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TECHNOLOGY OR UPSKILLING? TRENDS IN THE TASK COMPOSITION OF JOBS IN CENTRAL AND EASTERN EUROPE[•]

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Abstract

In this paper we analyse the changes in the task content of jobs in Central and Eastern European countries between 1998 and 2013. We link the O*NET data on occupational characteristics with EU-LFS, following the approach of Autor, Levy and Murnane (2003) as well as Acemoglu and Autor (2011). We find that the CEE countries witnessed similar trends of rising intensity of non-routine cognitive tasks, and a decreasing intensity of manual tasks, although they differed with regards to changes in the routine cognitive task content. We identify the contribution of structural and within-sector changes to this evolution of tasks. Furthermore, we assess the relative role played by education and technology in the development of task contents. Our results show that workforce upskilling was the major factor behind the evolution of non-routine cognitive and manual tasks in CEE, whereas structural changes have shaped routine cognitive tasks. Finally, we show that the evolution of task content was not uniform across cohorts, and a shift to non-routine tasks was most abundant among the youngest cohorts.

Keywords: task content of jobs, routinisation, job polarisation, Central and Eastern Europe

JEL: J21, J23, J24, I25

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Introduction

Recent research highlights a progressing shift of employment from low and middle-skilled occupations towards high-skilled occupations in many countries around the world. Machin and Van Reenen (1998) identified this occupational upgrading in the United States and six other OECD countries, and attributed it to 'skill-biased technological change', i.e. a demand shift towards high-skilled labour due to new technologies increasing its relative productivity. The refined 'routine-biased technological change' hypothesis (RBTC) argues that recent technological progress has increased demand for high-skilled workers who can perform non-routine cognitive work (which to date cannot be replaced by machines),[1] while on the other hand it has decreased the demand for middle-skilled workers performing routine work (which is already replaceable by machines).[2] The routinization hypothesis also implies growing demand for the least-skilled workers performing simple, yet unstructured, jobs,[3] since computers are, so far, unable to replace people performing non-routine manual tasks, at a price justifying a replacement. Autor et al. (2003) provided evidence that, between 1960 and 1998, computerisation in the US was associated with a reduced labour input of routine manual and routine cognitive tasks and an increased labour input of non-routine cognitive tasks, within industries, occupations and education groups. They also stressed that the task changes within occupations were substantial. Autor and Price (2013) showed that the decline of routine tasks continued in the US in the 2000s, while non-routine manual tasks grew in comparison to the 1990s, in line with RBTC.

Moreover, several authors (e.g. Acemoglu and Autor 2011; Autor 2014; Goos et al. 2014) showed that over the last three decades there has been a growing job polarisation (the share of middle-wage / middle-skilled workers has declined) and wage polarisation (rising relative wages of high-skilled workers) in the US and Western European countries. Michaels et al. (2014) analysed 11 OECD countries in the period 1980-2004 and provided additional evidence for the "routinisation hypothesis" of RBTC. Graetz and Michaels (2015) studied 14 industries in 17 OECD countries and found that industries with a higher share of routine tasks in 1980 had been more likely to adapt to industrial robots, and as a result experienced higher productivity growth. Deming (2015) showed, again for the US, that high-skilled, difficult-to-automate jobs increasingly require social skills which is consistent with RBTC, as computers are increasingly better in dealing with codifiable challenges while progress in automating social interactions has been poor (Brynjolfsson and McAfee, 2014). Machin and Van Reenen (1998) also showed that R&D intensity was a major driver of the demand for skilled workers in the most developed countries, thus strengthening the link between technology and occupational changes.

On the other hand, some research suggests that developments in employment with respect to skills and task distribution may be driven by supply-side changes. Salvatori (2015) argued that the decline in the share of middle-skilled jobs in the UK since 1979 was mostly fuelled by a decreasing number of non-graduates and to a lesser extent by technological progress. Oesch (2013) showed that in the UK, Germany, Spain and Switzerland, occupational upgrading and job polarisation were driven by factors both on the demand side (like technology) and on the supply side (educational expansion, migration), as well as labour market institutions. The lack of growth in non-routine cognitive tasks in the US in the 2000s (Autor and Price, 2013) is also at odds with RBTC, as ICT continues to improve. These findings suggest that routinisation and polarisation are more complex and need to be studied further, taking into account more, also middle and low-income, countries.

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[1] Mostly occupations numbered 1-3 in ISCO: managers, professionals, technicians and associate professionals.

[2] Mostly occupations numbered 4-8 in ISCO: clerical support workers, services and sales workers, skilled agricultural, forestry and fishery workers, craft and related trades workers, plant and machine operators and assemblers.

[3] Mostly occupations numbered 9 in ISCO: elementary occupations.

In this paper we apply the task approach of Autor et al. (2003) and Acemoglu and Autor (2011) to 10 Central and Eastern European (CEE) countries[4] in the period 1998-2013. To the best of our knowledge, the CEE labour markets have, so far, not been studied from that perspective, except for Hardy et al. (2015) for Poland. The CEE countries seem particularly interesting from the perspective of the cognitive vs. manual and routine vs. non-routine content of jobs. Since the mid-1990s their economic structures have been converging to those of the most developed countries, which has affected demand for labour and its structure in terms of occupation and skills (IBS, 2014). The labour supply has also changed considerably. Education attainment has improved swiftly and the number of graduates has increased substantially across the region (only partly due to initial gap compared to the Western Europe).[5] The demographic component of this process was crucial as populous younger cohorts leapfrogged the older cohorts in terms of tertiary attainment. Employment in high-skilled occupations (1-3 ISCO) has increased in all CEE countries, while the middle and low-skilled jobs (4-9 ISCO) have been in relative decline. However, this does not mean that routine tasks and jobs have declined, nor that technology driven labour demand shifts were the main factor behind these changes in the CEE.

The aim of this paper is to quantify the evolution of the task content of jobs in CEE between 1998 and 2013, identify the contribution of structural and within-sector changes to this evolution, evaluate intergenerational differences in the development of particular tasks, and assess the relative role played by education and technology in these processes. In the next section we present stylised facts on the evolution of the labour market structure in the CEE countries. Next we describe our framework of applying the O*NET based task measures to the EU-LFS data and estimating the task content of jobs by occupation in each country studied. Then we quantify the evolution of the task content of jobs in CEE countries, calculate a shift-share sectoral decomposition and run a panel regression to establish a link between the task content of jobs and workforce upskilling, as well as R&D spending. We also perform cohort decompositions. We conclude with a discussion of the findings and implications of our research.

We contribute to two fields of literature. On the one hand, we test whether patterns of task content of jobs in a group of European middle-income countries are consistent with those observed in the more advanced economies (often attributed to the RBTC). On the other, we offer a novel look on the medium-term structural changes in Central Eastern European countries.

[4] Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, Slovenia.

[5] In the early 1990s the share of tertiary educated workers in employment in CEE countries was modest - ranging from 8.4% in Poland in 1988 to 11.6% in Hungary in 1990, compared to 19.7% in Netherlands (Boeri and Keese, 1992).

1. Structural changes on the CEE labour markets in 1998-2013

The labour markets in the CEE countries followed a common pattern of sectoral changes over the period 1998-2013,[6] with significant shifts of employment from the primary and secondary sectors to the tertiary sector.[7] In the late 1990s, manufacturing and services, including e.g. financial, insurance and real estate activities; administrative and support activities; public administration and defence; health, social work; education; arts and entertainment (hence referred to as 'other services' as these are services other than commerce, accommodation and food activities; transportation, storage and communication[8]), employed the largest share of workers. The share of workers employed in manufacturing ranged from 19% in Latvia and Lithuania to 32% in Slovenia, the share of other services from 15% in Romania and 26% in Slovenia to 33% in Hungary (Table 1). Over the following 15 years, other services became even more important and recorded an increase of approx. 6-9 pp. in employment shares in CEE, whereas the share of manufacturing has declined by approx. 2-5 pp. (Table 2). Employment shares in agriculture have declined and converged across the region, although they still exhibited the largest differences between the analysed countries. In 1998, the employment share of agriculture ranged from 6-8% in Czech Republic, Hungary and Slovakia, and 19-20% in Latvia, Lithuania and Poland, to 42% in Romania. In 2013 these shares amounted to 3-5% in Czech Republic, Hungary and Slovakia, 8% in Latvia, Lithuania, 12% in Poland and 28% in Romania. Other sectors employed comparable shares of workers in 1998, with 0-2% of workers in mining, 1-3% of workers in energy, gas and water supply, 6-10% in construction, 15-19% in commerce, accommodation and food activities and 5-9% in transport, storage and communication. The latter two services subsectors recorded greater growth in the employment share across the region than mining, energy, gas and water supply, and construction.[9]

Table 1. Employment shares by sector in 1998, by country (in %)

SECTOR	HR*	CZ	EE	HU	LV	LT	PL	RO	SK	SI
Agriculture	17	6	9	7	19	20	19	42	8	12
Mining	1	2	1	1	0	0	2	2	2	1
Manufacturing	20	28	22	25	19	19	21	21	26	32
Energy, gas and water supply	2	2	3	3	2	3	2	2	2	1
Construction	8	10	7	6	6	7	7	4	9	6
Commerce, accommodation and food activities	19	17	16	16	16	16	15	10	15	17
Transport, storage and communication	6	8	9	8	8	7	6	5	8	6
Other services	27	28	32	33	30	29	27	15	30	26

*Note: *2003 for Croatia, due to data availability.*
Source: Own elaboration based on EU LFS data.

[6] We use the 1998-2013 period due to the restricted availability of data for the empirical part of the paper (see Section 2).

[7] Unless stated otherwise, all data used in this section comes from the EU-LFS datasets.

[8] We split services into four groups as the three listed here are jointly responsible for approx. 50% of total services employment (from 48% in Hungary to 56% in Czech Rep. and Romania in 1998; from 47% in Hungary to 58% in Romania in 2013).

[9] Romania again stood out with a fairly small construction sector (4% in 1998), as well as a undeveloped commerce, accommodation and food activities (10% in 1998), but until 2013 experienced an above-average growth of employment shares in both sectors (by 3 pp. and 5 pp., respectively).

Table 2. Changes in employment shares by sector, by country between 1998 and 2013 (in percentage points)

SECTOR	HR*	CZ	EE	HU	LV	LT	PL	RO	SK	SI
Agriculture	-6	-3	-5	-2	-11	-11	-7	-13	-5	-4
Mining	0	-1	0	-1	0	0	-1	-1	-1	0
Manufacturing	-3	-1	-3	-4	-5	-4	-2	-3	-3	-9
Energy, gas and water supply	1	0	-1	0	0	-1	0	0	0	1
Construction	-1	-1	2	0	2	1	1	3	1	0
Commerce, accommodation and food activities	1	-1	0	2	2	5	1	5	3	1
Transport, storage and communication	2	1	1	1	3	2	2	2	1	3
Other services	6	6	6	4	9	8	6	6	5	9

*Note: *2003 for Croatia, due to data availability.*
Source: Own elaboration based on EU LFS data.

In 1998, the share of workers with tertiary education attained in the CEE averaged 17%. It was highest in Estonia (32%), while Czech Republic, Hungary, Poland, Romania, Slovakia and Slovenia were below the CEE average. Romania was a clear outlier with the lowest share of tertiary education (8%) and the highest share of primary education (36%) in employment. However, between the middle of the 1990s and the middle of the 2010s, all CEE countries have enjoyed a thriving increase in tertiary education. Latvia, Lithuania and Poland (followed closely by Slovenia) were the irrefutable leaders – the employment share of tertiary graduates grew by 15 pp. in Latvia, 19 pp. in Lithuania and 17 pp. in Poland over the 1998-2013 period, and in 2013 reached 34% in Latvia, 40% in Lithuania and 30% in Poland. Even in Estonia the share in question rose (to 39% in 2013). Moreover, as shown in Table 3, Poland, Romania and Slovenia have also recorded the deepest drops in the share of workers with primary education (11 pp., 14 pp. and 12 pp., respectively). Latvia and Lithuania had seen the largest decrease in the share of workers with secondary education (from 67% in 1998 to 57% in 2013 in Latvia, from 66% in 1998 to 56% in 2013 in Lithuania).

Table 3. Educational attainment in the employment, in 1998 and 2013.

	Share of workers with primary education attained			Share of workers with secondary education attained			Share of workers with tertiary education attained		
	1998	2013	Δ	1998	2013	Δ	1998	2013	Δ
Croatia*	0.23	0.15	-0.08	0.58	0.62	0.04	0.19	0.23	0.04
Czech Republic	0.09	0.04	-0.05	0.79	0.75	-0.05	0.11	0.21	0.10
Estonia	0.12	0.08	-0.04	0.56	0.53	-0.04	0.32	0.39	0.07
Hungary	0.19	0.11	-0.08	0.65	0.63	-0.02	0.16	0.26	0.10
Latvia	0.14	0.09	-0.05	0.67	0.57	-0.10	0.19	0.34	0.15
Lithuania	0.13	0.04	-0.09	0.66	0.56	-0.10	0.21	0.40	0.19
Poland	0.18	0.07	-0.11	0.70	0.64	-0.06	0.12	0.30	0.17
Romania	0.36	0.23	-0.14	0.55	0.59	0.04	0.08	0.18	0.10
Slovakia	0.10	0.04	-0.06	0.78	0.75	-0.04	0.12	0.21	0.09
Slovenia	0.23	0.11	-0.12	0.62	0.59	-0.03	0.15	0.30	0.15

*Note: *Data for Croatia is for 2003 and 2013.*
Source: Own elaboration based on EU-LFS data.

Structural and educational developments have been reflected in occupational structures (Table 4). In all CEE countries, except Slovakia, the employment share of high-skilled occupations increased between 1998 and 2013. In Croatia, Latvia, Lithuania and Poland this increase was substantial (by 8.7 pp. on average) while the share of workers in medium-skilled occupations declined much more (by 6.9 pp.) than that of low-skilled workers (1.8 pp.). In the Czech Republic and Estonia, the employment share of high-skilled occupations increased modestly (3.5 pp. on average), and the share of low-skilled occupations decreased more (2.6 pp.) than that of medium-skilled (0.9 pp.) occupations. Hungary, Romania and Slovenia were the only countries with occupational job polarisation: the share of high-skilled occupations rose (by on average 7.9 pp.) as did the share of low-skilled occupations (2.8 pp), while that of medium-skilled declined (10.8 pp.). Finally, only Slovakia reported an increase in the share of medium-skilled occupations (2.7 pp.), a decrease in the share of low-skilled (2.7 pp.) occupations and no change in the share of high-skilled occupations.

Table 4. Employment shares in 1998 (in %) and changes between 1998 and 2013 (in. pp.) by occupational skill level in the CEE

OCCUPATIONAL SKILL LEVEL	HR*	CZ	EE	HU	LV	LT	PL	RO	SK	SI
	1998 (in %)									
High	29	34	39	31	31	31	28	17	32	28
Medium	63	57	50	60	55	57	64	76	57	67
Low	8	9	11	9	14	12	8	7	11	5
	Change (in percentage points) 1998-2013									
High	6.6	3.5	3.5	4.8	8.6	11.7	7.9	4.4	0.0	14.6
Medium	-4.8	-0.3	-1.5	-5.8	-7.7	-8.3	-6.7	-8.4	2.7	-18.1
Low	-1.8	-3.2	-2.0	1.0	-0.9	-3.4	-1.2	4.0	-2.7	3.5

Note: Following the official ISCO skill classification based on the ISCED levels connected to occupations: high skill – ISCO 1-3, medium skill – ISCO 4-8, low skill – ISCO 9.
**2003 for Croatia, due to data availability.*
Source: Own elaboration based on EU LFS data.

However, the ISCO skill classification of occupations is simplistic. It treats elementary occupations as the only low-skilled category. In medium-skilled occupations it bundles intense manual jobs (e.g. craft and related trades workers, plant and machine operators, and assemblers) with cognitive jobs (e.g. clerical support workers) and those that require personal interactions (e.g. services and sales workers). Behind any change in medium-skilled occupations, there may be a range of changes affecting these different types of jobs. Moreover, the content of these occupations is likely to change over time (Autor et al., 2003, Spitz-Oener, 2006). Therefore, in the next section we present the methodology of mapping occupations into five task content measures which we will use in the main empirical part of the paper.

2. Data & methodology

2.1. Data

We use the Occupational Information Network (O*NET) database as a source of information on the task content of occupations, applying the framework of Acemoglu and Autor (2011).[10] In applying O*NET data from the US to middle-income European countries we followed the approach of Aedo et al. (2013) and Arias and Sánchez-Páramo (2014). We make use of two distinct editions of O*NET (2003 and 2013) to correct the possible changes to the task content within occupations. Moreover, we utilize EU-LFS data to calculate the employment structure in CEE countries (people aged 15 or above). Since EU-LFS data is unavailable for several countries before 1998, we start our analysis period in 1998, with the exception of Croatia, which enters our sample in 2003. We also decided to drop Bulgaria from the sample as we have encountered severe inconsistencies in the Bulgarian EU LFS data.[11]

Although the assumption of task content equivalence between CEE countries and the US may seem strong, Handel (2012) showed that US occupation-based and non-US skill survey-based measures lead to very similar outcomes for European countries. In line with this, Cedefop (2013) showed that two surveys based on O*NET and recently conducted in Italy and Czech Republic (*Indagine sulle professioni* and *Kvalifikace 2008*, respectively) yielded results that correlated highly (mostly around 0.8) with those of O*NET. Cedefop (2013) argue that it is therefore methodologically valid to use O*NET data to construct occupational measures in European countries. Finally, we do not assume the equivalence of jobs in CEE countries and US *per se*, but rather use the US data as an approximation of the general task intensity distribution across occupations.

In the O*NET, data occupations are coded using ONET-SOC,[12] whereas in the EU-LFS data ISCO is used, and the ISCO coding is derived from the country-specific classifications.[13] To estimate the task content of jobs, we first mapped O*NET task items to the corresponding occupations in SOC and afterwards, using the official ILO crosswalk, we translated all SOC-based occupations into ISCO.[14] Both the SOC and ISCO have undergone several revisions during the 1998-2013 period with a major one in 2011, which introduced inconsistencies in the data series. In 2011 the ISCO-88 (COM) was revised and supplanted by the newer ISCO-08, resulting in some clear and visible shifts in the data since these two classifications are not entirely comparable.

In the EU-LFS data, occupations are coded coherently, although their level of detail varies between countries: some are coded at a 3-digit level, some at a 2-digit level. We used the highest level of detail available in each

[10] See Acemoglu and Autor (2011) for a detailed description of the method, and Hardy et al. (2015) for a related case of applying it to the Polish LFS data.

[11] Bulgaria was excluded due to the inconsistencies in encoding occupations. Between 2003 and 2006 we observed parallel shifts of similar magnitudes in public administration, where the number of “other associate professionals” curbed by 50 thousand and the number of “personal and protective workers” grew by approx. 40 thousand. We think that these occurring inaccuracies in the methodology of encoding occupations possibly resulted from Eurostat changing their coding guidelines.

[12] The ONET-SOC is built upon the SOC classification, however it is more detailed and thorough than its forerunner.

[13] Before 2011 the EU-LFS data was coded with the EU-specific classification - the ISCO-88 (COM). However, the differences between ISCO-88 (COM) and ISCO-88 are negligible.

[14] The crosswalks sometimes yield ambiguous mapping between two classifications. In such cases we followed the solution described in detail in Hardy et al. (2015).

country, which is predominantly 3 digits. In Romania 3-digit level codes were available in 1998, 1-digit level codes from 1999 to 2004 and 3-digit codes from 2005 onwards. For Romania we mapped all occupations into a 1-digit level over the entire period in order to avoid inconsistencies in the data.[15] Table 5 presents the used ISCO levels of detail by country.

Table 5. The final ISCO level of detail for all analysed countries.

Level of detail	Country
1-digit	Romania
2-digit	Poland, Slovenia
3-digit	Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Slovakia

Note: These are the levels available in EU LFS datasets. For consistency reasons, in the case of Romania we used the 1-digit level for the whole period and the highest available level for other countries.
Source: Own elaboration based on EU-LFS data.

Despite the EU-LFS data being unified to a common classification before dissemination, some visible shifts occurred in the task data due to a revision of the classification. In particular, the non-routine cognitive task content in several agricultural occupations proved much higher in the years with ISCO-08 classification than in the years with ISCO-88. Considering that agriculture is typically associated with more routine and manual tasks (e.g. Arias and Sánchez-Páramo, 2014), while non-routine cognitive tasks are mostly performed in occupations uncommon in agriculture (Aedo et al., 2013 listed the following occupations as examples: lawyers, teachers, physicians and managers), and assuming a higher precision of the more recent classifications, we imputed the values of task items from selected ISCO-08 occupations to years with ISCO-88 occupations. In each country separately, we ranked the ISCO-88 occupations by the shares in agricultural employment in 1998 and identified those that jointly constituted at least 80% of agricultural employment (starting with the occupations with the largest shares). For these country-specific subsets of ISCO-88 occupations, we ascribed the task items from relevant ISCO-08 occupations (average values of several occupations in some cases) – see Table A1 in the Appendix for a list of occupational matches by country. This procedure improved the consistency of data before and after the ISCO change, allowing us to disaggregate the data by sectors in a reliable way. At the same time, it had a negligible impact on country-level results: the correlation of the corrected and uncorrected yearly task content values ranges from 0.95 (non-routine cognitive analytical) to 1.00 (non-routine manual physical). No other sectors exhibited substantial differences between ISCO-88 and ISCO-08, although there are some breaks in the data which may be due to changes in country-specific classifications.[16] We address this issue in the following section.

[15] For countries with available 3-digit and 2-digit ISCO codes, we found that codes at different level may provide slightly different values of our variables of interest, although the general trends are the same. Consequently we follow the within-country analysis with various details of classification for particular countries. Results at 3-digit and 2-digit levels for countries which provided 3-digit codes, are available upon request.

[16] Some statistical offices introduced revised versions of their national classifications and Eurostat had to adjust its conversion to ISCO methodology. This in turn resulted in shifts at the ISCO level.

2.2. Calculating task contents

Having assigned the chosen task items to the EU-LFS data we standardised the values of each task item within countries to make them comparable over time, in line with Arias and Sánchez-Páramo (2014) and Dicarlo et al. (2015). Then, using the Acemoglu and Autor (2011) methodology, we constructed five task content measures, namely: non-routine cognitive analytical, non-routine cognitive interpersonal, routine cognitive, routine manual and non-routine manual physical.

As mentioned in section 2.1, we used relevant crosswalks to ascribe the task items to both ISCO-88 and ISCO-08, although the two standards are not fully comparable which leads to some inconsistent shifts in task content structure between 2010 and 2011. Our main tool for dealing with these conversions is the rescaling approach, previously applied in Hardy et al. (2015). The rescaling equates the mean task values in the two years surrounding the classification changes, and allows us to study the overall changes in a consistent manner. The main goal of this approach is to fit the post-revision data so that, firstly, it starts with the level reached in the previous period and, secondly, the inner variance of the data remains comparable with the earlier periods. Note that rescaling was conducted separately for each country. In all the countries studied, we corrected the data for shifts related to the ISCO-88 (COM)/ISCO-08 conversion, which took place between 2010 and 2011. We also, however, identified a large change in the classification of occupations in Slovakia (KZAM) that occurred in 2002 due to KZAM-2001 replacing the previous classification. We additionally rescaled the 1998-2001 period in Slovakia so that the changes are comparable with what happens later.

Although we calculate changes in the task content intensity over time, one should remember that the standardisation of tasks measures is performed within countries, thus the estimated values of task intensities between countries are not entirely comparable. However, we are able to interpret them within countries in relative terms (i.e. in comparison to previous and subsequent years) as the mean intensity of performing given tasks per worker in a given year. We can also derive information on the dynamics of task content changes and compare them to the dynamics in other countries. However, the greater increase of task content intensity in one country does not imply that this country's economy is more abundant in a given type of task.

For the sake of a common reference point (i.e. the initial level) and as the values of the task contents can only be interpreted in relationship to values from other years, we have shifted the country values of tasks so that the starting level is equal to zero and multiplied all values by 100. The resulting values for any task in any year, range from -29.5 (non-routine manual physical for Lithuania in 2011) to 29.1 (non-routine cognitive analytical for Slovenia in 2013), with a standard deviation of 10.4 for all calculated values (the smallest standard deviation is 5.9 in Croatia and the largest is 15.5 in Slovenia).

3. Task content of jobs in CEE

3.1. Overall changes

We find that trends in the evolution of task content structures were similar across the CEE countries. Firstly, all of them recorded a significant increase in the average intensity of non-routine cognitive tasks. Among the countries considered, it was Slovenia that experienced the largest growth (relatively to its task structure in 1998) in non-routine cognitive tasks: between 1998 and 2013 the intensity of non-routine cognitive analytical and personal tasks increased by 29 and 25, respectively. Slovakia experienced the smallest growth in the non-routine cognitive analytical (by 5) and personal tasks (by 9). Secondly, a prevalent increase in non-routine cognitive tasks went hand-in-hand with a substantial decline in the average intensity of manual tasks, both routine and non-routine. Non-routine manual tasks declined most in Lithuania (by 29), while routine manual tasks fell most in Slovenia (by 28). At the same time, the smallest decline of routine manual tasks was witnessed by Estonia (by 8) and the smallest drop in non-routine manual tasks – by Hungary (by 7). This is in line with trends identified for the most developed countries (Autor et al., 2003; Autor and Price, 2013; Spitz-Oener, 2006) and selected middle-income economies (Aedo et al., 2013; Arias and Sánchez-Páramo, 2014).

A more diversified picture emerges with respect to routine cognitive tasks, which also proved more enigmatic in previous literature – Autor et al. (2003) and Spitz-Oener (2006) found declining routine cognitive tasks in the US and Germany, while Jaimovich and Siu (2012) and Acemoglu and Autor (2011) found diverse trends for specific periods of time or gender. In general, three patterns can be distinguished regarding the evolution of the average intensity of routine cognitive tasks in CEE:

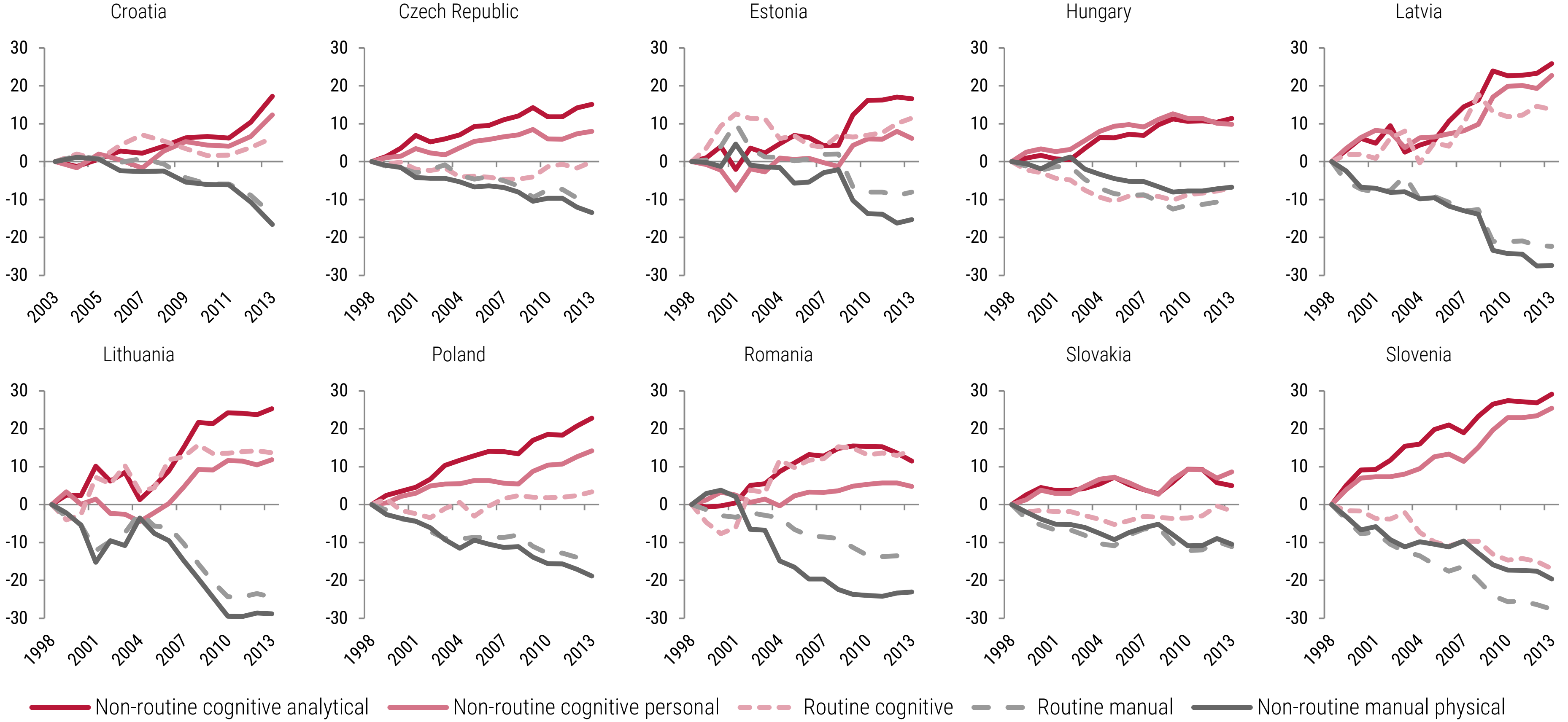
(1) In the Czech Republic, Poland and Slovakia it was rather stable and close to 0 (the change between 1998 and 2013 ranges from -2 in Slovakia to 3 in Poland).

(2) In Croatia, Estonia, Latvia, Lithuania and Romania the average intensity of routine cognitive tasks grew considerably (the change ranges from 6 in Croatia to 14 in Latvia). Romania stood out as the only country with higher increase in the average intensity of routine cognitive tasks (14) than in non-routine cognitive tasks (11 for analytical, 5 for personal).

(3) In Hungary and Slovenia routine cognitive tasks decreased, and the drop in Slovenia (by 17) was more than double that in Hungary (by 7).

Overall, our results show that the CEE countries recorded a substantial shift from manual to cognitive tasks, with a varying degree of non-routine content among the latter.

Figure 1. Evolution of the task content of jobs in the CEE countries between 1998 and 2013.



*Note: A moving average was used to combine the derived mean task content measures from the 2003 and 2014 O*NET data sets. To make the results comparable the task indices were rescaled so that the initial value of all of them was 0.*
*Source: Own calculations based on EU-LFS and O*NET data.*

3.2. Task content of jobs and structural changes

The CEE countries differed in terms of the evolution of routine cognitive tasks. These various patterns of routine cognitive tasks may be related to different paths of structural change. To quantify its impact we use the shift-share decomposition. For each task i we decompose the change (between 1998 and 2013) of the average task intensity per worker, T_i, into contributions of three factors: (i) changes in the sectoral structure of employment (between-sector effect), BS_i; (ii) changes in the task content intensities within a particular sector (within-sector effect), WS_i; and (iii) the interaction between shifts in the employment structure and associated task intensities, INT_i.[17] The decomposition was calculated for each country following the formula:

$$\forall_{i\in T}(T_{i,c}^{2013} - T_{i,c}^{1998}) = (\sum_{j\in H} t_{i,j,c}^{13} h_{j,c}^{13} - \sum_{j\in H} t_{i,j,c}^{03} h_{j,c}^{98}) = BS_{i,c} + WS_{i,c} + INT_{i,c}, (1)$$

$$\forall_{i\in T}\ BS_i = \sum_{j\in H} t_{i,j}^{03}(h_j^{13} - h_j^{98}), (2)$$

$$\forall_{i\in T}\ WS_i = \sum_{j\in H} h_j^{98}(t_{i,j}^{14} - t_{i,j}^{03}), (3)$$

$$\forall_{i\in T}\ INT_i = \sum_{j\in H}(t_{i,j}^{14} - t_{i,j}^{03})(h_j^{13} - h_j^{98}), (4)$$

whereby:

- $t_{i,j}^{14}$ and $t_{i,j}^{03}$ are the average values of task content i for workers in sector j, calculated using O*NET 2014 and O*NET 2003, respectively,
- h_j^{13} and h_j^{98} are the shares of workers in sector j in employment in 2013 and 1998, respectively,
- T is the set of five task content measures (as per Figure 1),
- H is the set of fourteen different sectors at NACE 1-digit level.[18]

Figure 2 shows that, in countries which recorded routine cognitive task growth (with the exception of Estonia), the between-sector effect was a dominant factor behind the growth. Moreover, the reallocation of the labour force away from agriculture accounted for a large share of growth in total routine cognitive tasks in all of these countries (see Table A5 in the Appendix). On average, the decreasing share of employment in agriculture (hence the between-sector effect) explained 87% of the total change of routine cognitive tasks in agriculture. However, the magnitude of routine cognitive change explained by the shrinking of agriculture differed between countries, as did the outflows from the primary sector. Lithuania, Latvia, Poland and Romania, where the share of agriculture reduced the most, reported the highest between-sector effect attributed to agriculture and the overall growth in routine cognitive tasks in these countries was to a large extent fuelled by this. Had the net outflows from agriculture in these countries been equal to the cross-country average, the growth of routine cognitive tasks would have been 26% lower. In Estonia, however, it was the within-sector effect that drove the growth of routine cognitive tasks, and it was mostly determined by transport and communication.

[17] The interaction term is positive (negative) if the task content i increases more (less) than implied by changes in the sectoral structure, and by changes in the task content of jobs recorded in a given sector in the initial year of the study.

[18] Due to the NACE revision in 2007 (from NACE 1.1 to NACE 2.0), we mapped all NACE 2.0 sectors to the previous classification (except for the sector B in NACE 1.1 which was coupled with sector A). Therefore, the decomposition is performed for fourteen economic sectors in accordance with NACE 1.1, see Tables A3-A7 in the Appendix.

Slovenia and Hungary were the only two countries to record a fall in the intensity of routine cognitive tasks, and a within-sector factor played a dominant role here. Table A5 in the Appendix shows that manufacturing contributed most as it experienced a large, above-average decline in routine cognitive intensity.[19] Both within and between-sector changes of routine cognitive intensity in manufacturing were above the cross-country average, but the within-sector changes outweighed the between-sector effects.[20] Manufacturing in these countries underwent changes in the structure of occupations, which provoked a negative within-sector effect of routine cognitive tasks. Hungary and Slovenia stood out with a large, negative between-occupation effect in manufacturing, amounting to -10 and -31 respectively, while the cross-country average stood at -3.7.[21] Both countries saw highly routine cognitive occupations in manufacturing shrinking, hence the negative between-occupation and within-sector effect.[22]

In Slovakia and the Czech Rep. where the change in routine cognitive tasks was close to 0, the between-sector effect accelerated the total change of routine cognitive tasks, although negative change within sectors muted it significantly. The positive between-sector effect was mostly driven by outflows from agriculture, which were, however, quite modest compared to other countries. At the same time, the decrease of routine cognitive tasks in manufacturing and trade counterbalanced the growth fuelled by employment reallocation.

The growth of non-routine cognitive analytical tasks was spurred by both within and between-sector effects in all CEE countries. Nevertheless, on average the between-sector effect was of greater importance. It was most intense in manufacturing and agriculture – the employment shares of these sectors declined and therefore brought about a relative increase in analytical tasks. In the Baltic States and Slovenia, transport and communication enjoyed a flourishing growth in non-routine cognitive analytical tasks due to the within-sector effect, fuelled by changes in the employment structure.[23] The sources of the increase in non-routine personal tasks proved more multifarious. Slovenia, Latvia and Poland, where non-routine cognitive personal tasks accrued most, experienced extraordinary within-sector changes to these tasks. These three countries stood out with relatively large within and between-sector effects in manufacturing, especially Slovenia where these effects were equal to 10.5 and 6.1, respectively, while cross-country they averaged 3.3 and 2.3. Furthermore, the intensity of non-routine personal tasks increased in all CEE countries, albeit starting from a low level. This growth was driven by a within-sector effect and was relatively uniform across the countries, on average 4.1.[24]

[19] This drop was more profound in Slovenia, where it amounted to 17.3 (out of 17.4). In Hungary it stood at 5.9 out of 7.1.

[20] The share of the decline explained by the between-sector effect stood at 2.5 and 8.3 for Hungary and Slovenia, respectively, and was mostly driven by decreasing employment in manufacturing (by 4.3 pp. and by 9.5 pp., respectively).

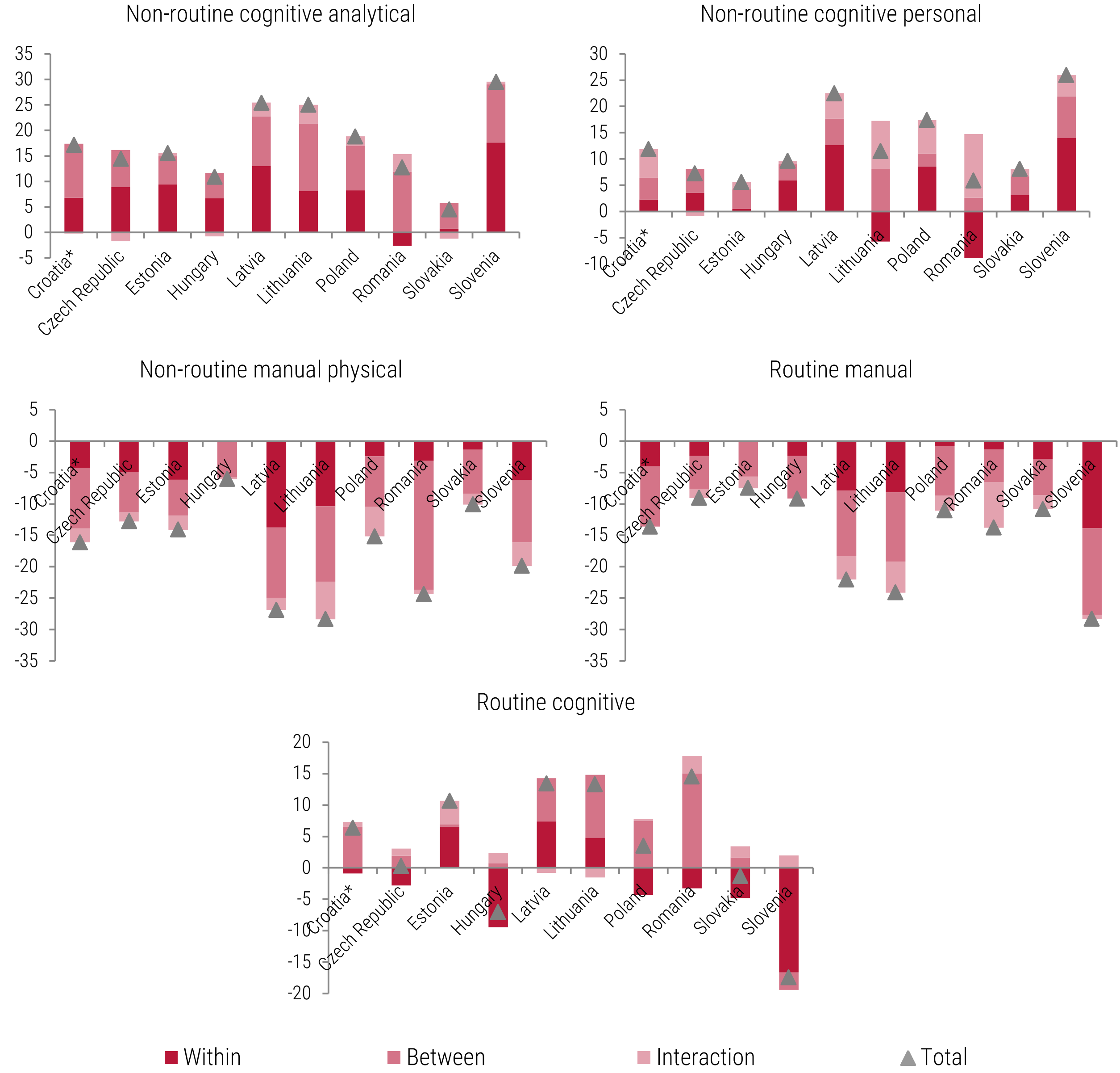
[21] To save space, the between- and within-occupation decompositions are available upon request. They were calculated in line with Hardy et al. (2015).

[22] In Slovenia the share of “Machine operators and assemblers” (code 82 in ISCO88) dropped by approx. 20 pp. Their routine cognitive tasks content in 1998 amounted to 1.62. In Hungary these drops in routine cognitive jobs in manufacturing were more uniform across occupations and smaller.

[23] A simultaneous increase in the number of IT workers and a drop in transport workers resulted in a positive and relatively large within-sector change in analytical tasks.

[24] It was mostly a within-occupation change that pushed non-routine personal tasks up in construction. Additionally, Slovenia and Latvia reported a relatively large between-occupation change in personal tasks (31.3 and 27.6 respectively compared to cross-country average of 10.2).

Figure 2. Decomposition of the change of task content intensity between 1998 and 2013 into between-sector, within-sector and interaction effect, by country.



Source: Own calculations based on EU-LFS and ONET data.

A rather simple picture emerges from the decomposition of manual tasks. All CEE countries saw these tasks plummeting and the between-sector effect contributed most to this plunge. However, the factors behind these between-sector effects were different in routine and non-routine manual tasks. Routine manual tasks dropped due to the negative between-sector effect in manufacturing, which was predominantly caused by outflows of workers from this highly routine manual sector. On the other hand, the between-sector change in non-routine manual tasks was determined by falling employment in agriculture. The between-sector change of these tasks in agriculture accounted for 51% of the cross-country between-sector average. Furthermore, transport and communication accelerated the declines in non-routine manual tasks with a negative within-sector effect.

3.3. Educational attainment, technology and task content of jobs in CEE

Previous literature indicated that changes in occupational structures are affected by both demand-side factors, in particular R&D spending (Machin and van Reenen, 1998; Michaels et al., 2014) which is typically used as a proxy for technological progress due to a shortage of data about the value of ICT capital and investment (Machin and van Reenen, 1998; Goos et al., 2015), and supply side factors, in particular the educational attainment of the workforce (Salvatori, 2015). In this subsection we analyse to what extent changes of task content intensities in CEE were related to factors on the supply and demand-side of the labour market. We use a fixed-effects panel regression to control unobservable country-specific factors and estimated the model for each j-th task content, where $j \in J$ and $J = \{1, \dots, 5\}$, in the following formula:

$$\forall_{j \in J}\; y_{ijt} = u_i + \beta_1 H_{it} + \beta_2 M_{it} + \beta_3 RD_{it} + \varepsilon_{it}\,, \qquad (5)$$

whereby:

- y_{ijt} is the overall change in mean *j* task content intensity during the period $t \in T$ in country $i \in C$, where *C* is the set of countries and *T={1998,..., 2012}*
- β_k are the estimated coefficients for independents variables (for *k*=1,2,3)
- H_{it} is the share of workers with tertiary education attained in employment in time *t* and country i
- M_{it} is the share of workers with secondary education attained in employment in time *t* and country i
- RD_{it} is the research and development expenditure as a percentage of GDP in time *t* and country i
- u_i is the unknown intercept for each country i
- ε_{it} is the error term for country i in time *t*

We use the EU-LFS data to calculate the shares of workers with a particular educational level (primary, secondary and tertiary), as well as World Bank data on R&D spending (as percent of GDP).[25] The data covers the 1998-2012 period except for Croatia (2003-2012). The year 2013 was dropped due to the lack of data on R&D spending. Table 6 presents the results of the estimation. Note that the reference variable for the educational structure is the share of workers with primary education.

We find that the non-routine cognitive analytical task content intensity was significantly, positively related to workforce upskilling, i.e. the rising share of workers with relatively better educational attainment. Across CEE, a 1 pp. increase in the share of workers with secondary education was associated with an increase in the intensity of non-routine cognitive analytical tasks by 0.7. For tertiary education the effect was twice as large (1.6). In the case of non-routine cognitive personal tasks, it was the share of workers with tertiary education that mattered – its increase by 1 pp. was associated with the intensity of these tasks higher by 0.8 – while we find no significant difference between workers with secondary and primary education.

At the same time, we find no significant relationship between the routine cognitive task intensity and the educational attainment structure of the workforce. This suggests that demand-side factors, e.g. structural change (see subsection 3.2), were more important for the evolution of these tasks than changes in the educational structure of the workforce.[26]

We also find that the shift towards tertiary education was driving the decline of both routine and non-routine manual tasks in CEE: a 1 pp. increase in the share of workers with tertiary education was associated with a lower task intensity of 1.2 and 1.8 respectively. In the case of routine manual tasks, the share of workers with secondary and primary education didn't matter. For non-routine tasks, a 1 pp. increase in the share of workers with secondary education at the expense of primary education was associated with a 1.2 decrease in the non-

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[25] Between 1998 and 2012 there were substantial differences in spending on research and development (measured as % of GDP) among the CEE countries, ranging from 0.4% to 1.3% in 1998 and from 0.5% to 2.8% in 2012. Slovenia, Czech Republic and Estonia recorded the highest increase of R&D spending (see Figure A1 in the Appendix).

[26] At least at the 3-class disaggregation of education, which is the only available for all years and observations of the EU-LFS data between 1998 and 2013.

routine manual physical task intensity. For the latter, there is no statistically significant difference between the impact of the share of tertiary and secondary education attainment[27].

Table 6. Panel fixed-effects regressions of task content measures in the CEE, 1998-2012

	Non-routine cognitive analytical	Non-routine cognitive personal	Routine cognitive	Routine manual	Non-routine manual physical
Share of workers with tertiary education	1.58*** (0.10)	0.82*** (0.15)	0.70 (0.45)	-1.22*** (0.13)	-1.78*** (0.26)
Share of workers with secondary education	0.72*** (0.18)	0.03 (0.32)	0.59 (0.87)	-0.34 (0.22)	-1.18** (0.51)
R&D expenditure as a percentage of GDP	2.96* (1.59)	2.99* (1.54)	-4.32 (3.78)	-2.65** (1.15)	-1.48 (2.95)
Observations	145 (10 countries)	145 (10 countries)	145 (10 countries)	145 (10 countries)	145 (10 countries)
R^2 (overall)	0.29	0.27	0.03	0.27	0.18

*Notes: All regressions include country-level fixed-effects and robust standard errors. * p<0.1; ** p<0.05; *** p<0.01.*
*Source: Own estimations based on EU-LFS, O*NET and World Bank data.*

The R&D spending, a proxy for technological progress, was positively and significantly related to the intensity of non-routine cognitive tasks, and negatively to the intensity of routine manual tasks. A 1 pp. increase in the R&D spending to GDP ratio was associated with a growth in both non-routine cognitive analytical and personal task intensity by 3.0. A 1 pp. increase in the R&D spending was also associated with a drop in routine manual task intensity by 2.6. The R&D coefficients in routine cognitive and non-routine manual tasks equations are negative, but not statistically significant. Altogether, R&D may replace routine manual work, but complement non-routine cognitive work (which is in line with the findings of e.g. Michaels et al., 2014).

In the next step, we calculate the contributions of each explanatory variable to the total change in the intensity of particular task content between 1998 and 2012. Given *C* is the set of countries and *J* is the set of five task content measures, the change in task content intensities may be approximated by the formula below:

$$\forall_{i \in C, j \in J}\ T_i^{2012} - T_i^{1998} \approx \hat{\beta}_1 \Delta H_i + \hat{\beta}_2 \Delta M_i + \hat{\beta}_3 \overline{RD_i}\ , \tag{6}$$

whereby:

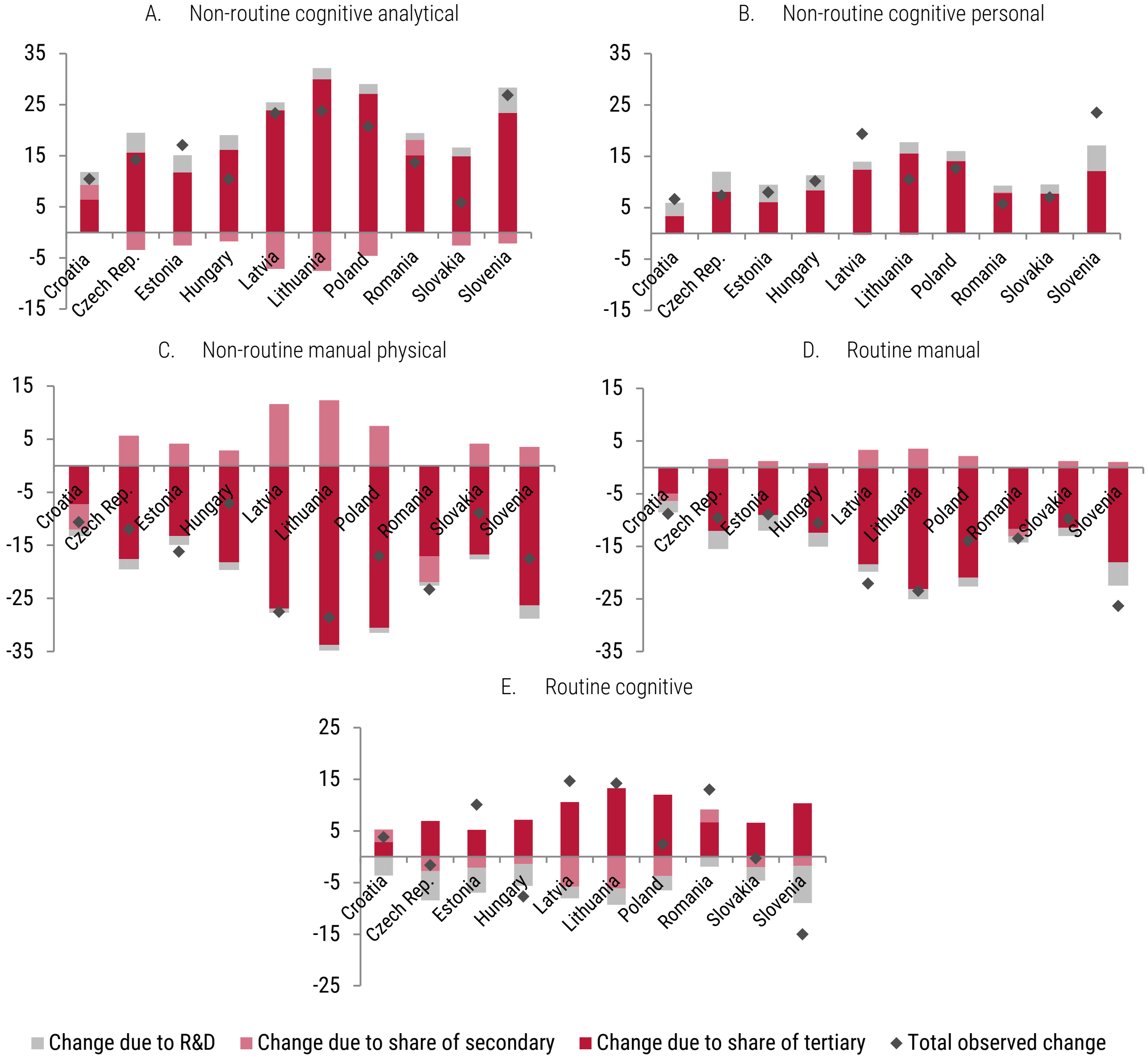
- T_j^{2012} and T_j^{1998} are the economy-wide task content intensities in 2012 and 1998, respectively,
- $\hat{\beta}_k$ are the estimated coefficients (Table 6) for independent variables (k=1,2,3) from equation (5)
- ΔH_i is the change in share of workers with tertiary education in country i between 1998 and 2012
- ΔM_i is the change in share of workers with secondary education in country i between 1998 and 2012
- $\overline{RD_i}$ is the mean R&D expenditure (as a percentage of GDP in country i) between 1998 and 2012.[28]

[27] The Wald test does not allow for the rejection of the hypothesis of equal coefficients at any viable level (p-value of 0.16).

[28] For Croatia the period analysed is 2003-2012.

The shares of workers with secondary and tertiary education are expressed in levels in regression (5), therefore ΔH_i and ΔM_i consistently reflect the magnitude of changes between 1998 and 2012 with the variables used in the estimation. R&D is measured in terms of flows, so we use the mean R&D expenditure between 1998 and 2012 as an approximation of R&D spending, distinguishing 2012 from 1998 in each country.[29] As all the parameters in the regression for routine cognitive tasks are insignificant, we don't discuss the decomposition for these tasks.

Figure 3. Decomposition of changes in task contents between 1998 and 2013 into contributions of workforce upskilling and R&D.



Source: Own calculations based on the results of the estimation presented in Table 6, EU-LFS and World Bank data.

The growth of non-routine cognitive tasks was mostly driven by workforce upskilling (see Figure 3). Since the increase of the share of tertiary educated workers, on average across the CEE, was four times larger than the drop in the share of workers with secondary education, the rise in tertiary attainment was the main factor

[29] This specification of decomposition (7) is equivalent to analysing the difference between hypothetical t_0 and t_1 where in t_0 each country exhibits the task contents and workforce education structures as per 1998, while in t_1 – the task contents and workforce education structures as per 2013, and R&D spending (as a share of GDP) in t_1 equals the country-specific average R&D spending over the period studied.

behind the growth of non-routine cognitive tasks.[30] The contribution of tertiary (secondary) education attainment averaged 18 (-3) and 10 (0) for analytical and personal tasks, respectively. Similar factors drove the change of non-routine cognitive personal tasks with almost no contribution from falling secondary education attainment.[31] Latvia, Lithuania and Poland witnessed the largest increases in the share of tertiary attainment and at the same time enjoyed the largest contribution of this factor to the change of non-routine cognitive analytical tasks, equal to 94%, 93% and 93% of the total positive input, respectively. Moreover, only Slovenia experienced a larger overall increase in non-routine cognitive analytical tasks between 1998 and 2012 than these three countries. Slovenia saw tertiary education attainment rise at a slightly slower pace, although it recorded rather high mean R&D spending, hence the largest growth of non-routine cognitive tasks. Hungary and Slovakia are the countries where the increase in analytical tasks was the smallest. It is also overestimated by our model. As we show in the next section, these two countries were the only ones where the oldest cohorts (born before 1949) contributed negatively to the total growth of tasks in question. Therefore, in Hungary and Slovakia analytical tasks grew rather modestly and less than implied by the changes in educational structure and R&D spending.

At the same time, the increase in the tertiary attainment of workers contributed to the decrease in routine manual tasks, and its contribution to the overall estimated change was even more pronounced than in the case of non-routine cognitive tasks. In Latvia, Lithuania and Poland it accounted, respectively, for 93%, 92% and 92% of the total negative input to the change in routine manual intensity. Mirroring the changes of non-routine cognitive analytical tasks, Slovenia experienced the largest drop in routine manual tasks, which was additionally fuelled by an extraordinary drop in these tasks in manufacturing (due to cross-occupational changes). Latvia and Lithuania likewise saw routine manual tasks plummeting more than would be implied by the model. The two countries stood out as agriculture experienced a decrease in routine manual tasks, hence putting more downward pressure on routine manual tasks than implied by changes in education and R&D.

The results of the estimation (Table 6) suggest that the share of workers with secondary education was most important for non-routine manual tasks and this has been confirmed by the decomposition. In most CEE countries the share of workers with secondary education declined, which pushed the non-routine manual tasks up. However, that was outweighed by the rising tertiary attainment. However, the workforce upskilling cannot solely explain the extraordinary drop in non-routine manual tasks in the Baltic States and Romania. In these countries the reduction of non-routine manual tasks was additionally fuelled by the steep decline in agricultural employment – in the Baltic States and Romania the decline in agriculture averaged 10 pp., whereas in other countries it amounted to 4 pp. Moreover, as shown in Section 3.4, the Baltic States also stood out due to the uncommonly large negative contribution of the cohort born 1969-1973 (-2.8 in Estonia, -4.4 in Lithuania and -2.5 in Latvia, with a mean of -1.3 in other CEE countries).

3.4. Cohort dimension of task content changes

The large contribution of workforce upskilling can be connected to intergenerational differences in skills and education attainment. WDR (2016) shows that, in developing countries, the bulk of "new economy skills", e.g. non-routine cognitive skills, is concentrated among younger workers (born after 1974). Workforce upskilling in CEE also largely involved younger workers – according to EU-LFS data, between 1998 and 2013 the share of

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[30] The share of tertiary educated workers increased on average by 11 pp., while the share of secondary education attainment dropped by approx. 3.6 pp.

[31] For the growth of non-routine cognitive personal tasks, the increasing tertiary education attainment constituted on average 76% of the positive inputs of the factors.

workers with tertiary education increased on average in CEE by 19 pp. among workers born after 1969, but only by 7 pp. among those born before 1969. Moreover, the PIAAC data shows that people aged 50-64 exhibit substantially lower numeracy, literacy and problem-solving skills compared to younger age groups (IBS, 2014). Hence, the evolution of the task content of jobs could have an important intergenerational dimension.

Indeed, our results (see Table A2 in the Appendix) show that cohorts born after 1969 (and before 1988) recorded the largest shifts in task content during the period studied. How these differences affected the overall change was, however, moderated by the age structure of the working population. Although the youngest workers experienced similar task content changes in all CEE countries, in some cases their contribution to overall changes was outweighed by the contribution of older workers (born before 1949). To analyse the intergenerational dimension of the evolution of tasks, we distinguish 10 mutually exclusive 5-year cohorts born between 1949 and 1998, and additionally a cohort of people born before 1949.[32] We decompose the task content intensity changes into contributions of particular cohorts, in line with the following equation:

$$\forall_{j \in J}\, \Delta T_j = T_j^{2013} - T_j^{1998} = \sum_{i \in I} \Delta t_{ij} = \sum_{i \in I} \left(\frac{l_i^{2013} t_{ij}^{2013}}{L^{2013}} - \frac{l_i^{1998} t_{ij}^{1998}}{L^{1998}} \right) \qquad (7)$$

whereby for a given country:

- ΔT_j is the total change in the task content intensity *j*, T_j^{2013} and T_j^{1998} are the economy-wide task content intensities in 2013 and 1998, respectively, and $J = \{1, \ldots, 5\}$ is the set of task contents.
- Δt_{ij} is the change of task content *j* intensity attributed to cohort *i*, t_{ij}^{2013} and t_{ij}^{1998} are the *j* task content values in cohort i in 2013 and 1998, respectively.
- L^{2013} and L^{1998} are the sizes of whole worker populations in 2013 and 1998 respectively, l_i^{2013} and l_i^{1998} are the sizes of cohort i populations in employment in 2013 and 1998.

Our results show that, in all CEE countries, the cohorts born between 1969 and 1988 contributed positively to the growth of non-routine cognitive tasks (Table 7). The bulk of changes was driven by workers born in the 1970s who entered the labour market after the transition. On average in CEE, the contribution of the 1974-1978 cohort amounted to 33% and 44% of the total change in non-routine cognitive analytical and personal tasks, respectively, and that of the 1979-1983 cohort – to 28% and 27%, respectively. The share of total change of non-routine cognitive analytical tasks within countries attributed to these two cohorts was largest in Slovakia (62% of the total change), and of non-routine cognitive personal tasks – in Estonia (75%). Also, older workers have pushed up the non-routine cognitive analytical tasks. The contribution of cohorts born before 1949 and cohorts born between 1949 and 1968 to the total change of analytical tasks in the CEE averaged 1.6 and 1.0, respectively (9% and 4% of the total change).[33]

The nature of this positive contribution was different among older and younger cohorts. Among those born after 1968, in all countries, it was due to the rising number and share of workers with a high (above the country median) content of analytical tasks. Among older workers, especially those born before 1949, it was

[32] The EU-LFS data doesn't report the exact age of responders, only the 5-year age groups that they belong to. Thus, in order to observe cohorts for the longest period possible, we follow the same 5-year cohorts in 1998, 2003, 2008 and 2013.

[33] In all countries, except for Slovakia and Hungary, workers born before 1949 contributed positively to the growth of analytical tasks. The largest share of total change in analytical tasks is attributed to cohorts born before 1949 in Latvia (17%), Lithuania (16%) and Romania (17%).

related to outflows from the labour force and the low initial saturation of these cohorts with non-routine cognitive analytical tasks. In 1998, in all but two countries (Hungary and Slovakia), workers born before 1949 were underrepresented in occupations with above-median intensity of analytical task content,[34] and thus had a negative analytical task content (except for Hungary and Slovakia where it was positive). After 1998, all countries experienced a decrease in the employment (size and share) of workers born before 1949.[35] The negative initial task content, together with plummeting employment shares, resulted in a positive contribution of cohorts born before 1949 to the total change of non-routine cognitive analytical tasks (except for Hungary and Slovakia where it was negative). This effect was strengthened by non-random outflows from the labour force which largely involved people with relatively low intensity of analytical tasks. For instance, in Latvia and Lithuania (countries with the highest contribution of the oldest cohort) the percentage of people born before 1949 with an intensity of analytical tasks above the 1998 country median, grew between 1998 and 2013 from 43% to 70% and from 42% to 60%, respectively.

Workers born before 1949 fuelled the growth of routine cognitive tasks. In all countries, except for the Baltic states, their contribution to the overall change in routine cognitive task intensity surpassed the total change and it was higher than contribution of any other cohort. Similarly, to non-routine analytical tasks, this contribution was mostly caused by outflows from the labour force. Its magnitude largely depended on the initial value of the routine cognitive task content intensity: the lower the initial value, the larger the contribution of the oldest cohort. In 1998, routine cognitive tasks were most abundant among workers born before 1949 in the Baltic states,[36] and the contribution of this cohort to the total change of routine cognitive tasks in Estonia, Latvia and Lithuania was relatively low – on average they amounted to 32% of total growth of routine cognitive tasks, while across the CEE it was 142%.[37] On the other hand, countries with the highest contribution by oldest cohorts to the total change of routine cognitive tasks (Croatia and Romania) exhibited, in 1998, relatively low intensity of routine cognitive tasks among workers born before 1949. Furthermore, by 2013 they experienced a substantial decline of mean routine cognitive intensity among cohorts born before 1949 (by 25.4 in Croatia and 36.6 in Romania).

Younger cohorts, born 1979-1998, also contributed positively to the average intensity of routine cognitive tasks (cross-country average of 0.9), but to a notably lesser extent than workers born before 1949 (5.3). These younger cohorts largely entered the labour market during the period studied. On the other hand, cohorts born between 1969 and 1978, who were in their prime age during the period studied, supressed the routine cognitive tasks. The cross-country average contribution of the 1969-1973 cohort amounted to -0.6, and that of the 1974-1978 to -1.7.[38] Moreover, in all CEE countries the employment of cohorts born 1974-1978 in

[34] In order to obtain reliable and robust results, the analysis of employment structure across 1998 task content deciles was conducted for all countries with 3-digit ISCO classification.

[35] The steepest 27-fold fall of the oldest cohort in employment occurred in Slovakia (from 315,000 to 11,500), while Estonia reported the smallest decline (from 157,000 to 25,000).

[36] In 1998, on average in the Baltic states 43% of workers born before 1949 had jobs with above-country-median intensity of routine cognitive tasks (37% on average in other CEE countries).

[37] Latvia and Lithuania were also the only countries where workers born before 1949 recorded a noticeable growth of mean routine cognitive task content (by 11.9 and 26.8, respectively) between 1998 and 2013. Estonia and Slovakia also recorded such growth, albeit close to 0, and therefore had relatively smaller contribution of the oldest cohorts to the overall change of these tasks.

[38] Hungary, Poland, Slovakia and Slovenia stood out with a strong downward pressure of the 1974-1978 cohort on the total changes in routine cognitive task intensity. At the same time, Poland and Slovenia exhibited the highest contribution of the 1974-1978 cohort to the growth of both non-routine cognitive tasks.

occupations with an above-country-median value of routine cognitive tasks dropped in the period studied (on average by 6 pp.). Meanwhile, the share of people born 1974-1978 in jobs with an above-country-median value of non-routine analytical tasks grew (on average by 22 pp.) and was highest in Latvia (growth of 30 pp.). In general, cohorts born 1974-1978 largely drove the positive shifts of non-routine cognitive tasks. Workers born in the 1970s, who had largely entered labour market after the transition, were shifting from routine to non-routine cognitive tasks and this was crucial for the overall evolution of cognitive task content intensities.

Patterns of changes in non-routine manual tasks were similar to those of routine manual tasks. Cohorts of entrants (1989-1998) pushed these tasks slightly upwards in all countries, but all other cohorts reduced them. The only significant exception was the 1949-1963 cohorts in Romania – their average contribution was equal to 1.7, whereas in the remaining countries it averaged -0.8 among these cohorts. Again, the 1974-1978 and 1979-1983 cohorts experienced the largest declines in non-routine manual tasks and contributed most to their decreases (in CEE on average 3.8 and 4.1, respectively). The 1984-1988 cohort also recorded a visible negative contribution, generally stronger than in the case of routine manual tasks. Contrary to routine manual tasks, workers born before 1949 experienced a drop in the average intensity of non-routine manual tasks and a negative contribution to the overall change of these tasks, especially in countries with an initially large but declining employment share of agriculture.

Table 7. Contributions of 5-year cohorts to task content changes between 1998 and 2013 in CEE countries (multiplied by 100)

A. Non-routine cognitive analytical											
	before 1949	1949-1953	1954-1958	1959-1963	1964-1968	1969-1973	1974-1978	1979-1983	1984-1988	1989-1993	1994-1998	Total
Croatia*	0.7	0.0	1.5	1.7	1.5	1.0	2.8	5.6	3.6	-1.0	-0.2	17.2
Czech Republic	0.5	1.9	1.5	0.8	0.9	1.9	4.5	3.0	1.4	-1.3	-0.2	15.1
Estonia	2.3	0.7	-0.6	-0.2	1.4	3.4	5.2	3.4	2.6	-1.2	-0.4	16.6
Hungary	-1.3	1.1	0.1	0.7	0.7	1.5	5.3	4.1	1.2	-1.8	-0.2	11.4
Latvia	4.5	1.5	0.2	2.1	2.1	2.3	5.7	5.4	3.1	-0.5	-0.4	25.9
Lithuania	4.2	1.2	0.0	0.8	0.8	5.1	5.3	5.9	3.5	-1.0	-0.3	25.3
Poland	1.8	1.2	1.6	1.7	1.4	3.0	6.6	5.1	2.8	-2.0	-0.3	22.8
Romania	2.0	-2.3	-0.4	0.2	1.5	1.3	4.4	5.3	2.0	-1.7	-0.6	11.6
Slovakia	-1.1	-0.1	-0.2	0.7	0.9	0.5	3.1	2.1	1.1	-1.9	-0.2	5.0
Slovenia	2.3	2.1	2.8	2.5	2.8	3.2	8.6	6.1	1.6	-2.0	-1.0	29.1
B. Non-routine cognitive personal											
Croatia*	-4.0	0.2	0.9	3.3	2.1	0.6	3.3	3.7	2.3	0.0	-0.1	12.4
Czech Republic	0.1	0.9	0.8	0.5	0.5	2.0	3.8	1.1	-0.2	-1.3	-0.2	7.9
Estonia	2.0	0.3	-1.8	-1.2	0.1	2.2	4.6	1.4	0.2	-1.4	-0.3	6.1
Hungary	-1.3	1.4	0.6	0.8	1.0	1.9	4.9	2.1	-0.3	-1.3	-0.1	9.8
Latvia	2.4	1.4	1.2	2.4	2.3	3.1	5.1	4.3	1.5	-0.8	-0.3	22.7
Lithuania	0.9	-0.4	-0.2	-0.3	-0.3	4.0	4.2	3.7	1.6	-1.3	-0.2	11.9
Poland	-2.6	0.6	1.0	1.5	1.6	3.7	6.2	3.0	1.2	-1.8	-0.2	14.2
Romania	-8.9	-0.9	1.2	1.7	2.7	2.4	3.4	3.5	1.4	-1.2	-0.5	4.8
Slovakia	-1.3	0.4	0.5	1.2	1.6	1.7	3.7	1.7	0.6	-1.2	-0.2	8.6
Slovenia	-3.2	2.1	2.9	3.4	4.0	4.8	8.0	4.5	0.8	-1.1	-0.6	25.5

	before 1949	1949-1953	1954-1958	1959-1963	1964-1968	1969-1973	1974-1978	1979-1983	1984-1988	1989-1993	1994-1998	Total
C. Routine cognitive												
Croatia*	7.5	-0.7	-0.6	-1.3	-0.8	0.8	-0.8	0.2	1.1	0.8	-0.1	6.2
Czech Republic	0.6	0.1	0.2	-0.2	-0.3	-0.7	-2.3	0.6	1.1	0.8	0.0	0.0
Estonia	2.4	1.6	2.1	1.6	0.9	0.2	-2.6	1.1	1.9	2.0	0.2	11.5
Hungary	1.1	-0.9	-0.5	-1.2	-1.3	-1.5	-3.7	-0.7	1.0	0.7	0.0	-7.0
Latvia	4.9	0.9	0.5	0.3	1.5	0.4	-0.5	1.2	2.7	1.7	0.1	13.8
Lithuania	5.3	1.8	0.1	1.1	0.1	0.0	-0.6	1.5	1.9	2.2	0.2	13.7
Poland	6.9	-0.5	-0.5	-1.3	-1.4	-2.2	-2.9	1.6	2.2	1.4	0.0	3.3
Romania	15.3	-4.5	-3.5	-2.0	-0.7	0.4	3.0	4.4	2.8	-0.1	-0.7	14.3
Slovakia	2.3	-0.1	-0.5	0.0	-1.1	-0.3	-3.1	-0.3	0.6	0.8	0.1	-1.7
Slovenia	6.5	-4.6	-4.2	-3.2	-3.9	-3.5	-3.7	-0.5	0.5	0.0	-0.5	-16.9
D. Routine manual												
Croatia*	1.3	-0.6	-0.9	-2.7	-1.0	-0.5	-2.8	-4.1	-3.2	0.5	0.1	-14.0
Czech Republic	0.1	-0.8	-0.8	-0.7	-0.6	-1.6	-3.8	-2.0	-1.0	1.3	0.2	-9.7
Estonia	-1.3	0.1	1.5	1.6	-0.7	-2.2	-4.4	-1.6	-1.6	0.4	0.2	-8.1
Hungary	0.9	-0.8	-0.5	-0.6	-0.5	-1.2	-4.7	-3.2	-0.8	1.2	0.2	-9.9
Latvia	-3.8	-1.2	-0.8	-1.8	-1.1	-2.0	-4.8	-4.7	-2.5	0.2	0.3	-22.3
Lithuania	-3.2	-1.3	-1.3	-1.4	-1.5	-4.8	-4.4	-4.8	-2.9	0.9	0.2	-24.4
Poland	0.1	-0.8	-1.0	-1.3	-1.0	-2.1	-4.9	-3.5	-2.3	1.3	0.2	-15.2
Romania	4.2	-0.3	-1.7	-2.0	-2.5	-1.9	-2.9	-3.9	-2.3	0.5	0.2	-12.6
Slovakia	0.1	-1.0	-1.1	-1.6	-1.7	-1.5	-3.0	-1.5	-1.3	1.4	0.2	-11.0
Slovenia	0.8	-2.7	-2.6	-3.1	-4.3	-3.6	-7.3	-5.1	-1.7	1.1	0.7	-27.6
E. Non-routine manual physical												
Croatia*	-1.5	-0.1	-0.3	-1.7	-1.1	-0.8	-2.9	-4.9	-3.6	0.3	0.1	-16.5
Czech Republic	-1.4	-0.7	-0.8	-1.2	-1.4	-2.4	-3.1	-1.9	-1.6	0.8	0.2	-13.4
Estonia	-2.8	-0.9	0.2	0.2	-1.0	-2.8	-3.7	-1.9	-2.4	-0.3	0.1	-15.3
Hungary	0.4	-0.3	0.2	-0.4	-0.8	-0.5	-2.8	-2.7	-1.1	0.9	0.2	-6.8
Latvia	-5.6	-1.3	-0.8	-1.9	-2.0	-2.5	-4.1	-5.4	-3.6	-0.4	0.1	-27.4
Lithuania	-4.3	-1.0	-0.9	-2.0	-1.5	-4.4	-4.7	-6.3	-4.1	0.2	0.2	-28.9
Poland	-3.3	-0.6	-1.1	-1.2	-0.4	-1.0	-3.8	-4.6	-3.5	0.4	0.2	-18.8
Romania	-11.1	3.2	1.6	0.5	-1.0	-1.4	-5.3	-7.2	-3.7	0.6	0.6	-23.1
Slovakia	-1.1	-0.9	-0.7	-1.5	-1.6	-1.3	-1.6	-1.0	-2.0	1.0	0.2	-10.5
Slovenia	-3.2	-0.7	-0.6	-1.3	-1.4	-1.5	-6.1	-5.3	-1.5	1.1	0.8	-19.6

*Note: *Data for Croatia is for 2003 and 2013.*
Source: Own calculations based on LFS and ONET data.

Conclusions

In this paper we study the evolution of labour markets in 10 Central and Eastern European countries in the period 1998-2013 using the task-based approach of Autor, Levy and Murnane (2003) and distinguishing between non-routine cognitive analytical, non-routine cognitive interpersonal, routine cognitive, routine manual, and non-routine manual physical tasks. To the best of our knowledge this is the first task-oriented analysis to cover this region. We use O*NET data from 2003 and 2014 and combine it with EU-LFS data, mostly using a 3-digit occupation classification. We analyse the economy-wide changes in the task content of jobs, their structural component and intergenerational dimension. We search for interactions between task content dynamics, workforce upskilling and R&D via a series of fixed-effect panel regressions.

We find that all CEE countries witnessed an increase in non-routine cognitive tasks and a decrease in manual tasks, which is line with the previous literature on the most developed economies (e.g. Acemoglu and Autor, 2011; Autor et al., 2003; Spitz-Oener, 2006). However, there is no clear pattern for routine cognitive tasks, which declined in two CEE countries, remained stable in three and increased in five. Using the shift-share analysis we conclude that between-sector changes, in particular diverse patterns of labour reallocation out of agriculture, were the main factor behind diverse developments in routine cognitive tasks in the CEE. However, the additional within-sector changes made Slovenia and Hungary the only countries with declining routine cognitive tasks (a pattern typical for Western European countries). Between-sector shifts were also crucial for an increase in non-routine analytical tasks, and a fall in manual tasks.

Our panel regressions identify a link between the evolution of the task content of jobs, education attainment changes and R&D spending (a proxy for technology adoption). We find a positive and statistically significant relationship between both non-routine cognitive task intensities and the share of workers with tertiary education attained. There is also a positive interplay between the intensity of non-routine cognitive analytical tasks and the share of secondary educated workers. Manual tasks are found to be negatively related to the share of workers with tertiary education. However, for routine manual tasks we find no significant difference between workers with secondary and primary education. The R&D spending was positively and significantly correlated with the intensity of non-routine cognitive tasks, and negatively with the intensity of routine manual tasks. At the same time, we find no significant relationship between the routine cognitive task intensity and the educational attainment structure of the workforce or R&D, thus suggesting that demand-side factors (structural shifts) were of greater importance for the evolution of these tasks.

The above findings suggest that workforce upskilling played a significant role in the evolving task structure of jobs in CEE, with the rapidly increasing tertiary education attainment having the largest impact on the task content structure. The most profound impact of educational expansion occurred for Latvia, Lithuania and Poland, where on average this factor explained 94% of the estimated the change in non-routine cognitive analytical tasks. As the workforce upskilling largely resulted from the increasing tertiary attainment of younger cohorts, the intergenerational differences in task content evolution were substantial. We find that people born during the 1974-1983 period added most to non-routine cognitive tasks growth between 1998 and 2013. They also suppressed routine cognitive tasks. The oldest cohorts, born before 1949, also slightly increased the non-routine analytical tasks and routine cognitive tasks, but due to outflows from the labour force of workers performing rather manual and routine tasks. The decline in routine manual tasks, however, was widespread except among the youngest cohorts (born 1989-1998).

Several implications stem from our findings. They stress the importance of workforce educational upskilling as a factor behind the rise in non-routine cognitive tasks and declining manual tasks in CEE. We also find that structural changes, which in CEE followed a standard pattern of declining agriculture and rising share of services, can largely explain why several CEE countries have experienced an increase in routine cognitive tasks, which have been declining in the most developed economies. In previous studies, workforce upskilling was often perceived as inferior to routine-biased technology progress. We find that educational change remains a major determinant of the labour market structure evolution. However, we provide evidence that it is not only the share of tertiary graduates but also the overall composition of the workforce that drives particular task contents in the post-transition, upper-middle income countries experiencing relatively fast structural change. We think that low and middle-income countries which experience a reallocation of labour from the primary sector should not expect the immediate de-routinisation of the labour market. To the contrary, the CEE experience shows that the widespread improvement of education attainment to at least secondary level can allow both routine and non-routine cognitive tasks to grow while manual tasks decline.

At the same time, the evolution of the task content of jobs and sectoral change can encompass substantial intergenerational differences, as younger workers record larger movements towards non-routine cognitive tasks and jobs than older workers. This suggests that older workers may be left behind by the emergence of new types of jobs, especially in countries with undeveloped systems of life-long learning. Older workers in more routine and manual jobs may also face bigger obstacles to working longer than they would face if they had more non-routine and cognitive jobs. On the other hand, younger and older workers may not compete for the same types of jobs, which suggests that the lump of labour fallacy is indeed a fallacy, and should facilitate the implementation of policies aimed at prolonging the working life. Moreover, we provide evidence that the shift towards non-routine cognitive jobs is also positively correlated (albeit to a smaller degree) with R&D spending, which proxies for technological improvements. The interaction between expenditure on research and development, technology adoption and sectoral change should be taken into account by the policy makers responsible for both labour market and R&D policies.

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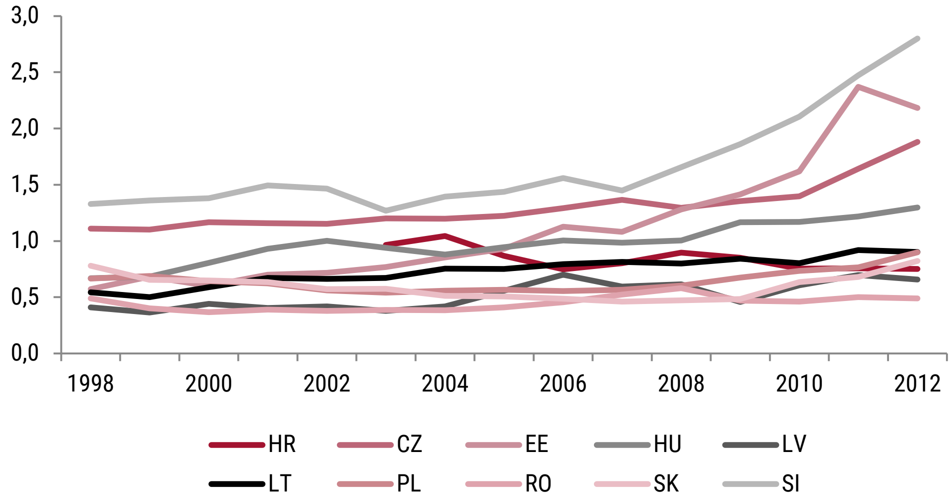
Appendix

Figure A1. R&D expenditure as % of GDP in CEE.



Source: Own elaboration based on the World Bank data.

Table A1. List of ISCO-88 occupations comprising at least 80% of agriculture in 1998, with the ascribed ISCO-08 values, by country

Country	ISCO-88 (ISCO-08)
Croatia	613 (613); 611 (611); 612 (612)
Czech Rep.	612 (612); 833 (834); 614 (621); 723 (723); 921 (921); 832 (832, 833); 611 (611); 321 (314, 321); 343 (331, 334); 613 (613)
Estonia	613 (613); 612 (612); 833 (834); 921 (921); 614 (621); 615 (622); 832 (832, 833); 321 (314, 321); 915 (962); 343 (331, 334); 834 (835)
Hungary	612 (612); 611 (611); 613 (613); 833 (834); 723 (723); 921 (921); 832 (832, 833); 614 (621); 412 (431); 722 (722); 914 (910, 912); 932 (932)
Latvia*	600 (6**); 613 (613); 921 (921); 833 (834); 611 (611); 512 (512, 513, 515); 612 (612)
Lithuania	613 (613); 921 (921); 612 (612); 833 (834); 610 (610, 611, 612, 613)
Poland	61 (61); 62 (63); 71 (71)
Romania	6 (6)
Slovakia	921 (921); 612 (612); 833 (834); 832 (833, 832); 723 (723); 614 (621); 915 (962); 611 (611); 321 (321, 314); 343 (331, 334); 814 (817); 413 (432)
Slovenia	61 (61)

*Note: * Despite being mostly coded at a 3-digit level, the Latvian dataset contains some observations with occupation coded as 600 and that jointly form a significant part of Agriculture. In this case, we ascribed the mean of tasks in all occupations in the '6' group of ISCO-08.*

Source: Own elaboration based on EU-LFS data.

Table A2. Task content changes between 1998 and 2013 within cohorts (multiplied by 100)

	before 1949	1949-1953	1954-1958	1959-1963	1964-1968	1969-1973	1974-1978	1979-1983	1984-1988	1989-1993
A. Non-routine cognitive analytical										
Croatia*	-34.6	11.5	13.9	12.8	11.0	7.3	18.3	55.1	78.9	26.6
Czech Republic	39.7	25.2	12.3	7.2	7.5	15.5	35.1	66.8	62.5	34.4
Estonia	9.1	8.2	-5.4	-1.1	12.3	27.5	48.1	69.5	116.8	57.5
Hungary	56.8	22.7	0.8	5.3	5.7	11.4	38.5	79.9	78.4	30.0
Latvia	45.3	22.1	2.5	16.0	16.9	18.3	54.0	95.0	77.0	53.3
Lithuania	30.9	23.3	0.9	5.2	6.1	38.2	51.2	99.6	87.1	25.2
Poland	25.7	23.2	11.7	12.2	11.7	24.2	58.5	98.9	77.9	21.5
Romania	-53.6	-39.9	-2.3	2.4	13.3	9.2	38.1	71.2	58.5	18.6
Slovakia	19.8	13.2	-1.4	4.4	7.2	4.4	25.6	49.3	54.8	24.8
Slovenia	-22.8	17.5	24.3	18.8	18.3	25.0	71.2	94.8	66.4	26.1
B. Non-routine cognitive personal										
Croatia*	-73.4	6.4	7.8	23.3	15.5	4.8	23.4	38.8	42.4	35.4
Czech Republic	27.5	16.2	7.1	4.3	3.9	15.6	29.8	41.4	36.5	16.6
Estonia	5.9	8.4	-14.8	-8.5	1.2	17.4	43.4	50.2	84.3	41.5
Hungary	31.7	20.9	4.0	6.7	8.3	14.9	36.7	60.0	54.4	25.4
Latvia	30.7	23.6	11.3	18.1	18.6	24.9	48.8	78.6	50.2	32.7
Lithuania	8.4	3.5	-0.3	-1.2	-2.2	30.3	41.2	62.0	62.4	13.1
Poland	7.3	18.9	8.5	11.3	14.0	30.0	57.1	58.3	42.7	15.1
Romania	-75.3	-22.0	9.6	15.7	25.1	17.3	28.6	34.1	18.8	9.0
Slovakia	25.9	24.9	5.2	8.7	12.0	13.5	29.5	46.9	41.9	31.6
Slovenia	-42.2	23.7	27.1	25.0	26.3	37.2	65.5	57.2	39.6	29.6
C. Routine cognitive										
Croatia*	-25.4	-23.0	-6.4	-7.1	-5.6	5.5	-8.6	-7.7	23.3	19.0
Czech Republic	-19.0	1.6	2.2	-1.5	-2.1	-6.7	-20.2	-13.5	-19.6	7.8
Estonia	-2.1	11.2	18.5	11.9	8.0	2.2	-26.9	-4.7	-14.1	18.8
Hungary	-25.4	-9.0	-3.1	-9.3	-10.6	-12.0	-29.8	-35.3	-9.0	-8.5
Latvia	11.9	7.2	4.7	2.6	12.3	3.1	-7.0	10.4	29.0	-0.4
Lithuania	26.9	18.7	1.6	7.9	1.0	0.0	-7.9	52.0	0.3	3.4
Poland	-4.7	-8.6	-2.0	-9.6	-11.7	-18.2	-33.8	25.7	35.5	15.9
Romania	-36.6	-72.4	-26.2	-16.9	-8.7	-0.4	21.0	69.2	73.1	42.1
Slovakia	2.8	-14.4	-4.7	-0.5	-8.7	-2.4	-26.3	-37.5	-24.2	0.4
Slovenia	-63.8	-85.3	-39.6	-22.4	-26.3	-27.2	-33.9	10.8	19.2	13.4

	before 1949	1949-1953	1954-1958	1959-1963	1964-1968	1969-1973	1974-1978	1979-1983	1984-1988	1989-1993
D. Routine manual										
Croatia*	21.4	-21.3	-9.9	-19.5	-7.6	-3.3	-19.2	-40.2	-59.5	-33.9
Czech Republic	-41.1	-12.7	-6.6	-6.3	-4.9	-12.5	-29.3	-50.5	-52.3	-32.4
Estonia	-17.1	-4.6	12.1	12.1	-6.4	-17.2	-41.2	-40.8	-95.8	-52.6
Hungary	-44.7	-13.9	-2.6	-4.5	-4.4	-9.1	-34.9	-75.9	-63.5	-40.5
Latvia	-37.3	-13.8	-6.4	-13.2	-9.3	-15.8	-47.3	-86.0	-65.5	-55.1
Lithuania	-35.5	-21.3	-12.0	-9.2	-11.2	-35.9	-43.4	-76.9	-67.6	-16.0
Poland	-22.8	-13.9	-6.1	-9.4	-8.4	-17.2	-43.5	-66.5	-49.8	-11.4
Romania	32.1	1.0	-14.8	-19.2	-23.0	-14.1	-22.9	-34.2	-26.8	1.7
Slovakia	-38.0	-23.1	-7.9	-10.9	-13.2	-11.9	-24.4	-33.5	-44.9	-39.8
Slovenia	18.6	-24.2	-23.7	-22.0	-28.6	-27.9	-59.0	-66.7	-32.6	-6.2
E. Non-routine manual physical										
Croatia*	28.1	-8.7	-3.9	-13.5	-8.0	-6.1	-19.5	-42.6	-63.0	-30.3
Czech Republic	-40.1	-8.6	-6.7	-10.2	-11.0	-19.1	-22.8	-35.5	-37.5	-28.7
Estonia	-20.9	-11.6	1.5	1.6	-8.8	-22.9	-32.4	-37.0	-91.9	-49.3
Lithuania	-34.1	-18.5	-8.4	-13.4	-11.2	-32.5	-44.8	-104.7	-63.7	-18.0
Latvia	-46.8	-17.8	-7.0	-14.0	-16.0	-19.9	-38.3	-90.4	-73.8	-49.0
Poland	-21.8	-4.7	-5.5	-7.8	-3.7	-7.9	-29.5	-80.8	-69.6	-21.3
Romania	25.8	48.0	10.8	3.1	-8.2	-8.1	-42.6	-99.5	-92.2	-38.2
Slovakia	-36.7	-12.2	-5.1	-10.0	-12.5	-10.3	-11.8	-2.4	-35.5	-33.2
Slovenia	34.7	8.8	-5.0	-9.6	-9.1	-11.8	-46.4	-76.8	-45.9	-27.4
Hungary	-36.8	-5.2	2.2	-3.1	-6.2	-3.8	-20.5	-50.7	-52.1	-21.7

*Note: *Data for Croatia is for 2003 and 2013. The change within cohort born 1984-1988 was calculated for years 2003 and 2013, while the change within the cohort born 1989 -1993 was calculated for years 2008 and 2013.*
*Source: Own calculations based on EU-LFS and O*NET data.*

Table A3. Decomposition of non-routine cognitive analytical task content change between 1998 and 2013 into within and between-sector effect

Within-sector change														
NACE 1.1	A	C	D	E	F	G	H	I	J	K	L	M	N	O
Croatia*	-3.0	-0.1	5.7	0.2	5.4	-0.7	-1.2	2.6	-0.2	-0.8	-0.1	-1.4	0.2	0.3
Czech Republic	-0.1	0.6	6.9	0.5	5.2	-1.2	-1.3	2.8	0.1	-1.6	-1.0	-1.6	0.3	-0.7
Estonia	0.0	0.7	2.0	0.2	3.5	-1.6	-1.2	5.2	0.2	-0.1	0.4	0.0	0.5	-0.4
Hungary	-1.0	0.3	4.0	0.5	3.8	-0.8	-1.4	3.1	0.2	-0.7	0.2	-2.9	0.9	0.4
Latvia	0.9	0.1	2.2	0.8	4.3	0.5	-0.7	4.2	-0.2	0.8	2.2	-2.7	0.4	0.2
Lithuania	-5.4	0.1	2.6	0.7	4.6	-0.1	-0.5	3.8	0.2	-0.4	2.9	-2.0	1.8	-0.2
Poland	-5.1	0.8	6.9	0.8	4.1	-1.1	-0.5	4.2	0.9	-0.4	0.1	-2.7	0.2	-0.2
Romania	-13.5	0.8	5.7	0.8	1.2	-2.2	-0.6	2.1	0.2	-0.6	1.8	1.2	0.6	-0.2
Slovakia	-1.2	0.3	0.7	0.6	4.8	1.2	-1.3	2.2	-0.3	-1.1	-1.8	-3.0	0.2	-0.7
Slovenia	-2.8	0.5	13.1	0.4	3.8	-2.7	-1.4	3.8	0.3	0.8	1.5	-0.6	1.0	0.1
Between-sector change														
Croatia*	4.3	0.0	0.9	0.1	0.5	-0.2	-0.3	-0.1	0.3	1.9	0.4	1.8	0.9	0.1
Czech Republic	1.3	0.6	0.6	0.0	0.7	-0.1	0.0	-0.2	0.5	2.1	0.3	0.5	1.0	0.0
Estonia	2.4	0.2	1.6	0.1	-0.7	-0.1	-0.5	-0.3	0.3	1.8	0.8	-0.1	0.1	0.0
Hungary	1.2	0.2	2.0	0.1	-0.1	0.1	-0.5	-0.2	0.1	2.2	0.4	-0.5	0.1	-0.1
Latvia	6.5	-0.3	2.0	0.1	-1.2	0.0	-0.4	-1.0	0.9	1.4	0.1	1.7	0.0	0.0
Lithuania	7.4	-0.1	1.5	0.1	-0.5	0.5	-0.3	-0.6	0.1	4.3	0.3	0.2	0.1	0.1
Poland	4.2	0.3	0.7	0.0	-0.4	0.0	-0.2	-0.6	0.1	2.5	1.1	2.0	-0.7	-0.2
Romania	5.2	0.3	0.6	0.0	-0.7	1.9	0.2	-0.4	0.7	2.9	0.4	-0.3	1.0	0.1
Slovakia	1.8	0.4	1.3	0.0	-0.4	0.0	-1.2	-0.1	0.5	2.4	0.6	-0.6	0.3	-0.1
Slovenia	2.5	0.2	5.0	0.0	-0.2	0.0	0.0	-1.1	0.4	1.2	0.7	2.1	0.6	0.1
Total change														
Croatia*	2.4	-0.1	5.9	0.5	5.2	-0.8	-1.7	3.4	0.0	0.6	0.3	0.0	1.1	0.5
Czech Republic	1.2	0.9	7.2	0.5	5.2	-1.2	-1.3	3.1	0.7	-0.4	-0.9	-1.2	1.4	-0.6
Estonia	2.4	0.7	3.3	0.2	3.6	-1.6	-2.3	5.6	0.6	1.7	1.3	-0.1	0.6	-0.4
Hungary	0.5	0.3	5.3	0.5	3.8	-0.8	-2.1	3.4	0.4	0.9	0.6	-3.3	1.1	0.3
Latvia	6.8	0.0	3.6	0.7	4.7	0.5	-1.5	5.1	0.6	3.5	2.3	-1.6	0.4	0.2
Lithuania	5.0	0.1	3.7	0.6	4.7	0.3	-1.1	4.6	0.4	3.0	3.9	-1.9	1.9	-0.1
Poland	1.0	0.9	6.9	0.9	4.3	-1.1	-0.8	5.0	1.0	1.6	1.3	-1.3	-0.5	-0.4
Romania	-4.0	0.7	5.7	0.8	1.5	-1.6	-0.7	2.6	1.0	1.3	2.9	0.9	1.9	-0.1
Slovakia	1.3	0.5	1.9	0.6	4.8	1.3	-3.5	2.3	0.1	0.3	-1.6	-3.4	0.5	-0.7
Slovenia	0.5	0.4	14.1	0.9	3.8	-2.9	-1.4	4.7	0.9	2.4	2.7	1.3	1.9	0.2

*Note: *Data for Croatia is for 2003 and 2013.*

Source: Own calculations based on LFS and ONET data.

Table A4. Decomposition of non-routine cognitive personal task content change between 1998 and 2013 into within and between-sector effect

Within-sector change														
NACE 1.1	A	C	D	E	F	G	H	I	J	K	L	M	N	O
Croatia*	-15.9	0.3	6.1	0.4	5.3	0.9	1.3	1.6	-0.5	-0.3	1.3	0.2	1.3	0.4
Czech Republic	-2.1	0.3	2.2	0.2	5.5	-0.7	0.4	-0.4	-0.6	-1.4	-0.4	0.8	0.2	-0.5
Estonia	-2.3	0.6	-1.0	-0.4	3.3	-2.3	-0.4	1.1	-0.3	-1.1	0.2	2.0	1.4	-0.3
Hungary	-3.0	0.3	1.7	0.3	3.7	1.0	0.2	0.6	-0.5	-0.4	1.0	-0.1	0.9	0.3
Latvia	-2.9	0.1	1.5	0.7	4.3	2.6	-0.3	3.3	-0.4	0.6	3.1	-0.4	0.5	-0.1
Lithuania	-15.8	0.0	1.0	-0.2	4.5	-0.5	-0.1	2.5	0.2	-0.7	2.6	0.2	1.2	-0.6
Poland	-12.6	0.8	7.9	1.2	5.4	-1.9	0.2	3.6	1.1	0.2	1.1	-0.1	0.9	0.7
Romania	-30.3	1.1	8.9	1.1	1.7	0.2	0.0	2.5	0.2	0.0	2.3	1.7	1.2	0.5
Slovakia	-2.3	0.0	-3.2	0.2	4.4	3.8	0.2	-0.1	-0.3	-0.9	-1.0	0.5	2.1	-0.4
Slovenia	-10.9	0.3	10.5	0.4	4.2	-0.5	0.5	2.4	0.1	0.8	1.9	2.4	1.1	0.8
Between-sector change														
Croatia*	-0.2	0.1	1.6	-0.4	0.6	-0.4	0.0	-0.5	0.2	0.6	0.0	1.7	0.8	0.0
Czech Republic	0.1	0.5	0.7	-0.1	0.7	-0.5	0.0	-0.1	0.4	1.0	0.1	0.5	1.3	-0.1
Estonia	0.9	0.2	1.7	0.2	-0.4	-0.4	-0.2	-0.2	0.3	1.2	0.4	-0.1	0.1	0.0
Hungary	0.1	0.3	2.6	0.1	-0.1	0.2	-0.2	-0.2	0.1	0.7	-0.2	-0.4	0.1	-0.1
Latvia	2.5	-0.2	2.8	0.2	-1.2	0.1	0.0	-1.2	0.5	0.0	0.0	1.5	0.0	0.0
Lithuania	2.2	0.0	2.0	0.1	-0.4	1.1	0.0	-0.6	0.1	3.4	0.1	0.2	0.1	0.1
Poland	0.3	0.4	1.1	-0.1	-0.6	0.0	0.1	-0.7	0.0	0.5	0.4	1.8	-0.6	0.0
Romania	-2.6	0.7	1.8	0.1	-2.2	2.8	0.4	-1.0	0.4	1.8	0.0	-0.2	0.6	0.0
Slovakia	0.5	0.4	1.6	0.1	-0.4	0.1	-0.2	0.0	0.3	1.2	0.3	-0.5	0.4	-0.1
Slovenia	-0.8	0.3	6.1	-0.3	-0.2	0.0	0.0	-1.1	0.3	0.7	0.3	2.1	0.4	0.0
Total change														
Croatia*	-10.3	0.3	6.9	0.2	5.2	0.5	1.4	1.7	-0.4	0.1	1.4	1.9	2.4	0.5
Czech Republic	-1.0	0.7	2.8	0.2	5.4	-1.1	0.4	-0.5	-0.4	-1.2	-0.4	1.4	1.5	-0.5
Estonia	-0.3	0.6	0.9	-0.1	3.5	-2.5	-0.7	1.1	-0.2	-0.6	0.7	1.9	1.5	-0.3
Hungary	-1.9	0.3	4.0	0.4	3.7	1.3	0.0	0.5	-0.5	-0.1	1.0	-0.5	1.1	0.2
Latvia	1.3	0.0	3.9	0.7	4.6	2.8	-0.4	3.6	-0.3	1.6	3.2	1.1	0.5	-0.1
Lithuania	-4.7	0.0	2.8	0.0	4.7	0.5	-0.2	2.8	0.3	1.0	3.2	0.4	1.3	-0.6
Poland	-7.7	0.9	8.3	1.2	5.6	-1.9	0.4	4.1	1.2	1.0	1.9	1.6	0.2	0.5
Romania	-23.1	1.2	9.6	1.1	0.9	3.0	0.4	2.5	0.8	1.9	3.3	1.4	2.2	0.6
Slovakia	-0.4	0.4	-1.2	0.3	4.4	4.2	0.2	-0.1	-0.1	-0.6	-0.9	-0.1	2.7	-0.4
Slovenia	-8.5	0.4	13.5	0.5	4.2	-0.5	0.5	2.6	0.5	1.9	2.9	5.2	1.8	0.9

*Note: *Data for Croatia is for 2003 and 2013.*

Source: own calculations based on LFS and ONET data.

Table A5. Decomposition of routine cognitive task content change between 1998 and 2013 into within- and between-sector effect

NACE 1.1	A	C	D	E	F	G	H	I	J	K	L	M	N	O
Within-sector change														
Croatia*	3.0	0.1	-3.2	0.5	0.8	-5.3	2.7	2.6	0.4	1.0	0.4	-4.1	-1.1	1.2
Czech Republic	1.2	-0.4	-4.2	0.2	-0.7	-3.6	0.8	4.2	0.6	1.4	1.9	-3.2	-2.1	1.2
Estonia	1.1	-0.2	-1.0	0.5	0.7	-3.3	1.4	5.9	0.8	2.3	2.5	-5.1	-1.0	1.8
Hungary	0.7	-0.3	-4.1	-0.3	-0.9	-6.6	1.0	3.4	1.2	0.7	-0.1	-4.8	-0.7	1.2
Latvia	6.0	0.0	0.4	0.1	0.0	-3.7	0.3	2.4	0.5	0.9	-0.5	-2.0	1.2	1.7
Lithuania	5.4	0.1	0.1	0.2	0.1	-5.8	0.6	1.1	0.1	0.9	0.8	-0.4	-0.7	2.5
Poland	1.9	-1.3	-1.4	0.0	-1.8	-2.2	0.2	0.8	-0.8	0.6	-0.3	-1.0	1.5	-0.5
Romania	-2.5	-0.2	-2.5	-0.5	-0.6	3.2	0.5	-1.2	0.1	0.3	-0.6	0.1	0.4	0.4
Slovakia	0.9	0.0	-1.0	0.3	0.2	-6.7	0.9	4.2	0.2	1.1	2.6	-4.7	-3.4	0.5
Slovenia	1.6	0.1	-12.9	-0.1	-1.5	-2.3	1.8	0.5	-0.2	-0.5	-0.1	-3.2	0.2	-0.1
Between-sector change														
Croatia*	7.7	0.0	-1.8	0.3	-0.1	-0.1	-0.2	0.6	0.2	0.1	0.2	-0.6	0.4	-0.2
Czech Republic	2.3	-0.6	-0.7	0.1	0.2	0.1	0.0	0.0	0.1	-0.3	0.2	-0.5	0.8	0.2
Estonia	3.5	-0.1	-1.7	-0.2	-0.3	0.0	-0.5	0.0	0.1	-0.6	0.1	0.1	0.1	0.1
Hungary	2.0	-0.3	-2.5	-0.1	0.0	0.1	-0.2	0.1	0.0	0.1	0.7	0.3	0.1	0.5
Latvia	8.6	0.1	-2.2	-0.2	0.2	0.0	-0.1	0.9	0.4	0.1	0.1	-1.2	0.0	0.1
Lithuania	11.2	0.0	-2.2	-0.3	0.1	0.3	-0.1	1.0	0.1	-0.3	0.2	-0.1	0.1	-0.1
Poland	7.3	-0.6	-1.0	0.1	0.4	0.0	-0.1	0.9	0.1	0.6	0.8	-1.0	0.0	0.0
Romania	12.2	-0.9	-2.3	-0.1	2.6	-0.5	-0.2	2.3	0.3	0.3	1.1	0.0	0.1	0.0
Slovakia	3.4	-0.3	-1.6	0.0	-0.1	0.0	-1.0	0.0	0.2	-0.3	0.4	0.5	0.2	0.2
Slovenia	5.0	-0.1	-8.3	0.4	0.1	-0.1	0.0	1.1	0.4	-0.1	0.1	-1.5	0.2	0.0
Total change														
Croatia*	9.6	0.0	-4.5	1.2	0.6	-5.0	2.8	4.2	0.7	1.6	0.7	-5.9	-0.9	1.3
Czech Republic	3.0	-0.8	-4.6	0.2	-0.5	-3.1	0.7	4.9	0.9	1.9	2.2	-3.9	-2.0	1.2
Estonia	4.1	-0.3	-2.5	0.1	0.6	-3.0	1.6	6.7	1.3	3.2	3.1	-5.0	-0.9	1.9
Hungary	2.5	-0.4	-5.9	-0.4	-0.9	-6.9	1.0	4.1	1.3	1.4	0.6	-4.2	-0.7	1.4
Latvia	11.2	0.1	-1.9	-0.1	0.2	-3.8	0.3	4.4	1.4	2.7	-0.5	-3.6	1.2	1.7
Lithuania	13.6	0.1	-2.1	-0.1	0.2	-7.0	0.8	2.5	0.2	2.6	1.1	-0.6	-0.6	2.5
Poland	8.5	-1.5	-2.2	0.1	-1.7	-2.2	0.2	1.9	-0.7	2.0	0.4	-2.2	1.3	-0.4
Romania	10.5	-1.0	-4.4	-0.6	1.5	4.5	0.6	0.5	0.4	1.1	0.2	0.1	0.7	0.5
Slovakia	3.8	-0.3	-2.4	0.3	0.1	-7.2	0.6	4.6	0.5	1.9	3.5	-3.8	-3.5	0.6
Slovenia	6.2	-0.1	-17.3	0.1	-1.5	-2.5	1.8	1.8	0.2	-0.8	0.0	-5.6	0.5	-0.1

*Note: *Data for Croatia is for 2003 and 2013.*

Source: own calculations based on LFS and ONET data.

Table A6. Decomposition of routine manual change between 1998 and 2013 into within- and between-sector effect

Within-sector change														
NACE 1.1	A	C	D	E	F	G	H	I	J	K	L	M	N	O
Croatia*	3.8	0.5	-3.8	0.5	-1.1	-4.1	0.2	0.5	-0.6	0.0	0.2	0.0	-0.5	0.2
Czech Republic	2.1	0.4	-0.8	-0.2	-0.3	-3.0	0.2	1.2	-0.6	-0.5	0.3	-1.0	-0.7	0.6
Estonia	3.1	-0.2	3.3	0.6	0.6	-4.0	0.2	0.6	-0.3	-0.2	-0.3	-2.0	-1.2	-0.2
Hungary	2.5	-0.1	-1.9	0.2	-0.5	-3.6	0.2	0.8	-0.3	0.2	1.2	-0.7	-0.8	0.2
Latvia	3.0	0.0	-0.1	-0.3	-1.7	-4.9	-0.1	-1.5	-0.2	-0.4	-2.6	1.5	-0.1	-0.4
Lithuania	3.6	0.0	0.2	-0.3	-1.4	-6.3	0.0	-1.7	-0.5	-0.1	-1.7	1.1	-1.5	0.4
Poland	5.3	0.6	0.3	-0.1	-0.6	-4.9	0.4	-0.5	-1.2	-0.2	-0.2	1.1	-1.0	0.3
Romania	12.6	-0.4	-2.3	-1.1	-0.5	0.2	0.1	-2.2	-0.3	-0.1	-4.2	-1.6	-0.9	-0.5
Slovakia	2.6	0.0	0.5	-0.3	-0.2	0.5	-0.1	0.4	-0.7	-0.5	0.1	-3.2	-2.2	0.1
Slovenia	6.1	0.1	-13.4	-0.3	-1.0	-1.1	1.5	-1.9	-0.6	-1.0	-1.0	-0.5	-0.4	-0.3
Between-sector change														
Croatia*	-1.5	0.0	-2.2	-0.1	-0.6	0.3	0.0	-0.3	-0.3	-1.4	-0.5	-1.9	-0.6	-0.3
Czech Republic	-0.1	-0.7	-1.0	0.1	-0.5	0.4	0.0	-0.2	-0.5	-1.3	-0.3	-0.5	-0.8	0.1
Estonia	-1.0	-0.3	-2.4	-0.2	0.5	0.3	0.0	-0.2	-0.3	-1.4	-0.8	0.1	-0.1	0.1
Hungary	-0.4	-0.3	-3.6	-0.1	0.1	-0.1	0.1	-0.2	-0.1	-1.9	-0.6	0.4	-0.1	0.3
Latvia	-5.0	0.2	-3.6	-0.2	1.3	-0.1	0.1	0.5	-0.7	-1.1	-0.1	-1.8	0.0	0.0
Lithuania	-4.3	0.1	-2.9	-0.2	0.5	-0.5	0.1	0.3	-0.1	-2.9	-0.5	-0.2	-0.1	-0.1
Poland	-1.9	-0.6	-1.3	0.1	0.5	0.0	-0.1	0.1	-0.1	-2.0	-1.2	-2.1	0.4	0.4
Romania	0.8	-0.8	-1.7	-0.1	1.8	-3.1	-0.6	1.4	-0.5	-2.1	0.4	0.2	-0.9	-0.1
Slovakia	-0.9	-0.7	-2.4	-0.1	0.4	-0.5	0.2	0.0	-0.3	-1.0	-0.6	0.4	-0.2	0.1
Slovenia	-0.2	-0.2	-9.3	0.2	0.1	-0.3	0.0	0.7	-0.4	-1.0	-0.9	-2.0	-0.5	-0.1
Total change														
Croatia*	0.9	0.3	-5.5	0.7	-1.5	-3.5	0.3	0.3	-1.0	-1.5	-0.2	-1.9	-1.2	0.0
Czech Republic	1.0	-0.5	-1.7	-0.2	-0.8	-2.3	0.3	1.1	-1.4	-2.1	0.0	-1.5	-1.6	0.7
Estonia	0.6	-0.4	0.4	0.1	1.3	-3.4	0.4	0.5	-0.7	-1.7	-1.1	-1.9	-1.3	-0.1
Hungary	1.2	-0.4	-5.2	0.1	-0.4	-3.9	0.3	0.8	-0.5	-1.5	1.0	-0.2	-1.0	0.5
Latvia	-3.7	0.2	-3.7	-0.5	-1.1	-5.1	0.0	-1.6	-1.2	-2.1	-2.7	-0.1	-0.1	-0.4
Lithuania	-2.8	0.1	-2.8	-0.5	-1.0	-8.3	0.0	-2.1	-0.7	-3.2	-2.6	0.9	-1.6	0.3
Poland	1.5	-0.2	-1.0	-0.1	-0.2	-4.9	0.4	-0.6	-1.3	-2.5	-1.5	-0.8	-0.5	0.6
Romania	9.3	-0.9	-3.8	-1.1	0.8	-2.8	-0.5	-1.7	-1.0	-2.4	-5.6	-1.3	-2.1	-0.6
Slovakia	0.1	-0.7	-2.0	-0.3	0.2	0.0	-0.1	0.4	-1.3	-1.9	-0.4	-2.5	-2.5	0.2
Slovenia	4.1	-0.2	-18.7	-0.4	-0.9	-1.4	1.5	-2.2	-1.3	-2.5	-2.2	-2.6	-1.1	-0.5

*Note: *Data for Croatia is for 2003 and 2013.*

Source: Own calculations based on LFS and ONET data.

Table A7. Decomposition of non-routine manual physical task content change between 1998 and 2013 into within and between-sector effect

Within-sector change														
NACE 1.1	A	C	D	E	F	G	H	I	J	K	L	M	N	O
Croatia*	3.2	0.2	-1.6	0.2	-0.1	-1.0	-0.5	-2.8	-0.4	-0.2	-0.5	0.9	-0.8	-0.8
Czech Republic	0.7	-0.3	2.1	-0.3	0.0	-0.4	-0.4	-3.3	-0.4	-0.2	-0.6	-0.8	-1.0	-0.1
Estonia	1.6	-0.5	2.0	0.2	1.5	-1.0	-0.3	-4.2	-0.4	-0.6	-1.1	-1.1	-1.2	-1.0
Hungary	1.7	-0.2	1.4	0.4	1.1	0.6	-0.4	-3.4	-0.2	0.6	1.9	-1.5	-1.5	-0.5
Latvia	-1.3	-0.1	-1.0	-0.2	-0.6	-1.8	-0.4	-3.5	-0.2	-0.4	-3.0	0.8	-1.2	-1.0
Lithuania	4.9	0.0	-1.2	-0.3	0.0	-3.1	-0.3	-4.0	-0.7	-0.1	-3.4	0.7	-2.2	-0.6
Poland	5.5	0.1	3.2	-0.4	1.1	-1.8	0.0	-3.3	-1.0	-1.0	-1.2	0.1	-3.0	-0.7
Romania	-2.7	0.1	4.2	-0.1	0.8	-1.0	-0.3	-0.2	0.0	0.2	-2.4	-0.9	-0.5	-0.4
Slovakia	1.0	-0.2	3.6	-0.3	1.0	3.2	-0.6	-2.1	-0.6	-0.5	0.2	-3.0	-2.4	-0.6
Slovenia	3.1	-0.3	-0.2	-0.1	-0.5	-0.9	-0.9	-4.1	-0.1	-0.9	0.0	-0.5	-0.2	-0.7
Between-sector change														
Croatia*	-4.6	-0.1	-0.8	0.2	-0.6	0.4	-0.1	1.1	-0.5	-1.5	-0.4	-2.1	-0.4	-0.1
Czech Republic	-1.7	-1.1	-0.4	0.1	-0.9	0.5	0.0	0.6	-0.8	-1.6	-0.2	-0.5	-0.5	0.1
Estonia	-3.2	-0.5	-1.1	-0.3	0.7	0.3	-0.2	0.7	-0.5	-1.3	-0.5	0.1	-0.1	0.0
Hungary	-1.6	-0.4	-1.6	-0.1	0.1	-0.2	0.0	0.7	-0.2	-2.2	-0.6	0.4	-0.1	0.2
Latvia	-8.4	0.3	-1.5	-0.2	1.3	-0.1	0.0	1.9	-1.2	-1.5	-0.1	-1.8	0.0	0.0
Lithuania	-7.9	0.1	-1.2	-0.2	0.5	-0.8	-0.2	1.5	-0.1	-3.3	-0.1	-0.2	0.0	-0.1
Poland	-4.6	-0.6	-0.1	0.1	0.5	0.0	-0.2	1.2	-0.1	-1.7	-1.0	-2.0	0.2	0.3
Romania	-10.8	0.0	0.2	0.0	-0.3	-3.1	-0.5	-0.5	-0.9	-3.0	-0.8	0.2	-1.1	-0.1
Slovakia	-3.4	-1.0	-1.0	-0.1	0.6	-0.6	-0.1	0.3	-0.6	-1.0	-0.5	0.4	-0.1	0.1
Slovenia	-2.9	-0.3	-3.6	0.2	0.2	-0.3	0.0	2.1	-0.8	-1.0	-1.0	-1.9	-0.6	-0.1
Total change														
Croatia*	-2.6	0.1	-2.2	0.6	-0.7	-0.6	-0.7	-2.8	-0.9	-1.9	-1.0	-1.0	-1.4	-1.1
Czech Republic	-1.3	-1.2	1.6	-0.2	-1.0	0.1	-0.4	-3.2	-1.4	-1.8	-0.9	-1.3	-1.8	0.0
Estonia	-2.4	-0.8	0.7	-0.2	2.6	-0.6	-0.6	-4.1	-1.1	-2.4	-1.8	-1.0	-1.4	-0.9
Hungary	-0.5	-0.4	-0.5	0.3	1.2	0.4	-0.6	-3.3	-0.4	-1.2	1.8	-1.0	-1.6	-0.2
Latvia	-9.0	0.1	-2.2	-0.3	0.5	-2.0	-0.7	-3.2	-1.6	-2.6	-3.1	-0.8	-1.2	-0.9
Lithuania	-5.7	0.0	-2.1	-0.4	0.5	-4.7	-0.7	-3.9	-1.0	-3.5	-4.2	0.5	-2.3	-0.7
Poland	-1.1	-0.5	2.7	-0.4	1.7	-1.8	-0.2	-3.1	-1.2	-4.1	-2.7	-1.8	-2.4	-0.2
Romania	-12.6	0.0	3.9	-0.1	1.2	-4.6	-0.9	-0.8	-0.9	-2.5	-4.2	-0.6	-1.8	-0.6
Slovakia	-3.0	-1.0	2.2	-0.3	1.7	2.9	-1.1	-2.0	-1.4	-2.0	-0.3	-2.4	-2.8	-0.4
Slovenia	-0.7	-0.4	-3.8	0.0	-0.3	-1.2	-0.9	-4.1	-0.9	-2.3	-1.0	-2.5	-0.8	-0.9

*Note: *Data for Croatia is for 2003 and 2013.*

Source: Own calculations based on LFS and ONET data.

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