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Technology, Skills, and Globalisation: Explaining International Differences in Routine and Non-Routine Work Using Survey Data

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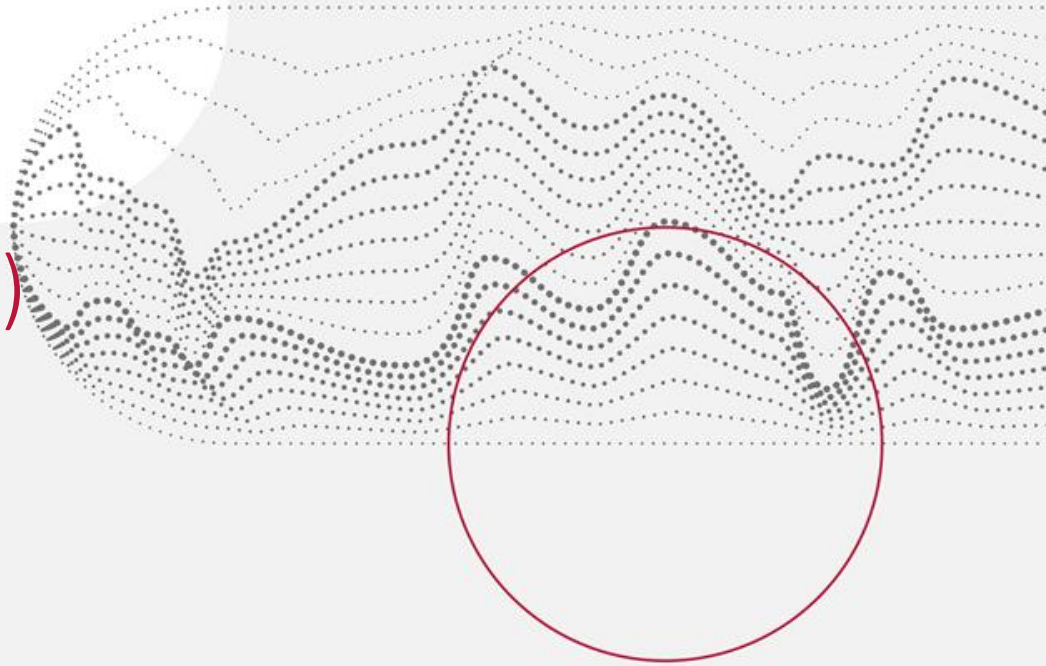
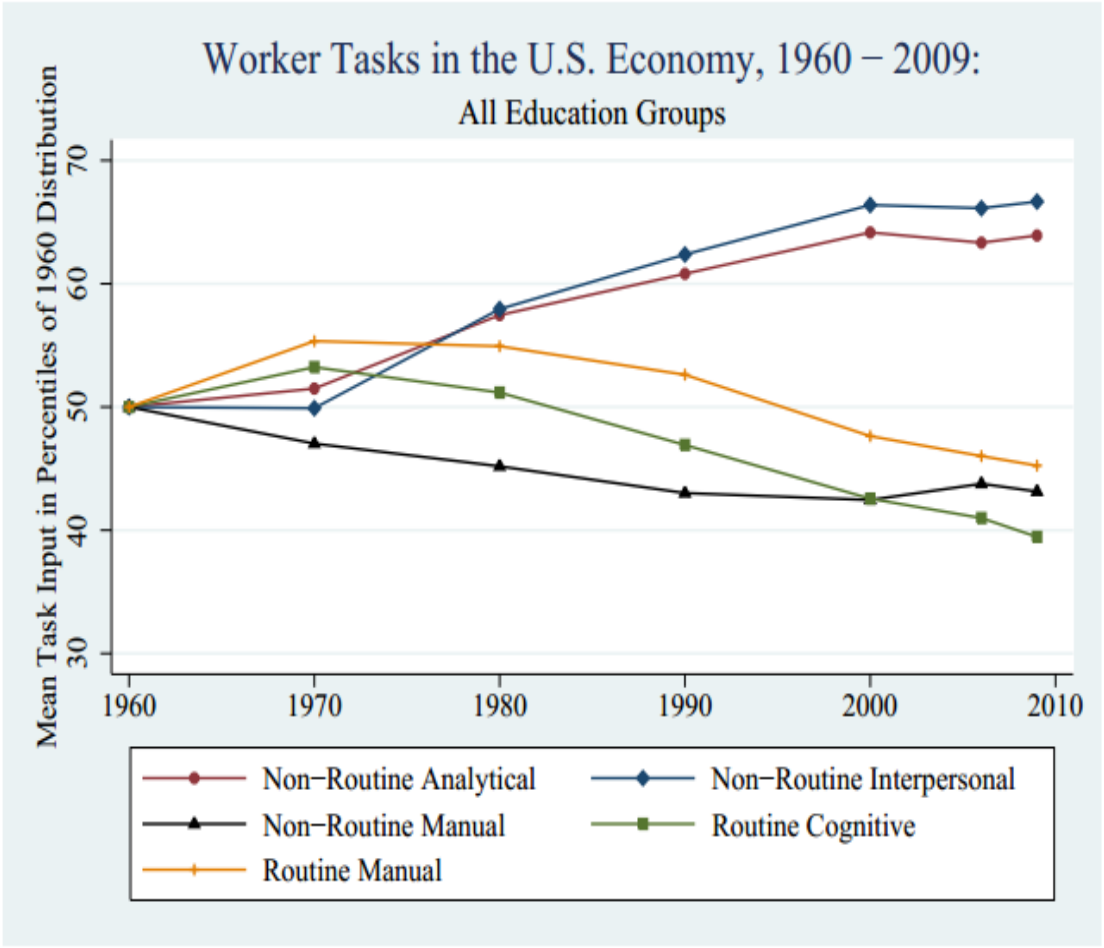
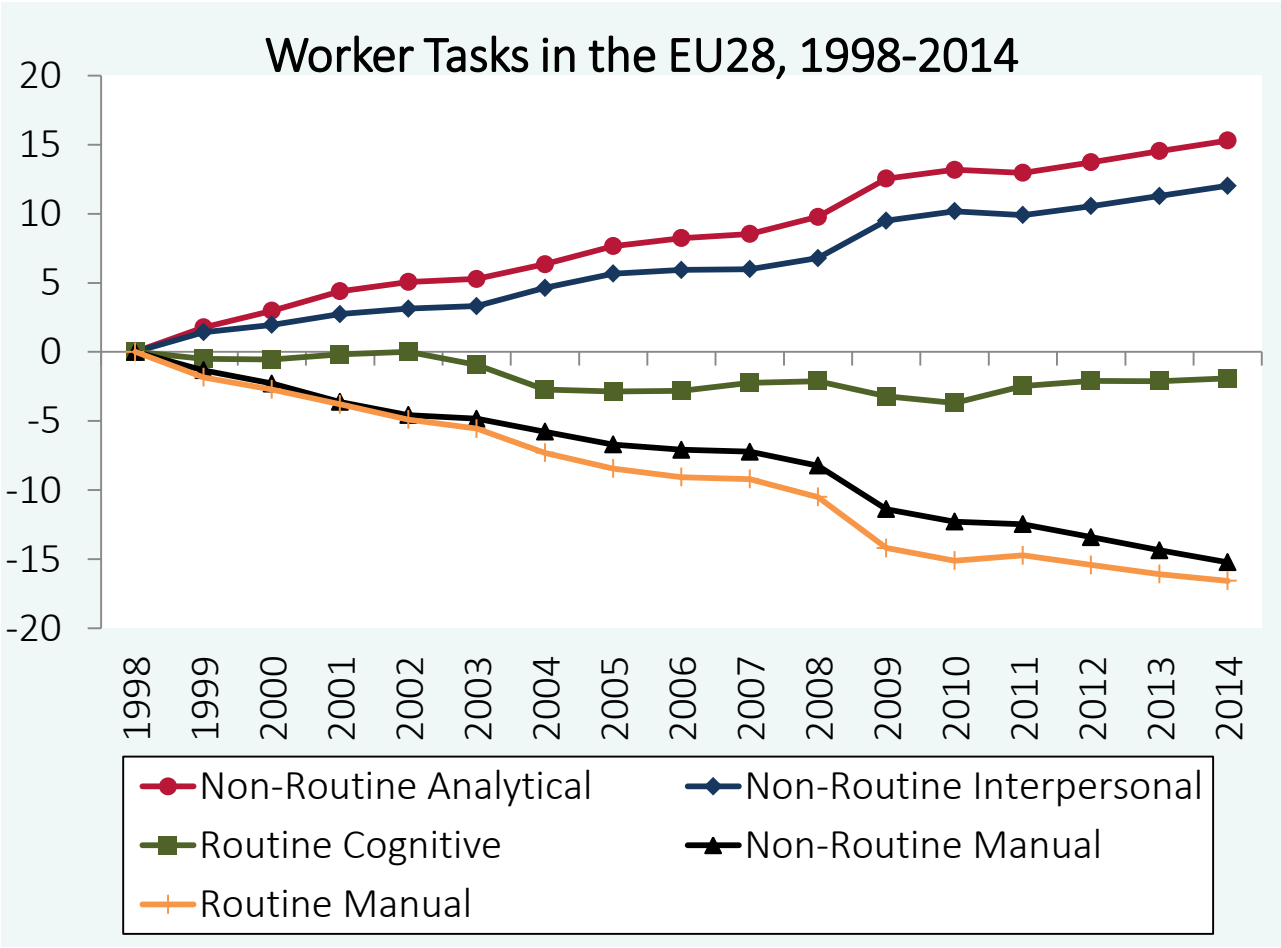


Motivation: the shift away from routine tasks and towards non-routine tasks is a secular change on developed countries' labour markets



Source: Autor, Price (2013)



Source: own calculations

Limitations in the global study of tasks

- Data: tasks are measured at the level of occupation with O*NET, the US database
  - Tasks in the same occupation may differ depending on workers' skills, tenure, etc.
- Data: most countries lack information on worker tasks
  - Focus on occupational structure assuming the US occupation-specific tasks
- Coverage: most research focused on the US and Western Europe
  - Story may be different in middle-income and developing countries

The contribution of this paper

- We construct task content measures which:
  - Are measured at the worker level and country-specific
  - Are consistent with the Acemoglu & Autor (2011) measures based on O*NET

- Data from worker surveys in 42 countries, including high, middle, and low-income
  - Previous studies using survey data examine only richer or poorer countries, and define tasks in an ad-hoc fashion (De la Rica & Gortazar 2016, Marcolin et al. 2016, Dicarlo 2016)

- We examine the contributions of technology, globalization, structural change, and skills to task differences across countries

We use three surveys which include comparable data on the skill use at work, literacy and labour market status

PIAAC (OECD)

- 32 countries surveyed between 2011 and 2015
- sample sizes: from 4000 (Russia) to 26000 (Canada)

STEP (World Bank)

- 9 countries surveyed between 2011 and 2015
- sample sizes: from 2400 (Ukraine) to 4000 (Macedonia) urban residents
- representative for the survey areas

CULS (Chinese Academy of Social Science)

- 6 cities (Guangzhou, Shanghai, Fuzhou, Shenyang, Xian, Wuhan) in 2016
- sample size 15500
- representative for the survey area

Representativeness of the data is limited in some countries. Bear that in mind when looking at the results

PIAAC

- Belgium – Flanders
- Russia – without Moscow municipal area
- UK – England and Northern Ireland
- Indonesia – Jakarta
- Singapore – only permanent residents (approx. 75% of population)

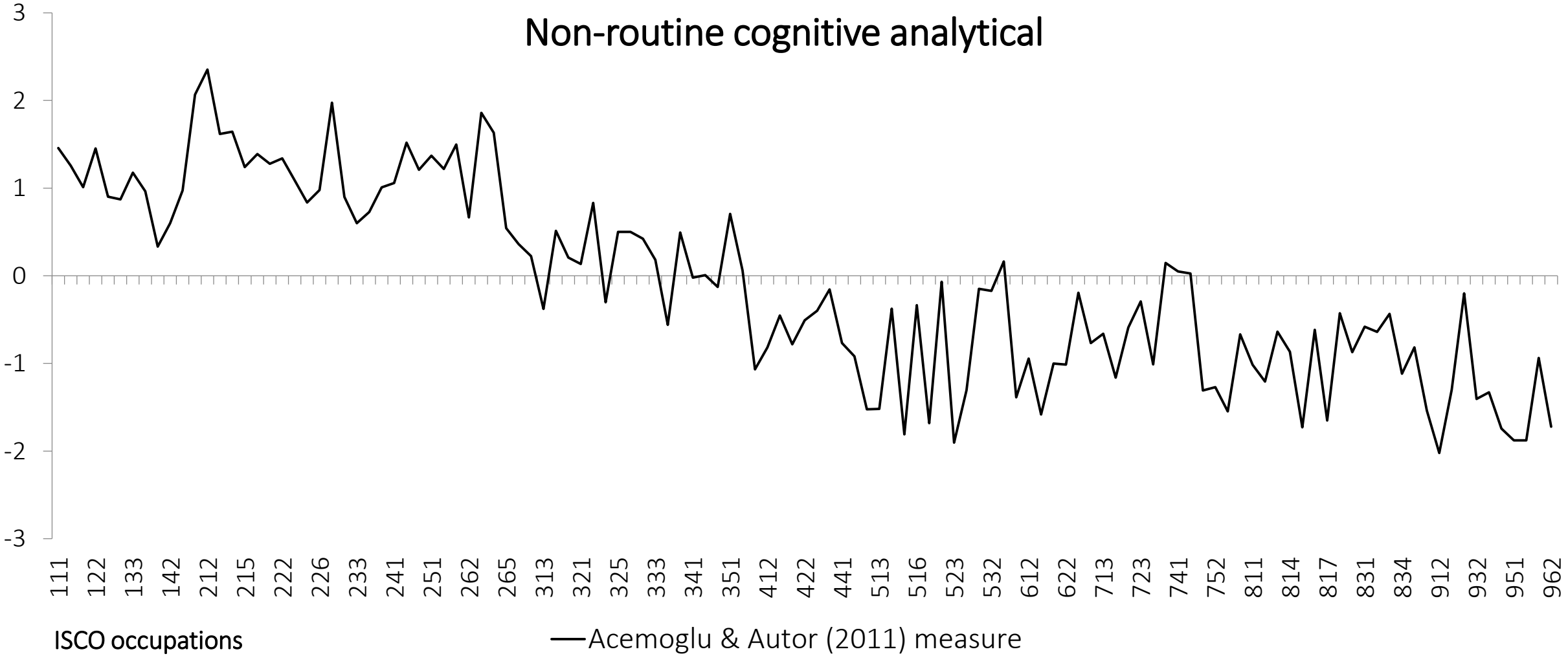
STEP – urban survey with additional limitations in some countries

- Bolivia – four main cities – La Paz, El Alto, Cochabamba and Santa Cruz de la Sierra (approx. 80% of urban population)
- Colombia – 13 main metropolitan areas
- Georgia – no Abkhazia, South Ossetia
- Lao PDR – both urban and rural, but we drop rural for consistency
- China (CULS) – 6 cities

We construct our task measures on the US PIAAC and O*NET data

Merge O*NET with the US PIAAC,
calculate the Autor & Acemoglu (2011) task contents

Autor & Acemoglu (2011) task contents calculated with O*NET merged with US PIAAC data



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group them into 4 categories: non-routine cognitive analytical and personal, routine cognitive, manual

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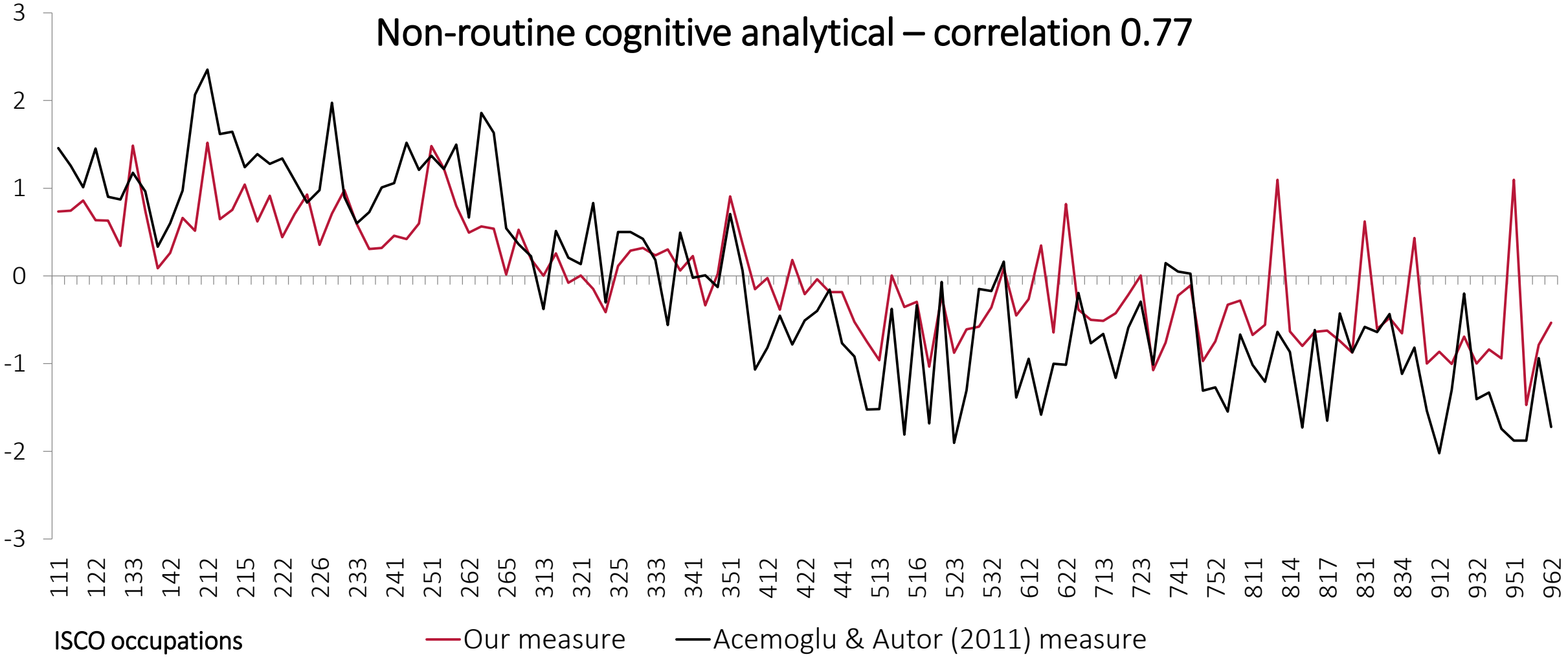
Apply Autor & Acemoglu (2011) method to PIAAC items, to find combinations that result in measures highly correlated with the O*NET tasks at the occupation level in the US

At the 3-digit occupation level in the US, the correlations between our measures and O*NET measures range from 0.55 to 0.77



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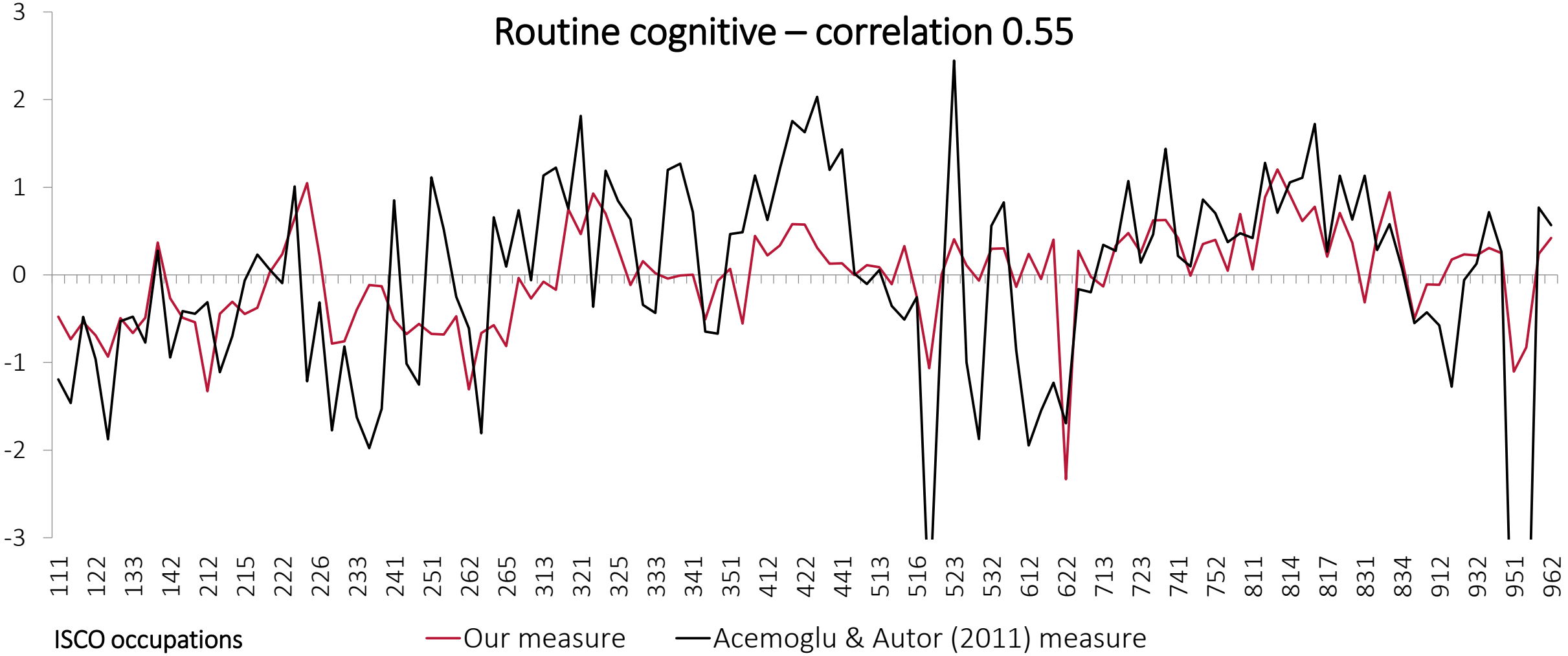


We define task contents with these PIAAC / STEP items

Task content measure	No. of item / cut-off combinations considered	Chosen PIAAC / STEP task items
Non-routine cognitive analytical	156 250	Reading news Reading professional titles Solving problems Programming
Non-routine cognitive interpersonal	24	Supervising Presenting
Routine cognitive	5 000	Changing order of tasks (reversed) Filling forms Presenting (reversed)
Manual	1	Physical tasks

We use the selected PIAAC / STEP questions to calculate the values of worker tasks in all 42 countries

There is no unit of a task – we relate all countries to the US distribution:

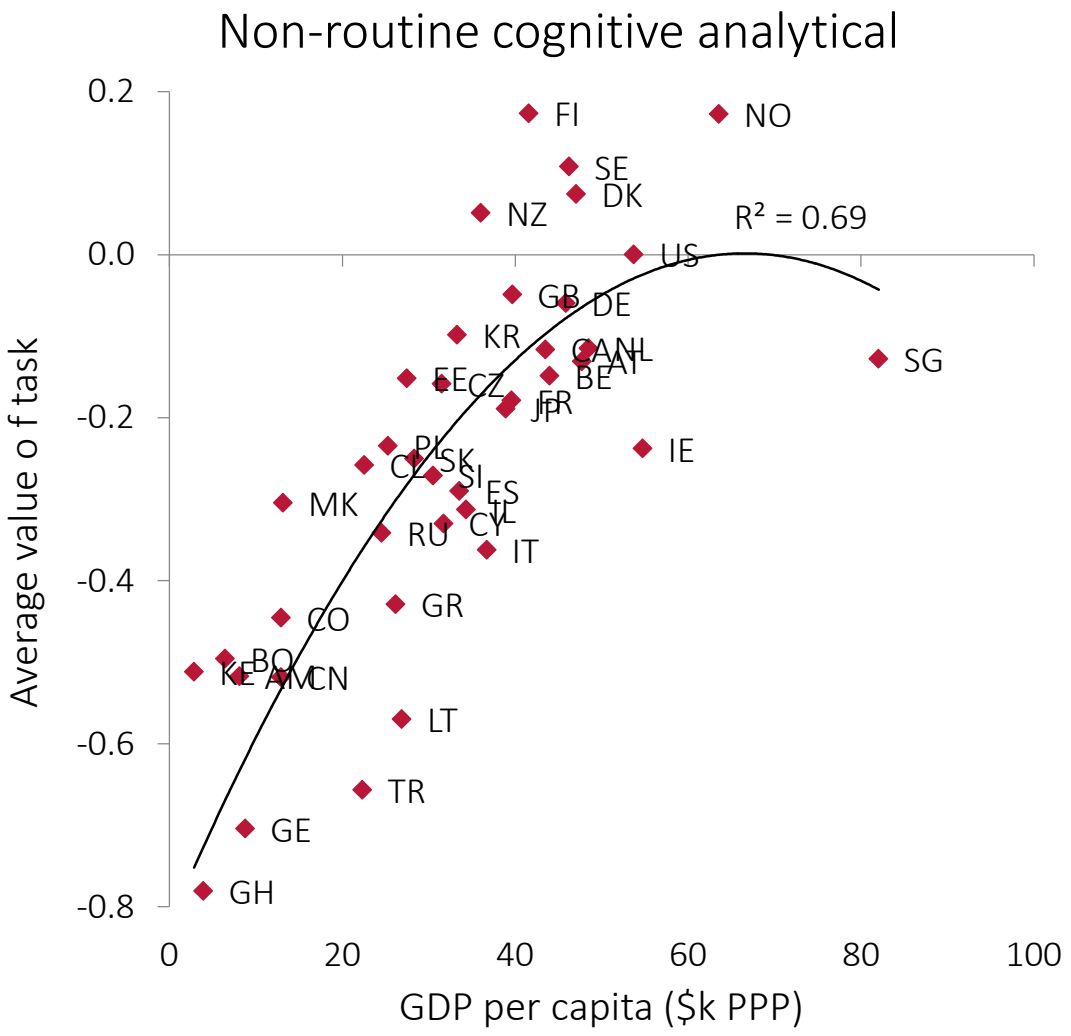
- 0 is the average level of a given task in the US
- 1 is equivalent to the standard deviation of a given task in the US

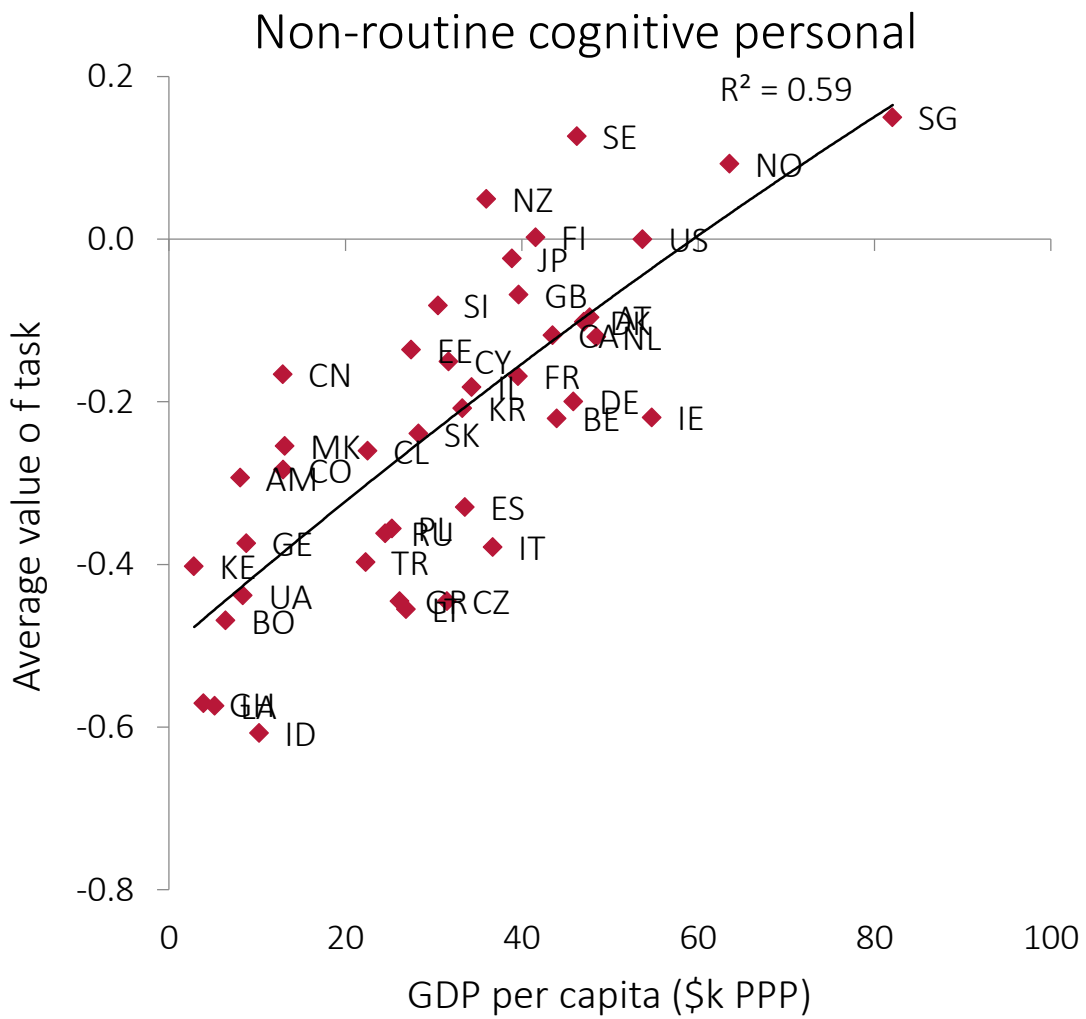
We also define routine task intensity (RTI)

$$RTI = \ln(r_{cog}) - \ln\left(\frac{nr_{analytical} + nr_{personal}}{2}\right)$$

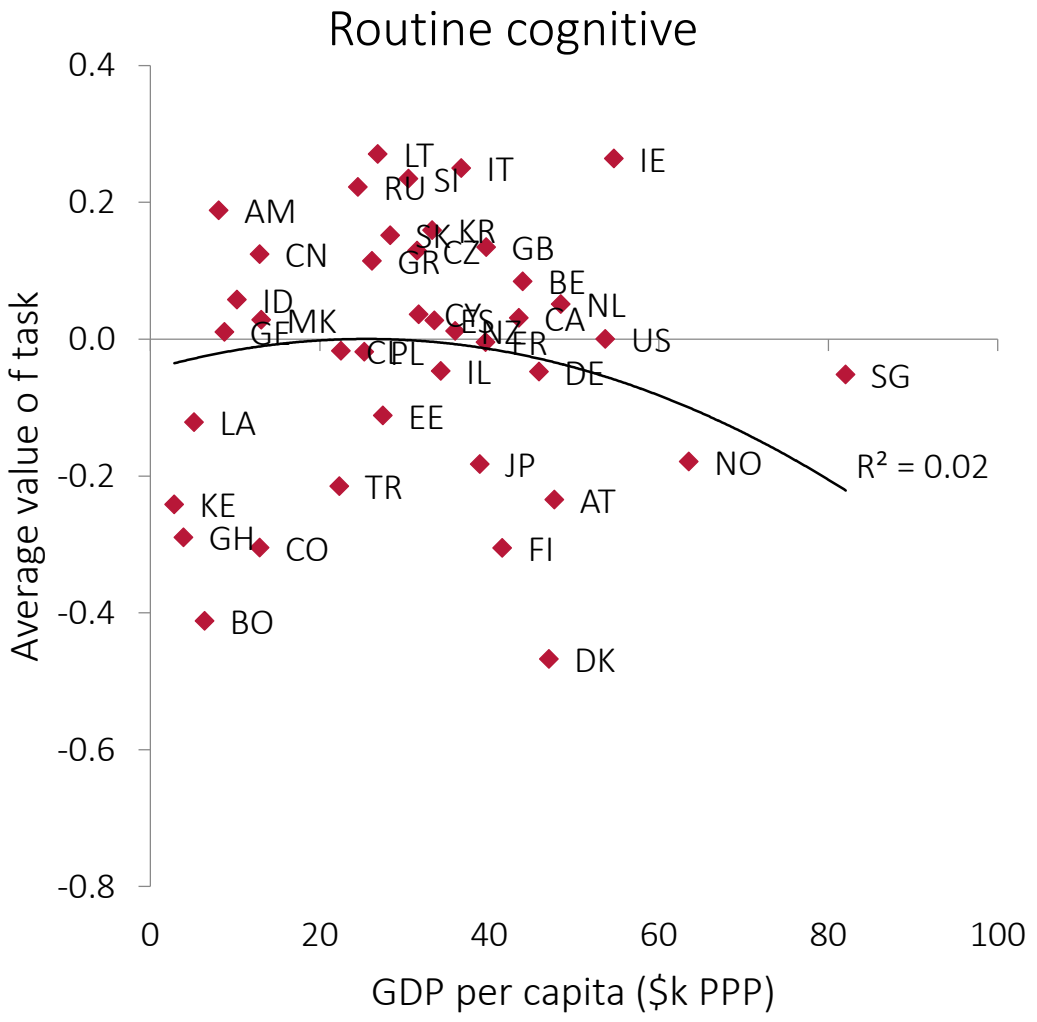
- RTI increases with the relative importance of routine tasks,
- RTI decreases with the relative importance of non-routine tasks.

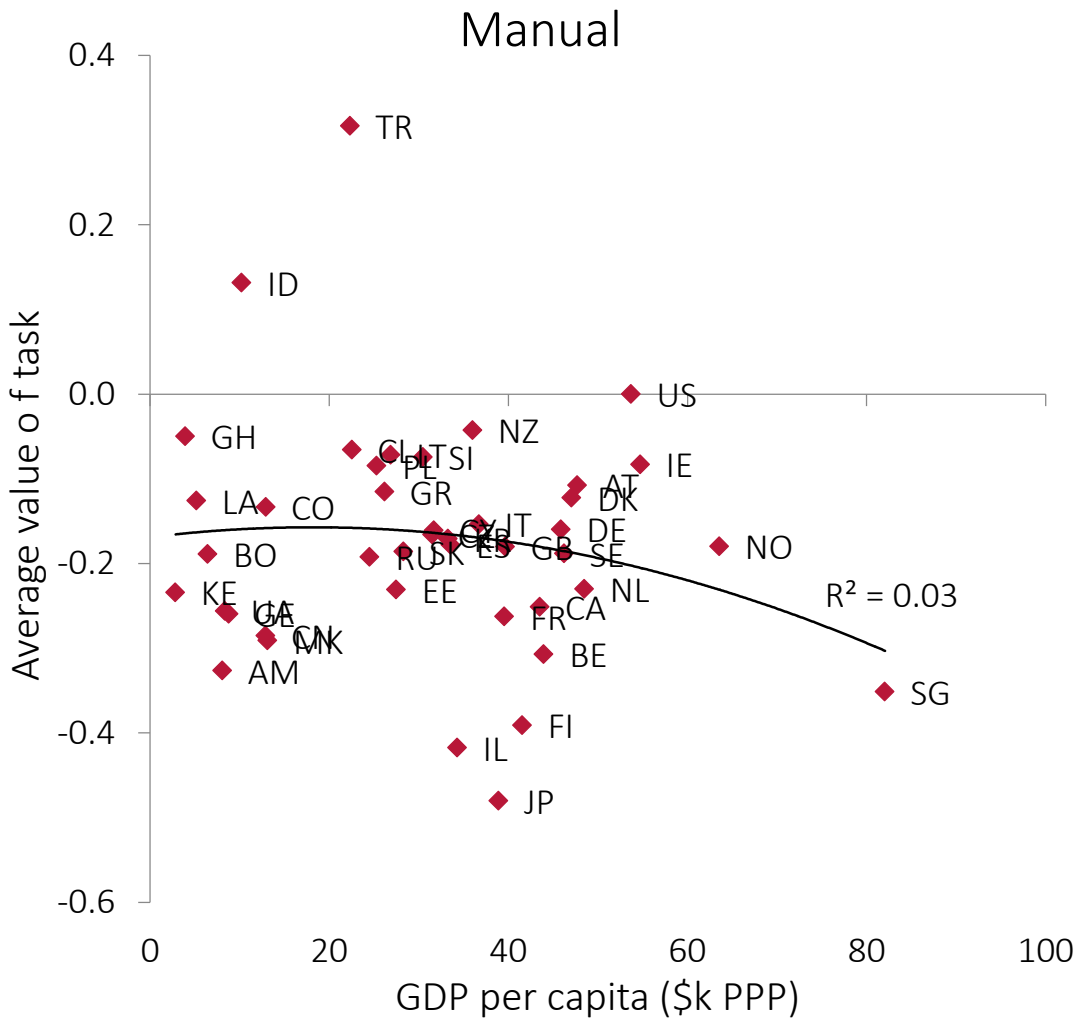
The more developed countries exhibit higher average values of non-routine tasks than the less developed countries



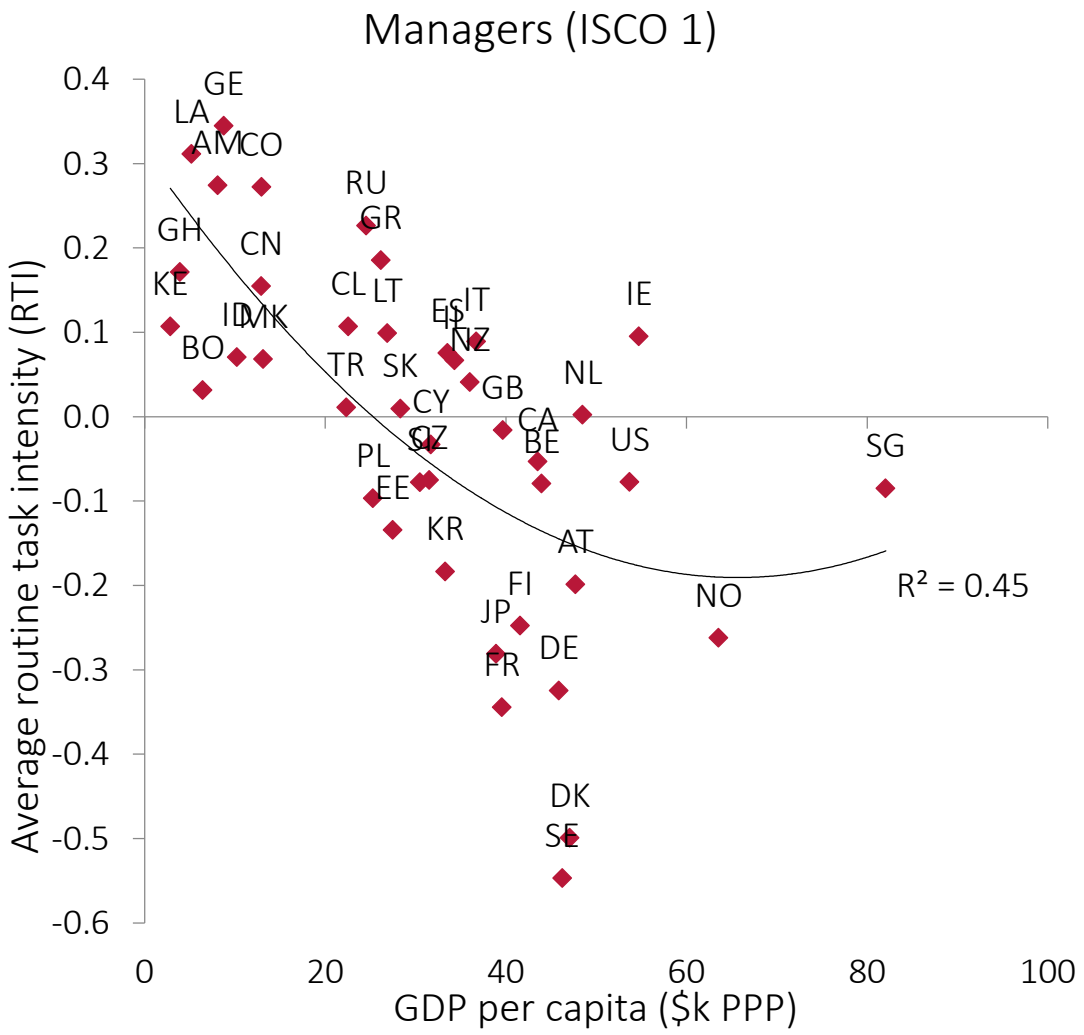


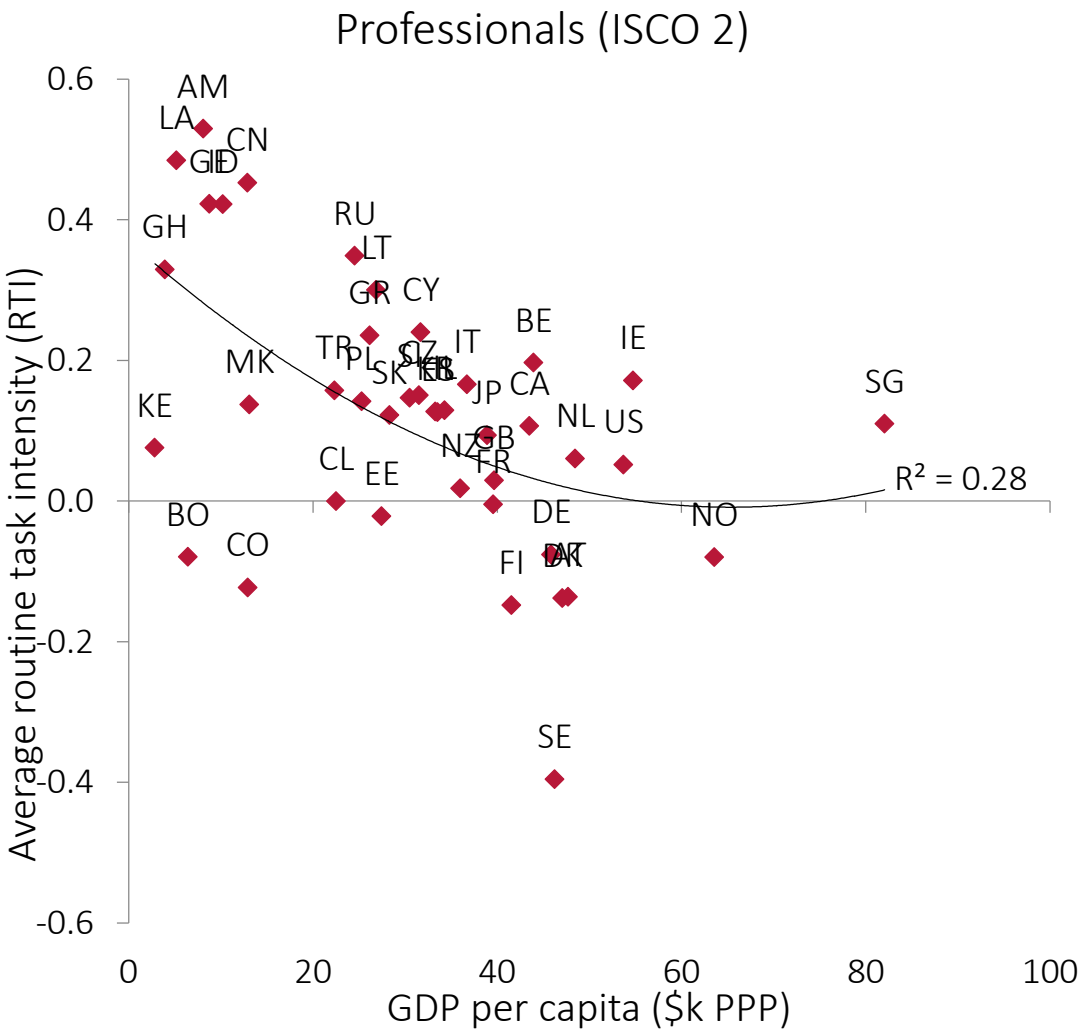
The relationship of routine cognitive and manual tasks with GDP per capita is inverse U-shaped but not significant



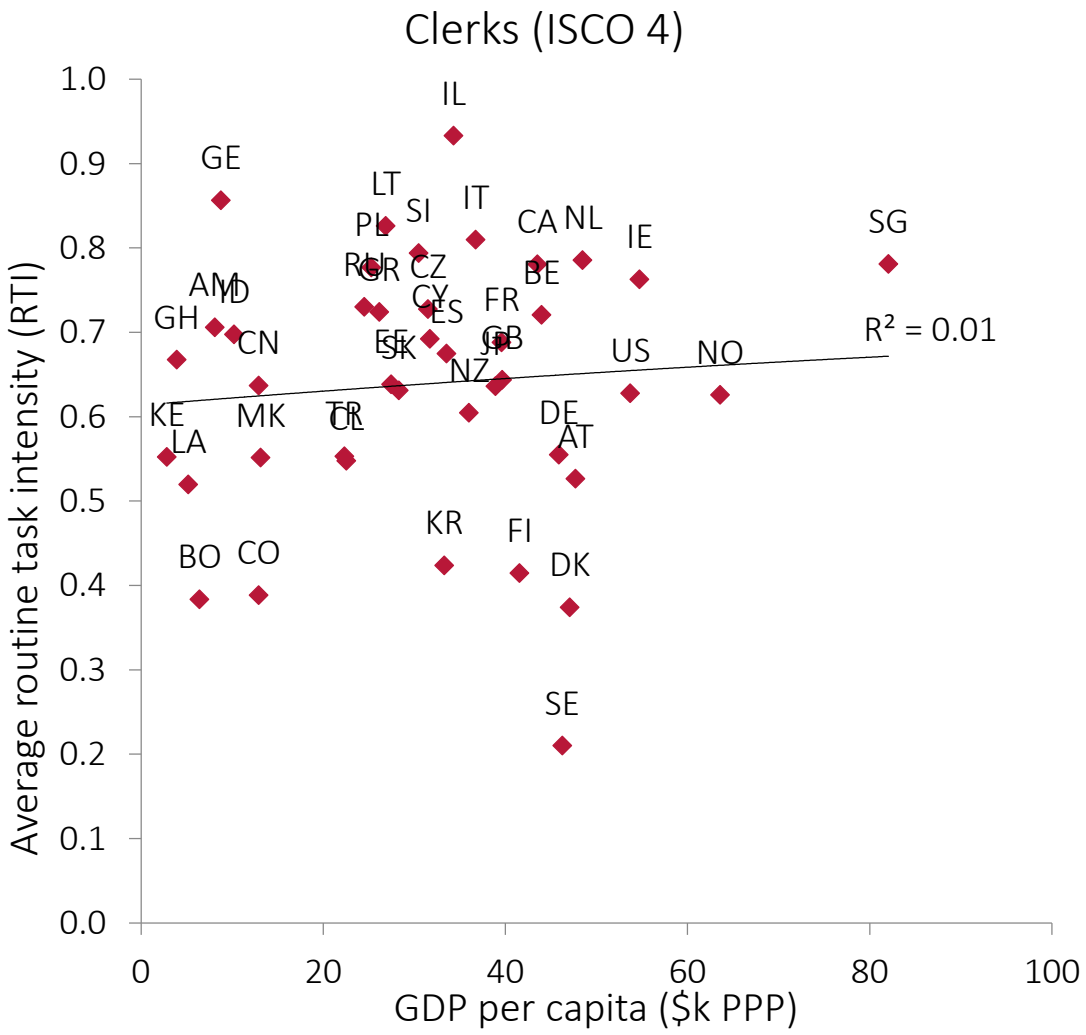


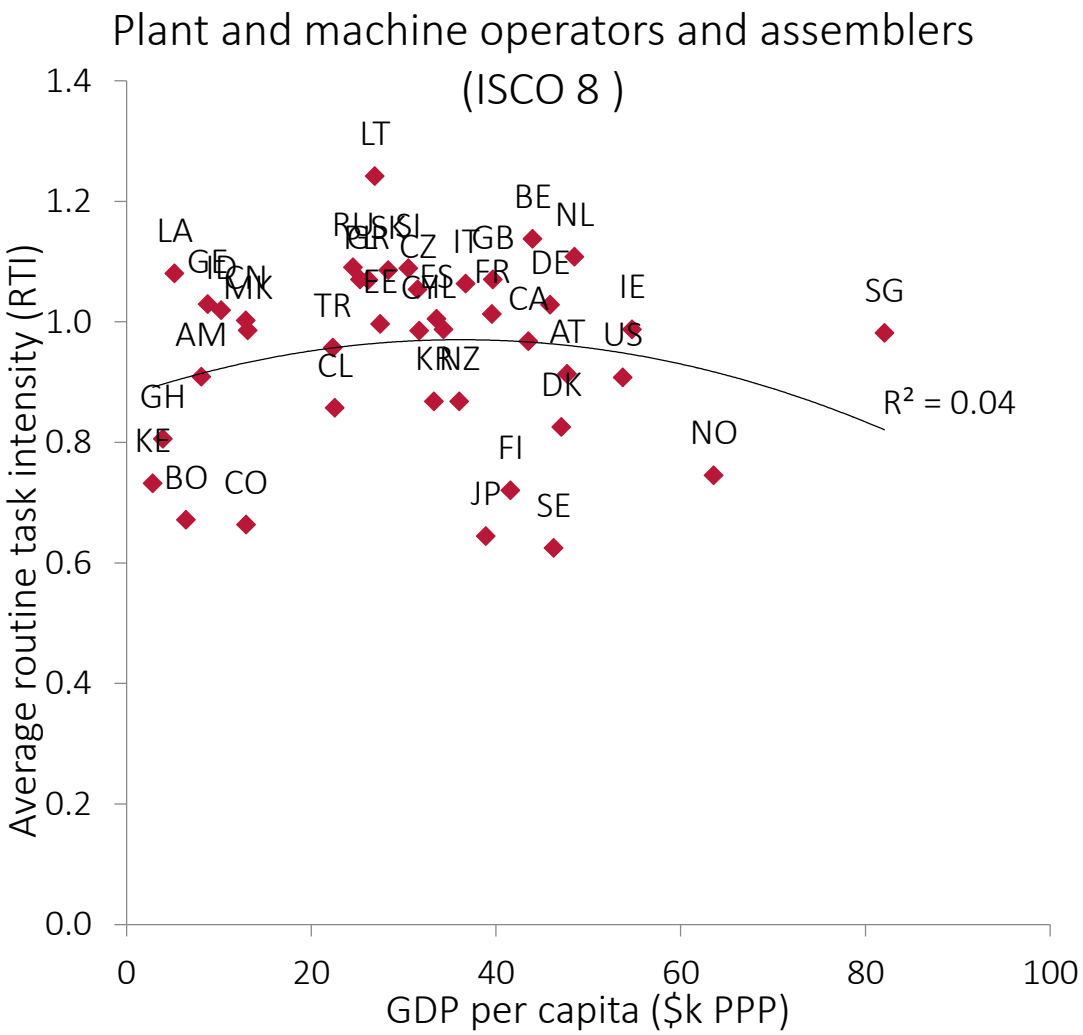
Noticeable differences in the routine task intensity of the high-skilled occupations in the less and more developed countries





Cross-country differences in RTI of middle- and low-skilled occupations are not systematicaly related to the development level





We estimate worker-level models to find correlates of routine intensity

$$RTI_{ijsc} = \beta_0 + \beta_1 Z_{ijsc} + \beta_2 G_{sc} + \lambda_s + \beta_3 E_{ijsc} + \varepsilon_{ijsc}$$

RTI_{ijsc} - routine task intensity of individual i in occupation j in sector s in country $\mathbf{c}$.

Z_{ijsc} - technology used by individual i,

G_{sc} - globalisation in sector s in country $\mathbf{c}$,

λ_s - sector fixed effects,

E_{ijsc} - skills and demographic characteristics of workers.

Regressions for all workers and for workers in high (ISCO 1-3), middle (ISCO 4-5) and low-skilled (ISCO 7-9) occupations

We measure the 4 factors with worker, sector-country and country variables

- Technology: individual computer use, *sector-country robot stock (per worker), *ICT capital stock per worker
- Globalisation: foreign value added share in domestic output (FVA), trade/GDP, FDI stock/GDP
- Structural change: 19 sectors, GDP per capita (log)
- Skill supply: education, literacy skills, female, age group

*available for 31 countries only

Female and younger workers perform more routine intensive tasks

		All workers	High-skilled occ. (ISCO 1-3)	Middle-skilled occ. (ISCO 4-5)	Low-skilled occ. (ISCO 7-9)
	Female	0.24***	0.24***	0.20***	0.28***
Ref. 25-44	Age 16-24	0.20***	0.20***	0.19***	0.13***
	Age 35-44	-0.07***	-0.06***	-0.04**	-0.04**
	Age 45-54	-0.05***	-0.08***	-0.03	0.01
	Age 55-64	-0.04**	-0.07**	0.03	0.02
	No. of obs. / R^2	148,567 / 0.30	62,906 / 0.14	47,373 / 0.15	38,288 / 0.16

*** p<0.01, ** p<0.05, * p<0.1.

Higher skills are associated with less routine tasks, mainly among workers in high-skilled occupations.

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	Female	0.24***	0.24***	0.20***	0.28***
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	Age 45-54	-0.05***	-0.08***	-0.03	0.01
	Age 55-64	-0.04**	-0.07**	0.03	0.02
Ref. Secondary	Primary education	0.11***	0.05*	0.13***	0.07***
	Tertiary education	-0.32***	-0. 22***	-0.12***	-0.078**
Ref. Lower	Medium literacy skills	-0.09***	-0.08***	-0.03	-0.00
	High literacy skills	-0.23***	-0.19***	-0.04	-0.07
	No. of obs. / R^2	148,567 / 0.30	62,906 / 0.14	47,373 / 0.15	38,288 / 0.16

**** p<0.01, ** p<0.05, * p<0.1.*

Computer use is related to less routine tasks.
Robots & ICT are insignificant if we control for computer use

	All workers	High-skilled occ. (ISCO 1-3)	Middle-skilled occ. (ISCO 4-5)	Low-skilled occ. (ISCO 7-9)
Computer use	-0.79***	-0.51***	-0.62***	-0.68***
Foreign VA share				
Foreign VA* GDP pc				
FDI / GDP				
GDP per capita (log)				
No. of obs. / R^2	148,567 / 0.30	62,906 / 0.14	47,373 / 0.15	38,288 / 0.16

**** p<0.01, ** p<0.05, * p<0.1.*

Globalisation is related to lower RTI in richer countries (and high-skilled workers) and higher RTI in poorer countries (and low-skilled workers)

	All workers	High-skilled occ. (ISCO 1-3)	Middle-skilled occ. (ISCO 4-5)	Low-skilled occ. (ISCO 7-9)
Computer use	-0.79***	-0.51***	-0.62***	-0.68***
Foreign VA share	0.33**	-0.02	0.21	0.85***
Foreign VA* GDP pc	-0.21	-0.33*	-0.20	-0.11
FDI / GDP	0.00	0.02***	0.01	-0.03***
GDP per capita (log)	0.01	-0.06	0.03	0.05
No. of obs. / R^2	148,567 / 0.30	62,906 / 0.14	47,373 / 0.15	38,288 / 0.16

**** p<0.01, ** p<0.05, * p<0.1.*

Decomposition:
What explains differences in routine task intensity with the US?

We use

- the estimated regression coefficients
- mean differences with the US in explanatory factors

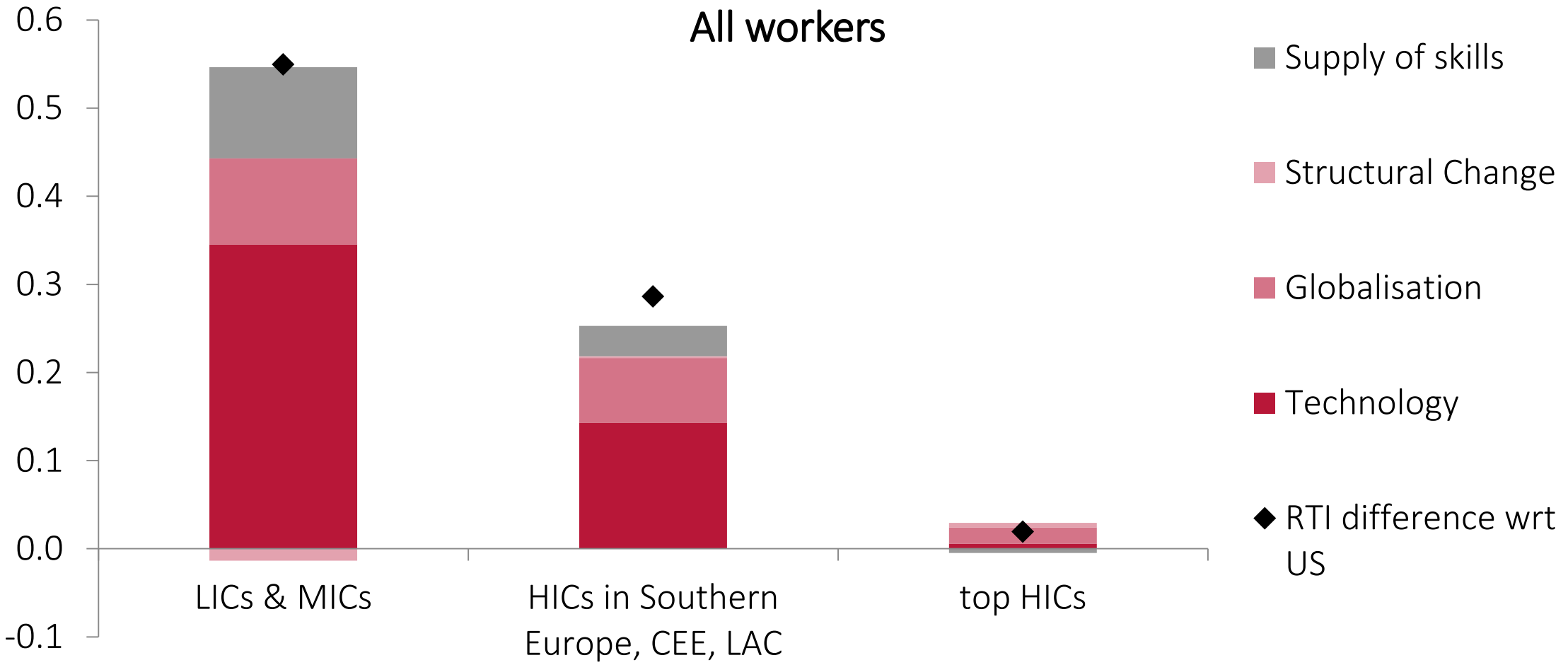
to decompose the difference in average RTI between each country and the US

$$\overline{RTI_j} - \overline{RTI_{US}} = \\ = \beta_1\left(\overline{Z_{ijsc}} - \overline{Z_{ijsUS}}\right) + \beta_2(\overline{G_{sc}} - \overline{G_{sU}}) + \beta_2(\overline{\lambda_{sc}} - \overline{\lambda_{sUS}}) + \beta_3\left(\overline{E_{ijsc}} - \overline{E_{ijsUS}}\right)$$

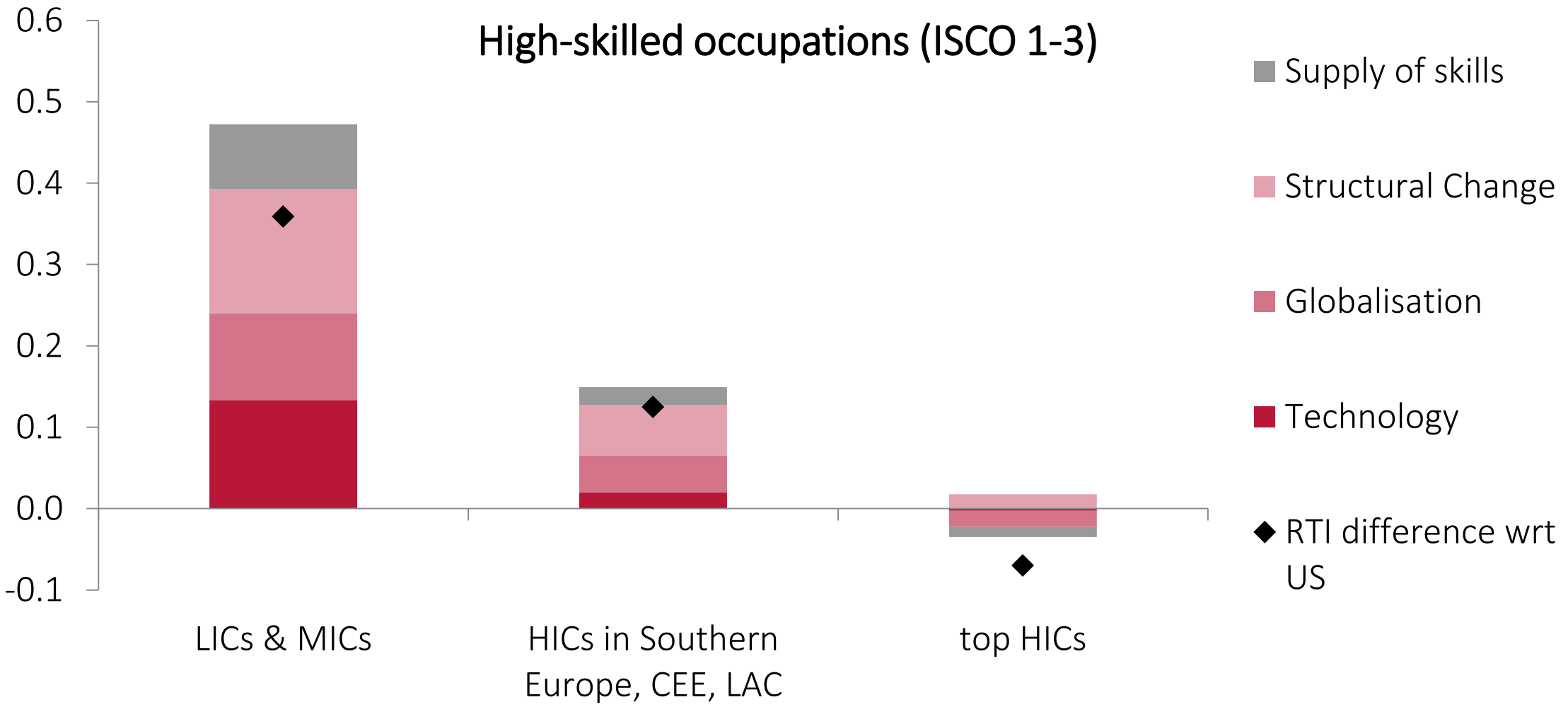
We group countries to three classes and take averages of decomposition results for each class

Low and Middle Income Countries	High Income Countries	Top High Income Countries
Kenya	Chile	Korea, Rep.
Ghana	Poland	France
Lao, PDR	Lithuania	Israel
Ukraine	Slovakia	Japan
Bolivia	Cyprus	New Zealand
Indonesia	Estonia	United Kingdom
China	Greece	Belgium
Armenia	Czech Rep.	Germany
Georgia	Slovenia	Canada
Colombia	Spain	Finland
Russia	Italy	Austria
Turkey		Netherlands
		Sweden
		Denmark
		Singapore
		Ireland
		Norway

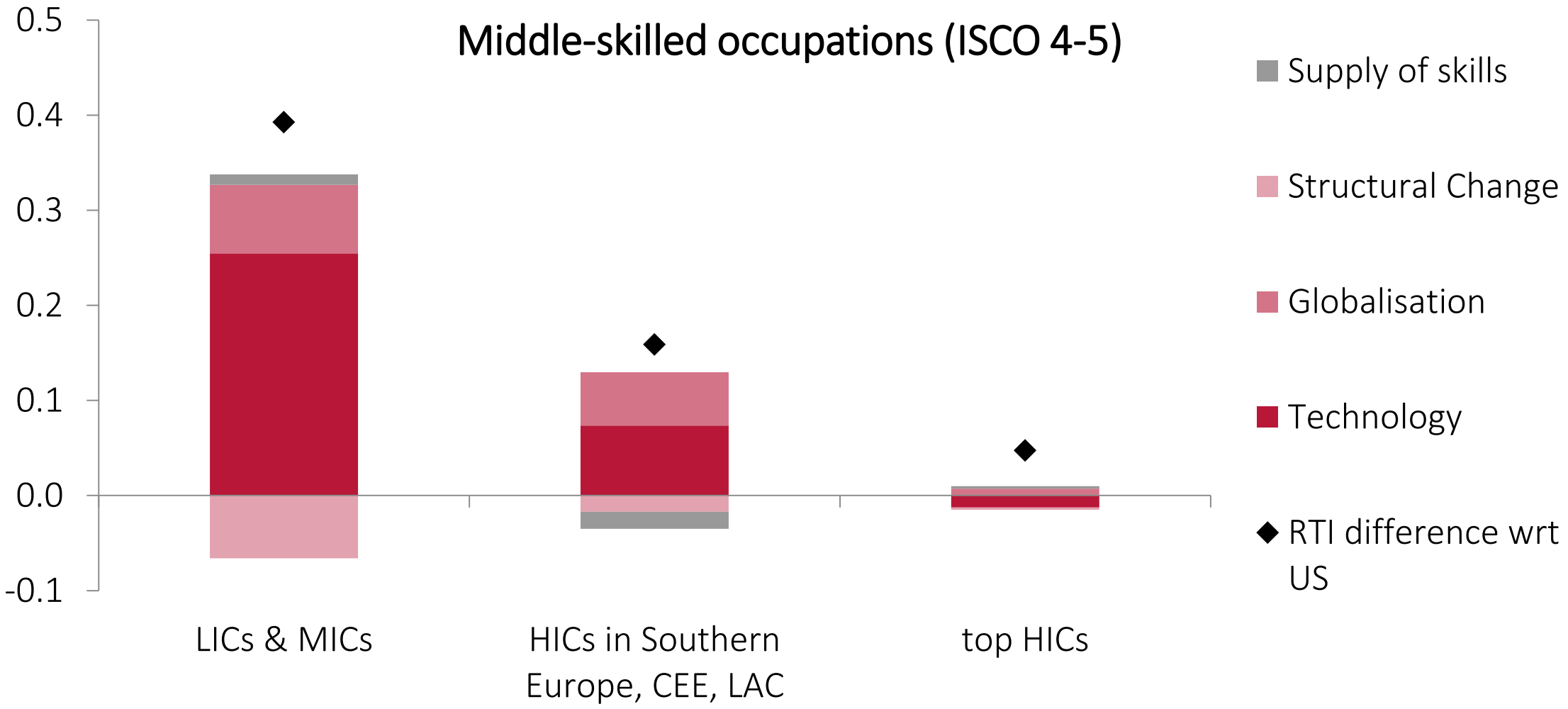
Technology has the largest overall contribution, while skills matter in low- and middle-income countries



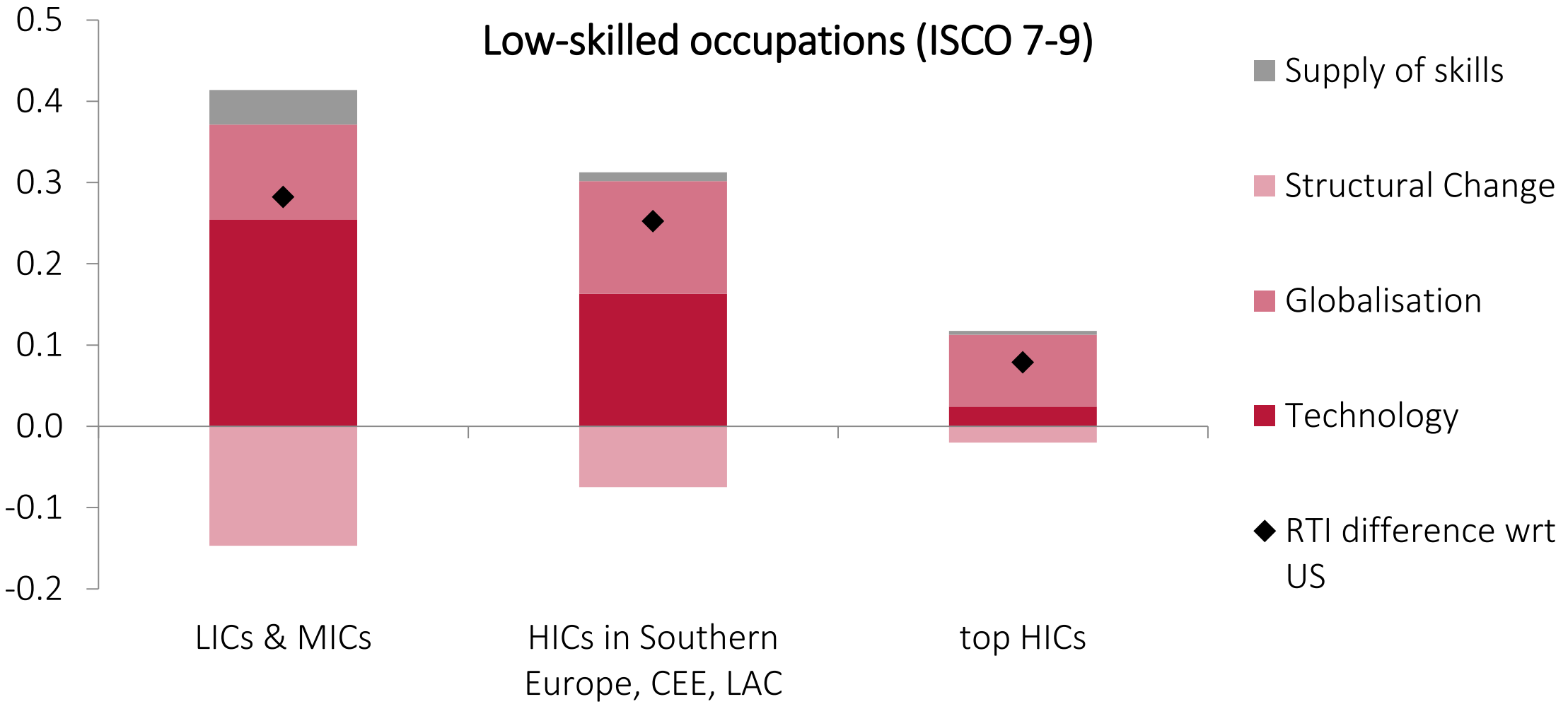
For the high-skilled occupations, technology and skills contribute only in LICs & MICs



Technology contributes the most to the differences in routine intensity of middle-skill occupations



The contribution of globalisation is the most pronounced for low-skilled occupations



What tasks tell us about the global division of work

- Occupations are indeed different around the world.
- Technology (especially computer use) contributes most to the cross-country differences in tasks, except for among the richest countries.
- Globalisation contributes substantially to differences between low-skilled occupations.
- Structural change and skills explain a modest amount of cross-country differences in tasks.

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Thanks for listening

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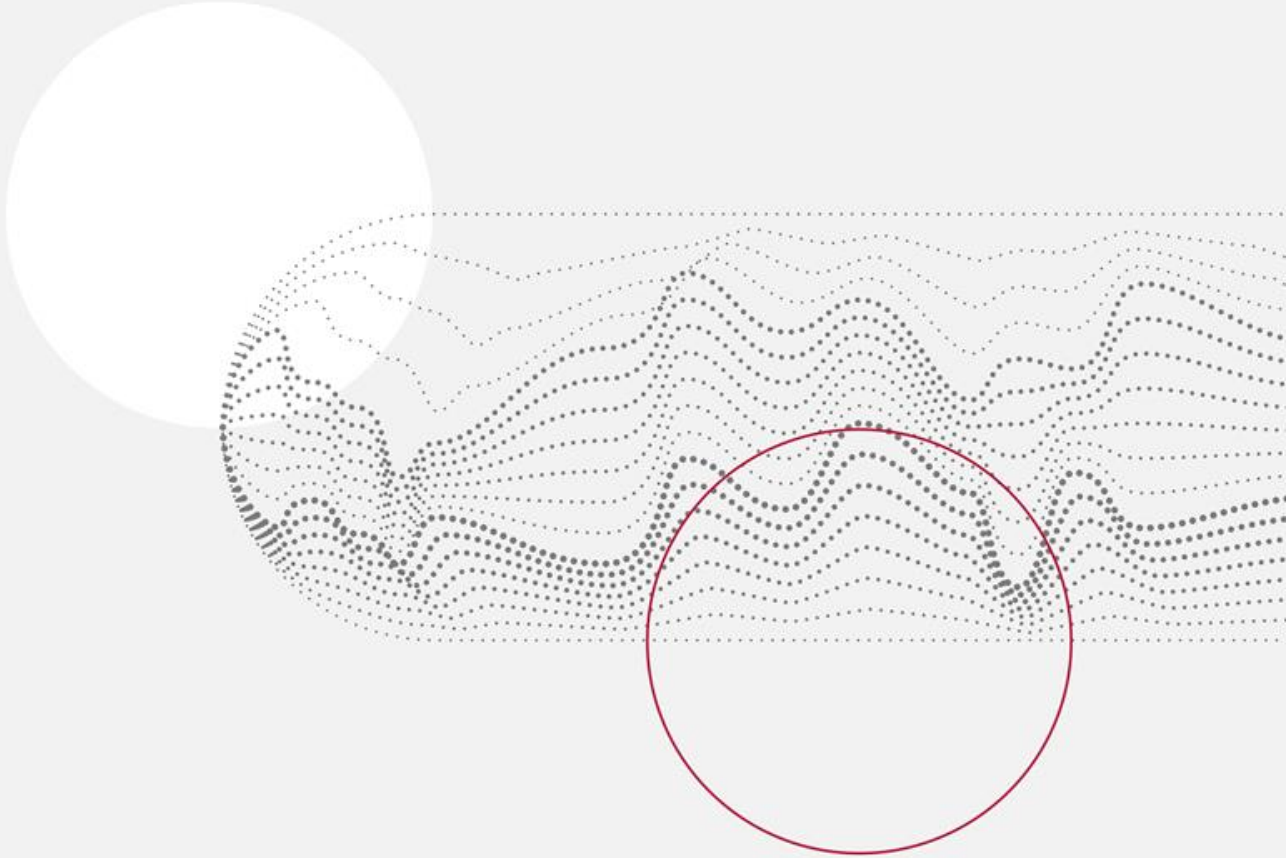
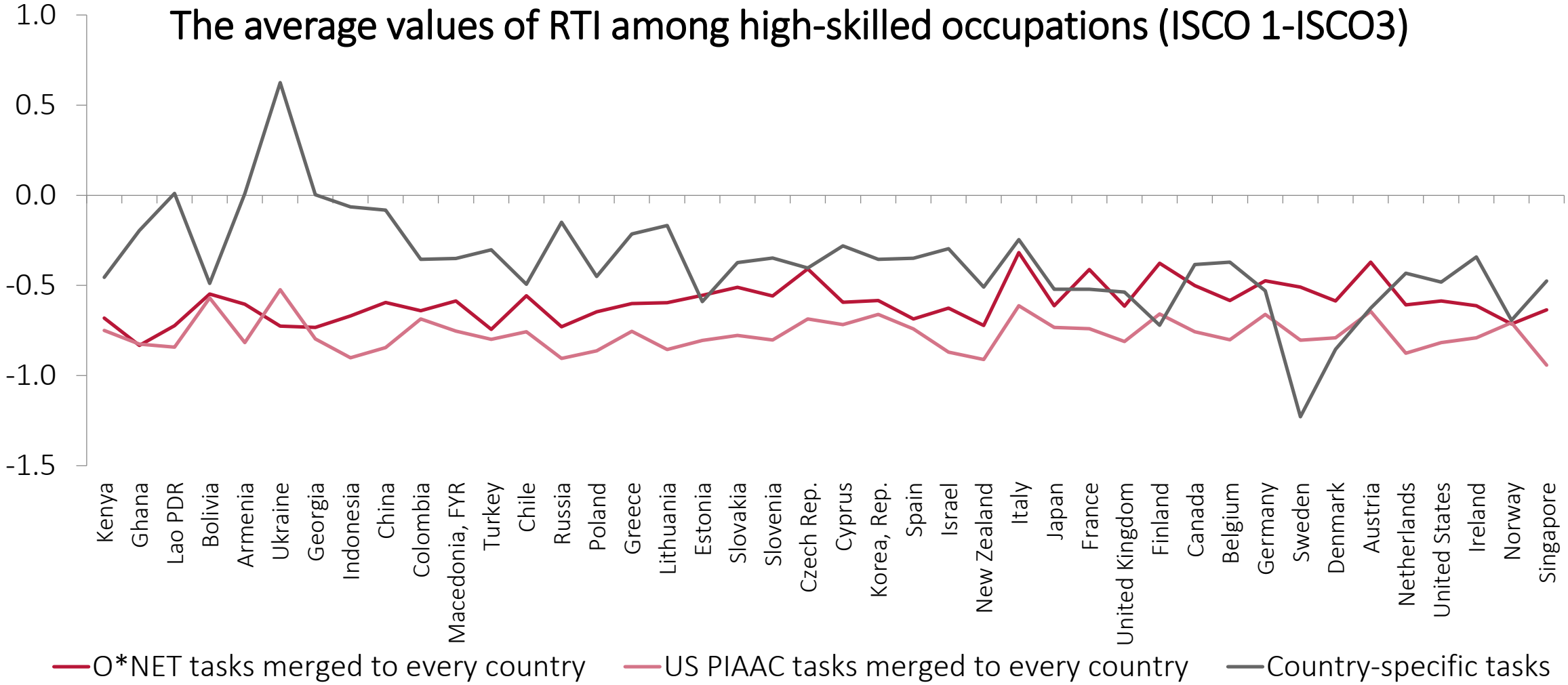


Appendix slides

Task contents are usually measured with O*NET, the US database on occupational demands (Autor et al. 2003, Acemoglu & Autor 2011)

	Non-routine cognitive (analytical / interpersonal)	Routine cognitive	Routine manual	Non-routine manual
Task items	Abstract thinking, creativity, problem solving /Guiding, directing, motivating, communicating	Repeating the same tasks, being exact or accurate, structured work	Pace determined by equipment, controlling machines and processes, making repetitive motions	Operating vehicles, mechanized devices, manual dexterity, spatial orientation
Relationship b/w human tasks and ICT	Complementary	Easy to automate	Easy to automate	Automation tough or unprofitable
Occupations rich in these tasks	Specialists (e.g designers, engineers, IT developers), technicians, managers	Office clerks, sellers, administrative workers, cashiers	Production workers, e.g. machine operators, assemblers and locksmiths	Drivers, miners, construction workers, waiters and waitresses, porters, cooks

Cross-country differences in particular occupations are visible only with the country-specific measurement

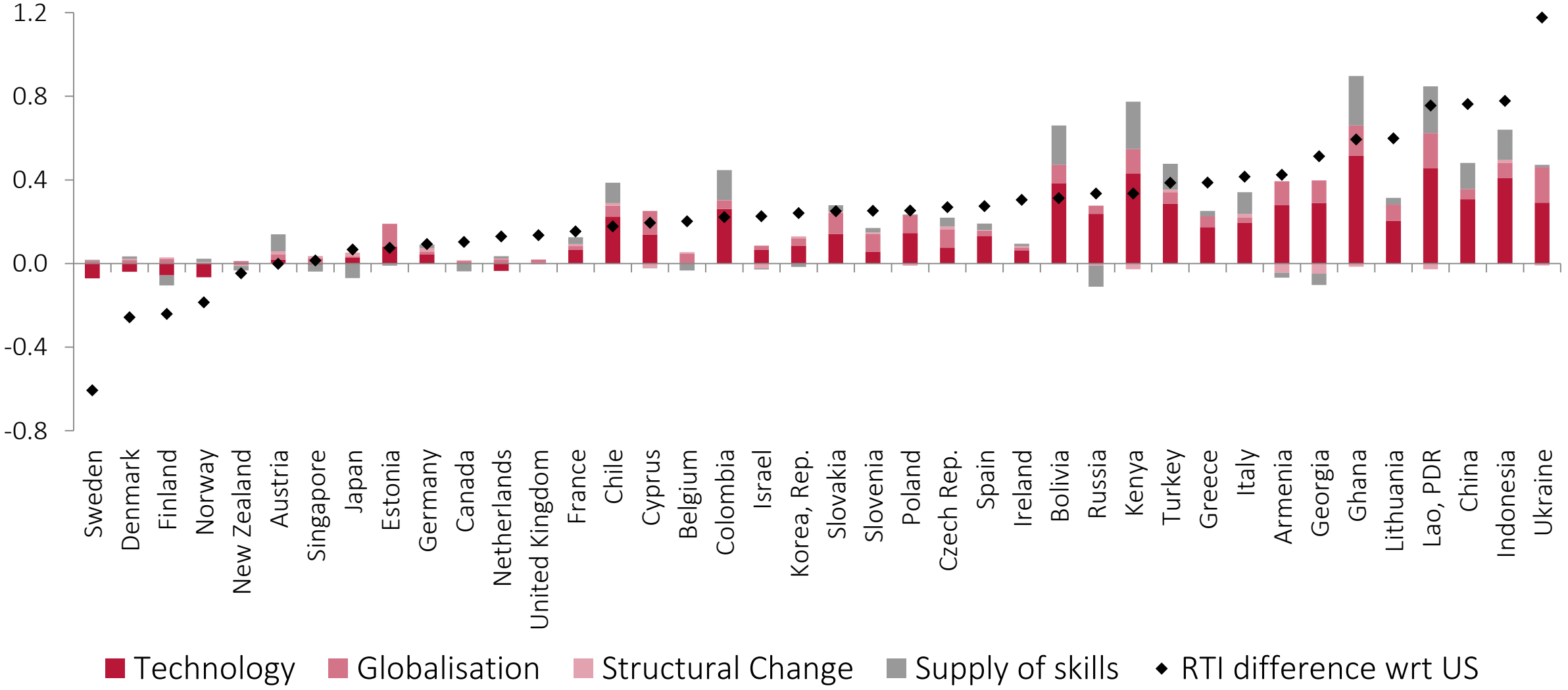


Once we control for GDP and literacy scores, the difference between PIAAC and STEP datasets is insignificant

	Non-routine cognitive analytical	Non-routine cognitive personal	Routine cognitive	Manual
Base model (I)	-0.22***	-0.03	-0.05	-0.38***
I+ literacy skills (II)	-0.11	-0.04	-0.20	-0.44***
II + GDP	-0.00	0.06	-0.07	-0.18***

The reported coefficients are for a STEP dummy in a whole sample models. The base regressions include dummies for gender, 10-year age groups, education, 1-digit occupations and sectors. The standard errors are clustered at a country level. The regressions with literacy scores exclude China (CULS), Laos and Macedonia due to lack of literacy skills assessment in these countries.

Differences in computer use, globalisation, and education and skills contribute the most to cross-country differences in RTI



Most of the task differences across countries cannot be explained by differences in occupational structure

Overall contribution of a factor k to cross-country differences in routine intensity

$$\sigma_k = \frac{cov(\beta_k(\bar{X}_k^c - \bar{X}_k^{US}), \overline{RTI}^c - \overline{RTI}^{US})}{var(\overline{RTI}^c - \overline{RTI}^{US})}$$

	Technology	Globalisation	Structural Change	Supply of skills	Occupations	Total
Model w/ no occupations	38%	10%	-2%	10%	-	56%
Model w/ occupations	28%	7%	4%	5%	11%	55%

Occupations capture some of the differences in technology and skills, but not much of the differences in globalization or structural change