeducated.

Occupational mobility in $t+1$ if vertical/horiz. mismatched in t (SES)

	Non-STEM	Business	STEM
Mismatch	0.054	0.071	0.055
	(23.35)	(22.12)	(28.64)
Overeducation	0.197	0.150	0.089
	(86.21)	(52.76)	(51.78)
N	754783	289469	654127

t-statistics in parentheses. All regressions include quadratic controls for potential experience and individual FEs.

Share of MA Liberal Arts majors and their earnings (Women)
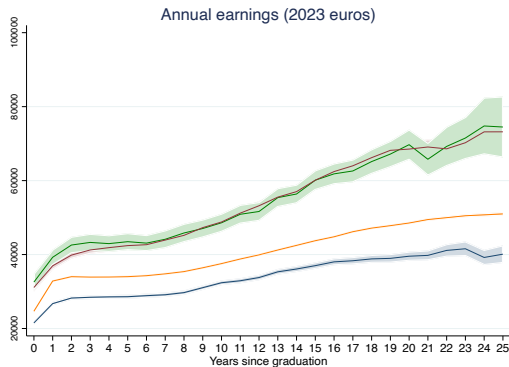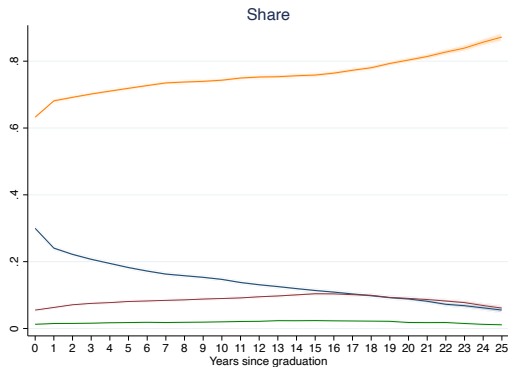
Matching

- The meeting rate between workers and jobs depend on aggregate labor market tightness

$$\kappa_0 = \frac{m(\hat{U}, V)}{\hat{U} V}$$

  - $\hat{U}$ and V are the number of effective job seekers and total number of vacancies
  - $\hat{U} = U + s(1 - U)$ takes the sum of unemployed and employed workers weighted by their relative search intensity s
  - $m(\hat{U}, V)$ is a standard aggregate matching function

- The total number of vacancies are determined by the free-entry condition, where the least productive job in the economy has a vacancy value of zero:

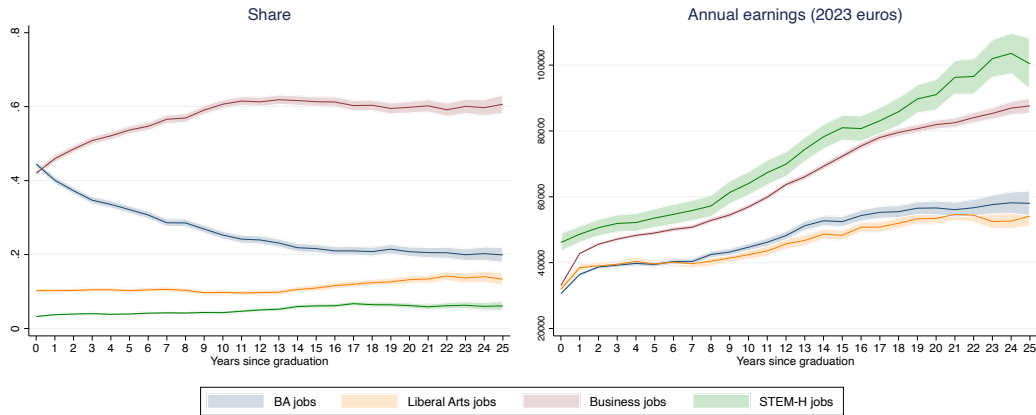$$\min \ J(\mathbf{y}) = 0$$

Notes on identification

Γ	The levels of earnings in each (major, occupation) cell
	Distribution of workers across (major, occupation) cells
γ	Returns to 4-dimensional HC in different sectors
	Sorting patterns across (major, occupation) cells as HC increases
$\boldsymbol{\rho}$	Wage change from JTJ transitions within a sector
	Sorting patterns across (major, occupation) cells as HC increases
$\delta,\ \kappa_0,\ \kappa_1$	Transition rates between sectors
	E-to-U and U-to-E rates

Back
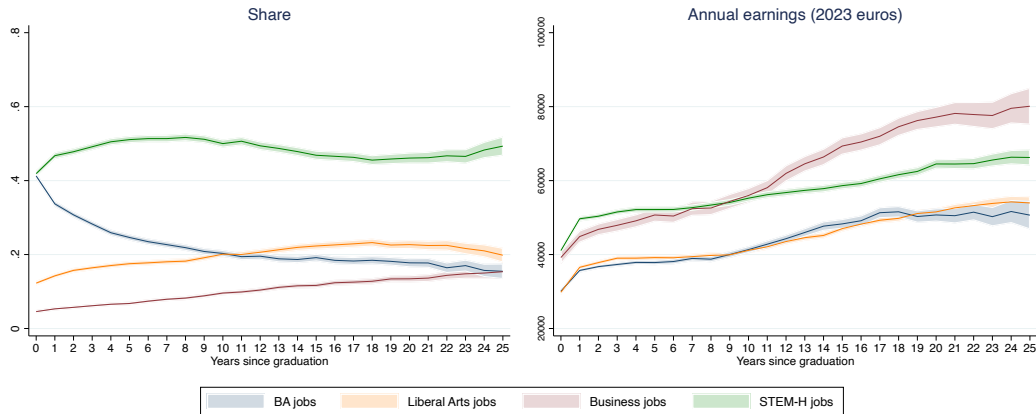
Model fit: Transition rates across sectors (Preliminary)
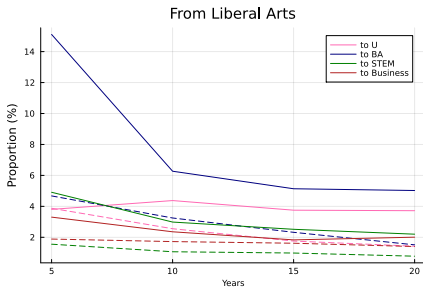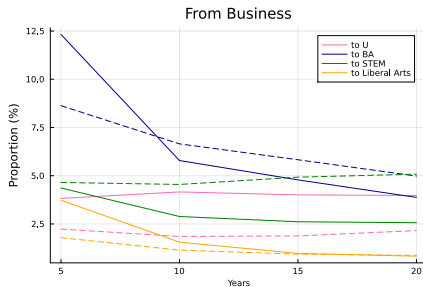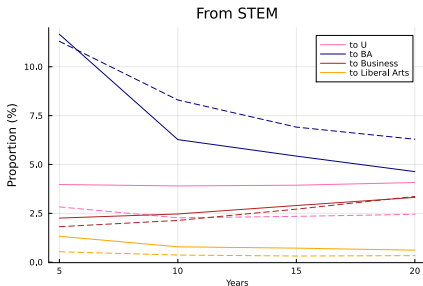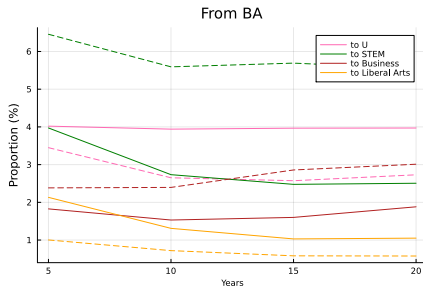
Solid lines = model; dotted lines = data
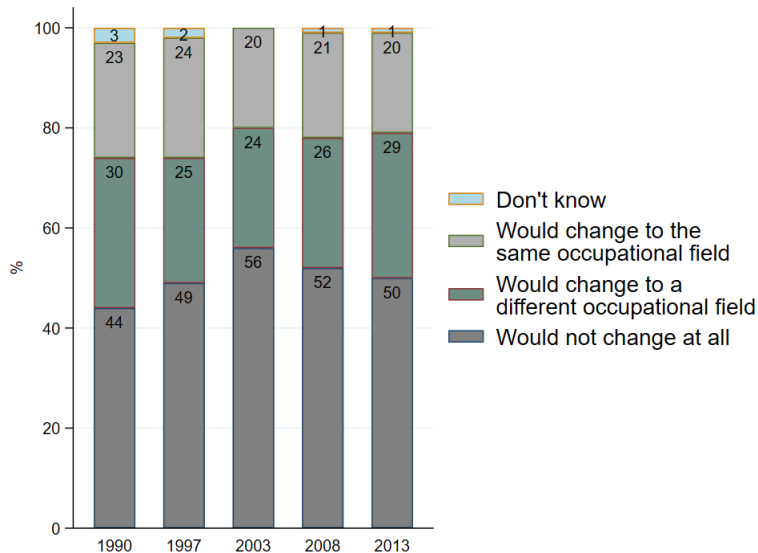
Share of MA Business majors and their earnings (Women)

Share of MA STEM majors and their earnings (Women)

Share

Annual earnings (2023 euros)

BA jobs   Liberal Arts jobs   Business jobs   STEM-H jobs

Quality of Work Life survey

"Willingness to change to another job, at the same pay"

Quality of Work Life survey

	Would change job, same pay, different field	Lower job satisfaction	Current tasks undemanding
Overeducated	0.067	0.097	0.058
	(1.97)	(2.81)	(2.21)
Mismatched (field of study)	0.088	0.013	0.029
	(3.10)	(0.65)	(1.06)
Mean of dep. var	0.241	0.099	0.303
N	1199	1200	1416

t statistics in parentheses. Regressions include controls for a quadratic in age, nationality, gender and year fixed effects.