Estimating Sector-Specific Elasticities of Substitution in the Swiss Labor Market

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Motivation

- I am building a macro model of Switzerland with an important labor market component
- For this model I need realistic, industry-specific estimates of the elasticity of substitution between low-skill and high-skill labor
- However, almost all existing research focuses on the USA
  - College graduates are considered high-skill and high school graduates are considered low-skill
  - Due to the dual education system, this distinction makes much less sense in Switzerland, need to find an alternative
  - Proposal: Use occupation-based classification (Competence Levels)

Research Questions

Research Question 1

Are Competence Levels a better tool for measuring the skill level of a worker than education levels?

Research Question 2

If so, what are the implied industry-specific elasticities of substitution between skill levels in Switzerland?

What are Competence Levels?

Competence Level	Description
1	Tasks with complex problem solving and decision making which require a large amount of factual and theoretical knowledge in an area of expertise
2	Complex practical tasks requiring a large amount of knowledge in an area of expertise
3	Practical tasks like retail, care, data processing and administration, operation of machines and eletronical equipment, security service or driving
4	Simple manual tasks

Why are education levels not a suitable proxy for skill in CH?

- Due to the dual education system, education for many occupations is much more applied
  - Many highly skilled workers never complete university or any tertiary education
  - Instead they complete an apprenticeship and later more specialized training which may or may not be recognized as a tertiary education
  - Many of these occupations are highly regarded, very skill-intensive and well-paid
- With the creation of technical colleges in the mid-nineties the share of labor force with a higher education started to increase drastically, making comparisons over the last 30 years even harder
- For these reasons it may be more suitable to categorize the Swiss labor force based on actual occupations

Preview of Results

Elasticities	Education-Based	Occupation-Based
CH	-18.01	2.037***
USA	1.996***	-2.846***

Education-Based elasticities of substitution for Switzerland are statistically insignificant (suggesting an elasticity of infinity) and negative (suggesting an incompatibility with the theoretical framework). Occupation-Based elasticities of substitution in the United States are clearly incompatible with the theoretical framework. The other elasticities are very comparable, plausible and compatible with theory and previous research.

Literature

- Basic Model: Katz and Murphy (1992)
- Extensions: Card and Lemieux (2001) (Age Groups), Blankenau and Cassou (2011) (Industries)
- European Context: Fitzenberger and Kohn (2006)
- Immigration: Borjas, Grogger and Hanson (2008, 2010), Aydemir and Borjas (2007), Ottaviano and Peri (2011), ...
- Occupations as skill levels: Orrenius and Zavodny (2007)

Theory (1)

Assumption 1

The labor module of the aggregate production function is a CES function consisting of unskilled and skilled labor.

$$Y_t = f(A_t, K_t, L_t) \tag{1}$$

and

$$L_t = (\theta_{u,t} U_t^{\rho} + \theta_{s,t} S_t^{\rho})^{\frac{1}{\rho}} \tag{2}$$

Research Question 1

Which definition should we use for U and S?

Research Question 2

What is the value of $\frac{1}{1-\rho}$?

Theory (2)

Assumption 2

Firms maximize profits and markets are competitive.

$$w_{u,t} = \frac{\partial Y_t}{\partial U_t} = \frac{dY_t}{dL_t}\frac{dL_t}{dU_t} \tag{3}$$

$$= \frac{dY_t}{dL_t}\left(\theta_{u,t}U_t^{\rho} + \theta_{s,t}S_t^{\rho}\right)^{\frac{1}{\rho}-1}\theta_{u,t}U_t^{\rho-1} \tag{4}$$

$$w_{s,t} = \frac{dY_t}{dL_t}\left(\theta_{u,t}U_t^{\rho} + \theta_{s,t}S_t^{\rho}\right)^{\frac{1}{\rho}-1}\theta_{s,t}S_t^{\rho-1} \tag{5}$$

$$\frac{w_{s,t}}{w_{u,t}} = \frac{\theta_{s,t}}{\theta_{u,t}}\left(\frac{S_t}{U_t}\right)^{\rho-1} \tag{6}$$

Estimation

Let $\tilde{w}_t \equiv \frac{w_{s,t}}{w_{u,t}}$, $\tilde{\theta}_t \equiv \frac{\theta_{s,t}}{\theta_{u,t}}$, and $\tilde{s}_t \equiv \frac{S_t}{U_t}$. Then taking logs yields

$$\log(\tilde{w}_t) = \log(\tilde{\theta}_t) + (\rho - 1)\log(\tilde{s}_t) \tag{7}$$

Additionally, substitute in the elasticity of substitution $\sigma \equiv \frac{1}{1-\rho}$:

$$\log(\tilde{w}_t) = \log(\tilde{\theta}_t) - \frac{1}{\sigma}\log(\tilde{s}_t) \tag{8}$$

This equation can be estimated as

$$log(\tilde{w}_t) = \beta_0 + \beta_1 t + \beta_2 log(\tilde{s}_t) + \varepsilon_t \tag{9}$$

where β_1 measures the growth rate of the relative skill share parameter (skill-biased technological change) and $\beta_2 = -\frac{1}{\sigma}$

Assumption 3

Within a period, skill shares drive wage gaps. Wage Gaps do not affect skill shares.

Industry-Specific Effects

Implementing heterogeneity over industries is straight forward in theory, just add an industry index i

$$\log(\tilde{w_{i,t}}) = \log(\tilde{\theta_{i,t}}) - \frac{1}{\sigma_i} \log(\tilde{s_{i,t}}) \tag{10}$$

Estimation - Industry

- Hoewever: Assumption 3 is violated!
- If labor is mobile between sectors, high skill labor will move to sectors with a high relative wage, causing endogeneity issues
- Solution: IV

Estimation: IV

- There is a natural instrument: the aggregate skill ratio
- If assumption 3 holds for the aggregate economy, then the aggregate skill ratio is not driven by wages
- However, by construction it is correlated to the industry skill ratios
- Therefore, I estimate industry-specific elasticities of substitution with 2SLS, using the aggregate skill ratio as an instrument for the industry-specific skill ratio

Data Sources

- Switzerland
  - Swiss Labor Force Survey
  - 1992 - 2017, time period covers 2 years
- USA
  - Current Population Survey, March Extracts
  - 1982 - 2016, time period covers 2 years

Sample Selection and Estimation of Wage Gaps

Sample Selection as in Katz and Murphy (1992):

- Sample for wage gaps: Only full time employed workers aged 26-60
- Sample for skill share: All workers aged 15-65, including self-employed and part time

Estimation of shares:

- Wage gaps: Regression of hourly (weekly) log wages on skill level dummy, gender dummy, (non-white dummy) and linear age term in every time period and age group (and industry). Inverse of variance is later used as weight in the main regression.
- Skill shares: Ratio of sum of hours worked

Education Skill Definitions

- Switzerland
  - High Skill: Has university degree (includes technical and pedagogical colleges)
  - Low Skill: Completed apprenticeship
  - Everything else is omitted (i.e. Gymnasium, higher vocational education, etc.)
- USA
  - High Skill: Completed College or "Advanced"
  - Low Skill: Completed High School
  - Omitted: "Some College", "Less than High School"

Data Issues

- Competence Levels are based on ISCO-Classification which is European and thus not in US data directly: Have to rely on crosswalks, recoding of occupations not possible 1:1
  - Example: "*Veterinary Assistants and Laboratory Animal Caretakers*" in the US CPS data corresponds to either "*Veterinary technicians and assistants*" (high skill) or "*Pet groomers and animal care workers*" (low skill) in the ISCO
  - This leads to some doubt about the validity of the use of Swiss competence levels in US data

Switzerland - Occupations

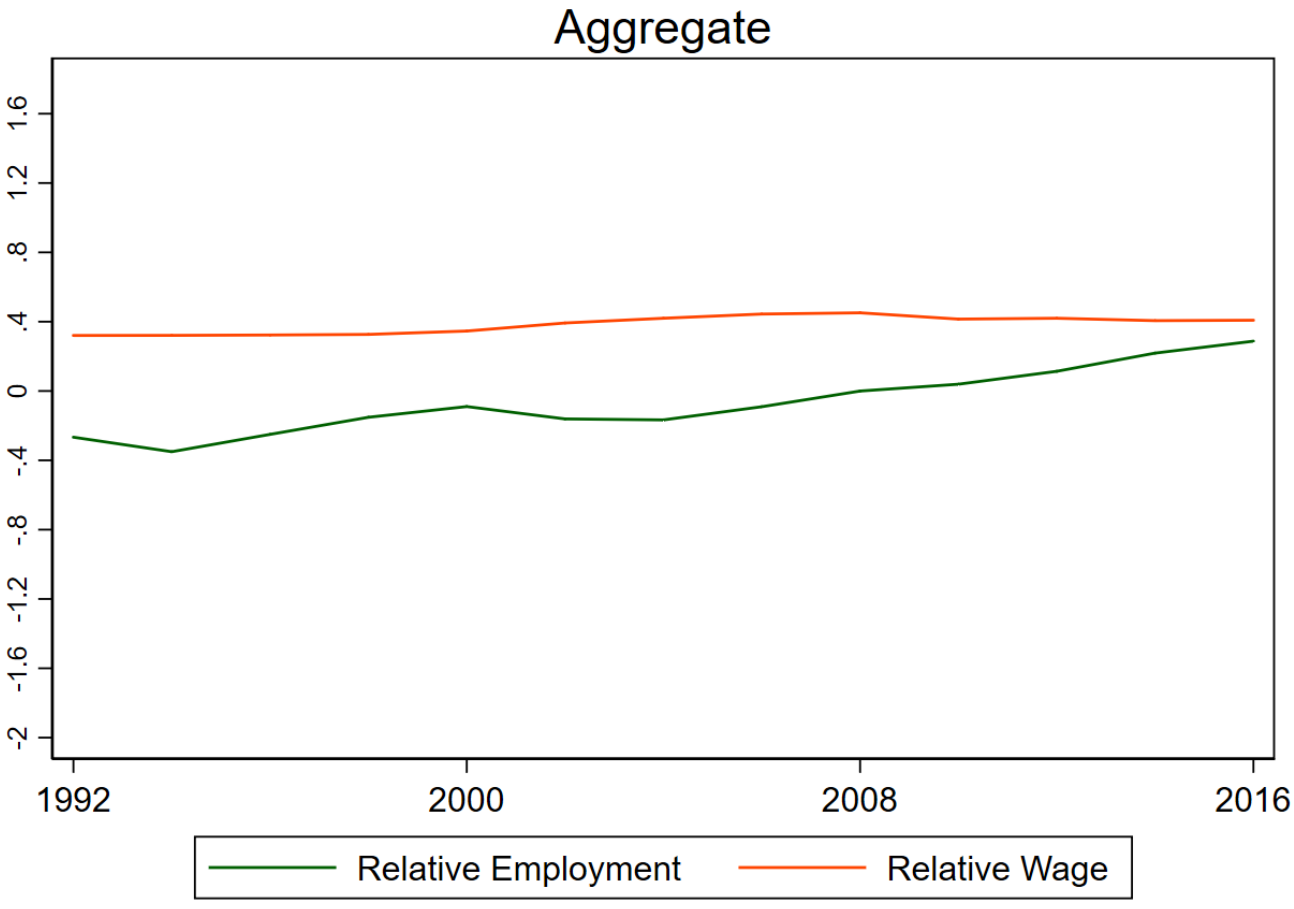

Figure: Relative Wages and Employment - Switzerland, Occupation

Switzerland - Education

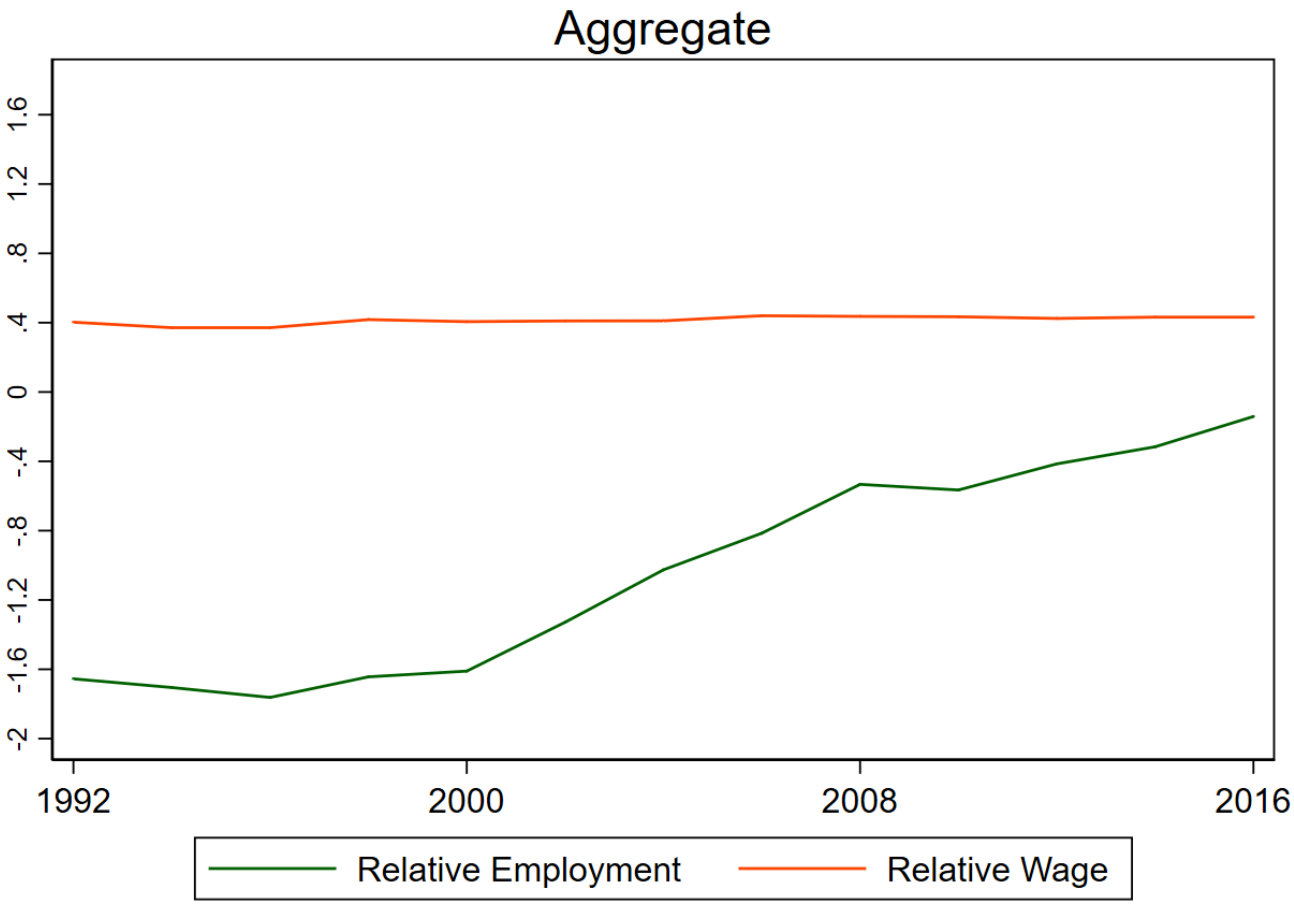

Figure: Relative Wages and Employment - Switzerland, Education

USA - Occupations

Figure: Relative Wages and Employment - USA, Occupation

USA - Education

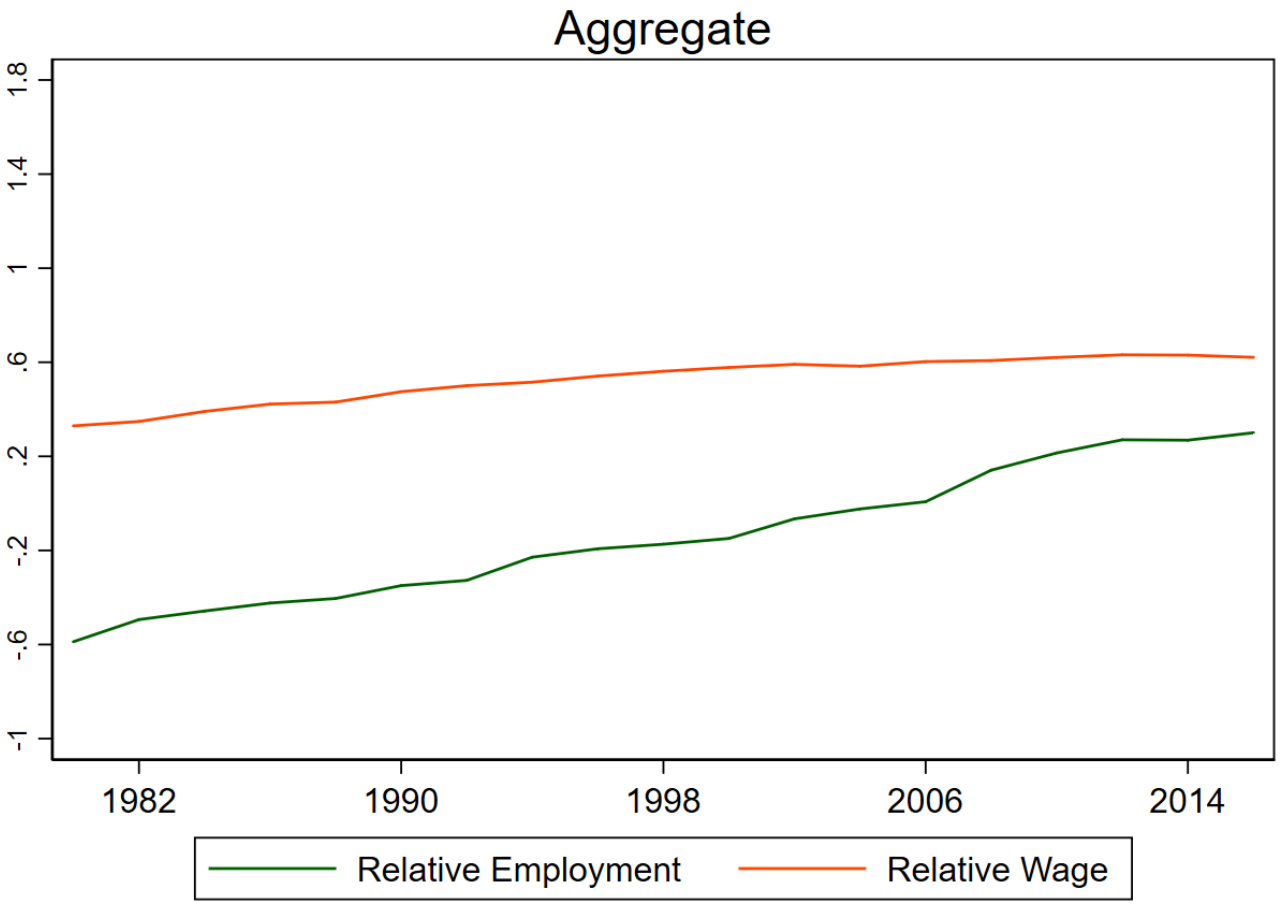

Figure: Relative Wages and Employment - USA, Education

Switzerland - Industries, Occupation

Figure: Relative Wages and Employment - Switzerland

Aggregate Economy Results - no Age Effects

	Switzerland		USA	
	College	Competence Level	College	Competence Level
Elasticity	-18.01	2.037***	1.996***	-2.846***
	(46.90)	(0.118)	(0.131)	(0.284)
Trend	-0.00157	0.0351***	0.0442***	0.0123***
	(0.00287)	(0.00143)	(0.00172)	(0.000548)

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Industry-Specific Results - no Age Effects

	Switzerland		USA	
	College	Competence Level	College	Competence Level
Manufacturing	-30.90	3.335***	1.915***	-8.081
	(2137.3)	(0.402)	(0.302)	(59.36)
Finance	-33.99	1.208***	2.080	0.617**
	(267.4)	(0.170)	(1.584)	(0.292)
Construction	6.581	10.91	5.453	2.696
	(435.7)	(125.2)	(81.62)	(36.56)
Trade & Transport	-5.098**	2.731***	1.981***	-6.332***
	(1.998)	(0.435)	(0.568)	(0.711)
IT	-56.02	3.946***	-2.789	-22.48
	(209.7)	(1.042)	(53.69)	(769.8)
Other Services	-39.85	2.904***	1.173***	-68.12
	(260.8)	(0.523)	(0.444)	(2173.1)
Health	4.498	7.413	1.658***	-2.369
	(22.52)	(73.93)	(0.336)	(9.768)

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Industry-Specific Results - Overview

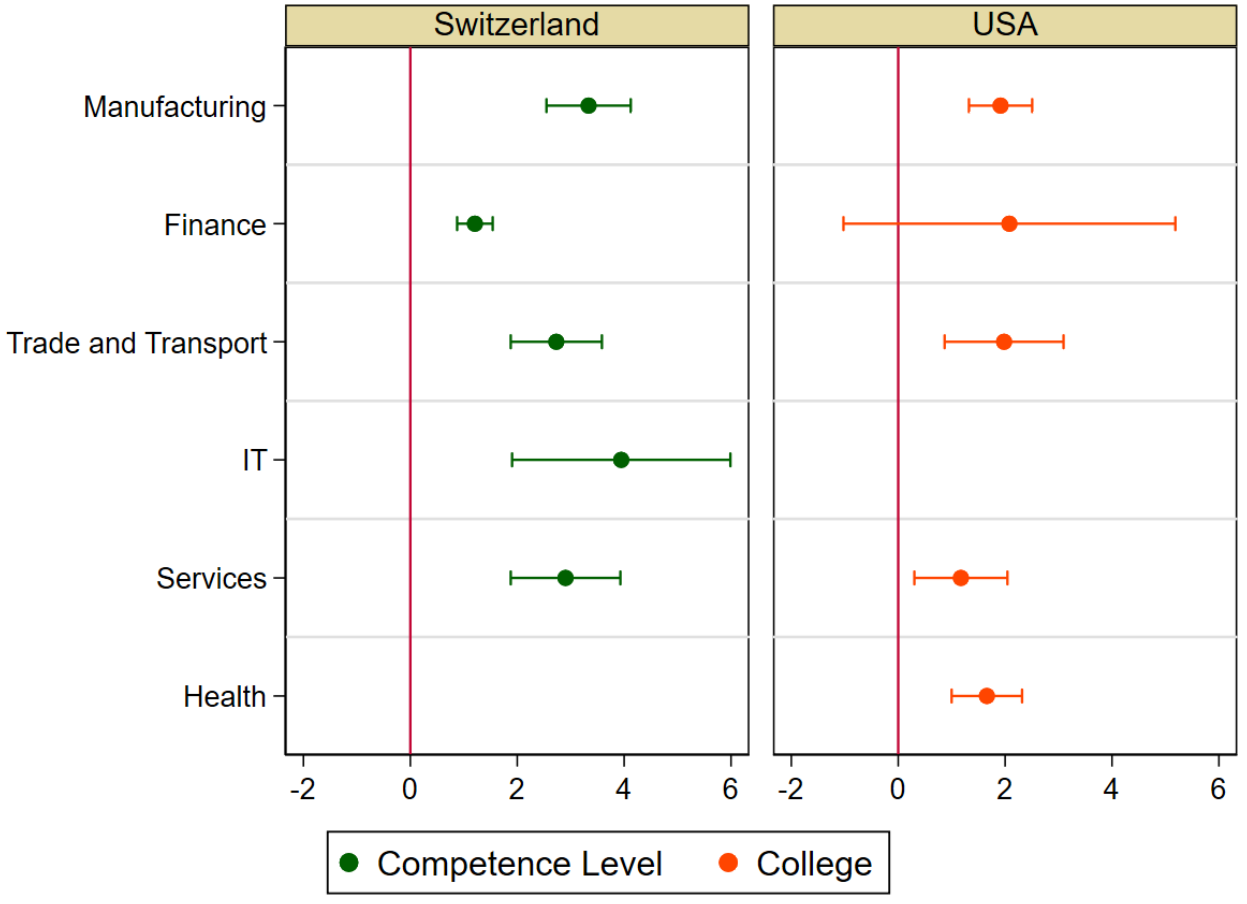

Figure: Industry Results, Preferred Models

Main Take-Aways

- Occupation as a proxy for skill level describes the Swiss labor market much better than Education. Do not blindly adopt definitions from USA
- Elasticities of substitution vary between industries, but less than expected
- The Swiss finance sector is special in that respect
- Not all sectors' elasticities can be estimated from quantitative data, need to rely on qualitative data as well

End of Presentation

Thank you for your attention!