Occupations, field of study, and substitution across skill groups

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Motivation (1)

- Increasing evidence that the elasticity of substitution across education groups is not constant
  - In the inequality literature, "Katz-Murphy" type regressions of relative wages on relative supplies yield different elasticity for HS vs dropout (very close substitutes) and HS vs college (e.g. Goldin and Katz 2008)
  - Similar finding in the immigration literature (Card, 2009, Ottaviano and Peri, 2012)
- This has important implications for the interpretation of inequality trends, and for assessing the impact of low-skill immigration on the wages of natives.
- In the canonical model, output depends on the supply of imperfectly substitutable skill groups (experience-education).
- A flexible production function (e.g. nested CES) can easily accommodate different elasticities of substitutions across different groups
- However, this is not helpful for helping understand **why** these elasticities are different

Motivation (2)

- A more promising avenue is to instead use a "Ricardian" model of the labor market (e.g. Acemoglu and Autor, 2011) that has the following features
  - Output depends on the supply of imperfectly substitutable occupations (or tasks)
  - Skills are perfect substitutes (efficiency units model) within a given occupation.
  - Differences in the relative efficiency of skills in the different occupations lead to a systematic sorting of skills into occupations (Roy model)
- The model helps explain a number of important inequality trends (AA) but also has a number of strong implications (in equilibrium):
  - Law of one price (no wage difference across occupations given skill)
  - "Perfect sorting" => no overlap in the distribution of occupation across skill groups

Motivation (3)

- When looking at actual data (e.g. CPS), we do find a lot of overlap in occupations across observed skill groups
- While this is not consistent with the simplest version of the model, it means that the elasticity of substitution across groups depends on the degree of overlap in the occupational distribution. For example:
  - If HS graduates and HS dropouts work in the exact same occupation the elasticity of substitution between these two groups with be infinite
  - If HS graduates and college postgraduates work in very different occupations their elasticity of substitution will be much smaller
- Also means we need to think more carefully about why different groups sort themselves into different occupations, and whether occupational wage differences (that may not vanish in equilibrium) play a role on this allocation
- Field of study is a potentially important determinant of occupation choice in that context, especially in the current context where a large fraction of the workforce work in jobs that require some sort of occupational licensing.

Plan for this presentation

1. Illustrate the connection between occupational overlap and substitution across skill groups using a CES production function
2. Show some evidence in occupational overlap from the CPS
3. Switch to the Canadian National Graduates Survey (NGS) to look at the role of fields of study, licensing and few other factors on:
   a) Occupation choice
   b) Occupational wage differences

Model

- Consider the CES production function:

$$Y = \left(\sum_j \theta_j L_j^{\rho} \right)^{1/\rho}, \ \sigma = (\rho - 1)^{-1}$$

- L_j is the amount of labor (in efficiency units) supplied in each occupation j.
- Efficient allocation of labor yields the usual CES formula:ln

$$ln(W_j/W_k) = ln(\theta_j/\theta_k) + -\frac{1}{\sigma} ln(L_j/L_k).$$

Model

- Let L_e represent the total labor supplied by education group e, and f_{ej} the fraction of workers in education group e who work in occupation j. Labor supplied by education group e to occupation j is:

$$L_{ej} = f_{ej} L_e.$$

- In the simple case with two occupations and two education groups, the elasticity of substitution between education groups, σ_e , is as follows in the two extreme cases where we have:
  - No specialization ($f_{ej} = f_j$ for all e): $\sigma_e = \infty$
  - Perfect specialization ($f_{ej} = 1$ *if* $f_{e'j} = 0$ and vice versa): $\sigma_e = 0$

Model

- In the case with imperfect specialization / imperfect overlap, it can be shown that:

$$1/\sigma(e, e') \propto \sum_j \frac{f_{ej} \cdot f_{e'j}}{f_j}$$

- So the (inverse) of the elasticity of substitution across education groups depends on the correlation in the shares of workers allocation in each occupation.
- Empirically the correlation is lower the further away education groups are from each other $=>$ "distance dependent" elasticity of substitution
- The correlation between HS graduates and dropouts is also larger than HS grads vs. college or college graduates vs. post-graduates.

2005 National Graduates Survey

- 2007 follow up of a sample of people who graduated from post-secondary education programs in Canada in 2005
  - Over 50 percent of young people (55.4 percent of 25-29 years old in the 2006 census) now getting such degrees.
- Information on the following variables:
  - Field of study (FOS)
  - Could you get a license?
  - Did you get a license?
  - How related is your job to your education?

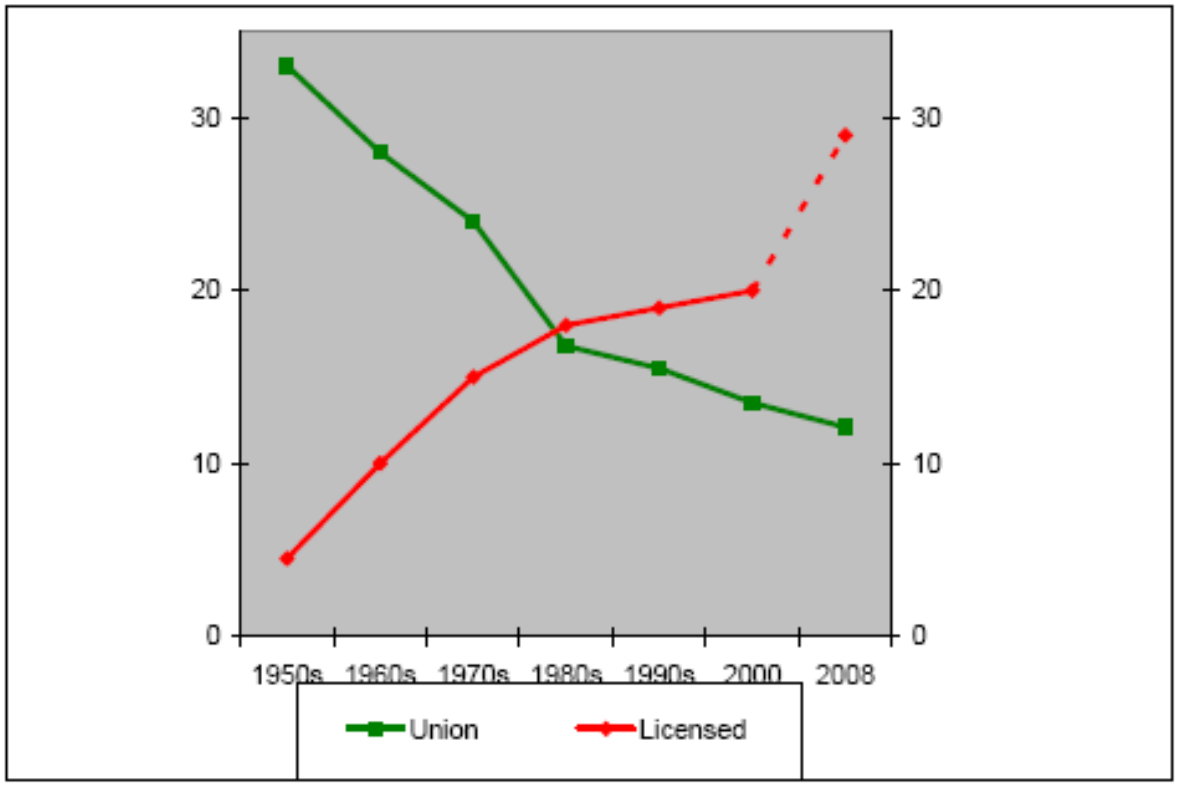
Questions about licensing

- Upon completion of your (certificate / diploma / degree) program, were there steps that you could take to obtain a licence to practise, register with your regulatory college/professional association, or obtain a professional designation?
- Have you obtained this licence, registration or professional designation? By obtained I mean that you have met all of the requirements, which include, but may not be limited to, successful completion of all national and/or provincial examinations.

Occupational licensing

- Like unions, this potentially creates a gap between marginal products and wages (Friedman and Kuznets, 1945)
- Recent work on this by Kleiner (2006), Kleiner and Krueger (2009)
- Why is this interesting?
  - The phenomena has been growing substantially over time
  - When licensing is important, we get a close connection between skills (field of study) and occupation. Can almost think of occupations as a measure of field-specific skills/education

*Figure 1: Comparisons in the Time-Trends of Two Labor Market Institutions: Licensing and Unionization**



From Krueger and Kleiner, 2009

Empirical strategy

- Basic goal: can we explain occupation wage effects by economic factors we better understand?
- Transition between field of study and occupations
  - How well can occupational choice be explained by field of study (skills)?
  - Is the mapping closer in the case of occupations with licensing?
- Effect of occupations on wages. How much of it can be "explained" by:
  - Field of study (specific skills)
  - Tasks (general skills)
  - Licensing
  - Is one's job related to his/her education

Table A1: Descriptive statistics from the 2005 NGS

Highest degree		Job related to education	
College or CEGEP	0.345	Closely related	0.582
University up to bachelor's degree	0.533	Somewhat related	0.196
Post graduate	0.122	Not related	0.178
		Could get a license:	0.454
Age in 2005			
Under 25	0.558	Did get a license:	0.238
25-29	0.195		
30-34	0.129	Currently a student:	0.169
35+	0.089		
Female:	0.613		

Note: 11822 observations. All statistics weighted using sample weights.

Table 1a: Distribution of occupation by field of study, 2005 NGS

Occupation:	Manag.	Business	Science	Health	Soc. Sc. & educ.	Arts	Sales	Trades	Manuf.	Proportion in field:	Duncan index:
Field of study:											
Business	15.2	47.1	4.0	1.0	15.1	1.5	13.5	1.3	1.4	16.2	40.6
Physical & life sc.	3.9	10.6	24.0	11.9	35.0	1.5	9.9	1.9	1.4	5.5	17.5
Math, computer & info.	3.1	10.3	62.6	0.0	9.8	6.5	5.7	1.4	0.7	6.5	48.7
Engineering & related	6.3	4.7	54.0	0.4	5.4	0.6	4.6	17.2	6.9	12.0	56.9
Health & fitness	2.3	5.2	1.2	73.7	9.9	2.0	4.9	0.4	0.5	13.6	62.0
Education	7.6	2.6	0.9	1.5	80.7	0.6	5.7	0.2	0.2	10.9	55.0
Social sc. & law	5.1	16.6	3.5	2.1	50.0	7.2	13.3	1.4	0.7	14.0	26.7
Humanities	5.6	20.5	3.4	2.2	31.1	10.0	20.3	3.5	3.3	7.2	22.3
Arts & communications	5.2	11.8	5.4	1.6	8.9	37.1	24.5	2.5	3.1	6.4	44.2
Other	6.0	11.1	14.9	1.8	13.7	1.5	35.1	6.3	9.7	7.7	32.4
Proportion in occupation:	6.7	15.9	15.0	11.7	26.7	5.4	12.5	3.6	2.6		42.6

Table 1b: Distribution of occupation by gender and degree, 2005 NGS

	Manag.	Business	Science	Health	Soc. Sc. & educ.	Arts	Sales	Trades	Manuf.	Proportion in field:	Duncan index:
A: Gender											
Men	8.1	12.7	27.0	4.2	17.4	4.7	13.1	8.2	4.7	40.6	20.7
Women	5.8	18.0	6.8	16.9	33.0	5.8	12.2	0.5	1.1	59.5	14.1
All	6.7	15.9	15.0	11.7	26.7	5.4	12.5	3.6	2.6		16.8
B: Degree											
Some college	3.4	16.4	13.7	14.5	12.8	6.7	20.1	7.7	4.7	35.5	18.5
Bacc. Degree	6.3	17.8	14.8	11.1	30.8	4.9	10.8	1.9	1.7	46.9	6.0
Post graduate	14.3	9.6	17.9	8.0	43.7	3.9	1.9	0.0	0.7	17.6	27.5
All	6.7	15.9	15.0	11.7	26.7	5.4	12.5	3.6	2.6		14.2

Table 2: Pseudo R-square in multinomial logit for occupational choice

Sample:	All	Could get license	Did get license	Job related to education	License & related
Covariates:					
1: Gender	0.043				
2: Degree	0.037				
3: FOS	0.275	0.373	0.492	0.422	0.588
4: All	0.308	0.404	0.529	0.453	0.626
No. Obs.	11822	5130	2726	6986	2222

Note: McFadden's pseudo R-square based on the formula

R-square =1 - lnL(M_full)/lnL(M_intercept)

Table A2: Tasks by occupation

	Manual	Analytical	Interactive
Management	0.513	0.885	0.973
Business	0.434	0.822	0.789
Science	0.475	0.892	0.881
Health	0.964	0.627	0.691
Soc. Sc. & educ.	0.476	0.698	0.964
Arts	0.404	0.842	0.866
Sales	0.573	0.696	0.958
Trades	0.982	0.466	0.367
Manufacturing	0.904	0.349	0.241

Note: Constructed using the measures provided in Gathmann and Schoenberg (2010)

Table 3: Standard deviations of occupation wage effects in the 2005 NGS

Adjusted for:	Standard deviation	Variance
1: nothing	0.196	0.0384
2: age, gender, & education	0.160	0.0257
3: 2 & FOS	0.145	0.0210
4: 3, license & related	0.126	0.0159
5: 3 & tasks	0.082	0.0068
6: 4 & tasks	0.054	0.0029

Table A3: Wage regressions, 2005 NGS

	[1]	[2]	[3]	[4]	[5]	[6]
Female	-0.212	-0.187	-0.171	-0.169	-0.168	-0.173
	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
College	-0.412	-0.431	-0.518	-0.469	-0.478	-0.513
	(0.018)	(0.019)	(0.019)	(0.019)	(0.018)	(0.018)
Bachelor	-0.181	-0.211	-0.224	-0.204	-0.207)	-0.226
	(0.016)	(0.017)	(0.017)	(0.017)	(0.017	(0.017)
Age <25	-0.318	-0.287	-0.269	-0.238	-0.226	-0.240
	(0.019)	(0.019)	(0.019)	(0.019)	(0.018)	(0.018)
Age 25-29	-0.181	-0.180	-0.159	-0.149	-0.160	-0.175
	(0.021)	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)
Age 30-34	-0.074	-0.085	-0.066	-0.066	-0.071	-0.079
	(0.023)	(0.022)	(0.022)	(0.021)	(0.021)	(0.021)
Other regressors	none	Occ.	FOS	occ & FOS	Occ, FOS, license & related	Tasks, FOS, license & related
Adjusted R-square	0.137	0.210	0.207	0.250	0.289	0.280

Table A3: Wage regressions, 2005 NGS (continued)

	[1]	[2]	[3]	[4]	[5]	[6]
Occupation:						
Business		-0.226		-0.219	-0.185	
		(0.022)		(0.022)	(0.021)	
Science		-0.067		-0.043	-0.080	
		(0.024)		(0.026)	(0.025)	
Health		-0.031		0.005	-0.112	
		(0.024)		(0.030)	(0.030)	
Soc. Sc. & educ.		-0.269		-0.224	-0.311	
		(0.021)		(0.022)	(0.022)	
Arts		-0.387		-0.222	-0.291	
		(0.030)		(0.030)	(0.030)	
Sales		-0.534		-0.474	-0.393	
		(0.024)		(0.024)	(0.024)	
Trades		-0.120		-0.099	-0.049	
		(0.036)		(0.037)	(0.036)	
Manufacturing		-0.168		-0.133	-0.063	
		(0.039)		(0.038)	(0.037)	
Other regressors (demogr. always in)			FOS	FOS	FOS license & related	Tasks, FOS, license & related
Adjusted R-square	0.137	0.210	0.207	0.250	0.289	0.280

Table A3: Wage regressions, 2005 NGS (continued)

	[1]	[2]	[3]	[4]	[5]	[6]
Field of Study:						
Education			0.031	0.018	-0.022	0.013
			(0.028)	(0.029)	(0.029)	(0.028)
Arts & comm.			-0.287	-0.293	-0.211	-0.244
			(0.032)	(0.033)	(0.032)	(0.031)
Humanities			-0.350	-0.350	-0.234	-0.236
			(0.030)	(0.030)	(0.029)	(0.029)
Soc. sc. & law			-0.167	-0.178	-0.119	-0.114
			(0.026)	(0.026)	(0.025)	(0.025)
Business			0.072	0.040	0.005	0.007
			(0.025)	(0.025)	(0.024)	(0.024)
Phys. & life sc.			-0.274	-0.340	-0.267	-0.259
			(0.034)	(0.034)	(0.033)	(0.033)
Math, comp. & info.			0.011	-0.121	-0.109	-0.099
			(0.033)	(0.034)	(0.033)	(0.032)
Engin. & related			0.164	0.014	-0.019	0.010
			(0.027)	(0.028)	(0.027)	(0.026)
Health & fitness			0.124	-0.062	-0.080	-0.120
			(0.026)	(0.031)	(0.030)	(0.028)
Other regressors (demogr. always in)		Occ.		Occ.	Occ. license & related	Tasks, license & related
Adjusted R-square	0.137	0.210	0.207	0.250	0.289	0.280

Table A3: Wage regressions, 2005 NGS (continued)

	[1]	[2]	[3]	[4]	[5]	[6]
Could get license					0.027	0.025
					(0.013)	(0.013)
Did get lic.					0.105	0.104
					(0.016)	(0.016)
Job very related					0.341	0.364
					(0.015)	(0.014)
Job somewhat rel.					0.234	0.252
					(0.017)	(0.016)
Tasks:						
Manual						0.502
						(0.221)
Analytic						1.087
						(0.281)
Interactive						-0.494
						(0.156)
Other regressors (demogr. always in)		Occ.	FOS	Occ. FOS	Occ. FOS	FOS
Adjusted R-square	0.137	0.210	0.207	0.250	0.289	0.280

Summary of the findings

- Field of study (specific skills) explain a large fraction of the choice of occupation
  - Especially in cases where workers can get a license
- Most of the occupation wage differentials can be explained using the following factors:
  - Standard demographics
  - Field of study (specific human capital)
  - “Tasks” (general capital / skill requirements)
  - Getting a license / relatedness of job and education