

Revisiting the effects of skills on economic inequality:

Within- and cross-country comparisons using PIAAC



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Motivation

- ✎ Correlations between skill levels and economic distributions noted in academic literature and popular discussion
- ✎ Previous studies of skills and economic distributions within and across countries found mixed results due to
 - variation in empirical methods
 - limited availabilities of consistent skill data separate from education
- ✎ Programme for the International Assessment of Adult Competencies (PIAAC) data allows study of how literacy, numeracy, and digital problem-solving skills relate to wage inequality in an international context characterized by
 - economic forces of demand and supply
 - institutions, customs, and culture

Research Questions

- ⌘ What are relative contributions to economic inequality of
 - (1) levels of observable variables such as skill and other indicators of human capital
 - (2) labor market rates of returns to these variables
 - (3) unobservable factors such as institutional differences
- ⌘ Do newly-released PIAAC data confirm previous results in the literature on effects of skills on wage and earnings inequality, or do these data provide different results?
 - Are any differences due to inclusion of problem-solving skills (that were not identifiable in previous datasets but are in PIAAC)?
 - Or, due to variable definitions, time period, cross-country variations in institutions, and/or the scope of country coverage?

Key Findings--Descriptive

- ∞ Descriptive statistics suggest
 - substantial economic inequality across countries, levels and distributions of skill measures, and gender
 - more variability in the lower half of each country's skill distribution by all skill measures
 - but, more variability in the upper halves of country-specific wage distributions

Key Findings--Modeling

- ∞ Econometric decomposition analysis of components of wage and earnings inequality differences across countries reinforces previous findings that skills (even when measured in a comprehensive way as by PIAAC) only partially explain observed patterns
 - *Unobservable characteristics* of institutions and people matter to a greater extent than demand and supply factors
 - New problem-solving measure does not substantially reduce importance of unobservable factors

Key Findings--Gender

- ∞ Specific demographic characteristic of gender is of particular interest given its importance as a determining factor of wages in the literature
 - Some results are sensitive to gender since wage inequality is higher for women in some contexts
 - But, importance of unobservables is unchanged

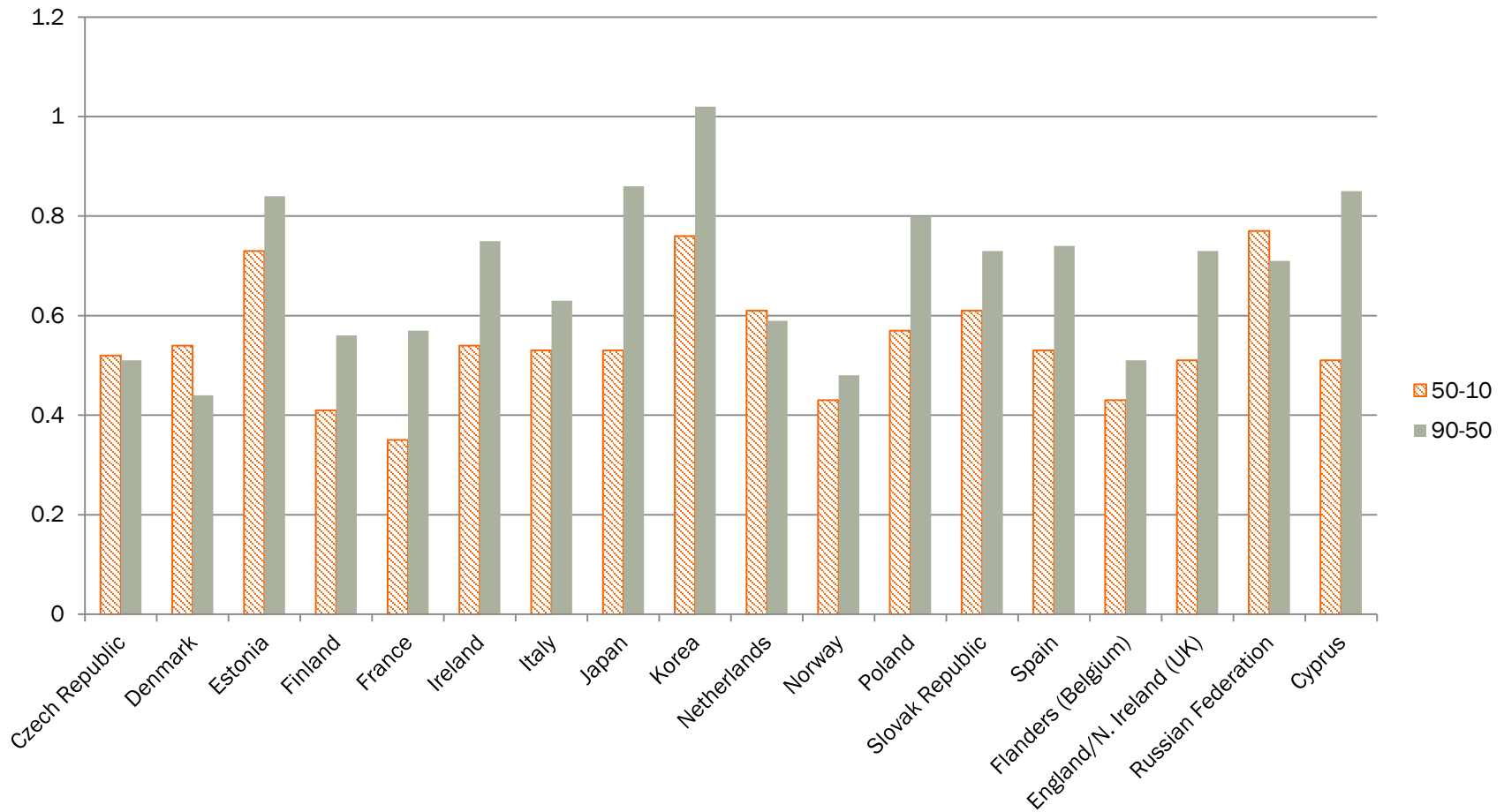
Data

- ∞ Public-use PIAAC data from 23 OECD countries between 2008 and 2013
 - Austria, Belgium (Flanders), Canada, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Ireland, Italy, Japan, South Korea, Netherlands, Norway, Poland, the Russian Federation, Slovak Republic, Spain, Sweden, the United Kingdom (England and Northern Ireland), and the United States
- ∞ Further restrictions in specifications due to specific variable information availability

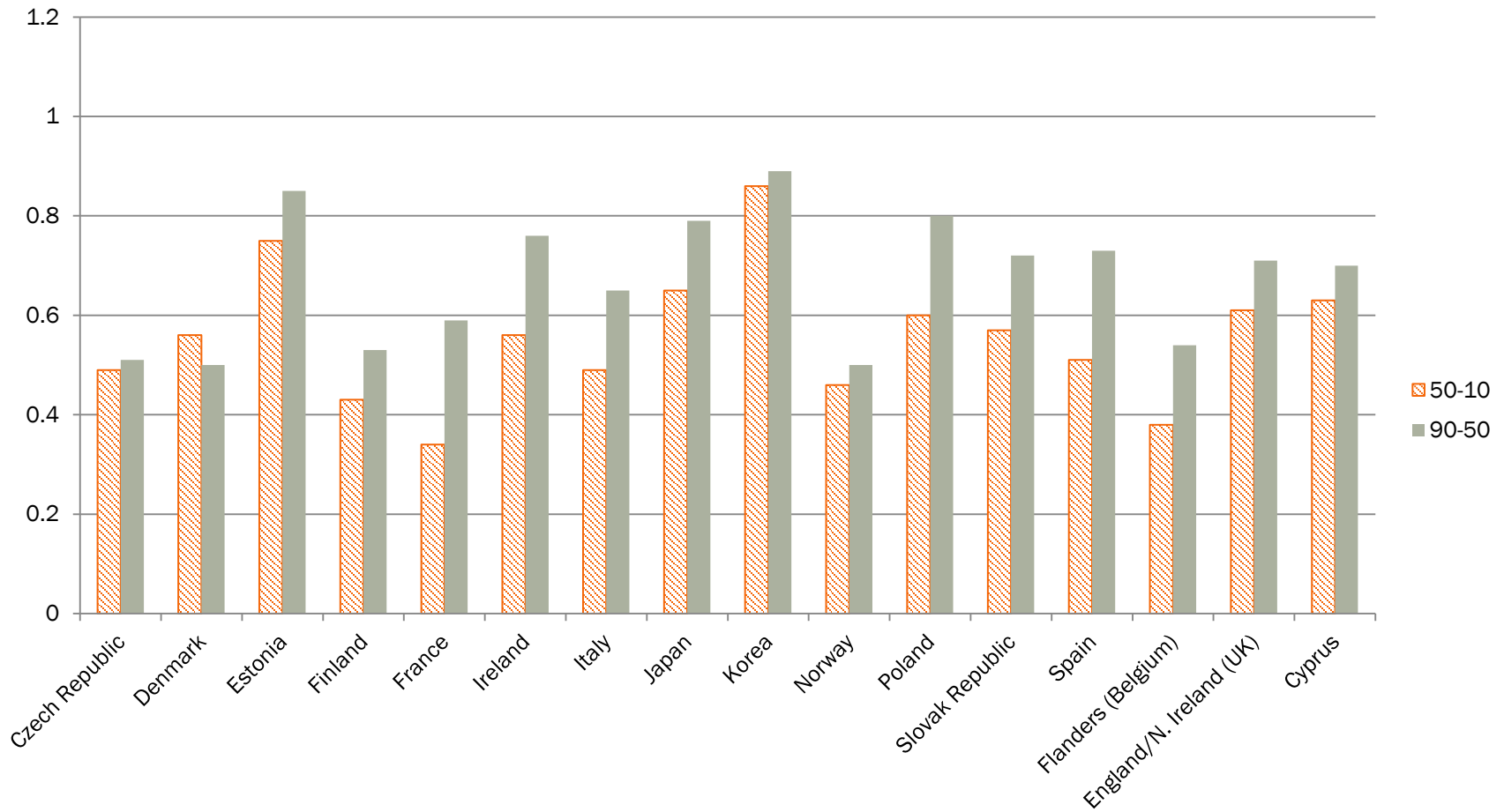
Distribution of Individual Average Test Scores

	Literacy				Numeracy				Problem Solving			
			Percentile Differential				Percentile Differential				Percentile Differential	
Country	mean	sd	50-10	90-50	mean	sd	50-10	90-50	mean	sd	50-10	90-50
Austria	269.45	43.96	59.6	50.51	275.04	49.29	65.3	55.94	283.98	38.01	52.17	45.91
Canada	273.34	50.43	69.39	56.21	265.24	55.6	75.81	62.69	282.29	45.23	63.08	52.96
Czech Republic	274.01	40.79	55.28	47.06	275.73	43.72	60.04	50.9	282.99	44.53	60.96	53.42
Denmark	270.79	47.72	66.38	49.88	278.28	51.23	68.63	57.47	283.08	42.39	59.55	48.99
Estonia	275.88	44.4	60.85	50.99	273.12	45.54	60.46	53.46	277.62	42.67	58.2	51.57
Finland	287.55	50.67	68.32	55.16	282.23	52.21	68.44	59.2	289.37	42.41	59.82	49.36
France	262.14	49.02	69.91	54.03	254.19	56.17	79.41	62.39	.	.	.	.
Germany	269.81	47.4	67.16	54.4	271.73	53.07	74	59.09	282.58	43.7	59.95	52.38
Ireland	266.54	47.19	63.57	52.14	255.59	53.66	70.05	59.28	276.8	40.16	54.56	48.45
Italy	250.48	44.69	60.05	53.69	247.13	49.99	66.39	59.87	.	.	.	.
Japan	296.24	39.71	55.72	44.06	288.17	43.98	59.17	50.89	294.03	44.46	62.65	50.06
Korea	272.56	41.69	57.5	46.31	263.39	45.64	63.29	51.3	282.97	37.64	51.92	44.86
Netherlands	284.01	48.39	69.73	51.89	280.35	51.07	71.14	53.97	286.4	41.71	57.99	48.76
Norway	278.43	47.02	65.33	49.97	278.3	54.21	73.87	57.9	286.49	40.25	56.91	45.42
Poland	266.9	47.98	65.81	55.11	259.77	50.72	68.66	59.2	274.92	48.35	65.15	57.69
Slovak Republic	273.85	40.07	56.49	42.88	275.81	47.6	66.12	51.04	281.08	36.9	49.3	44.38
Spain	251.79	49.03	68.23	55.29	245.82	51.32	72.53	57.08	.	.	.	.
Sweden	279.23	50.56	69.38	52.86	279.05	54.87	74.1	58.74	287.77	43.96	62.87	49.95
United States	269.81	49.19	68.99	57.14	252.84	57.03	78.18	66.66	277.44	43.5	58.67	52.47
Flanders (Belgium)	275.48	47.08	67.96	51.11	280.39	50.59	70.71	57.13	280.76	43.84	61.99	51.13
England/N. Ireland (UK)	272.46	48.97	66.41	57.04	261.73	54.88	73.33	64.38	280.33	42.05	57.13	51.44
Cyprus	268.84	40.27	56.39	46.33	264.63	46.84	62.67	53.51	.	.	.	.
Russian Federation	275.23	42.88	60.25	49.75	269.93	41.98	55.65	49.06	276.25	48.98	66.12	58.15

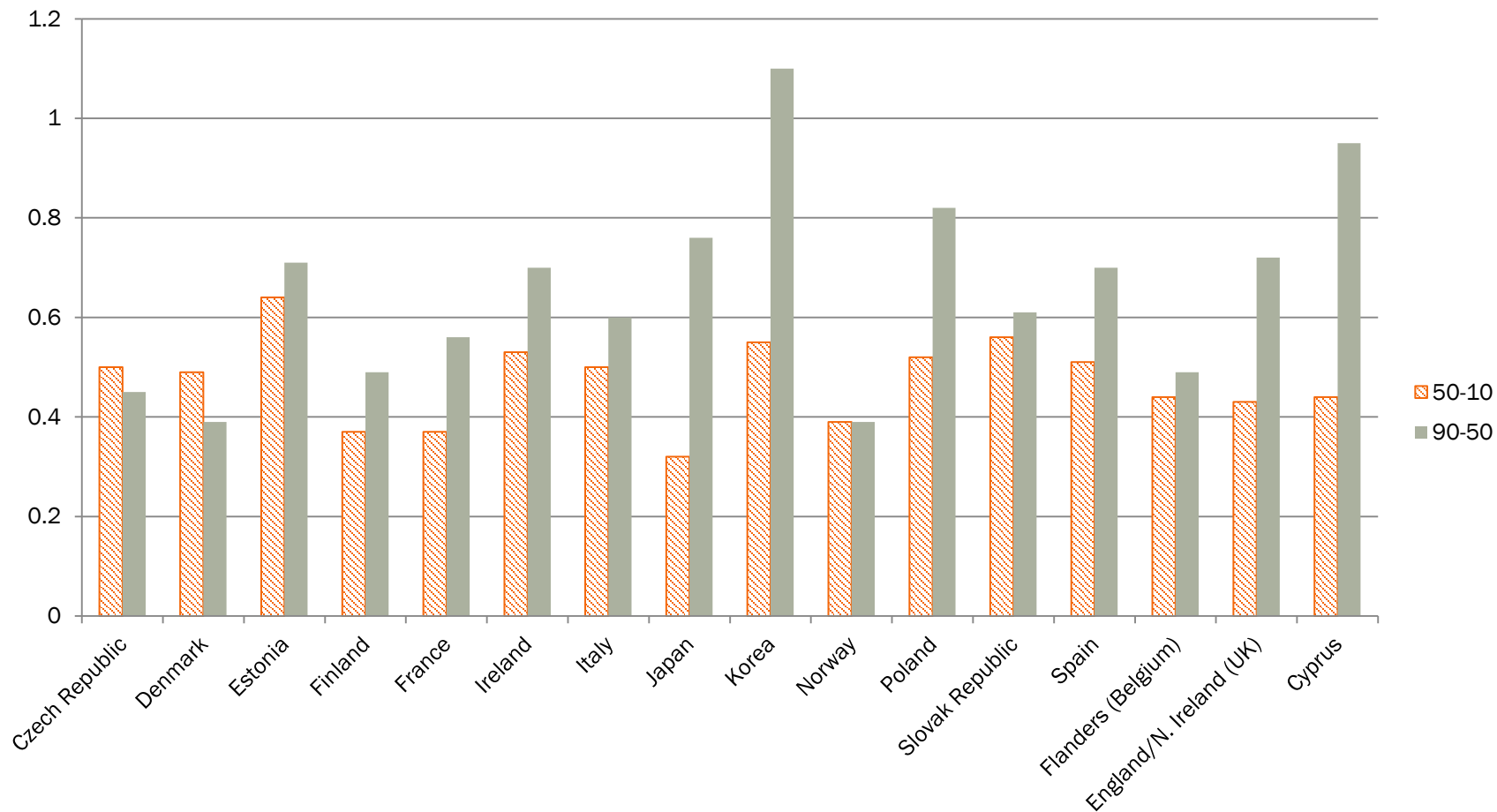
50-10 and 90-50 Log Wage Differentials



Log Wage Differentials--Men



Log Wage Differentials--Women



Previous Literature using PIAAC

- ∞ Hanushek et al. (2013) documents high lifetime labor market returns to numeracy, literacy, and problem solving by estimating Mincer (1974) type wage determination equations incorporating PIAAC skill measures
 - Mincerian framework involves modeling log wages as function of education, experience, and experience squared (to allow for nonlinearities in impact)
 - In base specifications, authors use PIAAC skills instead of education
 - Then include skills *and* educational attainment for robustness
- ∞ Statistically and economically significant relationships between skill and wage *levels* across countries

Inequality Literature and Methodology

- ∞ Approximately 7% correlations between skill inequality and earnings inequality (Devroye and Freeman, 2001; using International Adult Literacy Survey (IALS) for 11 countries)
- ∞ Labor market returns to skills and differences in unexplained portions of models dominate skill levels as determinants of wage inequality (Blau and Kahn, 2005; IALS for 9 OECD countries)
- ∞ Econometric decomposition of several inequality measures allows for analysis of relative importance of differences
 - in levels of skills and other observable wage determinants across countries
 - in measured rates of return to these levels
 - in “unobservable” (unmodeled) features (e.g., institutions, unobserved non-cognitive skill, etc.)

Juhn et al. (1993) Decomposition

Standard wage equation:

$$Y_{ij} = X_{ij}\beta_j + u_{ij} \quad (1)$$

Rewrite error term:

$$u_{ij} = F^{-1}(\theta_{ij}|X_{ij}) \quad (2)$$

Rewrite wage equation:

$$Y_{ij} = X_{ij}\beta_b + X_{ij}(\beta_j - \beta_b) + F_b^{-1}(\theta_{ij}|X_{ij}) + [F^{-1}(\theta_{ij}|X_{ij}) - F_b^{-1}(\theta_{ij}|X_{ij})] \quad (3)$$

Decompose into:

“Observable quantities”

$$X_{ij}\beta_b + F_b^{-1}(\theta_{ij}|X_{ij}) - Y_{ib} \quad (4)$$

“Observable returns”

$$X_{ij}\beta_j + F_b^{-1}(\theta_{ij}|X_{ij}) - [X_{ij}\beta_b + F_b^{-1}(\theta_{ij}|X_{ij}) - Y_{ib}] \quad (5)$$

“Unobservable factors”

$$X_{ij}\beta_j + F^{-1}(\theta_{ij}|X_{ij}) - [X_{ij}\beta_j + F_b^{-1}(\theta_{ij}|X_{ij})] \quad (6)$$

Baseline Country

- ⌘ Devroye and Freeman (2001) discuss high skill and wage inequality in English-speaking countries of Canada, United Kingdom, and United States that are also evident in PIAAC
- ⌘ U.K. stands alone from this group as having necessary PIAAC variables to serve as benchmark
 - U.S. and Canada do not have continuous wages in public-use data
- ⌘ Coefficients and residuals from U.K. specification used as reference prices and residuals for residual distribution
 - ⌘ Using outlier provides prior expectation as to directions of differences across countries and context for interpretation

Decomposition--Standard Deviation of Log Wage

Base Category: U.K., Skills Only as Regressors

Country	Total Difference (country j-b)	Observable Quantities Component	Observable Returns Component	Unobservables Component
Czech Republic	-0.0564	-0.0060	-0.0133	-0.0372
Denmark	-0.0870	-0.0117	-0.0111	-0.0642
Estonia	0.0668	-0.0076	-0.0018	0.0761
Finland	-0.1460	-0.0068	-0.0162	-0.1229
Ireland	0.0929	-0.0034	-0.0022	0.0985
Japan	0.0864	-0.0114	0.0198	0.0780
Korea	0.1668	-0.0172	0.0036	0.1804
Netherlands	0.1013	-0.0077	-0.0137	0.1227
Norway	-0.0896	-0.0090	-0.0091	-0.0715
Poland	0.0631	-0.0074	0.0064	0.0641
Slovak Republic	0.2134	-0.0137	-0.0084	0.2356
Sub-national entities				
Flanders (Belgium)	-0.1303	-0.0041	-0.0174	-0.1088
Partners				
Russian Federation	0.3129	-0.0164	-0.0114	0.3407

Decomposition--50-10 Log Wage Differential

Country	Total Difference (country j-b)	Observable Quantities Component	Observable Returns Component	Unobservables Component
Czech Republic	-0.0549	0.0630	-0.0338	-0.0841
Denmark	-0.0366	0.0261	-0.0233	-0.0394
Estonia	0.1640	0.0560	0.0039	0.1042
Finland	-0.1392	-0.0282	0.0071	-0.1181
Ireland	0.0189	-0.0051	-0.0208	0.0449
Japan	0.0348	0.0007	0.0166	0.0175
Korea	0.2336	0.0444	-0.0088	0.1980
Netherlands	0.0553	-0.0045	-0.0134	0.0732
Norway	-0.1217	-0.0233	0.0087	-0.1071
Poland	0.0959	0.0134	0.0033	0.0792
Slovak Republic	0.0024	0.0278	-0.0270	0.0016
Sub-national entities				
Flanders (Belgium)	-0.1317	0.0354	-0.0527	-0.1144
Partners				
Russian Federation	0.2404	0.0014	-0.0047	0.2437

Decomposition--90-50 Log Wage Differential

Country	Total Difference (country j-b)	Observable Quantities Component	Observable Returns Component	Unobservables Component
Czech Republic	-0.1861	-0.0649	-0.0309	-0.0903
Denmark	-0.2821	-0.0495	-0.0408	-0.1918
Estonia	0.0964	-0.0252	-0.0063	0.1280
Finland	-0.1658	0.0119	-0.0510	-0.1268
Ireland	0.0181	-0.0079	-0.0073	0.0333
Japan	0.1158	-0.0343	0.0483	0.1018
Korea	0.2475	-0.0611	0.0230	0.2857
Netherlands	-0.1304	-0.0326	-0.0139	-0.0840
Norway	-0.2366	-0.0170	-0.0276	-0.1920
Poland	0.0477	-0.0251	0.0150	0.0578
Slovak Republic	0.0046	-0.0434	-0.0118	0.0599
Sub-national entities				
Flanders (Belgium)	-0.2082	-0.0218	-0.0223	-0.1640
Partners				
Russian Federation	-0.0492	0.0154	-0.1181	0.0534

Contributions of Non-skill Determinants

- ∞ Further specification of X_{ij} includes control variables for age (four dummy variables for categorical age ranges), education (in years), experience (in years), and experience squared in addition to literacy, numeracy, and problem-solving skills
- ∞ For standard deviation of log earnings:
 - In 11 out of 12 country pairs (Czech Republic-U.K. being exception), unobservable factors of greater importance than are observable quantities (e.g., of skill, of other schooling) and returns to these factors (e.g., wages as functions of observable skill)
- ∞ For 50-10 log wage differential:
 - Unobservables most important for 9 of 12 cases
- ∞ For 90-50 log wage differential:
 - Unobservables most important for 8 or 12 cases
- ∞ Similar importance of unobservables in specifications by gender

Robustness

- ⌘ Robustness tests show few differences across immigration status categories (another characteristic suggested in literature as important for wage determination)
- ⌘ Major results also are robust to
 - alternative education measures (to include non-formal education)
 - exclusion of age variables
 - alternative earnings measures (hourly wages with bonuses, monthly wages, monthly wages with bonuses, and monthly wages of self-employed)

Caveat: Limitations and Data Availability

- ✎ Complete analysis not possible for several countries due to data limitations in terms of
 - problem solving skills
 - wages
 - basic demographics such as gender and years of education
- ✎ *Suggests that future skill surveys should be especially attentive to availability of comprehensive, comparable data across countries*
 - Paper highlights importance of greater international consistency in future releases of PIAAC variables for understanding true causes of economic inequality within and across nations and developing actionable plans

Conclusions

- ✎ Major finding is that while individuals who participate in programs may themselves experience labor market rewards associated with skill, skill measures (even as comprehensive as those in PIAAC) are only minor determinants of wage inequality
- ✎ Instead, unobservable factor differences are key
 - may include institutional attributes or unobserved individual characteristics such as non-cognitive skill
- ✎ Future work should further examine contributions to economic inequality of specific labor and product market regulation differences across countries
 - external institutional factor indicators may provide value-added if cross-country comparable data can be constructed and merged

Conclusions, cont.

- ⌘ Although beyond scope of paper to determine which institutional factors are causally related to wage inequality across nations, possible to consider some institutional factors more generally for discussion
- ⌘ Hanushek (2013) identifies several OECD indicators related to returns to skill, and Blau and Kahn (2005) hypothesize importance of collective bargaining arrangements
 - Reasonable some same factors also related to wage inequality here
- ⌘ Preliminary examination suggests that institutional factors such as union density and public sector employment may be inversely related to earnings inequality

Implications

- ✎ Paper suggests limits in terms of education and training opportunities that relate to increasing skills for purpose of reducing wage inequality across subgroups
 - Does not mean education and training opportunities are entirely unimportant for inequality
 - Instead, educational opportunity differences may be part of sizeable unobservable component in decompositions and effects may be imperfectly correlated with levels of and returns to observable skills
- ✎ Understanding *how* particular institutions matter is complex
 - Additional research warranted to pinpoint more of these details

Further Research Questions

- ⌘ Disadvantage of decomposition is it discounts supply and demand factor differences that affect wages
 - Possible incomplete estimates of effects of skill distribution changes
- ⌘ Leuven et al. (2004) construct supply and demand indices for low, middle, and high skills and run regressions of wage and skill differences on pairwise combos across countries
- ⌘ Other recent literature suggests quantile regression for studying effects of education on inequality
- ⌘ These methodologies may be relevant for comparison

Further Research, cont.

- ∞ Other future research may consider differences in inequality by race and ethnicity (indicators available for U.S.), and/or more detailed examinations of immigrants versus natives within or across countries
- ∞ Research incorporating future PIAAC releases can examine how economic risk (measured by inequality statistics) changes over time within and across countries
 - Macro-level analysis using aggregated statistics from microdata limited by small (cross-sectional) sample size, but eased with panel/longitudinal data methodologies and multiple data years