Is There a Devaluation of Degrees?
Unobserved Heterogeneity in Returns to Education and Early Experience

Damiano Argan [*] Robert Gary-Bobo [†] Marion Gousse' [‡]

[*] *European University Institute & LUISS*

[†] *Paris I Pantheon Sorbonne*

[‡] *CREST-ENSAI*

August 29, 2024

Motivation: Comparing return on education in times of tertiary education expansion

- In EU: tertiary education in age group 24-55 **36%** v.s. **21%** in 55-74 age group
- In France: share of Master 2 (M2) graduate doubled between 1998 (**5%**) and 2010 (**10%**)
- Over time the composition of graduates changes

Goal: Compute ATE of education for each cohort

- Allows to asses if there is a change in the return in education over time
- Assess whether selection changed over time

How: Assume that unobserved heterogeneity can be modelled with a system of latent types and estimate a finite mixture model

Preview of Results

- Not computing ATE of education can lead to misleading evaluation of changes in return to education over time
- Selection matters and changes over time
- Return on education are heterogeneous
- The expected real wages commanded by Master degrees in France decreased in the period 2010-2017 compared to 1998-2005
- Student selection improved in spite of the fact the number of graduates increased substantially

Related literature

- **Return to education over time:** US return in education 1820-2020 (Goldin and Katz, 2010 and 2020), **among many many others**

- **Selection and return to education:** ↑enrollment, ↓ quality, ↓ college premium *1960-2000 US* (Carneiro and Lee, 2011), ↑ access, ↓ income of incumbent (Bianchi, 2020), US selection into college between 1979 and 2000 cohort declined (Belzil and Hansen 2020)

Road Map

- Data Description
- Real wage and offer of graduates between 1998-2010
- The model and estimation method
- The latent types and the policy relevant parameters
- Results
- Conclusion

Data Description

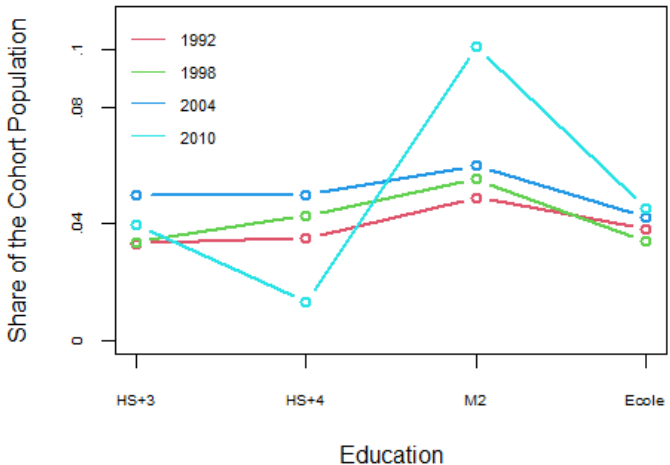
- Unbalanced panel of three cohorts of male youngsters entering the labor market in 1998 (7383 ind.), 2004 (5500 ind.) and 2010 (3521 ind.) followed for 7 years (CEREQ data)
  - Criteria: individual exiting education and not re-entering for the survey period
- Variables: social background, education, employment, full time real wages
- Employment rate and wages are observed at the beginning and the end of every employment spell and at the 3rd, 5th and 7th year (av. 11 obs. per ind.)

▸ Destat

Real Wages of highly educated across cohorts

	HS+3 log(wage)	HS+4 log(wage)	**M2 log(wage)**	Business school log(wage)	Engeniring school log(wage)
Men × 2004	−0.103***	−0.0802***	**-0.0752*****	0.0439	−0.0962***
	(0.0168)	(0.0128)	(0.0160)	(0.0400)	(0.0147)
Men × 2010	-0.0329	-0.0288	**-0.0758*****	-0.0581	−0.0872***
	(0.0215)	(0.0232)	(0.0154)	(0.0360)	(0.0160)
Women × 2004	0.0735***	-0.0158	**-0.0798*****	-0.0488	−0.110***
	(0.00994)	(0.00980)	(0.0140)	(0.0396)	(0.0238)
Women × 2010	0.0622***	0.0462**	**-0.0711*****	−0.126***	−0.121***
	(0.0127)	(0.0166)	(0.0143)	(0.0380)	(0.0257)
Constant	7.438***	7.491***	7.697***	7.791***	7.848***
	(0.0146)	(0.0101)	(0.0126)	(0.0309)	(0.0109)
Observations	1,493	1,836	2,373	414	1,122

Evolution of the Offer of Graduates by Cohort



Variables

Call:

- $c_i \in \{1998, 2004, 2010\}$: cohort
- $h_i \in$ {Less than High-School, HS, Some College, M2, Ecole}: education level
- $X_i \in$ {Father professional, Urban , Peri-Urban, Rural}: social background
- $e_{it} \in \{0, 0.3, 0.5, 0.6, 0.8, 1\}$: employment rate at t
- Γ_{it}: experience accumulated at time t
- w_{it}: log real full time wage at time t
- u_{it}: aggregate quaterly unemployment at time t
- k: latent type

- Education choice as a function of X_i and c_i $\rightarrow$ **Multinomial Logit** $\Lambda_k(h_i|X_i, c_i)$
- Employment choice at t as a function of $h_i \times c_i$, $\Gamma_{it} \times c_i$, X_i, and u_{it} $\rightarrow$ **Ordered Probit** $P_k(e_{it}|X_i, c_i, h_i, \Gamma_{it}, u_{it})$
- Log real full time wages at t as a function of $h_i \times c_i$, $\Gamma_{it} \times c_i \times h_i$, X_i and u_{it} $\rightarrow$ **Linear Regression** $f_k(e_{it}|X_i, c_i, h_i, \Gamma_{it}, u_{it})$

Every variable is interacted with a latent type k: every latent type has its own model

The contribution to the likelihood of ik :

$$L_{ik} = L_{ik}(y_i|.) = \prod_{t \in T} f_k(e_{it}|X_i, c_i, h_i, \Gamma_{it}, u_{it}) \prod_{t \in T} P_k(e_{it}|X_i, c_i, h_i, \Gamma_{it}, u_{it}) \Lambda_k(h_i|X_i, c_i)$$

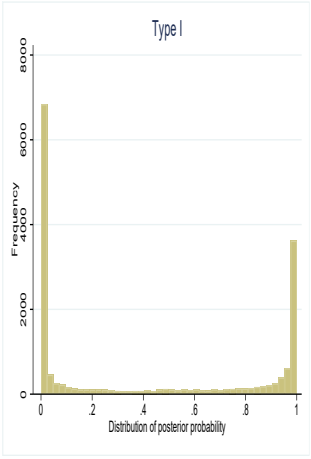
- $L_i(y_i|X_i) = \sum_{k=1}^{K} p_k L_{ik}$, $L = \prod_{i=1}^{N} L_i$ and $lnL = \sum_{i=1}^{N} ln \sum_{k=1}^{K} p_k L_{ik}$

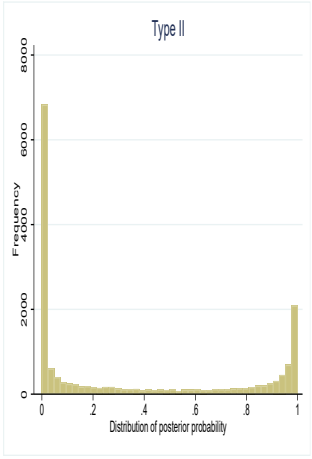
A priori and a posteriori probability

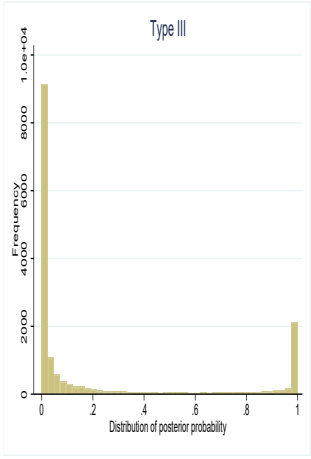
- $\hat{p}_k$ are estimated parameter
- $\hat{p}_k$ are called a *priori* probability and they are the share of type k in the population
- We can compute *a posteriori* probability p_{ik} that this the probability i is of type k, using Bayes rule:

$$p_{ik} = \frac{p_k L_{ik}}{\sum_{j=1}^{k} p_j L_{ij}}$$

A posteriori probability of type







▸ Sel. Criteria ▸ type content ▸ type and grade

Probability of type in the population and by cohort

Table: Distribution of types by cohort

cohort	type		
	I	II	III
all	0.42	0.36	0.22
s.e.	(.006)	(.006)	-
1998	0.40	0.36	0.23
2004	0.42	0.37	0.21
2010	0.45	0.33	0.22

Who are the types I, II and III

- Type I: smaller returns to experience, smaller returns to education than other types and study less than other types. Type with a smaller ability.
- Type II: median position in terms of returns to education and experience, and highest employment rate. Type 2 have a good level of ability and find stable jobs.
- Type III: is the 'top type' characterized by markedly higher returns to experience and the highest returns to degrees. They have a much smaller employment rate than 2.

▸ return to educ ▸ return to exp ▸ employment ▸ educaction attainments

Policy Relevant Parameters: ATE and ATT

- Call $y_t(h)$ any outcome
- To compute ATT we assume that for any h and h$'$, E$[y_t(h)|h', k]$= E$[y_t(h)|h]$
- We assume (*conditional independence assumption*) that: ATT(h,k,t) = ATE(h,k,t)
- Define the average treatment effect conditional on type k: ATE(h,k,t)=E$[y_t(h)|k]$-E$[y_t(0)|k]$
- With, $\hat{E}[y_t(h)|k] = \frac{\sum_{i|h_j=h} \hat{p}_{ik} y_{it}}{\sum_{i|h_i=h} \hat{p}_{ik}}$
- The (unconditional) average treatment effect at time t: ATE(h,t)=$\sum_k p_k ATE(h,k,t)$
- ATT(h,t)= $\sum_k p(k|h)$ATE(h,k,t)

Changes in ATE of education over time

ATE(h) by cohort			
	1998	2004	2010
Less than HS (Ref)	-	-	-
High School	12,1%	15,0%	19,7%
Some college	33,1%	35,4%	53,2%%
Master 2	105%	71,6%	75,1 %
Ecole	102,5%	93,9%	171%
ATT(h) by cohort			
Less than HS (Ref)	-	-	-
High School	12,7%	13,6%	19,8%
Some college	35,9%	42,2%	62,2%
Master 2	95,4%	89,8%	104,4 %
Ecole	119,2%	119,4%	169%

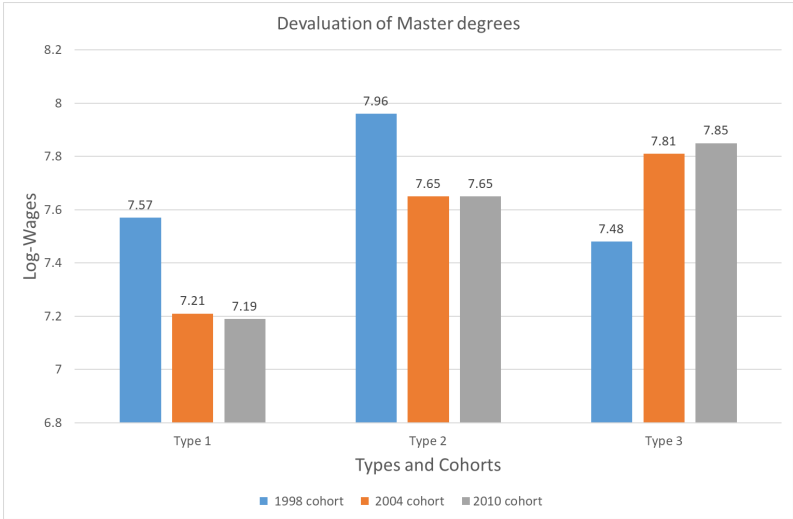
Table: ATE(h) by cohort

▸ Av. earnings by type, cohort, educ

Selection Matters and Changes

Cohort	Education	ATT	ATE	Selection: $\frac{ATT-ATE}{ATT}$
1998	Less than HS	813	824	-1,3%
1998	HS	916	924	-0,8%
1998	Some col	1105	1097	0,01%
1998	M2	1589	1689	-6,3%
1998	Ecole	1782	1669	6,3%
2004	Less than HS	806	831	-3,0 %
2004	HS	932	956	-2,6%
2004	Some col	1146	1125	1,9%
2004	M2	1530	1426	6,8%
2004	Ecole	1769	1611	8,9%
2010	Less than HS	691	720	-4,3%
2010	HS	828	862	-4,1%
2010	Some col	1121	1103	1,5%
2010	M2	1414	1261	10,8%
2010	Ecole	1862	1954	-4,9%

Heterogeneity in the devaluation of Master 2 at experience 0



▸ Return in experience ▸ Field choice ▸ Sector choice ▸ Firm dimension ▸ Employment spell

Conclusion

- Not taking into account changes in selection across education over time can lead to mistakes in assessing the evolution of return to education
- ATE of education for M2 in France decreased by 30 p.p. in the period 1998-2010 while the offer increased by almost 100%
- Selection matters and changes over time
- Returns on education are heterogeneous
- Changes in return to education over time can mask winners and losers

Descriptive statistics: occupation and full time wages

return

Cohort	Education	Individuals	obs.	Average occupation	Average FT real salary
1998	Less than HS	3026	35285	0.65	7.16
	HS	1815	19216	0.64	7.23
	Some coll	2038	20902	0.64	7.39
	M2	203	1826	0.64	7.72
	School Grads	301	2777	0.69	7.85
	All	7383	80006	0.65	7.28
2004	Less than HS	1601	20475	0.61	7.23
	HS	1406	16038	0.65	7.27
	Some coll	1628	16580	0.68	7.39
	M2	470	4363	0.70	7.65
	School Grads	395	3461	0.73	7.80
	All	5500	60917	0.65	7.36
2010	Less than HS	870	10855	0.50	7.22
	HS	917	10538	0.58	7.27
	Some coll	964	9554	0.65	7.40
	M2	419	3869	0.67	7.62
	School Grads	351	2673	0.76	7.78
	All	3521	37489	0.60	7.39

Descriptive statistics: Social Background

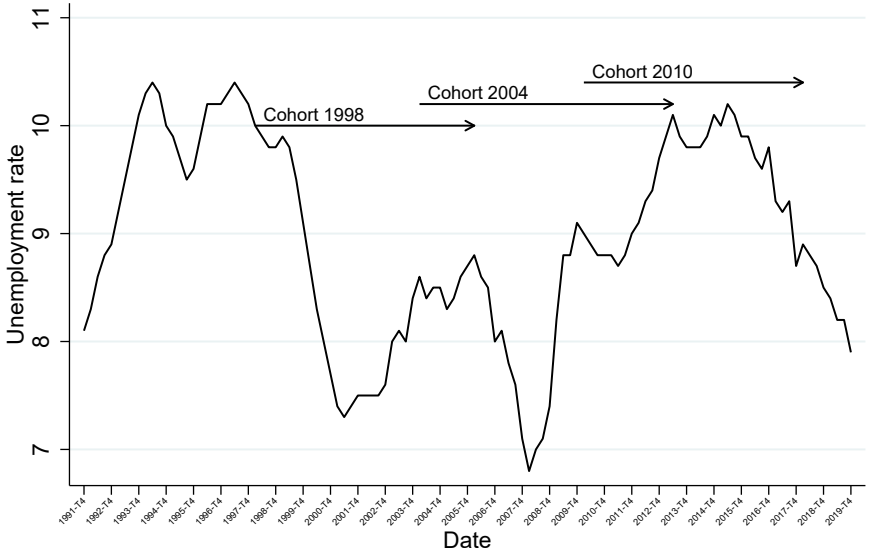
Cohort	Education	Father professional	Urban	Peri Urban	Rural
1998	Less than HS	0.07	0.47	0.20	0.33
	HS	0.15	0.49	0.19	0.32
	Some coll	0.23	0.56	0.19	0.25
	M2	0.39	0.67	0.13	0.20
	School Grads	0.54	0.71	0.12	0.17
	All	0.16	0.51	0.19	0.30
2004	Less than HS	0.10	0.46	0.20	0.33
	HS	0.19	0.46	0.22	0.32
	Some coll	0.30	0.54	0.19	0.27
	M2	0.46	0.60	0.15	0.24
	School Grads	0.49	0.57	0.2	0.23
	All	0.24	0.50	0.20	0.30
2010	Less than HS	0.11	0.57	0.22	0.21
	HS	0.22	0.62	0.20	0.19
	Some coll	0.30	0.60	0.21	0.19
	M2	0.45	0.68	0.17	0.15
	School Grads	0.50	0.66	0.19	0.16
	All	0.27	0.61	0.20	0.18

Descriptive statistics: Employment

Cohort	Education	Unemployed	0.3	0.5	0.6	0.8	FT
1998	Less than HS	0.33	0.006	0.02	0.006	0.01	0.62
	HS	0.34	0.006	0.02	0.007	0.02	0.62
	Some coll	0.34	0.007	0.01	0.007	0.01	0.62
	M2	0.35	0.004	0.007	0	0.01	0.63
	School Grads	0.31	0.003	0.001	0	0.005	0.68
	All	0.34	0.006	0.02	0.006	0.014	0.62
2004	Less than HS	0.37	0.006	0.02	0.01	0.01	0.58
	HS	0.33	0.01	0.02	0.02	0.01	0.61
	Some coll	0.30	0.01	0.02	0.01	0.01	0.65
	M2	0.28	0.01	.01	0.01	0.006	0.68
	School Grads	0.26	0.003	0.005	0.002	0.005	0.72
	All	0.33	0.01	0.02	0.01	0.01	0.62
2010	Less than HS	0.46	0.02	0.03	0.02	0.02	0.46
	HS	0.39	0.02	0.02	0.02	0.01	0.53
	Some coll	0.32	0.01	0.02	0.01	0.01	0.62
	M2	0.31	0.01	0.01	0.008	0.02	0.64
	School Grads	0.23	0.004	0.004	0.002	0.002	0.76
	All	0.37	0.01	0.02	0.02	0.01	0.56

Unemployment dynamics over time

return



Selection Criteria: Number of Types

return

types	formula	I	II	III	IV
# par(k)		85	158	231	304
loglik: L(K)	$\sum_n ln(\sum_k p_k \times f_{ik})$	-167,263	-150,893	-143,745	-141,210
L(K)-L(I)		0	16,370	23,517	26,053
Reg Adj R2		.4020	.5630	.5851	.6350
AIC	$2 \times pa - 2 \times ln(L)$	334,696	302,102	287,952	283.028
BIC	$pa \times ln(N) - 2 \times ln(L)$	335,351	303,319	289,732	285,370
Average Herfindal	$\frac{1}{N} \sum_n \sum_k (p_{ik})^2$	-	0.89	0.84	0.79
Entropie: Ent(K)	$-\sum_n \sum_k p_{ik} ln(p_{ik})$	-	2825	4391	6160
ε	$\frac{Ent(K)}{Nln(K)}$	-	0.248	0.244	0.271
NEC	$\frac{E(K)}{(L(K)-L(1))}$	-	0.172	0.186	0.236

Elastic-net regressions of posterior probabilities: "Contents" of type

return

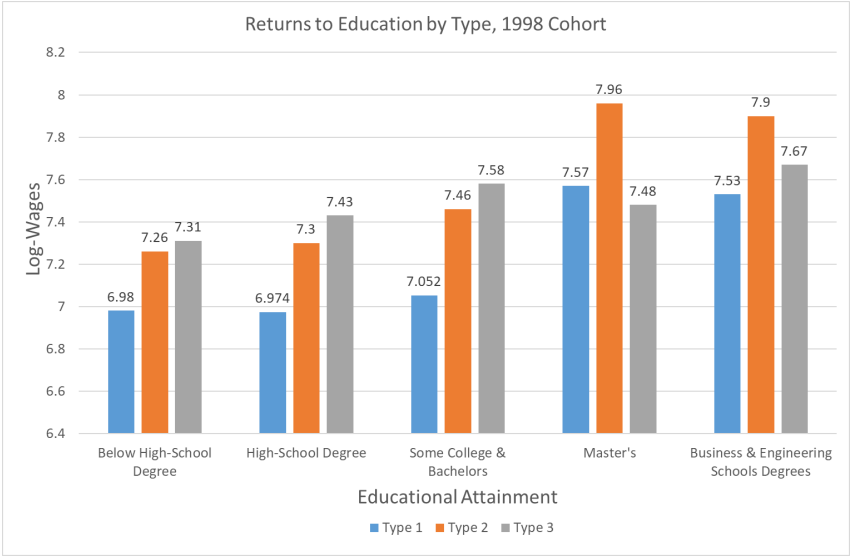
	Type I	Type II	Type III
retained before 6th grade	0,20	-0,04	-0,16
Father situation:			
working	-0,06	0,04	0,03
unemployed	0,05	0,03	-0,09
Training	-0,11	-0,07	0,18
Father occupation;			
Farmer	0,27	-0,11	-0,16
Mother occupation:			
Farmer	0,16	0,03	-0,19
Business	-0,09	-0,06	0,15
White collar	-0,08	-0,02	0,09
Blue collar	0,07	0,02	-0,09
Region of living in 6th grade			
Paris (1*)	-0,31	-0,02	0,33
Ile-de-France (1)	-0,16	-0,02	0,19
Grand Est (5)	-0,14	-0,02	0,16
Nouvelle Aquitanie (9)	0,20	-0,05	-0,14
Occitanie (11)	0,22	-0,09	-0,13
Corse (12)	0,24	0,03	-0,27
DOM (14-18)	0,23	-0,17	-0,06
Mother graduate (only 2010)	0	0	0,204

Type and school final grade exam in 2010 return

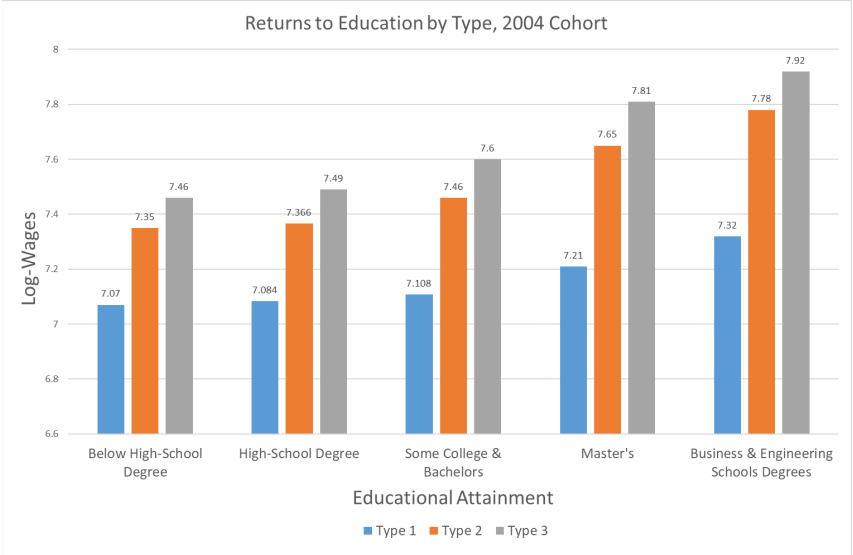
	Grade D	Grade C	Grade B	Grade A
type II	-0.0560***	0.0195	0.0287**	0.00776
	(0.0137)	(0.0127)	(0.00877)	(0.00398)
type III	-0.0807***	0.00378	0.0487***	0.0282***
	(0.0150)	(0.0139)	(0.00961)	(0.00436)
_cons(type I ref)	0.605***	0.292***	0.0912***	0.0115***
	(0.00917)	(0.00849)	(0.00585)	(0.00266)
N	2.322	2.322	2.322	2.322

Standard errors in parentheses

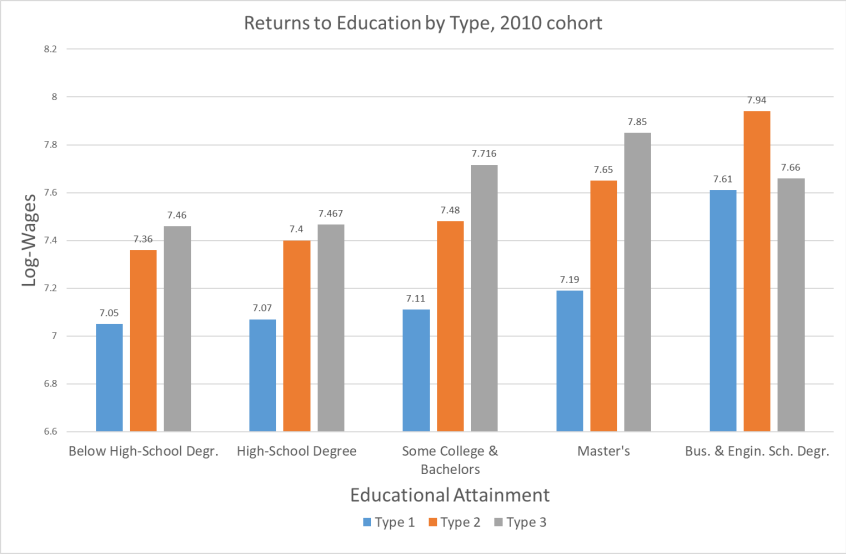
Return on Education by type: cohort 1998 return



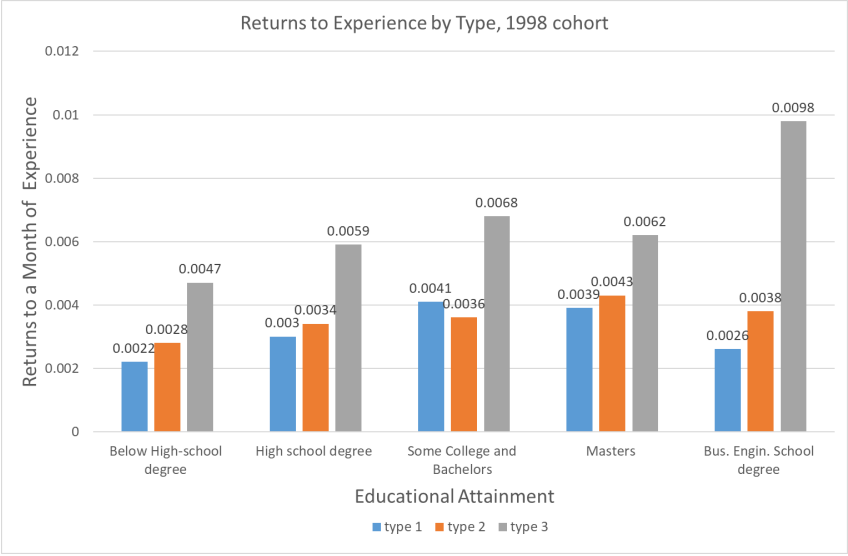
Return on Education by type: cohort 2004



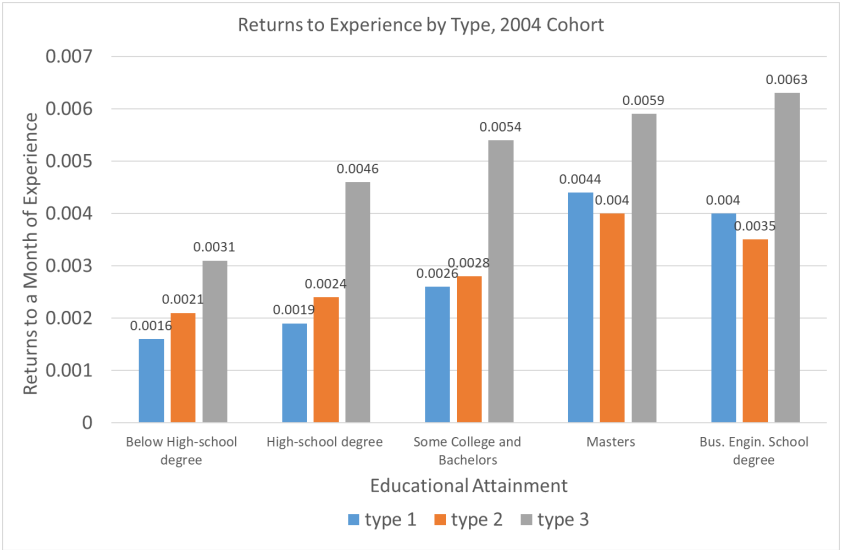
Return on Education by type: cohort 2010



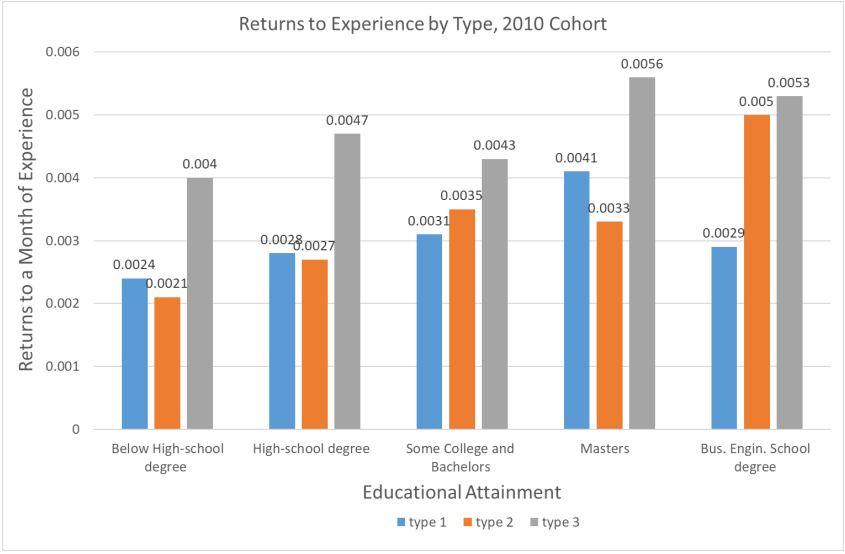
Return on experience by type: cohort 1998 return



Return on experience by type: cohort 2004

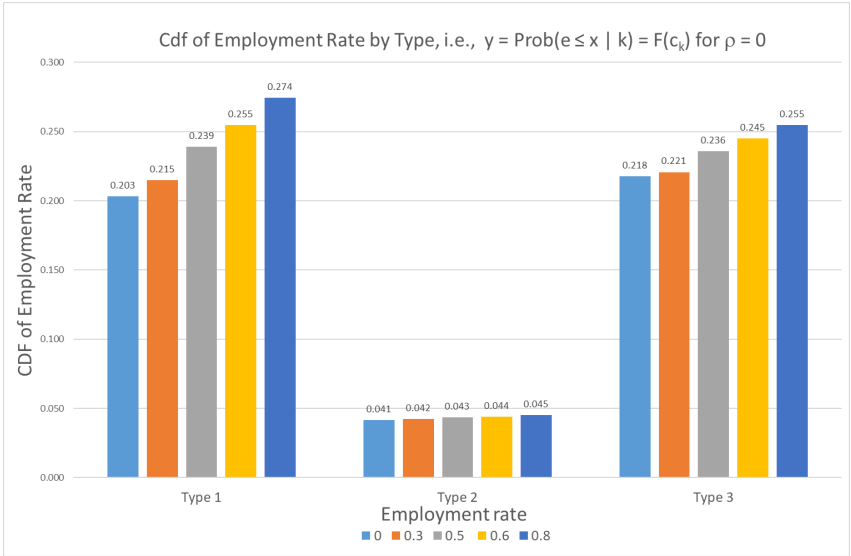


Return on experience by type: cohort 2010



Type and employment: Cuts of Ordered Probit

return



Education Attainment of Types

return

Table: Probability of reaching an education level given the type and cohort

	$p(h\|k,c)$								
Conditional on cohort ...	1998			2004			2010		
and conditional on type ...	1	2	3	1	2	3	1	2	3
Less than High-school Degree	0.43	0.37	0.43	0.34	0.26	0.24	0.29	0.24	0.18
High-school Degree	0.26	0.25	0.22	0.29	0.23	0.22	0.31	0.20	0.25
Some College and Bachelors	0.26	0.30	0.26	0.27	0.31	0.32	0.24	0.34	0.23
Masters	0.03	0.02	0.04	0.06	0.09	0.13	0.08	0.14	0.18
Bus. Engin. School Degrees	0.02	0.06	0.05	0.03	0.11	0.08	0.08	0.08	0.16

Distribution of Types by Education Attainment

return

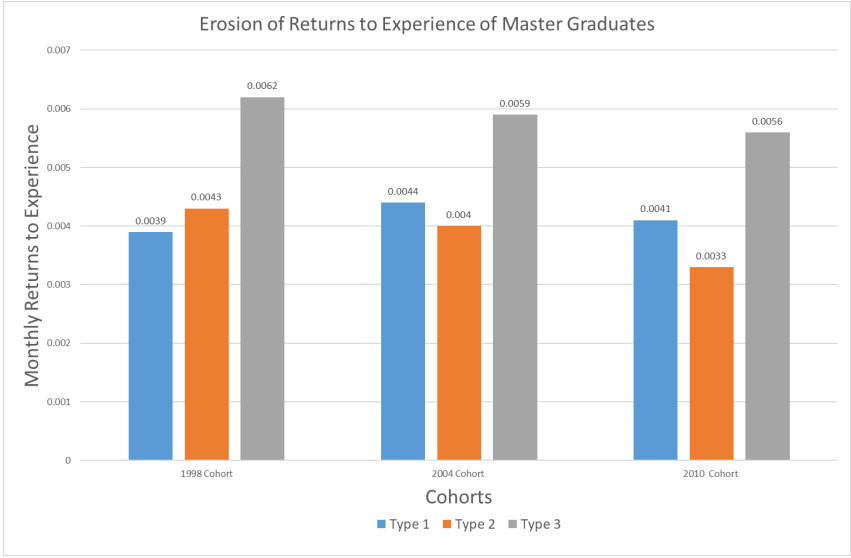
Table: Mix of types by education level and cohort

	$p(k\|h,c)$								
	1998 cohort			2004 cohort			2010 cohort		
Probability of type ...	1	2	3	1	2	3	1	2	3
Less than High-school Degree	0.43	0.33	0.25	0.50	0.33	0.18	0.52	0.32	0.16
High-school Degree	0.42	0.37	0.21	0.48	0.34	0.18	0.54	0.25	0.21
Some College and Bachelors	0.38	0.40	0.22	0.38	0.38	0.23	0.40	0.41	0.19
Masters	0.38	0.29	0.33	0.29	0.39	0.32	0.29	0.38	0.33
Bus. Engin. School Degrees	0.21	0.51	0.28	0.19	0.57	0.24	0.37	0.27	0.36

Table: Mix of types by education level and cohort

	$p(k\|h,c)$								
	1998 cohort			2004 cohort			2010 cohort		
Probability of type ...	1	2	3	1	2	3	1	2	3
Less than High-school Degree	0.43	0.33	0.25	0.50	0.33	0.18	0.52	0.32	0.16
High-school Degree	0.42	0.37	0.21	0.48	0.34	0.18	0.54	0.25	0.21
Some College and Bachelors	0.38	0.40	0.22	0.38	0.38	0.23	0.40	0.41	0.19
Masters	0.38	0.29	0.33	0.29	0.39	0.32	0.29	0.38	0.33
Bus. Engin. School Degrees	0.21	0.51	0.28	0.19	0.57	0.24	0.37	0.27	0.36

Heterogeneity in the Erosion of Return to experience: Master 2 return



Type characteristics: Field choice M2 return

Master II Graduates				
Type	overall	I	II	III
1998:				
Humanities	0.53	0.44	0.52	0.65
STEM	0.47	0.56	0.48	0.35
2004:				
Humanities	0.45	0.53	0.38	0.47
STEM	0.55	0.43	0.62	0.53
2010:				
Humanities	0.59	0.61	0.59	0.57
STEM	0.41	0.39	0.41	0.43

Type Characteristics: Sector Choice return

Type	overall	I	II	III
1998:				
Private	0.81	0.81	0.78	0.85
Public	0.19	0.18	0.22	0.15
2004:				
Private	0.83	0.81	0.83	0.88
Public	0.17	0.19	0.17	0.11
2010:				
Private	0.80	0.78	0.78	0.85
Public	0.20	0.22	0.22	0.15

Type Characteristics: Firm dimension return

Type	overall	I	II	III
1998:				
Small($w < 10$)	0.26	0.34	0.22	0.19
Medium($w > 9$ & $w < 50$)	0.27	0.31	0.24	0.24
Big($w > 49$)	0.47	0.36	0.54	0.57
2004:				
Small($w < 10$)	0.26	0.33	0.23	0.21
Medium($w > 9$ & $w < 50$)	0.28	0.30	0.28	0.25
Big($w > 49$)	0.46	0.37	0.49	0.54
2010:				
Small($w < 10$)	0.25	0.32	0.21	0.20
Medium($w > 9$ & $w < 50$)	0.24	0.25	0.24	0.21
Big($w > 49$)	0.51	0.43	0.55	0.59

Type Characteristics: Average Employment Spell return

	Overall	I	II	III
1998	2.95	3.12	2.68	3.07
2004	3.15	3.45	2.90	2.98
2010	2.98	3.17	2.69	3.02

Table: Average sequence de travail by type and cohort

Robustness: matching probabilities of types between all cohort and model on separated cohort 1998

	Together		
Type	I	II	III
I	0.09	0.89	0.02
II	0.91	0.07	0.02
III	0.01	0.15	0.85

Table: Share by type of matching type: most likely type $p_{ik} > 0.8$

Average Discounted earnings by type, cohort and education return

Average discounted wage by type, diplome and cohort									
	1998			2004			2010		
	I	II	III	I	II	III	I	II	III
Non Dip	652	1017	819	635	994	934	510	865	930
HS	711	1050	1094	723	1113	1145	664	1072	952
Some col.	802	1239	1382	801	1273	1507	772	1288	1496
M2	1412	2362	1121	1017	1628	1879	837	1357	1974
Ecole	1327	1924	1861	1151	1786	2215	1874	2411	1443

Table: Average earnings by type, education and cohort

Discounted wage

To summarise the information on the effect over the seven years and to take into account the effect on employment we compute for individual i of type k the discounted sum of earnings:

$$W_{ik} = \frac{(1-\delta)}{(1-\delta^T)} \sum_{t=1}^{T} \delta^{t-1} e_{\tilde{itk}} w_{\tilde{itk}}$$

Then, we can compute expected-discounted values conditional on a degree h for type k:

$$H_k(h) = \frac{\sum_{i|h_i=h} \tilde{W_{ik}} p_{ik}}{\sum_{i|h_i=h} p_{ik}}$$