Routinization: How robust is the evidence for the EU?

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BACKGROUND

During the period 1990-2010 many OECD countries experienced **increases in wage inequality** (and income inequality altogether).

Three main explanations: 1) changes in labour market institutions; 2) increase in trade with countries where unskilled labour is cheaper; 3) Skill Biased Technological Change.

Skill Biased Technological Change (SBTC; demand driven) posits that technology (i.e. digitalization) complements high - skilled labour and substitutes for low - skilled labour.

Implications: employment should increase for high - skilled and decrease for low - skilled individuals. The implications for wages are theoretically less clear, as supply effects could be working as well. But in empirical work, SBTC has been used to explain increased wage inequality and, especially, increases in the skill premium.

BACKGROUND

However, some scholars (David Autor *in primis*) argued that changes in the wage and employment distribution in the US were **not consistent with the SBTC hypothesis**. In particular, together with other co-authors, Autor showed that **job polarization was happening in the US.**

Job polarization happens when jobs are growing at the extremes of the wage distribution and shrinking in the middle.

A new theory was proposed by Autor, Levy and Murnane (2003) and later developed and formalized by Autor and Acemoglu (2011), called **Routine Biased Technological Change** (RBTC).

BACKGROUND

The RBTC hypothesis is based on the idea that:

1) **Jobs are seen as bundles of tasks**. Hence we should focus on the demand for tasks.

2) **Tasks can be categorised as either routine or non-routine, and either cognitive/abstract/interactive or manual in content**. Computers and advanced machinery can more easily replace workers employed in jobs that are very intensive in routine tasks. These are tasks that are repetitive and can be easily codified and programmed into some form of algorithm.

BACKGROUND

Challenges for the RBTC:

1) how many types of tasks do we have? Researchers lack shared consistency concerning the typologies and definitions of tasks.

2) How can we capture these tasks in actual data (e.g. how to capture a routine job)? Information on tasks is not commonly collected by representative data sources.

3) Are results driven by the choice of data? This is something we explore here.

DATASETS

We work with **two types of data** sources:

A) Occupational database (Occupational Information Network database: **O*Net**): it is based on experts opinions for the US, with no variability within occupations. Only vary few upgrades and no direct measure for the EU.

B) Workers surveys: the Princeton Data Improvement Initiative Survey (**PDII**) for the US, the Programme for the International Assessment of Adult Competencies (**PIAAC**) and the European Working Condition Survey (**EWCS**). Allow for variation within occupations but prone to measurement error.

With the exception of the **EWCS (six waves from 1990)**, the other databases collect data do not have time variability.

We classify occupations according to the ISCO-88 nomenclature (2 digit).

METHODOLOGY

We choose to work with the simplest approach.

i) For each occupation we compute **an Abstract, a Routine and a Manual index** (as in Autor and Dorn, 2013).

ii) Then we use the LFS to compute the same three indexes **at the country level** (using occupational weights by 2015 LFS).

iii) Finally, for each country *c,* **we create an overall (relative) routine index** given by

$$RTI_c = \ln\left(T_{c,2015}^R\right) - \ln\left(T_{c,2015}^A\right) - \ln\left(T_{c,2015}^M\right)$$

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METHODOLOGY

Table 1. A comparison of task measures among the PDII, the EWCS, and the PIAAC

Autor and Dorn (2013) – O*net	Autor and Handel (2013) – PDII	EWCS	PIAAC
Abstract			
1) GED maths 2) Administration and management	1) The length of the longest document typically read as part of the job		1) Read diagrams, maps, or schematics (g_q01h) 2) Write reports (g_q02c)
	2) The frequency of mathematical tasks involving high school or higher maths		3) Prepare charts, graphs, or tables (g_q03f) 4) Use simple algebra or formulas (g_q03g)
	3) The frequency of problem-solving tasks requiring at least 30 minutes to find a good solution	1) Does your main paid job involve: learning new things? (y10_q49f) 2) Does your main paid job involve: solving unforeseen problems on your own? (y10_49c)	5) Face complex problems (>30 minutes) (f_q05b)
	4) The proportion of the day spent managing or supervising other workers	3) Does your main paid job involve: assessing yourself the quality of your own work? (y10_q49b)	6) Persuading/influencing people (f_q04a) 7) Negotiating with people (f_q04b)
Routine			
1) Finger dexterity 2) Customer and personal services	1) Complete absence of face-to-face interactions with 1.1. Customers and clients 1.2. Suppliers or contractors 1.3. Students or trainees	1) (Not) dealing with people (y10_q11j) 2) Your pace of work depends on direct demands from people such as customers … (y10_q21b)	1) Learn work-related things from co-workers (d_q13a) 2) Learning by doing from tasks performed (d_q13b) 3) Keeping up to date with new products or services (d_q13c)
	2) The proportion of the working day spent performing short and repetitive tasks	3) Short repetitive tasks (from 1 minute to 10 minutes) (1 minute: y10_q20a_a) (10 minutes: y10_q20a_b)	4) Change sequence of tasks (d_q11a) 5) Change how do you work (d_q11b) 6) Change speed of work (d_q11c) 4) Change working hours (d_q11d)
Manual			
1) Arm-hand steadiness 2) Manual dexterity	1) The proportion of the working day spent performing physical tasks, such as standing or operating machines or vehicles	1) Does your job involve … 1.1. Tiring or painful positions? (y10_q11a) 1.2. Carrying or moving heavy loads? (y10_q11c) 1.3. Repetitive hand and/or finger movements? (y10_q11c)	1) Hand/finger skill accuracy (f_q06c) 2) Physical work (f_q06b)

Source: Author's analysis from the references quoted in the table.

RESULTS: ABSTRACT

Table 3. The five countries with the highest and lowest abstract index

	EWCS	PIAAC	PDII	O*Net
Five countries with the lowest abstract index	Hungary Latvia Bulgaria Slovakia Greece	Portugal Bulgaria Greece Slovakia Spain	Slovakia Bulgaria Portugal Hungary Italy	Bulgaria Slovakia Poland Slovenia Hungary
Five countries with the highest abstract index	Denmark Sweden Norway Luxembourg Netherlands	Luxembourg Norway Sweden Finland Netherlands	Luxembourg Norway Sweden Finland Denmark	Luxembourg Norway Sweden Finland Netherlands

Sources: Author's analysis from the EWCS (2015), PIAAC, O*Net, PDII, and EU-LFS (2014).

Table 6. Correlation of the abstract index based on the different surveys at the country level (2014)

	EWCS	PIAAC	PDII	O*Net
EWCS	1			
PIAAC	0.723	1		
PDII	0.691	0.827	1	
O*Net	0.743	0.963	0.818	1

Source: Author's analysis from the EWCS, PIAAC, PDII, and O*Net.

RESULTS: ROUTINE

Table 4. The five countries with the highest and lowest routine index

	EWCS	PIAAC	PDII	O*Net
Five countries with the lowest routine index	Sweden Hungary Netherlands Norway United Kingdom	Luxembourg Norway Sweden Netherlands Finland	Norway Sweden Denmark Belgium Finland	Luxembourg United Kingdom Netherlands Denmark Sweden
Five countries with the highest routine index	Greece Latvia Cyprus Portugal Spain	Slovakia Hungary Bulgaria Spain Portugal	Slovenia Greece Hungary Poland Latvia	Poland Slovenia Bulgaria Hungary Latvia

Sources: Author's analysis from the EWCS (2015), PIAAC, O*Net, PDII, and EU-LFS (2014).

Table 7. Correlation of the routine index based on the different surveys at the country level (2014)

	EWCS	PIAAC	PDII	O*Net
EWCS	1			
PIAAC	0.149	1		
PDII	0.362	0.537	1	
O*Net	0.174	0.642	0.662	1

Source: Author's analysis from the EWCS, PIAAC, PDII, and O*Net.

RESULTS:MANUAL

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Table 5. The five countries with the highest and lowest manual index

	EWCS	PIAAC	PDII	O*Net
Five countries with the lowest manual index	Norway Germany Czech Republic Denmark Netherlands	Luxembourg Netherlands United Kingdom Norway Sweden	Luxembourg Norway Netherlands Sweden United Kingdom	Luxembourg Netherlands Denmark United Kingdom Sweden
Five countries with the highest manual index	Cyprus Greece Spain France Estonia	Bulgaria Poland Slovakia Slovenia Portugal	Slovakia Bulgaria Hungary Latvia Greece	Slovakia Czech Republic Hungary Bulgaria Latvia

Sources: Author's analysis from the EWCS (2015), PIAAC, O*Net, PDII, and EU-LFS (2014).

Table 8. Correlation of the manual index based on the different surveys at the country level (2014)

	EWCS	PIAAC	PDII	O*Net
EWCS	1			
PIAAC	0.217	1		
PDII	0.226	0.937	1	
O*Net	0.175	0.903	0.952	1

Source: Author's analysis from the EWCS, PIAAC, PDII, and O*Net.

Table 2. Distribution of abstract, manual, and routine tasks based on the EWCS, PIAAC, O*Net, and EWCS

Country		Abstract				Routine				Manual			
		EWCS (1)	PIAAC (2)	PDII (3)	O*Net (4)	EWCS (5)	PIAAC (6)	PDII (7)	O*Net (8)	EWCS (9)	PIAAC (10)	PDII (11)	O*Net (12)
Austria	AT	80.22	34.56	42.54	40.49	45.39	46.11	53.62	39.20	28.68	60.21	58.73	29.94
Belgium	BE	80.04	34.72	42.11	41.08	44.77	46.40	53.44	38.18	29.40	57.89	56.57	28.42
Bulgaria	BG	63.59	30.90	40.04	37.29	45.05	47.99	53.75	42.07	32.72	66.47	63.39	30.91
Cyprus	CY	69.20	32.14	40.75	39.42	53.64	47.41	53.79	38.23	44.55	59.27	58.55	28.26
Czech Republic	CZ	70.80	34.02	41.41	39.77	45.76	47.41	53.78	40.96	25.53	62.52	61.71	31.81
Germany	DE	75.20	35.67	42.41	41.32	44.94	45.98	53.68	38.69	24.28	58.22	56.58	29.72
Denmark	DK	89.65	35.74	43.11	41.59	46.59	45.86	53.41	37.43	25.68	57.02	55.47	27.86
Estonia	EE	84.83	33.49	41.39	39.65	50.18	47.42	53.87	40.45	35.04	61.95	61.49	30.47
Spain	ES	79.79	32.11	40.68	39.09	52.15	47.90	53.79	39.07	39.02	61.62	61.10	29.99
Finland	FI	83.88	36.39	43.89	41.74	49.19	45.29	53.59	38.52	30.96	58.44	56.42	28.89
France	FR	80.52	33.74	41.43	40.06	47.62	46.81	53.79	38.70	38.95	59.66	58.48	29.41
Greece	GR	66.09	31.89	42.00	39.01	61.15	46.47	54.29	41.05	42.98	63.45	62.29	30.26
Hungary	HU	59.46	32.54	40.59	38.91	41.55	48.07	54.27	41.37	28.78	63.22	62.79	31.28
Ireland	IE	79.12	34.18	42.35	40.59	44.72	46.04	54.01	39.15	27.06	59.64	58.13	29.37
Italy	IT	70.21	32.71	40.66	39.19	48.12	47.62	53.80	39.68	27.24	61.37	60.61	30.33
Lithuania	LT	72.85	33.26	42.13	39.42	57.27	46.47	54.09	41.32	34.08	62.56	61.91	30.33
Luxembourg	LU	86.81	40.21	45.72	44.06	48.57	42.35	53.93	35.77	32.61	49.09	45.93	24.00
Latvia	LV	62.86	32.26	41.16	38.95	48.38	47.66	54.11	40.44	30.38	62.61	62.65	30.48
Netherlands	NL	85.92	35.93	42.91	41.65	41.58	45.27	53.65	37.28	26.17	56.13	54.43	27.61
Norway	NO	88.21	37.68	44.75	42.58	43.83	44.71	52.94	37.55	23.69	56.89	54.38	28.34
Poland	PL	77.11	32.11	41.76	38.40	45.79	46.26	54.12	42.93	30.73	66.37	61.23	30.46
Portugal	PT	74.52	30.57	40.46	38.91	52.84	47.73	53.97	40.14	33.33	64.10	61.97	30.48
Sweden	SE	88.75	37.02	43.99	42.03	41.48	45.13	53.17	37.49	33.49	56.96	54.82	28.24
Slovenia	SI	81.92	33.11	41.79	38.49	44.62	46.29	54.51	42.61	34.53	64.38	58.48	29.62
Slovakia	SK	65.41	31.91	39.72	38.33	44.47	48.74	53.87	41.21	31.06	64.78	64.84	32.23
United Kingdom	UK	82.94	35.67	42.61	41.57	44.31	45.61	53.72	37.28	29.23	56.57	55.08	27.90

Notes: Countries are arranged in alphabetical order. The cells highlighted in grey are the highest value in the column; those in bold are the lowest value in the column. Columns (1) to (12) report normalized task measures in 2014, ranging [0,100].
Sources: Author's analysis from the EWCS (2015), PIAAC, O*Net, PDII, and EU-LFS (2014).

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RESULTS: RTI INDEX

Table 10. The five countries with the highest and lowest RTI index

	EWCS	PIAAC	PDII	O*Net
Five countries with the lowest RTI index	Norway Netherlands Denmark Germany Ireland	Luxembourg Norway Sweden Netherlands United Kingdom	Luxembourg Norway Sweden Netherlands Denmark	Luxembourg Netherlands Norway United Kingdom Denmark
Five countries with the highest RTI index	Greece Cyprus Latvia Spain Portugal	Bulgaria Portugal Slovakia Poland Hungary	Slovakia Bulgaria Hungary Portugal Latvia	Bulgaria Slovakia Poland Hungary Slovenia

Sources: Author's analysis from the EWCS (2015), PIAAC, O*Net, PDII, and EU-LFS (2014).

RESULTS: RTI INDEX

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Table 9. Distribution of RTI based on EWCS, PIAAC, PDII and O*Net

Country		Routine Task Index			
		EWCS	PIAAC	PDII	O*Net
Austria	AT	-0.59	-0.18	-0.10	0.01
Belgium	BE	-0.55	-0.42	-0.49	-0.67
Bulgaria	BG	0.65	1.44	1.02	1.35
Cyprus	CY	2.04	0.37	0.11	-0.40
Czech Republic	CZ	-0.53	0.35	0.77	0.90
Germany	DE	-0.98	-0.62	-0.41	-0.29
Denmark	DK	-1.27	-0.78	-0.84	-1.05
Estonia	EE	0.21	0.39	0.69	0.52
Spain	ES	0.98	0.69	0.63	0.25
Finland	FI	-0.20	-0.82	-0.71	-0.60
France	FR	0.63	0.01	0.03	-0.14
Greece	GR	2.53	0.73	0.58	0.69
Hungary	HU	0.15	0.79	1.15	1.01
Ireland	IE	-0.80	-0.18	-0.14	-0.16
Italy	IT	-0.11	0.51	0.57	0.43
Lithuania	LT	1.15	0.37	0.60	0.68
Luxembourg	LU	-0.19	-3.03	-3.11	-2.89
Latvia	LV	0.68	0.73	0.89	0.65
Netherlands	NL	-1.41	-1.00	-0.98	-1.15
Norway	NO	-1.71	-1.30	-1.38	-1.07
Poland	PL	-0.19	0.95	0.48	1.18
Portugal	PT	0.72	1.25	0.86	0.60
Sweden	SE	-0.72	-1.12	-1.13	-1.02
Slovenia	SI	-0.08	0.56	0.15	0.91
Slovakia	SK	0.31	1.17	1.52	1.31
United Kingdom	UK	-0.71	-0.86	-0.75	-1.06

Notes: Countries are order by alphabetic order. Cell highlighted in grey is the highest value in the column; in bold is the lowest value in the column. Column (1) to (12) report normalised task measures in 2014, ranging [0,100]
Sources: Author's analysis from EWCS (2015), PIAAC, ONET, PDII, and EU-LFS (2014).

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The EWCS allows us to have different pictures of the indexes, from 1990 to 2015.

We work with the **2005, 2010 and 2015 waves**.

First, we look at the **evolution of each task index and its change between 2005 and 2015.**
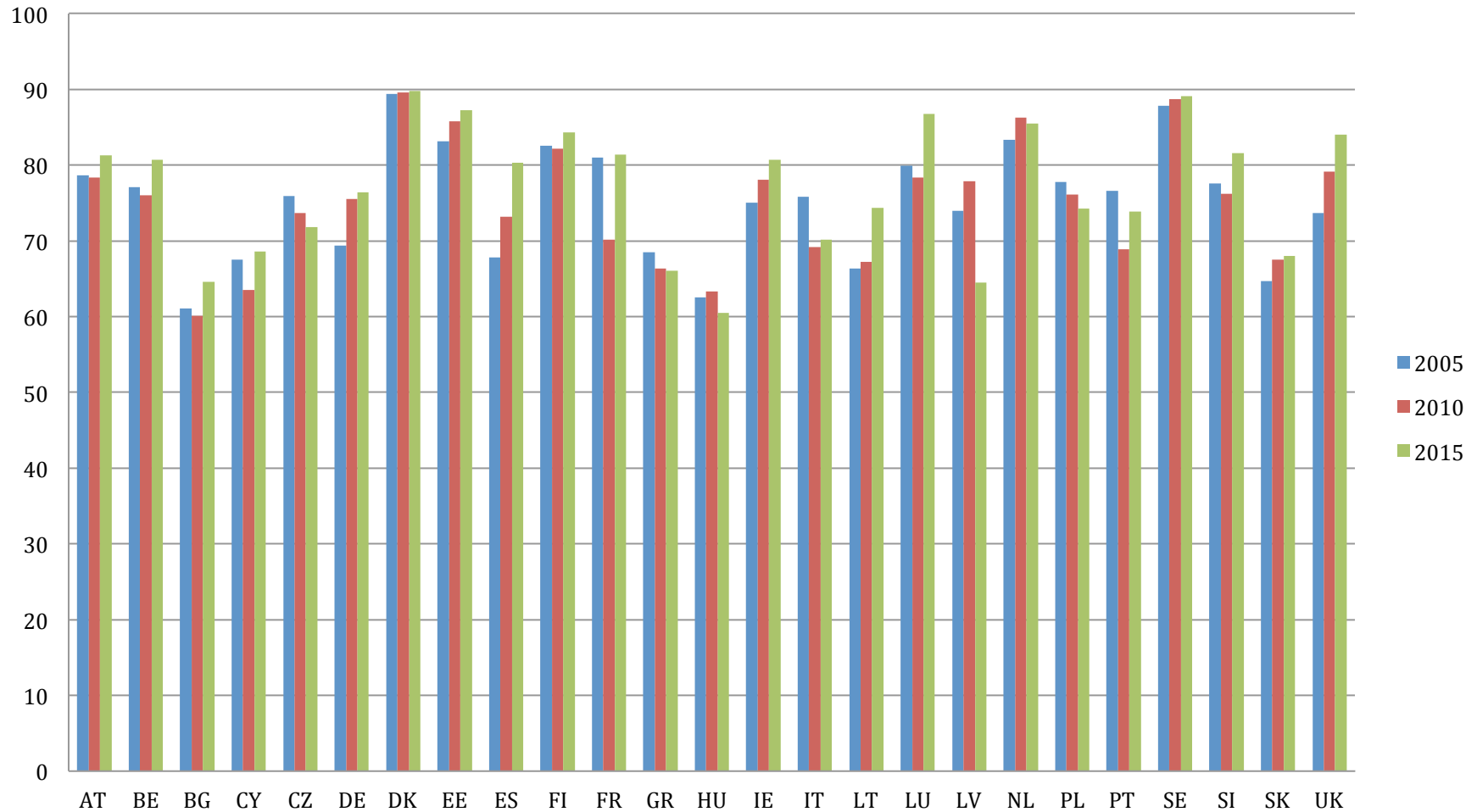
Overall, the **change for Abstract intensity is positive** (in all but 7 countries) while the one for **Manual intensity is negative** (in all but 4 countries).
For Routine intensity the picture is less clear: increasing in 16 and decreasing in 9.

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Abstract Index – EU25

Routine Index – EU25
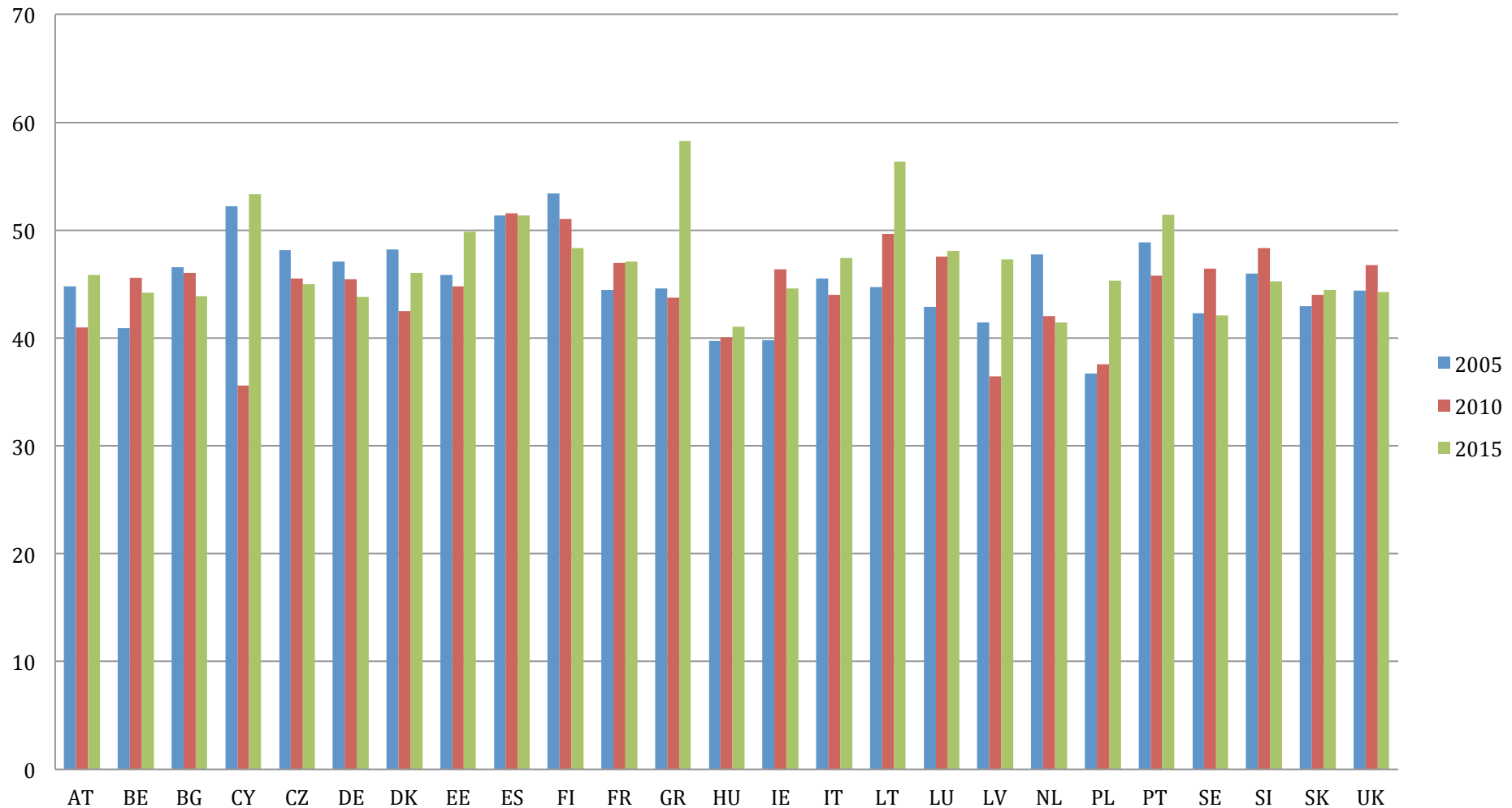
Manual Index – EU25
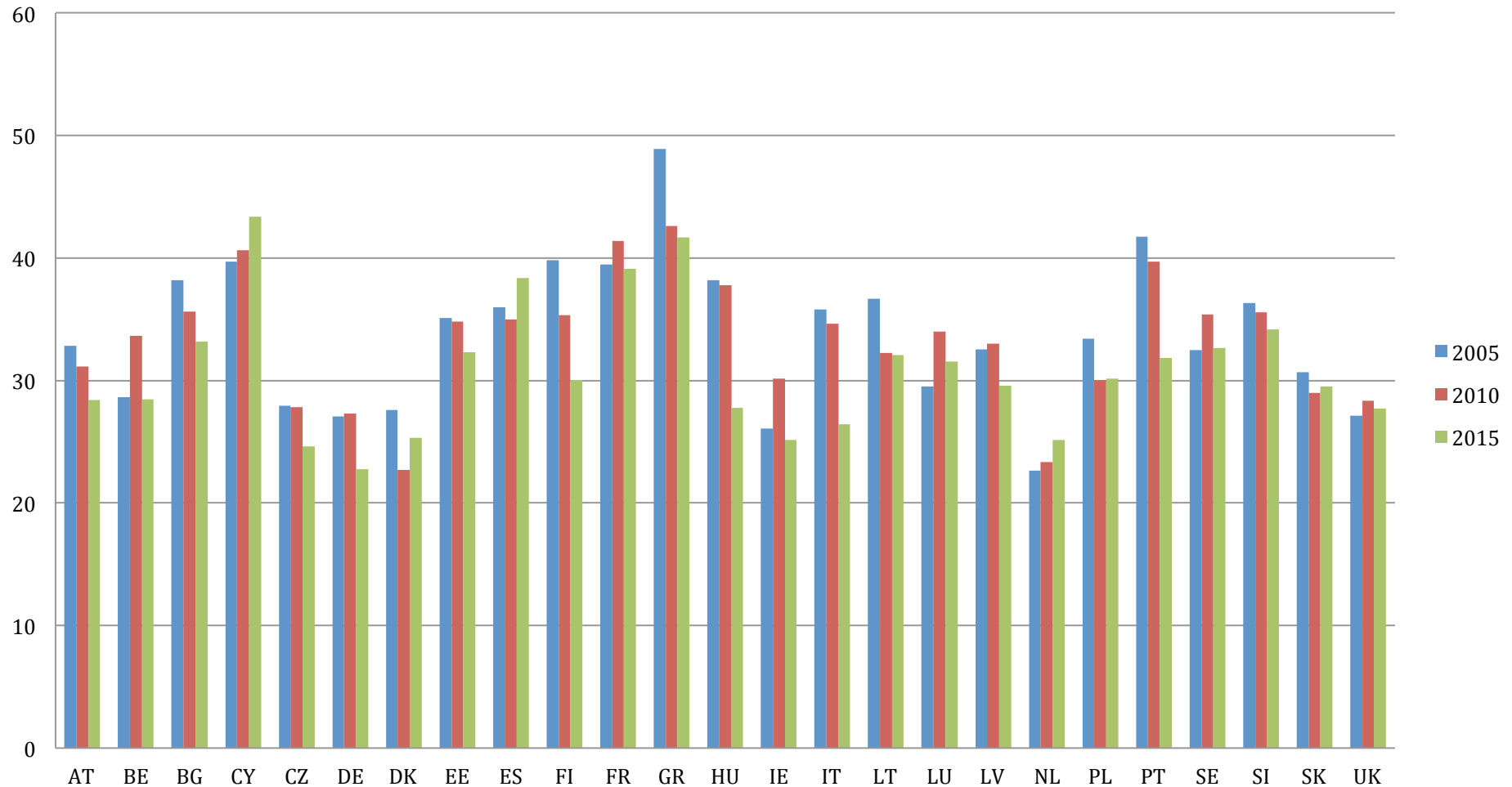
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Second, for each Index, we look at the **decomposition of the change** between 2005 and 2015.

The **change between 2005 and 2015** can be written as

$$\Delta T_{\downarrow k} = \sum_{j} \Delta E_{\downarrow j} \; \gamma_{\downarrow jk} + \sum_{j} \Delta \gamma_{\downarrow jk} \; E_{\downarrow j}$$

so that $\sum_{j} \Delta E_{\downarrow j} \; \gamma_{\downarrow jk}$ represents the **extensive margin** (change due to shifts in employment shares **between occupations**) while $\sum_{j} \Delta \gamma_{\downarrow jk} \; E_{\downarrow j}$ represents the **intensive margin** (change happening **within occupations**).

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For Abstract: the change in Extensive margin is positive in all countries. The Intensive one is positive in all but 8.

For Routine: the change in Extensive is negative in all countries, while the one in the Intensive is positive in all but 7 countries.

For Manual: the change in Extensive is negative in all countries but 6, while the change in Intensive is negative in all but 8 countries.

Note: **for Routine index, in most countries the change in the intensive margin clearly dominates.**

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RESULTS: INTENSIVE VS EXTENSIVE MARGIN FOR ASTRACT TASKS

Table 13. Abstract task shifts, extensive and intensive margins

	Country	Importance in 2005	Importance in 2015	Change 2015–2005	Extensive margin	Intensive margin
Austria	AT	78.68	81.30	2.62	2.02	0.60
Belgium	BE	77.04	80.65	3.61	0.41	3.20
Bulgaria	BG	61.11	64.59	3.48	1.05	2.43
Cyprus	CY	67.49	68.62	1.13	1.05	0.08
Czech Republic	CZ	75.89	71.83	-4.06	1.18	-5.24
Germany	DE	69.36	76.38	7.02	1.12	5.90
Denmark	DK	89.35	89.81	0.46	0.46	0.00
Estonia	EE	83.13	87.29	4.16	1.36	2.80
Spain	ES	67.85	80.31	12.46	1.20	11.26
Finland	FI	82.51	84.32	1.81	0.96	0.85
France	FR	80.99	81.34	0.35	0.76	-0.41
Greece	GR	68.46	66.05	-2.41	0.81	-3.22
Hungary	HU	62.50	60.46	-2.04	0.58	-2.62
Ireland	IE	75.00	80.66	5.66	1.69	3.97
Italy	IT	75.80	70.11	-5.69	0.50	-6.19
Lithuania	LT	66.32	74.33	8.01	1.89	6.12
Luxembourg	LU	79.91	86.78	6.87	1.90	4.97
Latvia	LV	73.92	64.52	-9.40	1.69	-11.09
Netherlands	NL	83.30	85.49	2.19	0.90	1.29
Poland	PL	77.76	74.26	-3.50	0.85	-4.35
Portugal	PT	76.57	73.86	-2.71	1.40	-4.11
Sweden	SE	87.79	89.11	1.32	0.96	0.36
Slovenia	SI	77.53	81.56	4.03	0.78	3.25
Slovakia	SK	64.65	67.95	3.30	0.86	2.44
United Kingdom	UK	73.67	84.04	10.37	2.06	8.31

RESULTS: INTENSIVE VS EXTENSIVE MARGIN FOR ROUTINE TASKS

Table 14. Routine task shifts, extensive and intensive margins

	Country	Importance in 2005	Importance in 2015	Change 2015–2005	Extensive margin	Intensive margin
Austria	AT	44.78	45.83	1.05	-0.47	1.52
Belgium	BE	40.93	44.22	3.29	-0.20	3.49
Bulgaria	BG	46.57	43.87	-2.70	-1.35	-1.35
Cyprus	CY	52.20	53.35	1.15	-0.77	1.92
Czech Republic	CZ	48.12	44.96	-3.16	-0.13	-3.03
Germany	DE	47.06	43.83	-3.23	-0.41	-2.82
Denmark	DK	48.19	46.02	-2.17	-0.95	-1.22
Estonia	EE	45.84	49.88	4.04	-0.10	4.14
Spain	ES	51.38	51.38	0.00	-1.37	1.37
Finland	FI	53.40	48.34	-5.06	-0.40	-4.66
France	FR	44.47	47.06	2.59	-0.62	3.21
Greece	GR	44.59	58.29	13.70	-1.01	14.71
Hungary	HU	39.72	41.02	1.30	-0.37	1.67
Ireland	IE	39.83	44.60	4.77	-0.64	5.41
Italy	IT	45.53	47.43	1.91	-0.35	2.26
Lithuania	LT	44.75	56.38	11.63	-1.47	13.10
Luxembourg	LU	42.87	48.06	5.19	-1.00	6.19
Latvia	LV	41.42	47.28	5.86	-0.97	6.83
Netherlands	NL	47.73	41.46	-6.27	-0.37	-5.90
Poland	PL	36.69	45.31	8.62	-0.42	9.04
Portugal	PT	48.87	51.44	2.57	-1.79	4.36
Sweden	SE	42.33	42.08	-0.25	-0.34	0.09
Slovenia	SI	45.99	45.24	-0.75	-0.38	-0.37
Slovakia	SK	42.98	44.49	1.51	-0.30	1.81
United Kingdom	UK	44.37	44.27	-0.10	-0.91	0.81

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Table 15. Manual task shifts, extensive and intensive margins

	Country	Importance in 2005	Importance in 2015	Change 2015-2005	Extensive margin	Intensive margin
Austria	AT	32.86	28.38	-4.48	-0.92	-3.56
Belgium	BE	28.67	28.47	-0.20	-0.20	-0.00
Bulgaria	BG	38.19	33.18	-5.01	-2.30	-2.71
Cyprus	CY	39.69	43.39	3.70	-2.35	6.05
Czech Republic	CZ	27.92	24.61	-3.31	-1.11	-2.20
Germany	DE	27.08	22.76	-4.32	-1.13	-3.19
Denmark	DK	27.60	25.35	-2.25	-1.05	-1.20
Estonia	EE	35.09	32.28	-2.81	-1.39	-1.42
Spain	ES	35.98	38.39	2.41	-2.86	5.27
Finland	FI	39.83	30.06	-9.77	-1.58	-8.19
France	FR	39.46	39.11	-0.35	-1.25	0.90
Greece	GR	48.91	41.67	-7.24	-1.86	-5.38
Hungary	HU	38.19	27.74	-10.45	-0.79	-9.66
Ireland	IE	26.07	25.17	-0.90	-1.32	0.42
Italy	IT	35.77	26.44	-9.33	-1.15	-8.18
Lithuania	LT	36.69	32.07	-4.62	-2.73	-1.89
Luxembourg	LU	29.51	31.56	2.05	-3.05	5.10
Latvia	LV	32.55	29.59	-2.96	-1.49	-1.47
Netherlands	NL	22.65	25.17	2.52	-0.54	3.06
Poland	PL	33.40	30.13	-3.27	-1.59	-1.68
Portugal	PT	41.74	31.82	-9.92	-1.97	-7.95
Sweden	SE	32.48	32.66	0.18	-1.45	1.63
Slovenia	SI	36.34	34.18	-2.16	-1.33	-0.83
Slovakia	SK	30.69	29.51	-1.18	-0.88	-0.30
United Kingdom	UK	27.15	27.70	0.55	-0.98	1.53

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CONCLUSIONS

A) **PIAAC, O*NET and PDII give similar results, while results from the EWCS appear to differ, in terms of both value and range of the indexes. This is especially true for the Routine Index.** Confirmed when we look at the correlation between indexes, which is lowest for the EWCS.

Unclear whether this is due to sampling or to the actual choice of the variables used to construct the indexes.

B) Countries with **high values for the Abstract index and low values for Routine and Manual indexes are concentrated in the North**.

Countries with **high values for Routine and Manual indexes and low values for the Abstract index are concentrated in the South and East**.

Does this imply that digitalization is increasing inequalities in the EU?

CONCLUSIONS

C) **We have used EWCS to decompose the time evolution of the indexes into a between and a within component.**
For the **Routine Index, in the vast majority of cases the within component dominates**: this implies that even if employment in "routine occupations" is declining, all occupations are becoming more routine intensive.

Is this increasing the chances of labour substitution by digitalization?

FUTURE WORK

Try to better understand how robust the evidence from the EWCS is to the definition of abstract/routine tasks (but we have a limited set of questions that we can use)

Explore the relationship between the Routine and Abstract indexes and the diffusion and use of digital technologies.