AGE, TASKS AND SKILLS IN EUROPEAN LABOUR MARKETS

BACKGROUND PAPER FOR THE WORLD BANK REPORT
GROWING UNITED: UPGRADING EUROPE'S CONVERGENCE MACHINE

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Abstract

There are important intergenerational differences behind aggregate shifts away from manual jobs towards cognitive jobs, and away from routine work towards non-routine work. We built upon our first background paper and study these age and cohort patterns in tasks and skills in European countries. Changes in the task composition were happening much faster among workers born in the 1970s and 1980s than among those born before 1970. The most routine occupations aged faster, while the least routine jobs slower than the average. Changes in the cohort-specific growth in the intensity of non-routine cognitive tasks and in the decline of the intensity of manual tasks can be attributed to changes in workforce upgrading – the rise in tertiary attainment was embodied in younger cohorts. By the 2010s, older workers across Europe were significantly less likely to be highly proficient in various skills, and significantly more likely to have low proficiency. These effects were visible among workers as young as 45 years, and were the most pronounced in the case of problems solving skills.

Keywords: task content of jobs, routinisation, ageing, occupational change, skills, O*NET, PIAAC

JEL: J21, J23, J24

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1. Introduction

This is a companion paper that expands the analysis presented in our first background paper for the "Growing United" report. We use the same methodology and data sources, so please refer to the first paper to become familiar with them. The first paper includes also the literature review and motivation behind analysing tasks. They also apply here. The main aim of this paper is to broaden the first study by accounting for age and cohort differences.

In the second section we present the evolution of task content of jobs by age. We distinguish between employed and unemployed individuals. We also analyse the relative ageing of the most and the least routine intensive jobs. In the third section we identify differences in the pace of task content changes between cohorts, and we relate them to education upgrading of particular cohorts. In the fourth section we estimate a range of models to see how age is related to the probability of high and low skill proficiency. In the fifth section we discuss how other labour market outcomes by age evolved in the European countries between the late 1990s and the middle 2010s. the final section concludes.

2. The evolution of tasks by age

2.1. Employment

The evolution of task content intensities within particular age groups was quite similar among European countries. At the same time, within particular countries young, prime-aged and older workers recorded different patterns of task content changes. Age was a crucial dimension of changes in the task contents.

In the EU15, the shift away from manual tasks and routine cognitive tasks, and towards non-routine cognitive tasks, was the most pronounced among workers between the ages of 25 and 44. The changes among younger (15-24) and older (45-59) workers were less noticeable. However, the EU South countries differed from the other sub-regions in that regard – the changes of task content intensities were the largest among workers aged 15-29, and less pronounced among workers aged 30-49. The 60-64 group has also recorded substantial changes, but in the EU15 Continental and EU15 South countries these changes were not entirely consistent with the overall trends (discussed in the background paper 1 and not repeated here). In particular, the intensity of routine cognitive tasks increased among workers aged 60-64 in these regions. This was likely related to prolonging working lives – as the labour force participation rate of older workers increased, more workers in routine cognitive jobs remained in employment.

In the NMS countries, the set of age groups recording the most pronounced changes was more narrow – it included workers between the ages of 25 and 39. The routine cognitive tasks were flat among prime-aged workers but they increased among workers aged 55-64, except for the NMS North countries where the intensity of routine cognitive tasks across among all age groups. In the NMS Continental countries, the intensity of manual tasks increased among older workers. This apparent puzzle can be explained by self-selection to retirement. In the late 1990s, working after the age of 60 was rare in these countries. These were mainly the high-skilled workers who kept working after the age of 60. As the participation rate of older workers and the age of exiting the labour force have both increased, a more balanced sample of workers have remained in employment – thus, the intensity of manual tasks among older workers increased.

The biggest difference between EU-15 and NMS with respect to age dimension of tasks changes is the evolution of routine cognitive tasks. While for EU-15 countries we observe an increase of intensity of these

tasks only for people aged 15-24 and 50-64, and a steep fall for other age groups, in NMS countries the growth of routine cognitive tasks was more common. This was especially the case in NMS North region, where routine cognitive tasks have been increasing for each age groups we consider. NMS South countries were likewise characterised by a more prevalent growth of routine cognitive tasks which increased their intensity among workers aged 15-24, and 50-64. In NMS Continental countries routine cognitive tasks plummeted for the youngest workers, slightly declined for workers aged 20-49, and increased for people aged 50-64.

Finally, the youngest workers, aged 15-19, experienced a drop in the intensity of non-routine cognitive tasks in all regions exception for the EU-15 South. However, the intensity of these tasks among the youngest workers was very low even in the late 1990s and its decline can be attributed to the rising age of labour market entry of tertiary educated workers.

Figure 1. The evolution of task content of jobs (among employed) in the EU15 countries between 1998-2015 by age groups
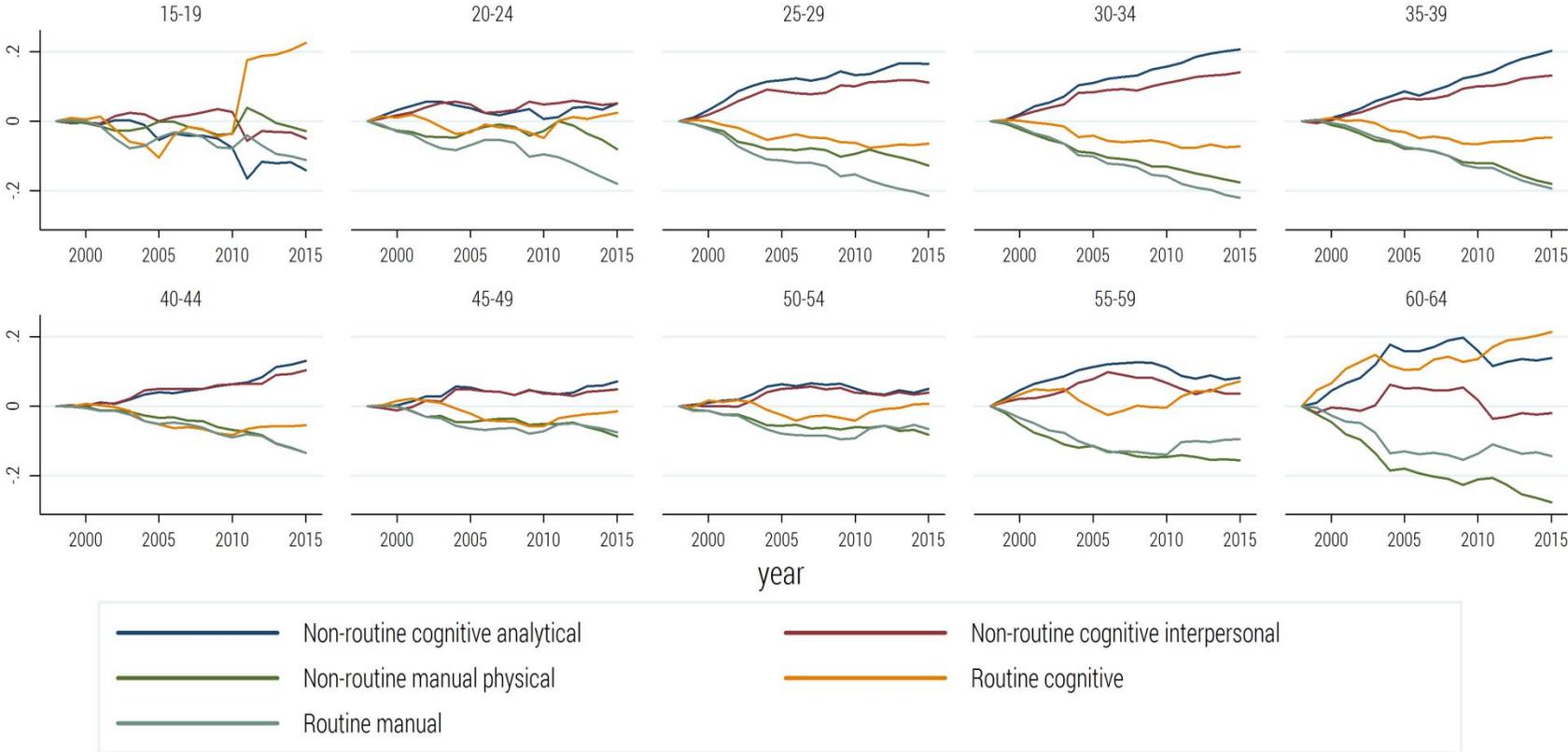
Graphs by age

*Source: Own calculations based on EU-LFS and O*NET data.*

Figure 2. The evolution of task content of jobs (among employed) in the EU15 Continental countries between 1998-2015 by age groups

Graphs by age

Figure 3. The evolution of task content of jobs (among employed) in the EU15 North countries between 1998-2015 by age groups

Graphs by age

*Source: Own calculations based on EU-LFS and O*NET data.*

Figure 4. . The evolution of task content of jobs (among employed) in the EU15 South countries between 1998-2015 by age groups

Graphs by age

*Source: Own calculations based on EU-LFS and O*NET data.*

Figure 5. The evolution of task content of jobs (among employed) in the NMS countries between 1998-2015 by age groups

Graphs by age

*Source: Own calculations based on EU-LFS and O*NET data.*

Figure 6. The evolution of task content of jobs (among employed) in the NMS Continental countries between 1998-2015 by age groups

Source: Own calculations based on EU-LFS and O*NET data.

Figure 7. The evolution of task content of jobs (among employed) in the NMS North countries between 1998-2015 by age groups

Graphs by age

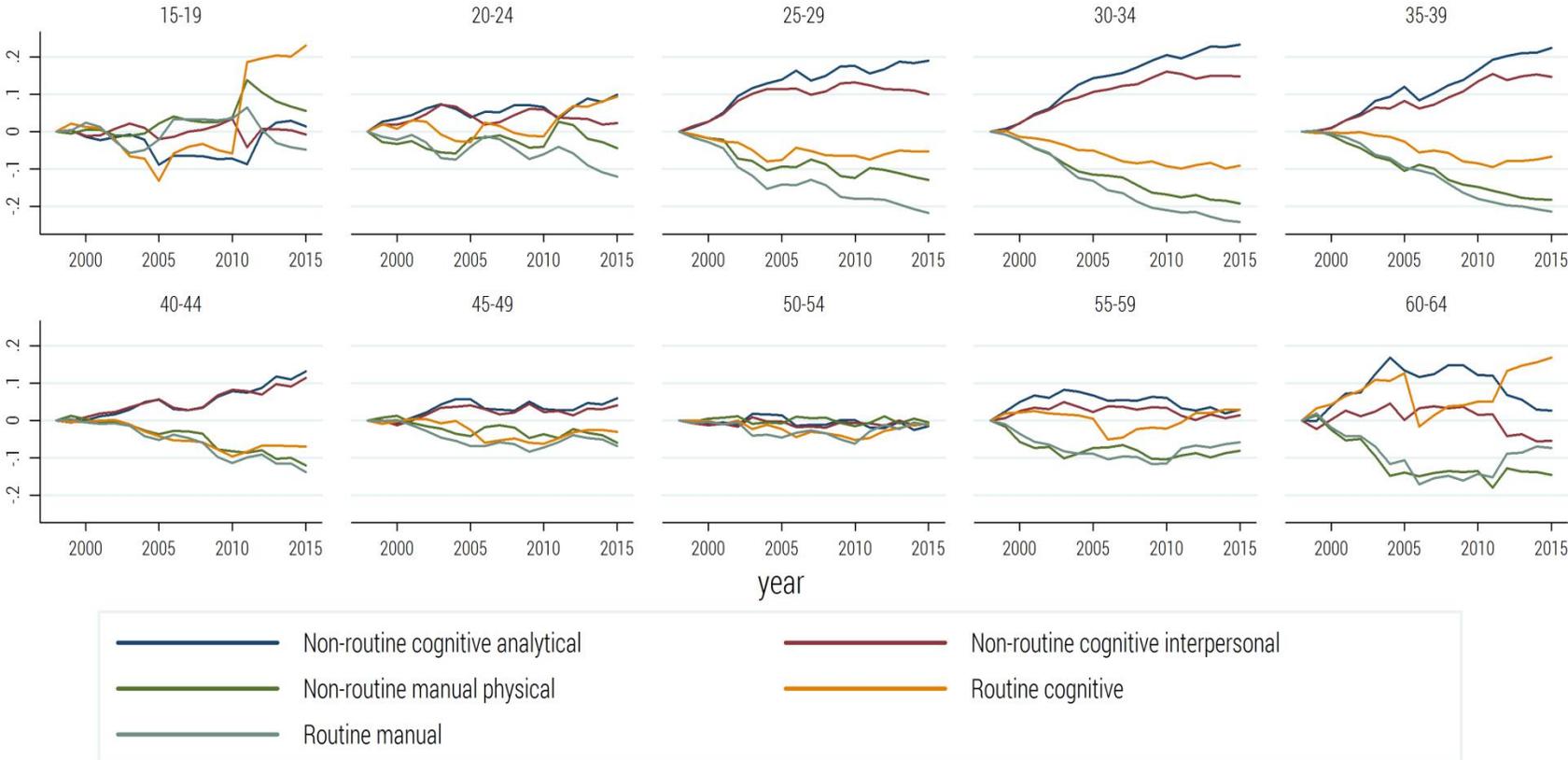*Source: Own calculations based on EU-LFS and O*NET data.*

Figure 8. The evolution of task content of jobs (among employed) in the NMS South countries between 1998-2015 by age groups

Graphs by age

*Source: Own calculations based on EU-LFS and O*NET data.*

2.2. Unemployment

The evolutions of task content intensities among unemployed individuals were quite similar within age groups and across regions.[1] In all regions manual tasks dominated among the unemployed, followed by routine cognitive tasks and non-routine cognitive tasks, which were strongly negative. Contrary to the trends among employed individuals, age did not seem to be an important factor determining the tasks changes among the unemployed. Although there were some differences between different age groups, they seem to be rather modest. Again, these are the youngest and oldest workers who witnessed the most peculiar trends.

The trends for non-routine cognitive tasks among the unemployed were homogeneous in all EU-15 countries. Apart from the youngest group, the intensity of non-routine cognitive tasks was rising among the unemployed in the EU-15 between 1998 and 2015, echoing the changes recorded among the employed. Nevertheless, the intensity of non-routine cognitive tasks remained negative in all countries and age groups, implying that the highly non-routine cognitive workers were least likely to be unemployed (compared to workers in jobs rich in routine cognitive or manual tasks). The intensity of non-routine cognitive tasks among the unemployed was negative also in the NMS countries. However, contrary to the EU-15, the intensity of non-routine cognitive tasks among the unemployed in NMS was flat. Only the youngest unemployed in NMS experienced an increase of non-routine cognitive intensity, and this was largely implied by the trends occurring within NMS Continental countries.

In the EU-15 regions, the intensity of manual tasks among the unemployed declined slightly for workers aged 15-49. In the NMS it was the case only among the youngest unemployed workers, who recorded a modest increase of routine and non-routine manual tasks intensity. This effect was largely driven by the developments taking place in NMS South countries.

Unemployed workers in all regions were characterised by a positive intensity of routine cognitive tasks. In the EU-15 countries, the intensity of these tasks increased slightly between 1998 and 2015 among unemployed aged 15-49 and 60-64, while barely any changes occurred for others age groups. These increases of routine cognitive tasks were, however, rather modest, and were mostly induced by the EU-15 South and Continental countries. Contrary to the EU-15, in NMS countries the routine cognitive tasks on average decreased among unemployed people at the age of 15-44. Some positive changes can be also observed for the oldest workers, but one should be careful with these results due to small sample sizes.

Summing up, individuals in highly manual and routine cognitive jobs were most likely to be unemployed throughout the analysed period. The intensity of non-routine cognitive tasks among unemployed was strongly negative, making individuals able to perform these tasks least likely to be unemployed. There were some differences between age groups in the patterns of task content changes, but they are significantly less marked then those observed for employed individuals.

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[1] By the occupations of unemployed we mean their last occupation before they entered the unemployment.

Figure 9. The evolution of task content of jobs (among unemployed) in the EU15 countries between 1998-2015 by age groups
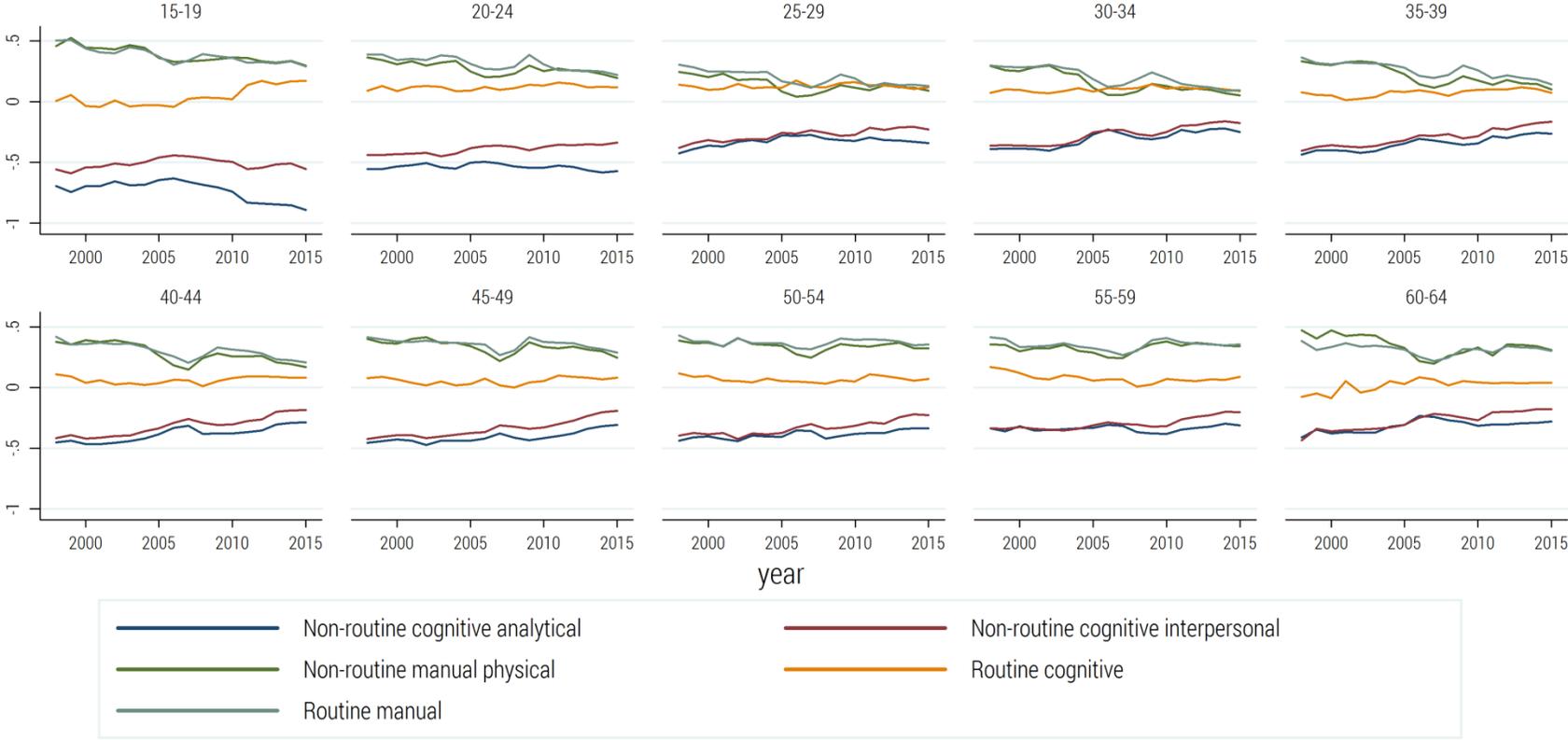
Graphs by age
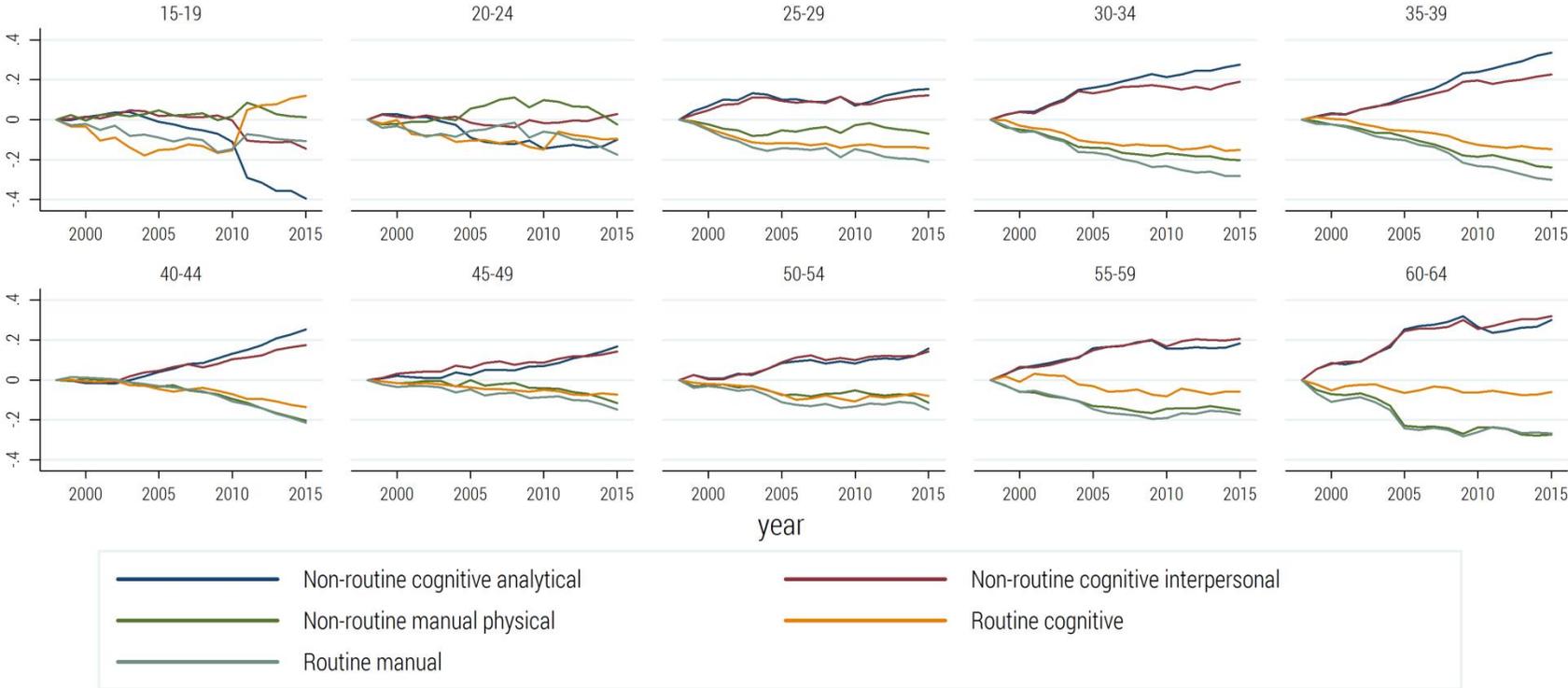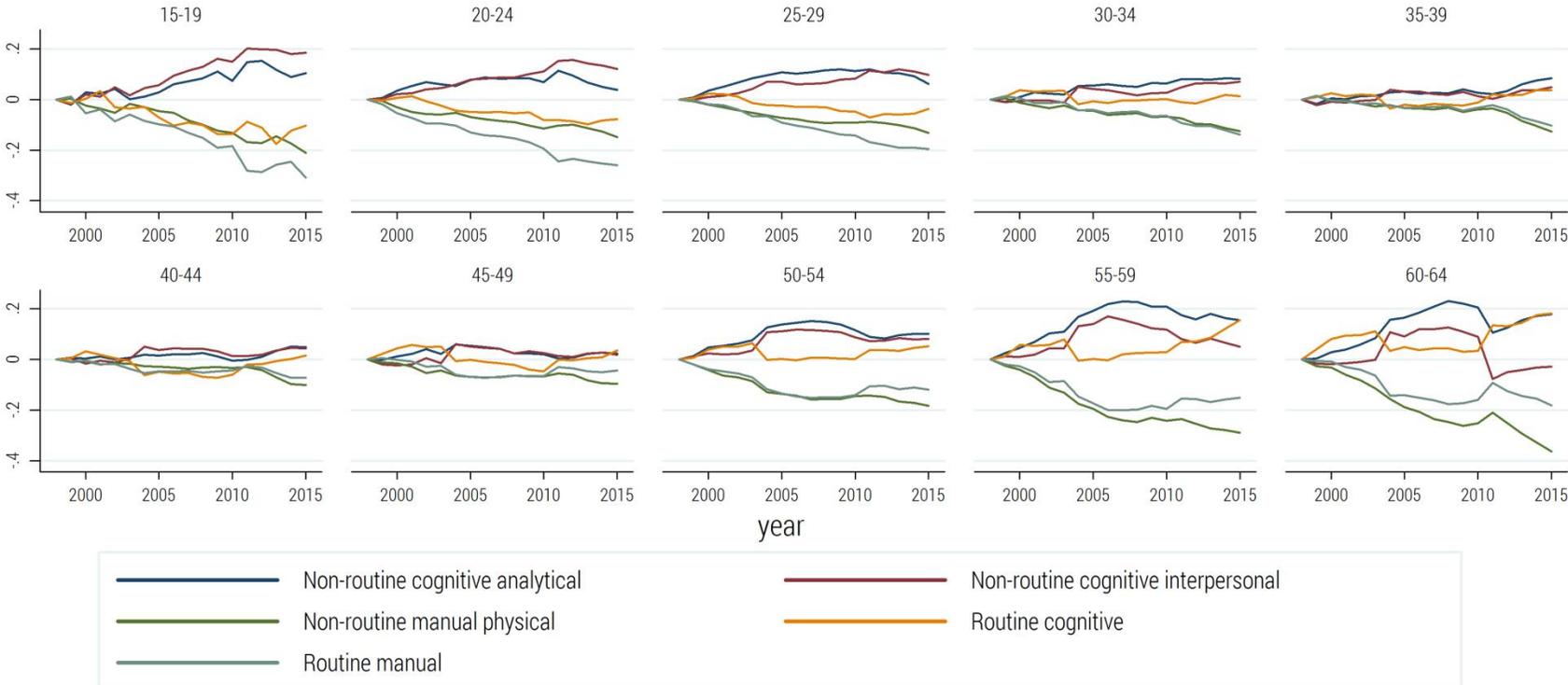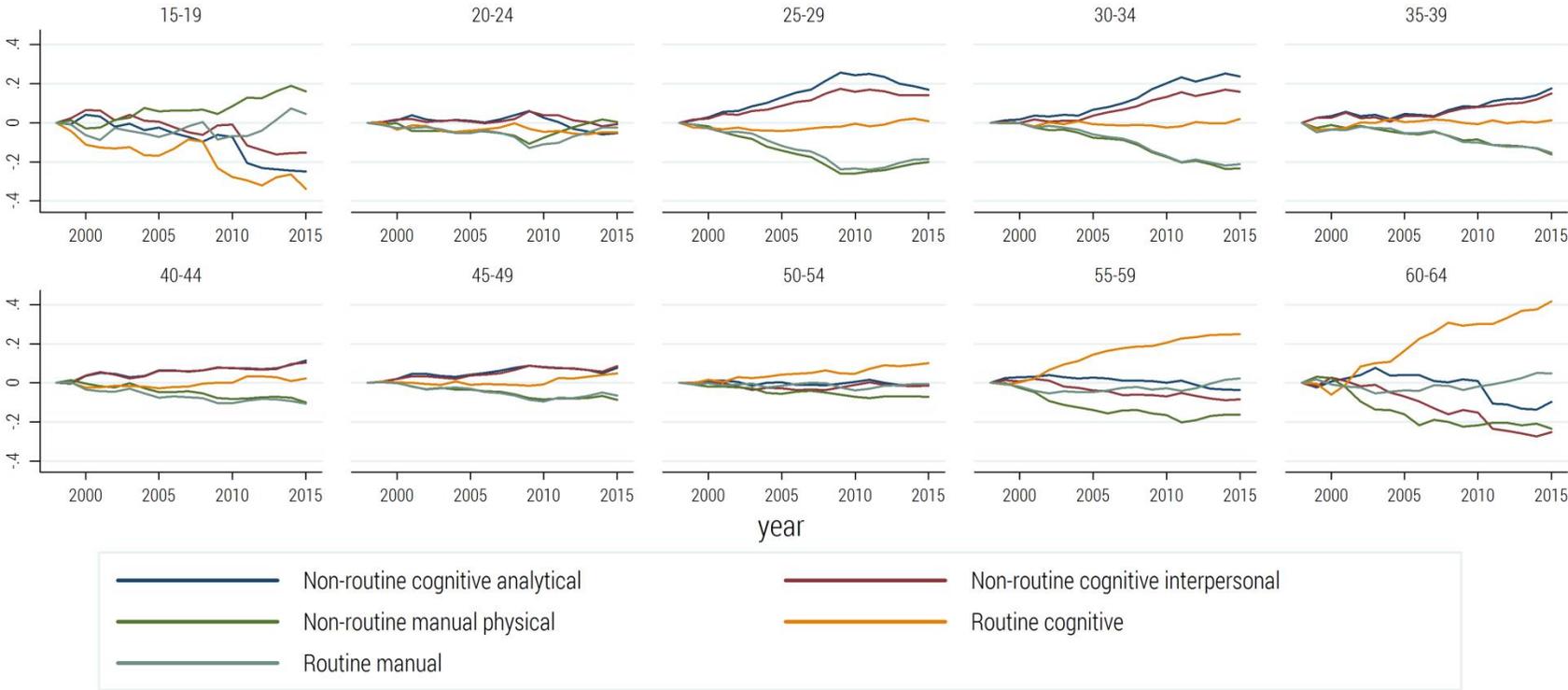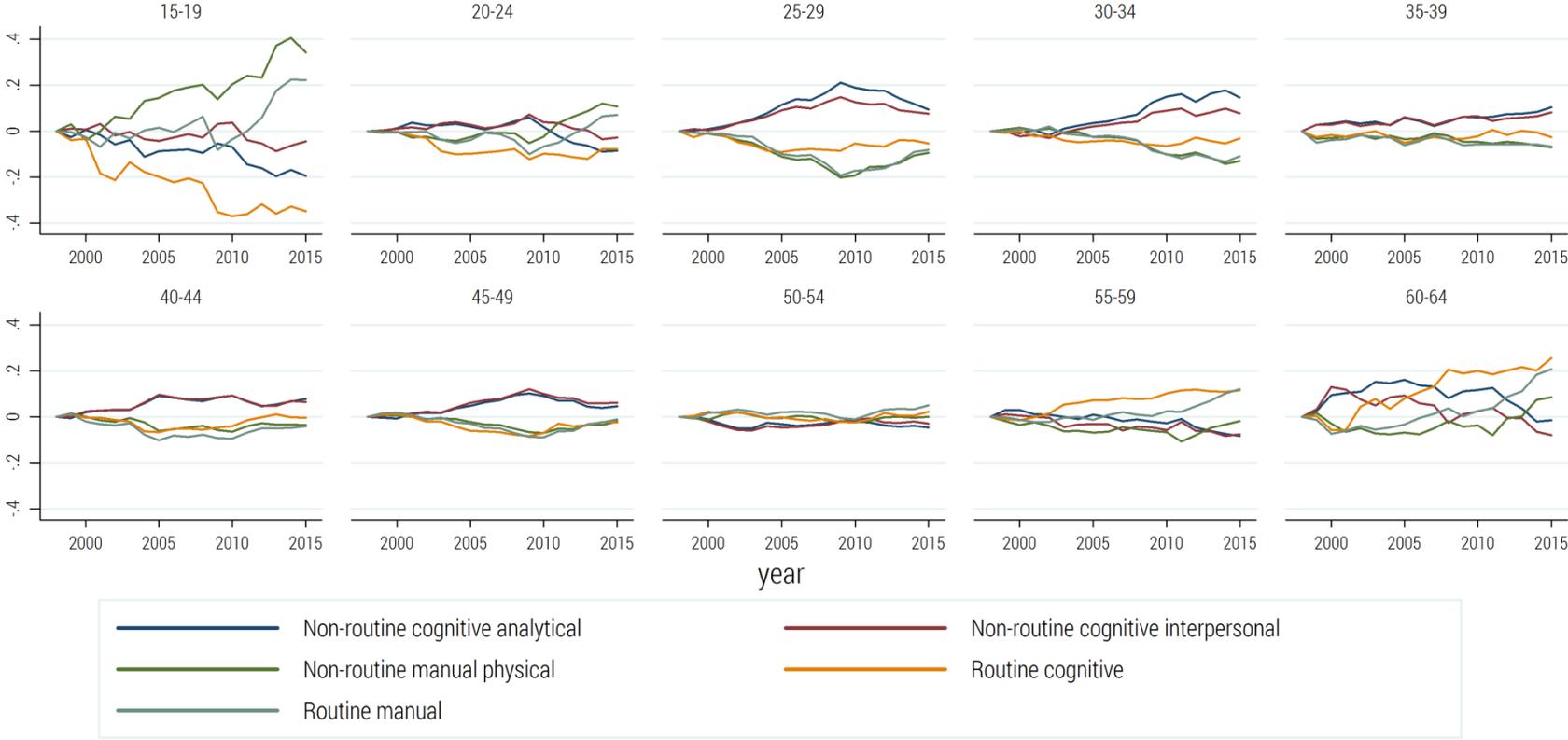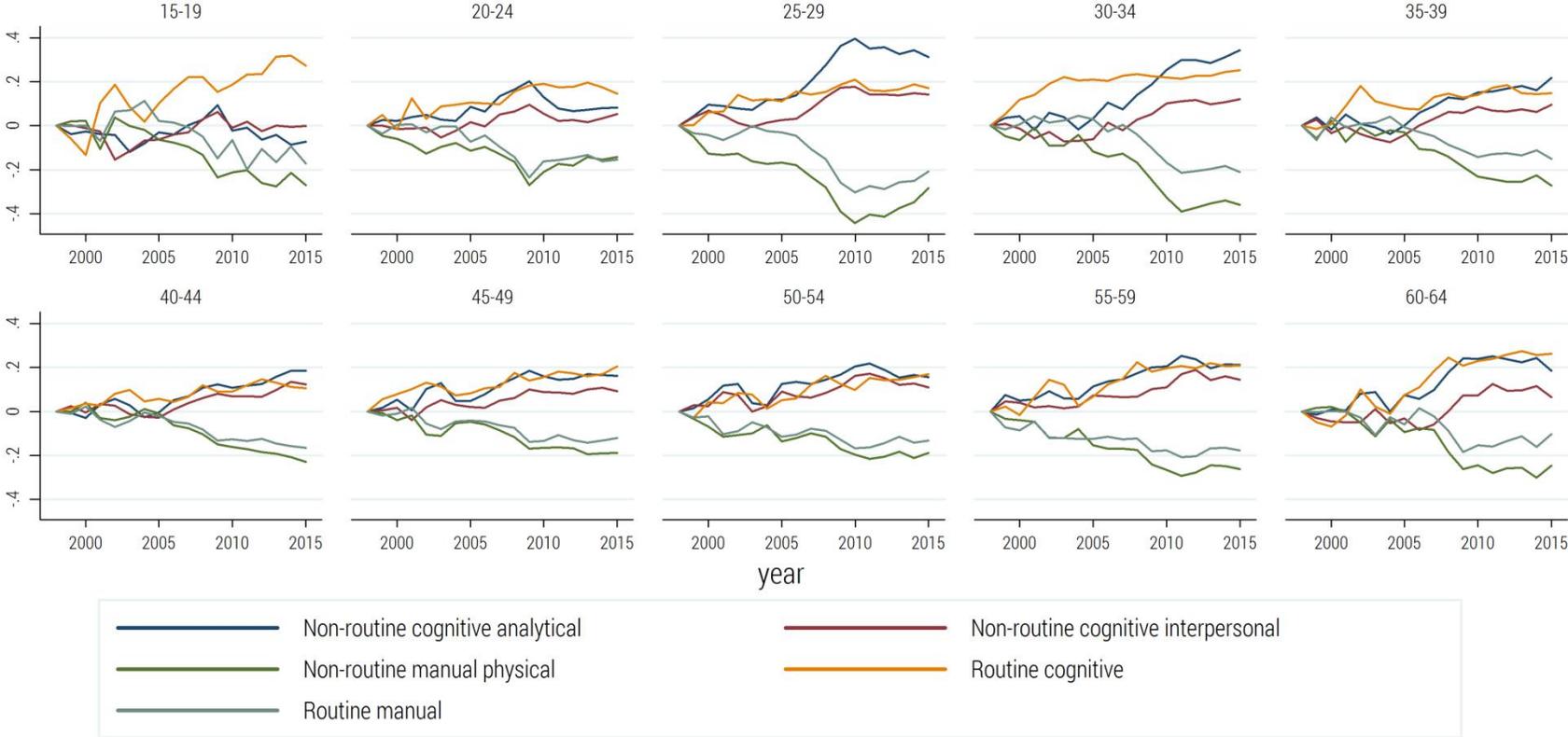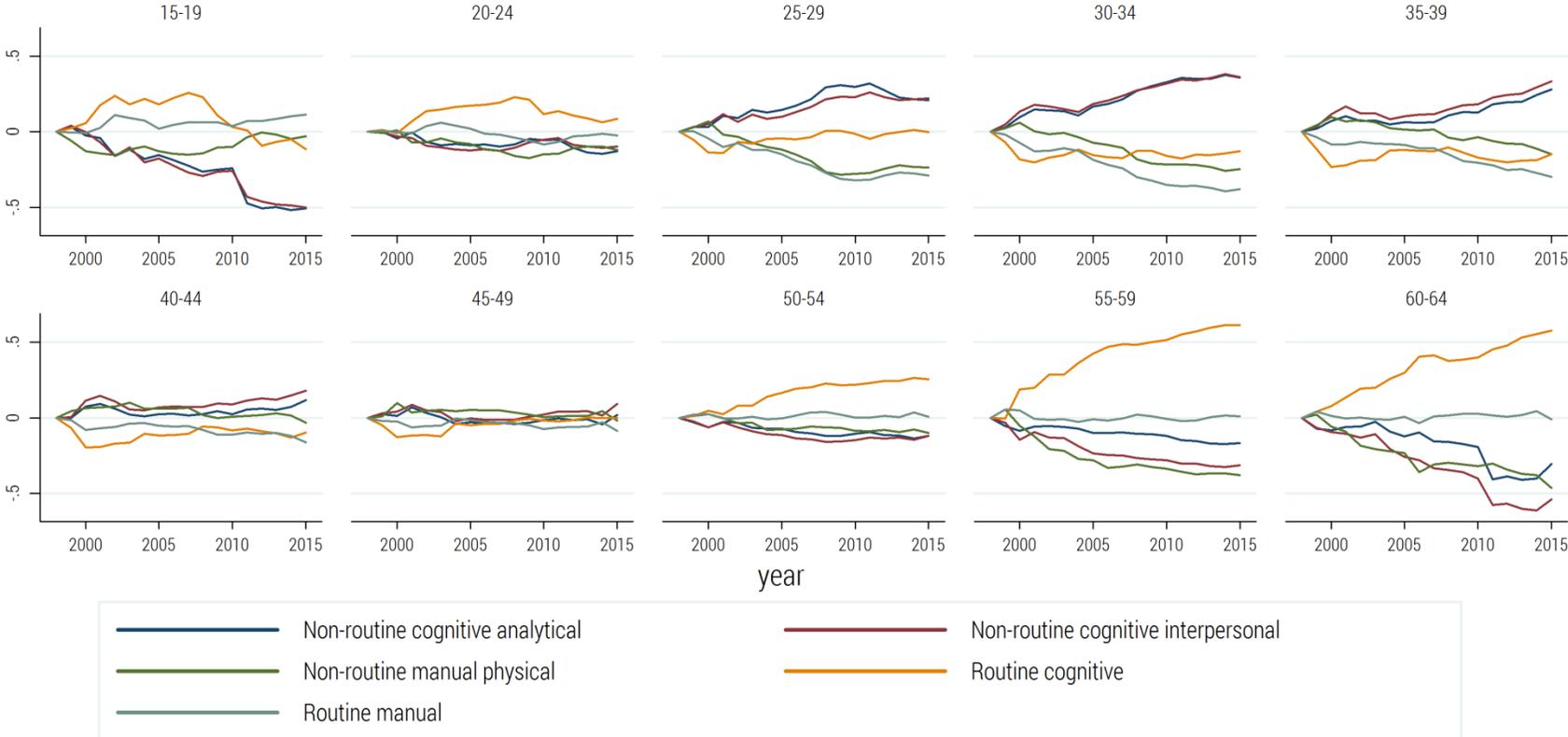
*Source: Own calculations based on EU-LFS and O*NET data.*

Figure 10. The evolution of task content of jobs (among unemployed) in the EU15 Continental countries between 1998-2015 by age groups

Graphs by age

Source: Own calculations based on EU-LFS and O*NET data.

Figure 11. The evolution of task content of jobs (among unemployed) in the EU15 North countries between 1998-2015 by age groups

*Source: Own calculations based on EU-LFS and O*NET data.*

Figure 12. The evolution of task content of jobs (among unemployed) in the EU15 South countries between 1998-2015 by age groups

Graphs by age

Source: Own calculations based on EU-LFS and O*NET data.

Figure 13. The evolution of task content of jobs (among unemployed) in the NMS countries between 1998-2015 by age groups

Graphs by age

*Source: Own calculations based on EU-LFS and O*NET data.*

Figure 14. The evolution of task content of jobs (among unemployed) in the NMS Continental countries between 1998-2015 by age groups

Graphs by age

Source: Own calculations based on EU-LFS and O*NET data.

Figure 15. The evolution of task content of jobs (among unemployed) in the NMS North countries between 1998-2015 by age groups
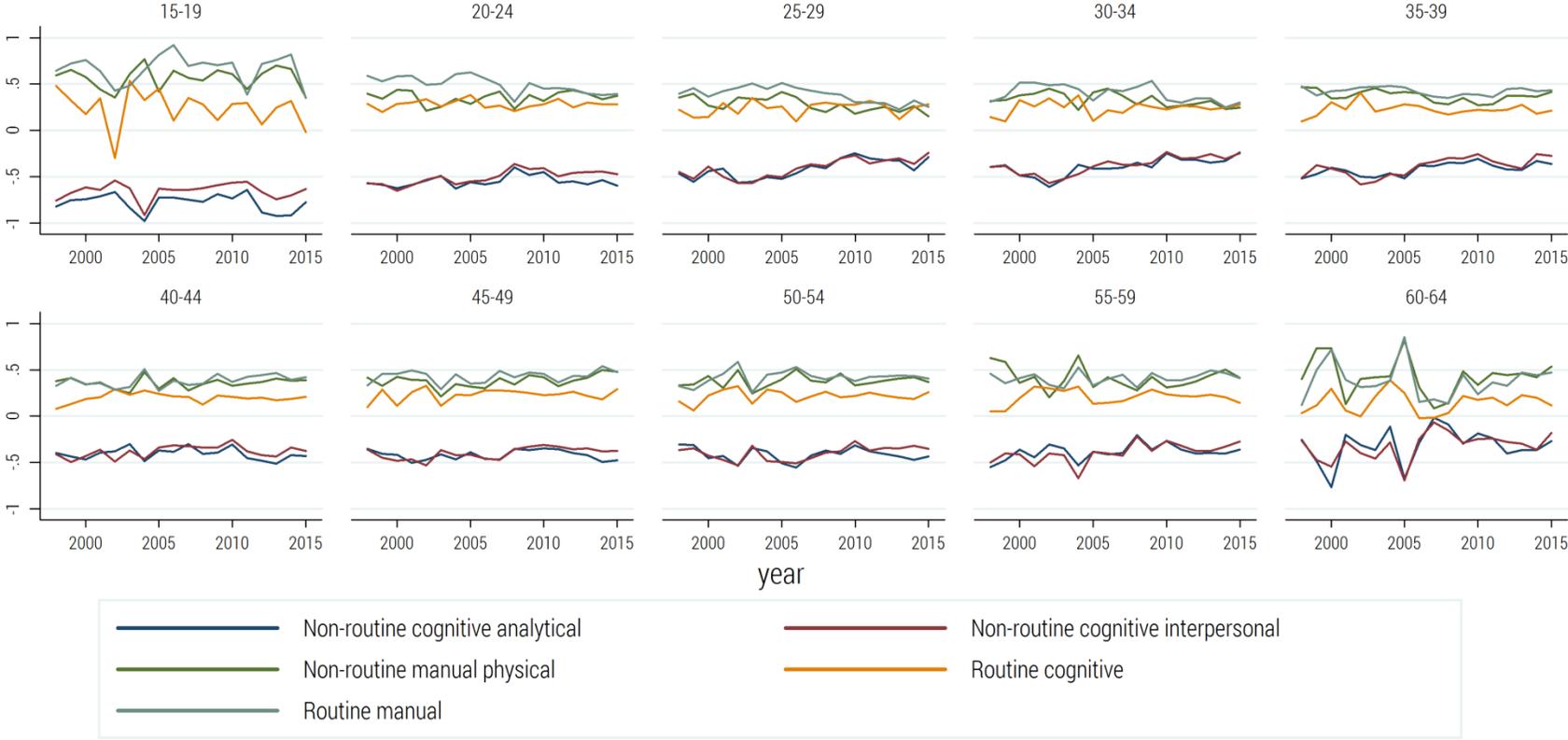
Graphs by age

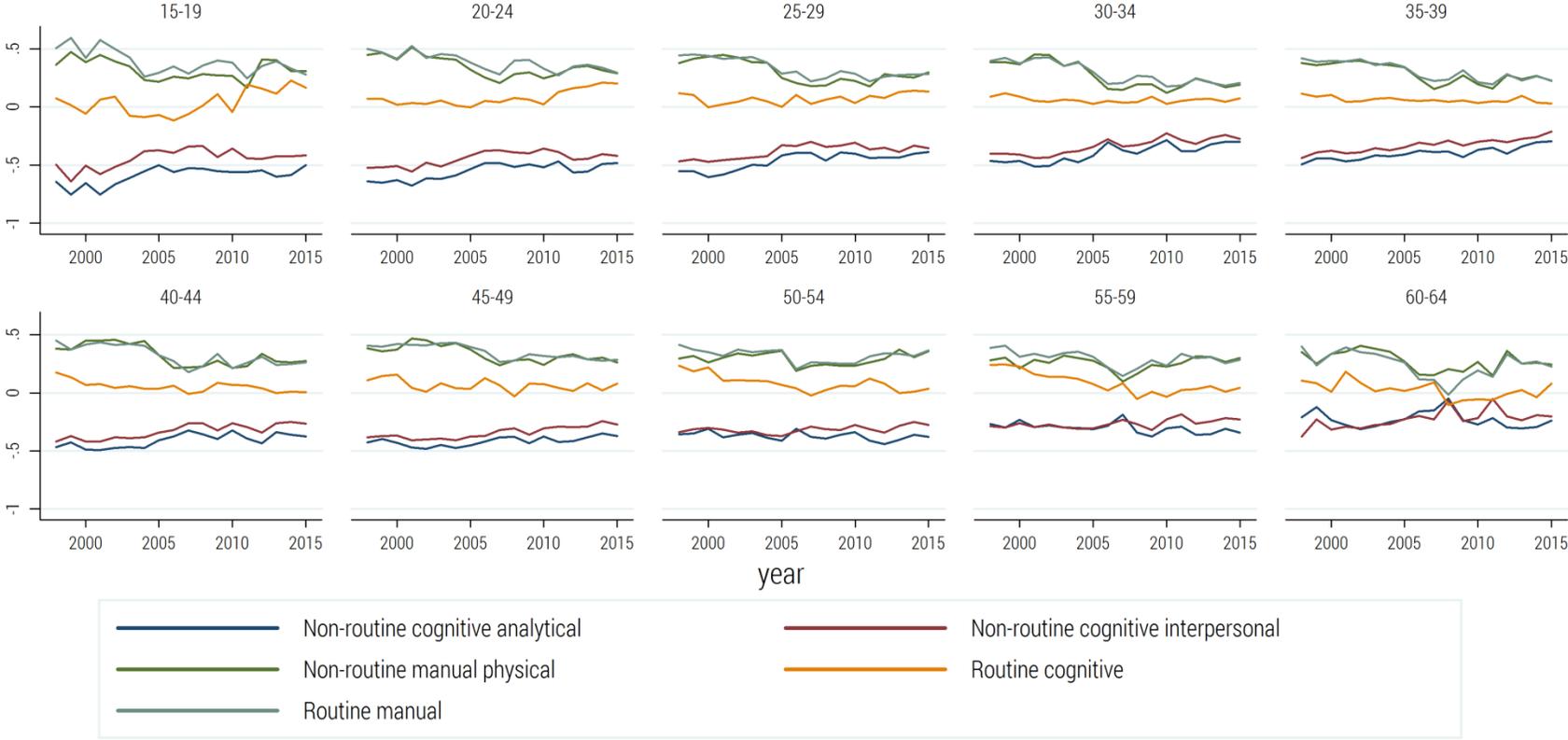*Source: Own calculations based on EU-LFS and O*NET data.*

Figure 16. The evolution of task content of jobs (among unemployed) in the NMS South countries between 1998-2015 by age groups
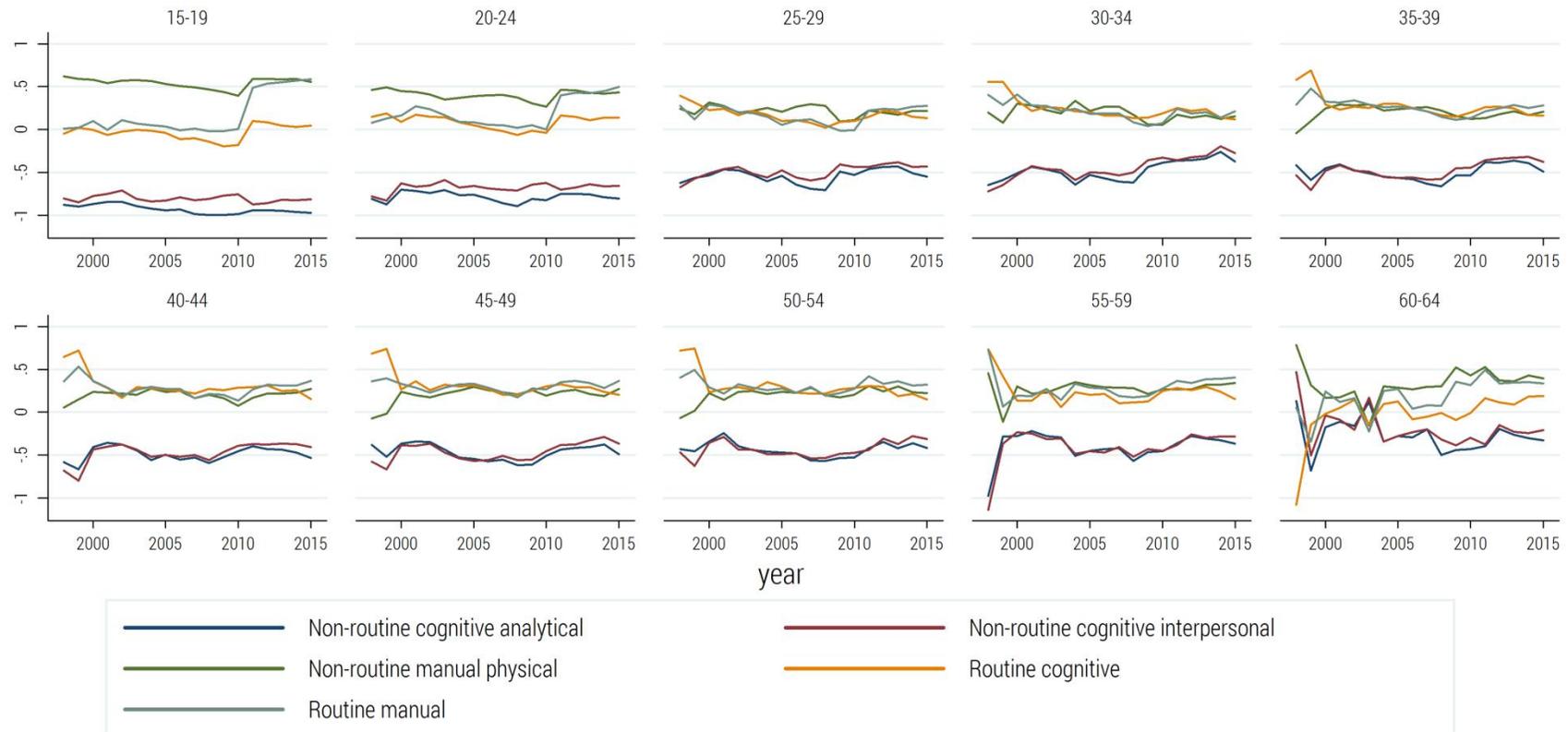
Graphs by age
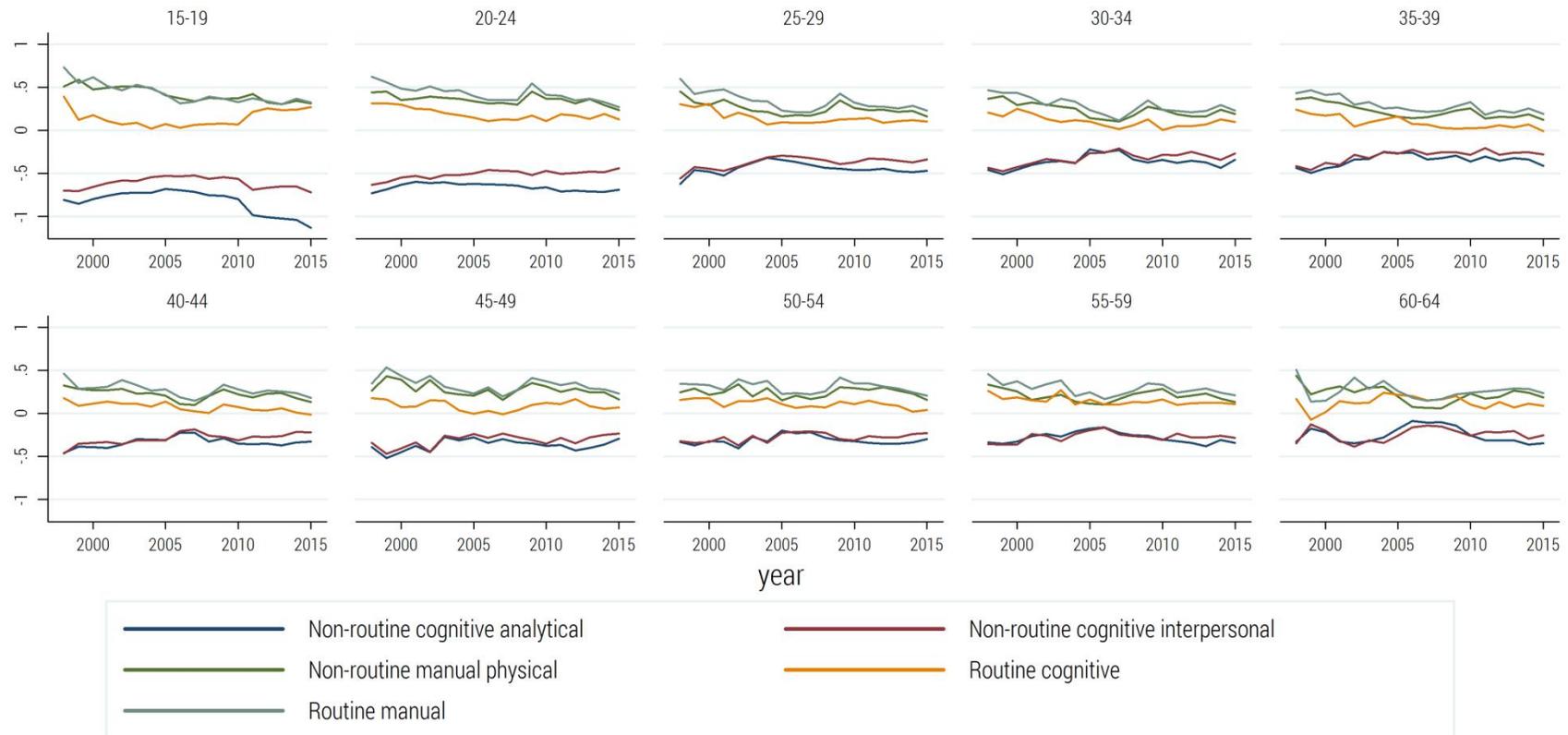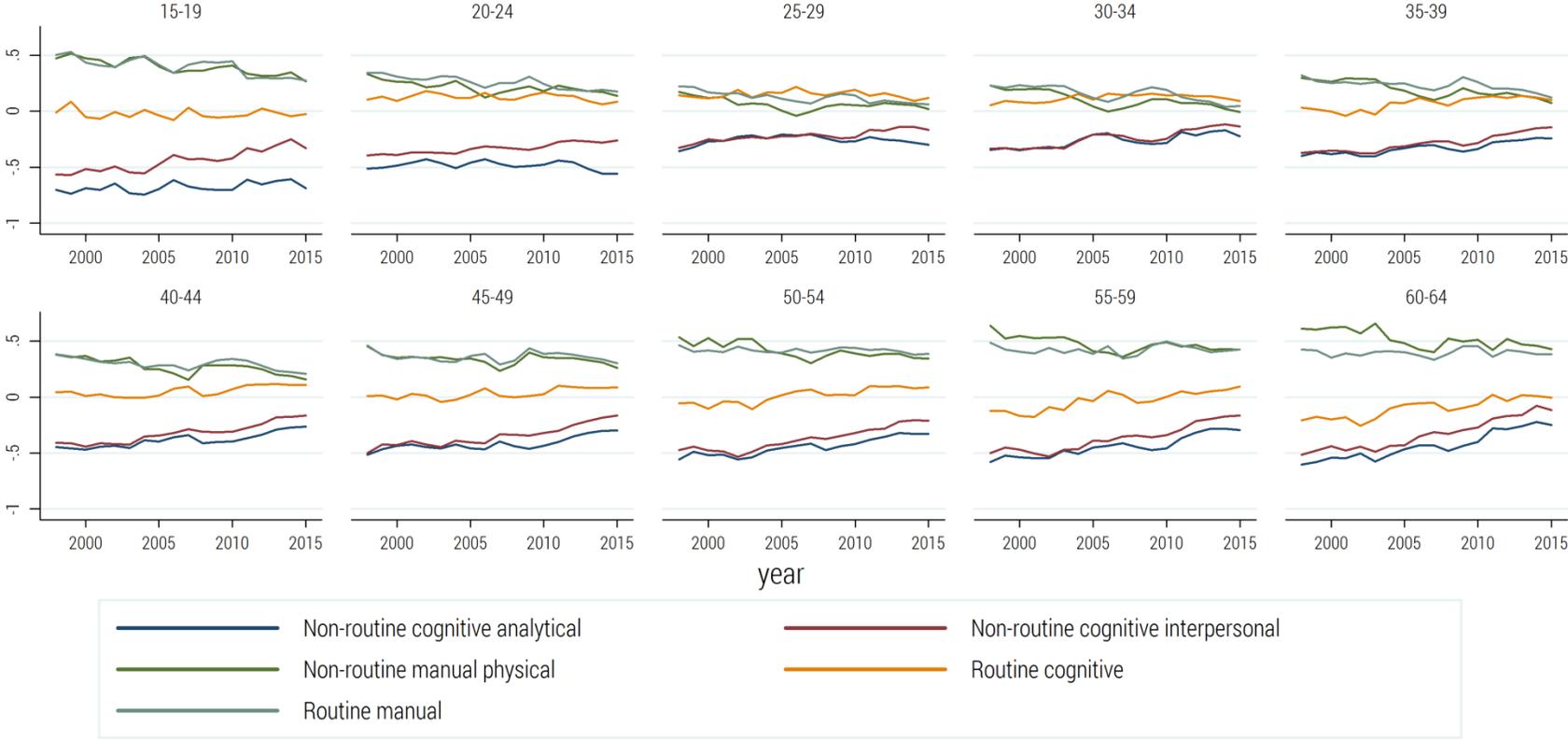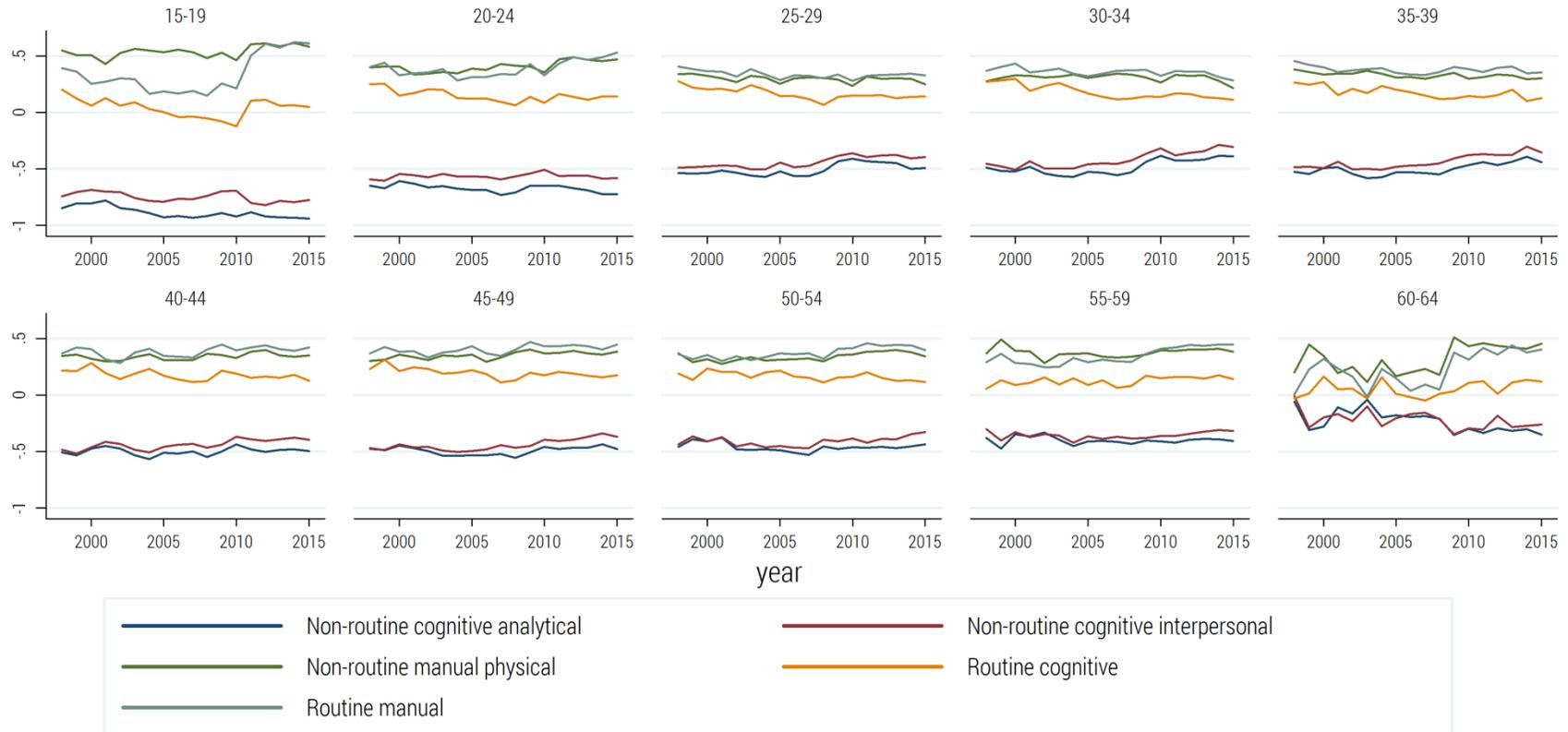
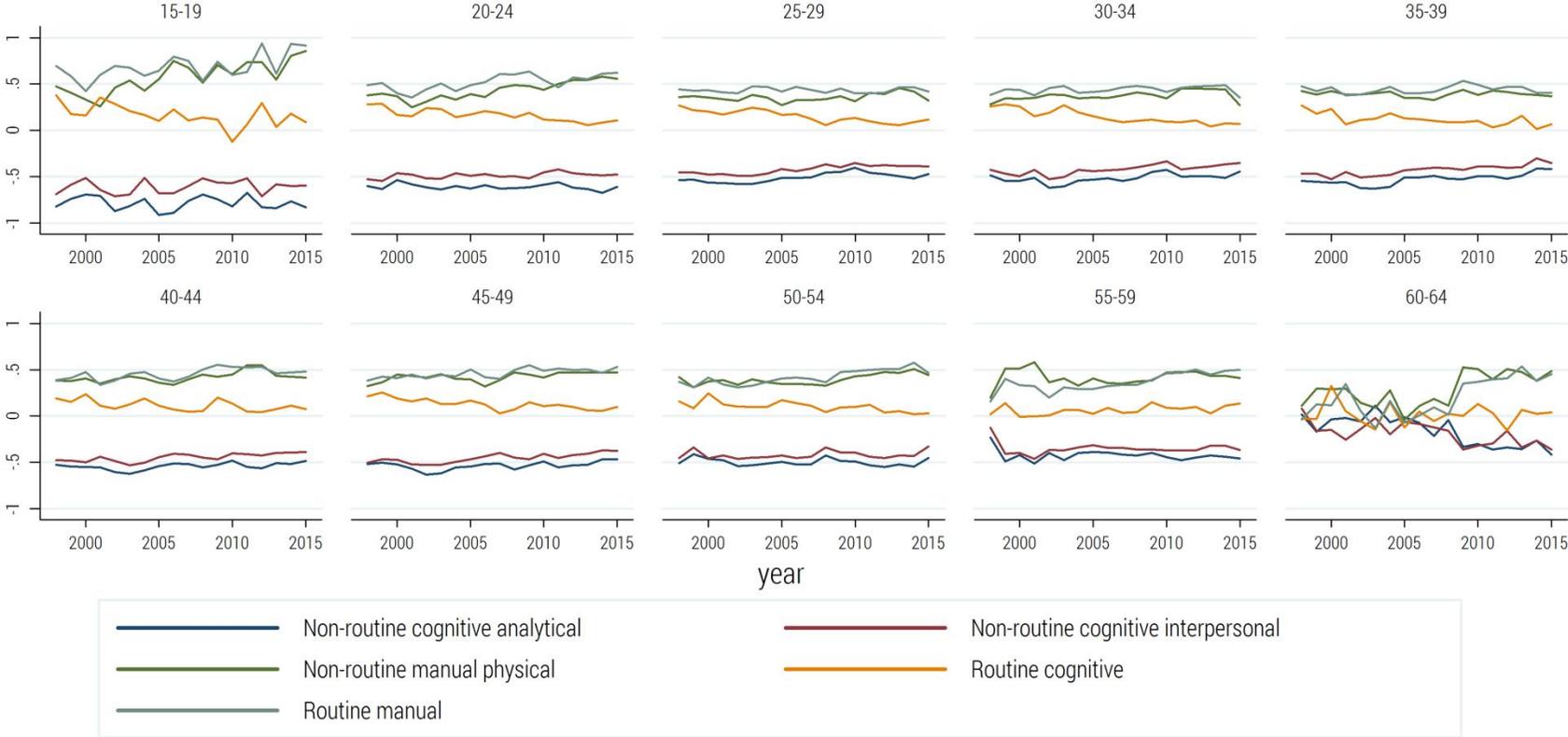*Source: own calculations based on EU-LFS and O*NET data.*

2.3. Relative routine intensity of jobs and & age

The ageing of routine occupations was reflected in the increasing concentration of older workers among the 20% of jobs with the highest relative routine intensity, and decreasing presence of older workers among the 20% of jobs with the lowest relative routine intensity. In line with our first background paper on the general evolution of task content of jobs, we utilise the RTI measure (relative routine intensity). We focus on the 1st and 5th quintiles of country-specific distributions of RTI.

Between the late 1990s and the middle 2010s, the highly routine jobs became increasingly dominated by the older workers, e.g. those aged 45-64.[2] This was true for all regions, but particularly pronounced for NMS countries. At the same time, in all regions except for the NMS South and the NMS Continental, the older workers were overrepresented in highly routine jobs (compared to the their overall employment share). By contrast, the share of youngest workers (15-24) in the highly routine employment decreased more than their share in total employment. However, these were still the youngest workers who accounted for the largest share of employment in the 20% of the most routine occupations. Their shares in the 5th RTI quintile were larger than their overall share of employment by 52% in EU-15 North and 14% in NMS North (largest and smallest difference reported). In all regions the share of prime-aged workers (25-44) who worked in the 20% most routine jobs slightly decreased.

In general, the changes of age structures within the 1st RTI quintile (the least routine jobs) were less marked than those that occurred within the 5th quintile. For example, the share of prime-aged workers working in the 20% least routine jobs remained flat over the analysed period. The share of the oldest workers decreased in three regions (EU-15 North, EU-15 Continental and NMS Continental), remained flat in two regions (NMS North and EU-15 South), and increased in one (NMS South). The share of the youngest workers in least routine jobs likewise has not revealed any unambiguous pattern of changes, with different sub-regions experiencing different trends. But overall, within the NMS region the share of youngest workers in least routine jobs decreased, whereas it held firm or inched up in the EU-15 region.

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[2] The employment shares of different age groups in RTI quintiles are divided by the overall share of this age group in the employment in order to partly cancel out the effect of changing demographic structure.

Figure 17. Distribution of age-group-specific relative employment shares within 1st and 5th RTI quintile in 1998-2000 and 2012-2014
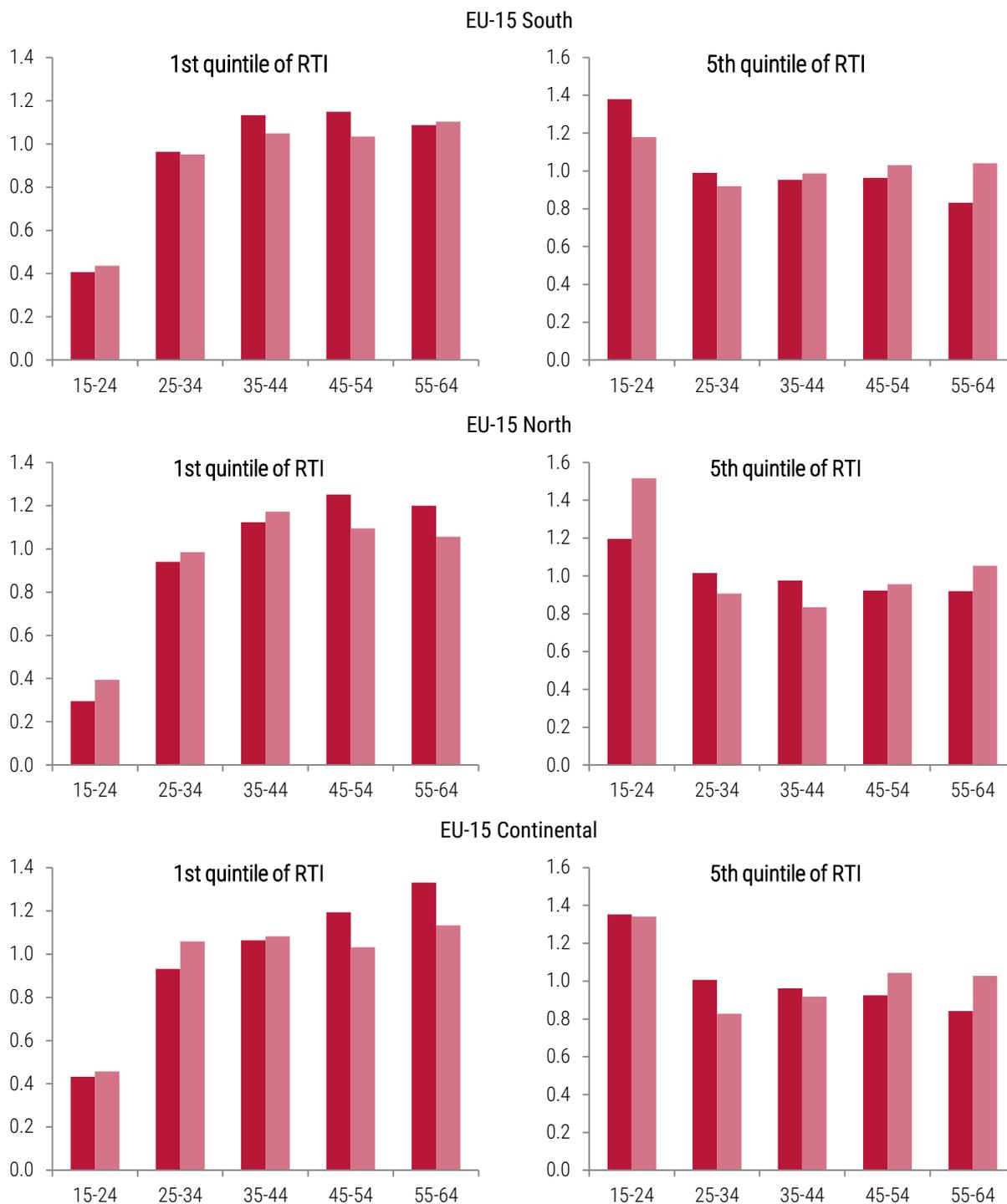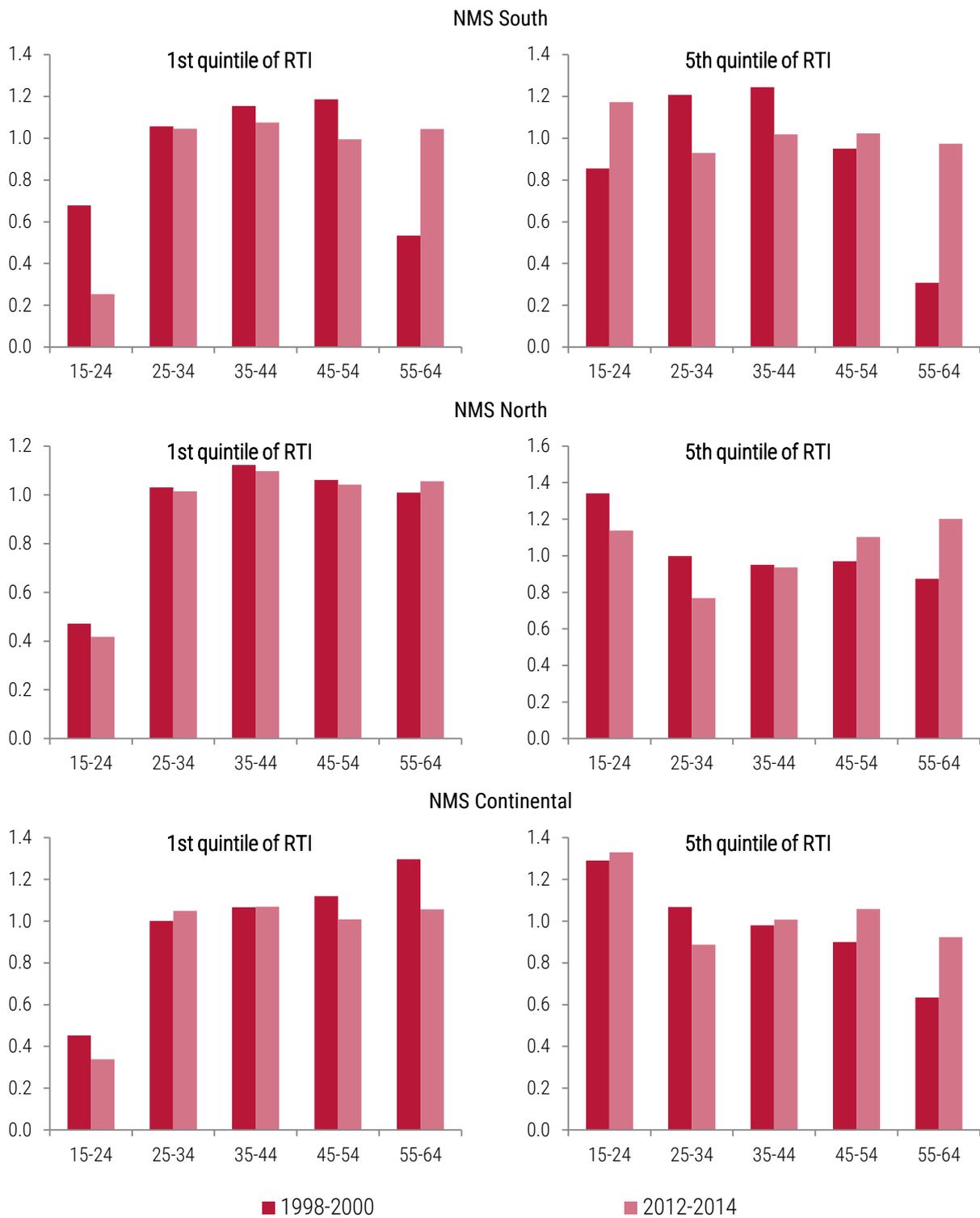
EU-15 South

EU-15 North

EU-15 Continental

NMS South

1st quintile of RTI

5th quintile of RTI

NMS North

1st quintile of RTI

5th quintile of RTI

NMS Continental

1st quintile of RTI

5th quintile of RTI

■ 1998-2000   ■ 2012-2014

Note: Countries groups are as follows: EU15 North (IE, DK, FI, SE, UK), EU15 Continental (AT, BE, FR, DE, NL), EU15 South (ES, IT, PT, GR,CY), NMS South (RO, BG), NMS Continental (CZ, SI, HU, SK, PL, HR), NMS North (EE, LT, LV).

Source: own calculations based on EU-LFS and O*NET data.

3. Cohort effects in tasks changes and workforce upskilling

In this section, we analyse task content changes within particular cohorts. This approach complements the analysis by age. It shows that task contents among workers born before 1970 have barely changed, whereas among workers born between 1970 and 1989 they were substantial. Instead of presenting the descriptive statistics, we focus on linear time-trend coefficients from fixed-effects panel regressions on the task content intensities within cohorts – the higher the absolute value of a coefficient, the faster the change of a particular task content in a given cohort.

The patterns of changes in the task content of jobs varied substantially across cohorts, but not between regions. In general, younger cohorts recorded faster changes of the task content intensity than the older cohorts. This translated into an intergenerational gap in the evolution of tasks content, both in the EU-15 and the NMS. Clearly, the dynamic of all task content changes for cohorts born before 1970 was sluggish, whereas the shifts recorded by cohorts born after 1970 were much more evident (see Figure 18). The largest differences between younger and older cohorts were observed for non-routine cognitive analytical tasks, and were more pronounced for EU-15 countries than NMS countries. Between 1998 and 2015, the average annual growth rate of non-routine analytical tasks in the EU15 region averaged 0.4 for cohorts born 1950-1969, but it was more than 10 times larger for cohorts born 1970-1989. The numbers in questions for NMS countries were 0.5 and 3.8, respectively. Mirroring the changes of non-routine cognitive tasks, younger cohorts saw a steeper fall of manual tasks compared to older ones. Non-routine manual tasks among older cohorts were declining at a mean pace of -0.4 in EU-15 and -0.3 in NMS, while among younger cohorts these rates averaged -2.7 and -3.1, respectively.

Figure 18. Linear time-trend coefficients from fixed-effects panel regressions on the task content intensities within cohorts

*Source: own calculations based on EU-LFS and O*NET data.*

The intergenerational gap in changes of routine cognitive tasks was much smaller than in the case of manual and non-routine cognitive tasks. Both the older and the younger cohorts have recorded rather small average rates of changes. The estimated time-trend coefficients equalled -0.8 in the EU-15 and -0.5 in the NMS for cohorts 1950-1969, while cohorts 1970-1989 saw the annual growth rate of -0.8 in EU-15 and 1.0 in NMS. An important feature distinguishing the NMS countries from the EU-15 countries is the growth rate of routine cognitive tasks among the youngest cohort in our sample, namely the cohort born 1985-1989. In both regions the youngest cohorts documented a positive growth rate of routine cognitive tasks, but it was significantly

higher for NMS countries, where it amounted to 2.1 compared to 0.3 in EU-15. This positive growth rate was persistent within NMS region (NMS South, North and Continental), but it was significantly larger for NMS South countries where it stood at 4.9, compared to 1.9 among NMS Continental and 0.8 among NMS North countries.

Summing up, European countries have experienced some kind of intergenerational divide in the changes of tasks composition of jobs. The pace of shifting from highly manual towards non-routine cognitive jobs was significantly higher for younger cohorts, whereas older cohorts were experiencing much slower changes. The gap between generations was the smallest in the case of the evolution of routine cognitive tasks.

Figure 19. Linear time-trend coefficients from fixed-effects panel regressions on the task content intensities within cohorts
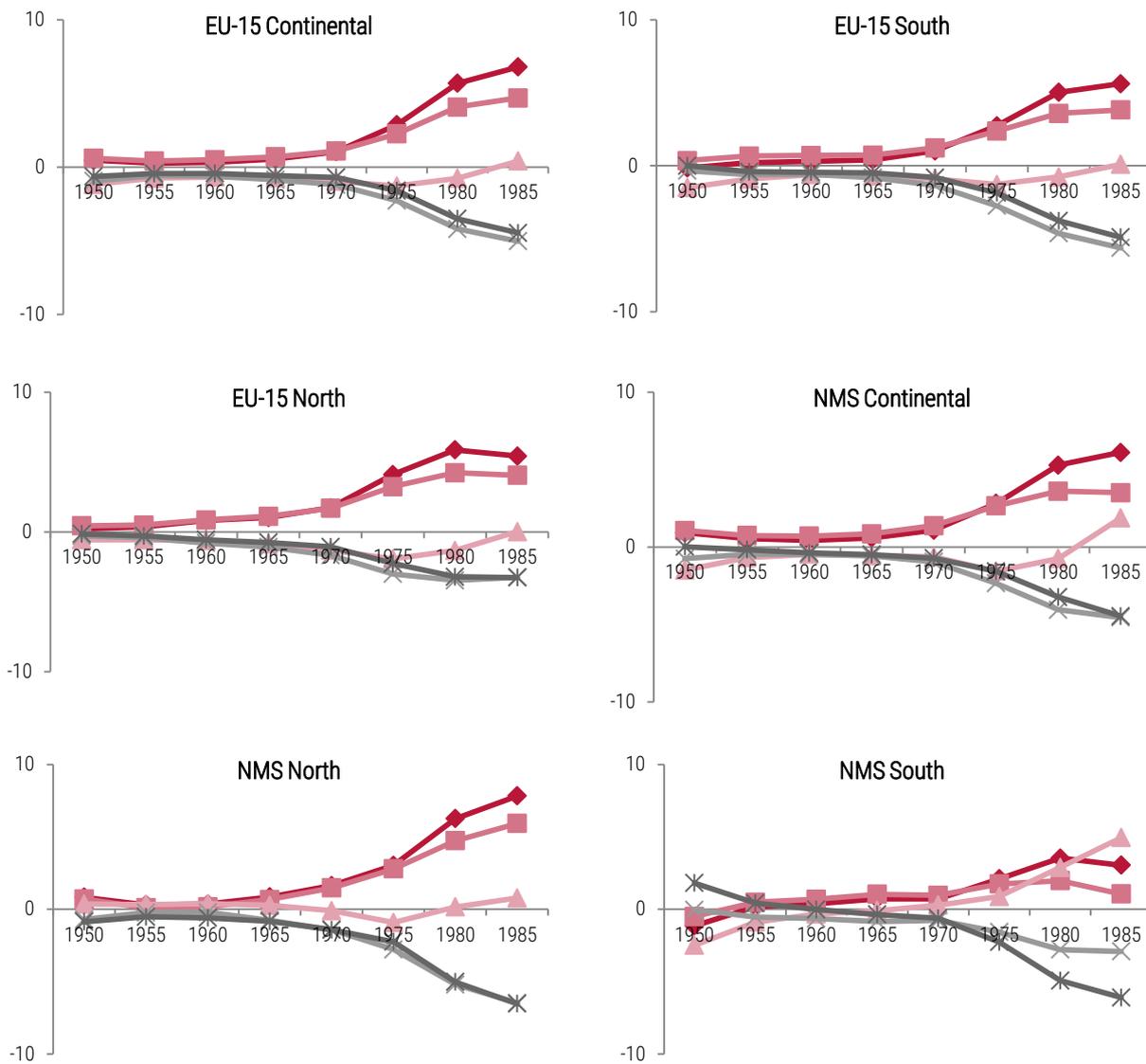
Note: Countries groups are as follows: EU15 North (IE, DK, FI, SE, UK), EU15 Continental (AT, BE, FR, DE, NL), EU15 South (ES, IT, PT, GR,CY), NMS South (RO, BG), NMS Continental (CZ, SI, HU, SK, PL, HR), NMS North (EE, LT, LV).
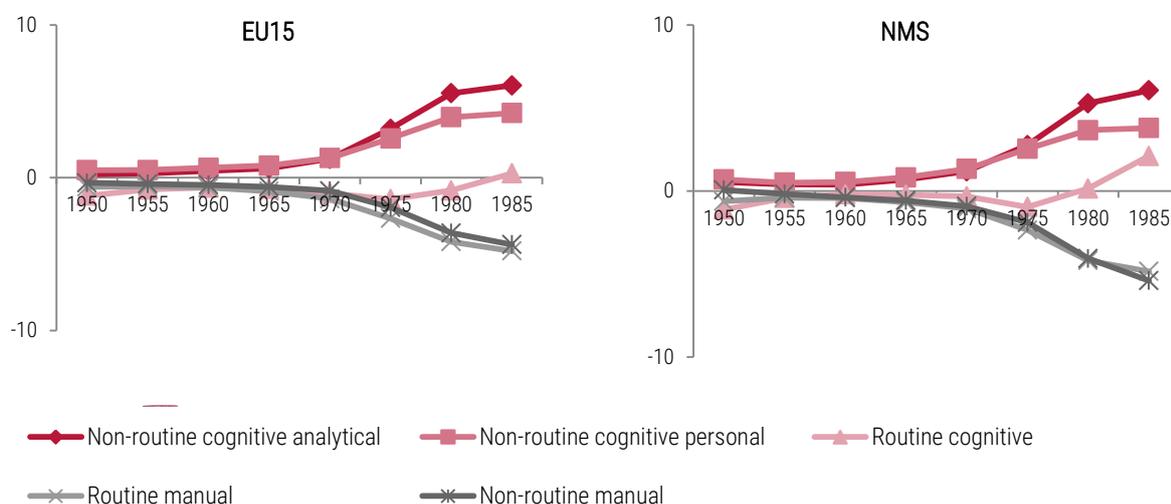
Source: own calculations based on EU-LFS and O*NET data.

The intergenerational divide in the task content changes may partly stem from the differences in the education structures of older and younger cohorts. More specifically, younger cohorts are likely to be better educated than older cohorts. This can be particularly the case for the NMS regions, which since the 1990s experienced a vast educational boom that was largely embodied in the younger cohorts.

In fact, the change of the share of tertiary educated workers within cohorts was positively and strongly correlated to the change of the intensity of non-routine cognitive tasks within cohorts. This relationship was evident in all regions we study as the basic correlation coefficients exceeded 75% (Table 1 and Figure 20). A similar pattern occurred for non-routine cognitive personal tasks, where the correlations ranged from 65% in NMS Continental region to 84% in NMS North region. In general, manual tasks exhibited the relationship of opposite direction, with cohorts becoming more educated performing less manual intensive tasks. Here the correlation coefficients were strongly negative varying from -0.76 in NMS North to -0.91 in NMS South.

Once again, more ambiguous patterns emerge for routine cognitive tasks and their relationship to the upskilling of cohorts. In all regions except for NMS South and NMS Continental, this relationship was slightly negative and rather statistically insignificant (ranging from -0.24 in the EU15 North to -0.03 in the EU15 South). In NMS South and NMS Continental the correlation coefficient was positive, but it was statistically significant at the 5% significance level only in NMS South region[3]. Hence, in the more developed sub-regions the growth of tertiary educated workers within cohorts was insignificant for the evolution of routine cognitive tasks. Yet, in NMS South which represents the least developed region in our sample, this relationship was positive.

Table 1. Correlations between the change of cohort-specific tasks intensities and the change of cohort-specific share of tertiary educated workers (in employment) between 1998-2013

	Non-routine cognitive analytical	Non-routine cognitive personal	Routine Cognitive	Routine manual	Non-routine manual
EU15 Continental	0.89	0.74	-0.14	-0.90	-0.83
EU15 North	0.92	0.79	-0.24	-0.88	-0.87
EU15 South	0.77	0.66	-0.03	-0.80	-0.77
NMS South	0.84	0.78	0.72	-0.91	-0.90
NMS Continental	0.77	0.65	0.20	-0.89	-0.84
NMS North	0.85	0.84	-0.10	-0.76	-0.81

*Source: own calculations based on EU-LFS and O*NET data.*

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[3] Based on the basic significance test for Pearson correlation coefficient.

Note*: Each dot represents a cohort in a given country. For the sake of clarity presented here are only three out of five task contents. As non-routine cognitive analytical tasks are highly correlated with non-routine cognitive personal tasks, and routine manual are highly correlated with non-routine manual tasks, their relationship to the workforce upskilling would resemble this presented above.

Source: own calculations based on EU-LFS and O*NET data.

4. Skill proficiency and age

In this subsection we utilise PIAAC data to analyse the relationship between age and skill proficiency. We estimate a range of country-specific logit models, explaining both high proficiency (levels 4 and 5) and low proficiency (below level 2) in numeracy, literacy and problem solving. Thus, we estimate six sets of models, controlling for age (10-year age groups) education, gender and computer use at work. Results are presented in Tables 2-7.

Older workers clearly stand out when it comes to skill proficiency. They were much more likely to have low skills and less likely to have high skills (individuals aged 25-34 constitute a reference group), even if other factors are controlled for. This was especially pronounced in the case of problem solving skills. In all countries with available data,[4] individuals aged 45-54 and individuals aged 55-64 were significantly less likely than workers aged 25-34 to be highly proficient in these skills. The estimated differences are also quite large. Older workers were also significantly more likely to have low proficiency of problem solving skills, except in Czechia, Ireland and Poland. Workers aged 55-64 were also significantly less likely to be highly proficient in literacy (numeracy) skills in 18 (16) out of 20 European countries with available data. Significant differences among workers aged 45-54 were less common (14 and 12 countries) but still noticeable. We find similar patterns in terms of significantly high probability of having very low skills.

There is no consistent evidence of differences in the probabilities of low or high skills between the 25-34 and 35-44 age groups. There is some evidence of workers aged 15-24 having lower numeracy and literacy skills in EU countries but higher problem solving skills, but members of this age group might have continued formal education after taking part in the PIAAC survey.

In line with intuition, education turns out as a strong predictor of the skill levels. Tertiary educated workers are from two to eight times more likely to have high numeracy skills than secondary educated workers in EU countries. Secondary educated workers are from 1.4 to 5 times more likely to have high numeracy skills than primary educated workers in EU countries. These findings extend to the literacy and problem solving skills. Female workers are found to be less likely to possess a high proficiency of numeracy and problem solving skills . At the same time, they were more likely to have low numeracy and problem solving skills. There was no consistent difference between men and women regarding the literacy skills. Using a computer at work was positively related to having high skills and negatively to having low skills of any type.

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[4] Problem solving skills assessment is not available for Cyprus, France, Italy and France

Table 2. Odds ratios from logit regressions on the probability of having high numeracy skills, among workers

	AT	BE	CY	CZ	DK	EE	FI	FR	DE	GR	IE	IT	LT	NL	PL	ES	SK	SI	SE	UK
Education																				
Tertiary	3.31***	5.14***	2.74***	7.26***	3.45***	3.10***	4.20***	7.89***	4.23***	4.27***	4.89***	2.11***	2.80***	3.49***	5.31***	2.72***	2.99***	2.97***	4.46***	2.58***
Primary	0.25***	0.37***	0.19**	0.21*	0.33***	0.27***	0.55**	0.32**	0.43***		0.10**	0.20***	0.53	0.32***	0.27***	0.28***	0.05***	0.35*	0.25***	0.35***
Female	0.46***	0.27***	0.48***	0.67**	0.37***	0.37***	0.36***	0.40***	0.42***	0.59**	0.31***	0.24***	0.64***	0.35***	0.44***	0.22***	0.72***	0.43***	0.37***	0.39***
Age																				
15-24	0.82	0.82	0.66	0.77	1.33	1.49**	0.88	0.77	2.26***	0.58	0.9	0.17*	0.9	0.99	1.41**	1.28	0.69	1.03	1.2	0.66
35-44	1.09	0.84	1	0.37***	1.08	0.68***	0.56***	0.81	1.26	0.95	1.29	0.85	0.81	0.84	1.04	0.67*	1.02	1.07	0.92	1.33*
45-54	0.62***	0.73**	0.79	0.50**	0.79*	0.56***	0.43***	0.54***	0.72**	1.04	0.93	0.89	0.68*	0.59***	0.81	0.94	0.72**	0.72*	0.64***	0.86
55-64	0.41***	0.32***	0.42*	0.54	0.49***	0.32***	0.19***	0.40***	0.36***	1.04	0.56*	0.45**	0.26***	0.27***	0.92	0.41**	0.46***	0.35***	0.44***	0.87
Computer at work	4.10***	6.15***	4.43***	3.34***	2.66***	4.51***	2.50***	4.18***	4.17***	2.97***	2.13***	4.01***	4.31***	1.73***	2.79***	3.73***	2.34***	8.93***	2.39***	4.33***
Constant	0.07***	0.05***	0.03***	0.04***	0.10***	0.05***	0.17***	0.02***	0.04***	0.02***	0.03***	0.04***	0.04***	0.19***	0.03***	0.02***	0.08***	0.01***	0.14***	0.04***
Observations	3,735	3,366	2,798	3,616	5,261	5,319	3,858	4,503	4,067	1,959	3,647	2,857	3,189	3,904	5,113	3,369	3,310	3,015	3,312	5,850

*Note: *** p < 0.01; ** p < 0.05; * p < 0.1.*
Source: own estimations based on PIAAC data.

Table 3. Odds ratios from logit regressions on the probability of having low numeracy skills, among workers

	AT	BE	CY	CZ	DK	EE	FI	FR	DE	GR	IE	IT	LT	NL	PL	ES	SK	SI	SE	UK
Education																				
Tertiary	0.31***	0.21***	0.52***	0.06***	0.49***	0.42***	0.33***	0.20***	0.27***	0.32***	0.34***	0.78	0.40***	0.30***	0.28***	0.37***	0.33***	0.22***	0.36***	0.57***
Primary	3.56***	2.75***	2.79***	3.26***	2.89***	3.15***	1.99***	2.97***	4.68***	2.95***	3.01***	2.30***	2.03***	3.09***	2.63***	2.10***	4.99***	2.75***	3.32***	2.61***
Female	1.38**	1.50***	1.30*	1.28	1.42***	1.84***	1.59***	1.34***	1.63***	1.15	1.91***	1.15	1.07	1.47***	1.18	2.12***	0.94	1.27**	1.51***	1.67***
Age																				
15-24	0.76	1.70**	1.26	1.22	0.37***	0.89	0.53*	1.73***	0.49***	0.82	0.88	2.02***	0.53**	0.38***	0.59***	0.75	0.53*	0.69	0.50**	0.79
35-44	1	1.60**	0.8	1.68*	0.69**	1.45**	1.37	1.73***	0.86	0.91	1.13	1.18	1.36	1.25	1.01	0.87	1.1	0.96	1.56**	0.78
45-54	0.78	1.91***	0.75	1.63	0.86	1.73***	1.45	2.17***	1.62***	0.56***	1.04	1.12	2.12***	1.37	0.89	1.27*	0.62**	1.31*	1.4	1.16
55-64	0.87	2.36***	0.77	2.90***	0.86	1.59***	2.06***	2.33***	1.49**	1.08	1.18	1.85***	1.69**	1.64**	0.97	2.42***	1.18	1.96***	1.32	0.84
Computer at work	0.24***	0.29***	0.52***	0.35***	0.30***	0.40***	0.29***	0.29***	0.34***	0.70**	0.42***	0.32***	0.37***	0.23***	0.48***	0.32***	0.29***	0.34***	0.25***	0.32***
Constant	0.21***	0.12***	0.22***	0.09***	0.23***	0.10***	0.14***	0.31***	0.21***	0.41***	0.25***	0.28***	0.18***	0.16***	0.36***	0.28***	0.11***	0.38***	0.19***	0.39***
Observations	3,735	3,366	2,798	3,616	5,261	5,319	3,858	4,503	4,067	2,459	3,647	2,857	3,189	3,904	5,113	3,369	3,310	3,015	3,312	5,850

*Note: *** p < 0.01; ** p < 0.05; * p < 0.1.*
Source: own estimations based on PIAAC data.

Table 4. Odds ratios from logit regressions on the probability of having high literacy skills, among workers

	AT	BE	CY	CZ	DK	EE	FI	FR	DE	GR	IE	IT	LT	NL	PL	ES	SK	SI	SE	UK
Education																				
Tertiary	4.16***	5.60***	3.28***	5.59***	4.21***	2.76***	3.93***	8.23***	3.94***	4.40***	3.70***	3.23***	1.68**	3.98***	5.89***	4.00***	2.69***	3.53***	4.75***	2.33***
Primary	0.16***	0.26**	0.30*	0.31	0.33***	0.39***	0.42***	0.41*	0.34***		0.17**	0.38*		0.31***	0.48*	0.25**	0.21	0.68	0.24***	0.17***
Female	0.72**	0.43***	0.98	0.78	0.60***	0.74***	0.80***	0.74**	0.70***	1.16	0.53***	0.67	1	0.67***	1.01	0.43***	0.9	0.70*	0.61***	0.65***
Age																				
15-24	1.60**	0.75	0.22***	0.77	2.01***	1.62***	1.19	0.83	1.98***	0.12**	0.89	0.36	1.09	1.44**	1.65***	0.49	0.79	0.93	1.07	0.58**
35-44	0.88	0.60***	0.72	0.57**	0.81	0.69***	0.61***	0.55***	0.87	1.39	1.16	0.74	0.74	0.87	0.87	0.99	1.14	0.93	0.94	1.12
45-54	0.37***	0.38***	0.8	0.44***	0.35***	0.43***	0.38***	0.45***	0.39***	1.12	0.60**	0.65	0.65	0.41***	0.63**	0.79	0.50***	0.69	0.48***	0.72**
55-64	0.10***	0.21***	0.41**	0.17***	0.16***	0.32***	0.10***	0.20***	0.12***	0.89	0.40***	0.19**	0.28***	0.17***	0.64	0.29***	0.22***	0.20***	0.24***	0.61**
Computer at work	3.10***	4.62***	2.30***	4.19***	2.57***	3.97***	2.86***	2.04***	4.08***	1.96*	2.37***	3.13***	3.13***	2.10***	2.68***	3.35***	1.88***	12.10***	2.97***	4.06***
Constant	0.04***	0.04***	0.02***	0.02***	0.04***	0.04***	0.13***	0.02***	0.03***	0.01***	0.04***	0.02***	0.03***	0.13***	0.02***	0.02***	0.04***	0.00***	0.08***	0.05***
Observations	3,735	3,366	2,798	3,616	5,261	5,319	3,858	4,503	4,067	1,959	3,647	2,857	3,062	3,904	5,113	3,369	3,310	3,015	3,312	5,850

*Note: *** p < 0.01; ** p < 0.05; * p < 0.1.*
Source: own estimations based on PIAAC data.

Table 5. Odds ratios from logit regressions on the probability of having low literacy skills, among workers

	AT	BE	CY	CZ	DK	EE	FI	FR	DE	GR	IE	IT	LT	NL	PL	ES	SK	SI	SE	UK
Education																				
Tertiary	0.20***	0.24***	0.52***	0.27***	0.38***	0.43***	0.37***	0.26***	0.31***	0.46***	0.28***	0.67**	0.46***	0.46***	0.23***	0.36***	0.51**	0.22***	0.55***	0.55***
Primary	3.16***	2.51***	1.96***	3.30***	2.49***	2.32***	2.33***	2.79***	3.65***	2.93***	2.91***	2.59***	2.03***	3.24***	2.25***	2.26***	3.52***	2.34***	3.58***	2.64***
Female	1.01	0.88	0.82	1.21	0.9	1.08	0.86	0.92	0.96	0.88	0.99	0.78**	0.75**	0.98	0.78**	1.56***	0.88	1.14	1.1	0.88
Age																				
15-24	1.19	1.34	1.52	1.13	0.28***	0.54***	0.53	1.42*	0.51***	1.02	0.60*	1.39	0.59	0.23***	0.47***	0.95	0.77	0.58**	0.39**	0.98
35-44	1.61**	1.76***	1.01	1.29	0.79	1.19	1.55	1.92***	0.94	1.19	1.32	1.09	1.67**	1.22	1.13	1.19	1	0.97	1.27	1.01
45-54	1.43*	2.17***	0.92	1.61*	1.08	1.82***	1.54	2.31***	1.96***	0.79	0.94	0.97	2.03***	1.53*	1.24	1.52***	1.06	1.27	1.59**	1.34
55-64	1.44	2.73***	0.89	2.15**	1.45**	1.88***	2.45***	2.84***	1.56**	0.87	1.38	1.35	1.35	2.44***	0.98	3.24***	1.49	2.01***	1.66**	1.36
Computer at work	0.36***	0.30***	0.86	0.43***	0.25***	0.52***	0.33***	0.36***	0.36***	0.83	0.61***	0.41***	0.40***	0.21***	0.45***	0.54***	0.43***	0.49***	0.21***	0.33***
Constant	0.15***	0.17***	0.17***	0.11***	0.36***	0.14***	0.12***	0.21***	0.26***	0.38***	0.16***	0.29***	0.18***	0.15***	0.31***	0.18***	0.09***	0.40***	0.19***	0.23***
Observations	3,735	3,366	2,798	3,616	5,261	5,319	3,858	4,503	4,067	2,459	3,647	2,857	3,189	3,904	5,113	3,369	3,310	3,015	3,312	5,850

*Note: *** p < 0.01; ** p < 0.05; * p < 0.1.*
Source: own estimations based on PIAAC data.

Table 6. Odds ratios from logit regressions on the probability of having high problem solving skills, among workers

	AT	BE	CZ	DK	EE	FI	DE	GR	IE	LT	NL	PL	SK	SI	SE	UK
Education																
Tertiary	2.06***	4.67***	2.39***	2.82***	2.16***	3.78***	4.08***	1.76**	3.26***	2.46***	3.51***	3.13***	2.89***	3.24***	3.14***	2.68***
Primary	0.27***	0.27**	0.6	0.34***	0.43***	0.68	0.68	0.03***	0.16*	0.35	0.30***	0.66	0.29	0.28*	0.30***	0.48**
Female	0.59***	0.44***	0.60***	0.61***	0.61***	0.60***	0.67***	1.02	0.49***	0.89	0.65***	0.56***	0.77	0.65***	0.59***	0.43***
Age																
15-24	1.28	1.68**	0.99	1.52**	2.13***	1.11	1.69***	0.76	1.23	1.48	1.30*	1.37**	1.75**	1.32	1.38*	1.02
35-44	0.45***	0.64***	0.46***	0.52***	0.39***	0.42***	0.50***	0.68	0.79	0.75	0.55***	0.55***	0.76	0.60***	0.69***	0.71**
45-54	0.20***	0.22***	0.21***	0.18***	0.14***	0.15***	0.20***	0.41***	0.41***	0.28***	0.21***	0.15***	0.42***	0.42***	0.27***	0.46***
55-64	0.06***	0.10***	0.13***	0.04***	0.02***	0.01***	0.07***	0.39*	0.05***	0.06***	0.06***	0.05***	0.18***	0.05***	0.11***	0.27***
Computer at work	3.63***	5.82***	5.36***	3.60***	4.37***	2.34***	3.33***	7.07***	4.18***	10.49***	2.12***	4.57***	3.99***	6.38***	2.67***	4.83***
Constant	0.07***	0.03***	0.06***	0.08***	0.04***	0.14***	0.07***	0.02***	0.02***	0.01***	0.14***	0.03***	0.03***	0.02***	0.14***	0.05***
Observations	3,735	3,366	3,616	5,261	5,319	3,858	4,067	2,459	3,647	3,189	3,904	5,113	3,310	3,015	3,312	5,850

Note: Problem solving skills assessment is not available for Cyprus, France, Italy and France.

*** p < 0.01; ** p < 0.05; * p < 0.1.

Source: own estimations based on PIAAC data.

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Table 7. Odds ratios from logit regressions on the probability of having low problem solving skills, among workers

	AT	BE	CZ	DK	EE	FI	DE	GR	IE	LT	NL	PL	SK	SI	SE	UK
Education																
Tertiary	0.63	0.29***	0.25***	0.34***	0.55***	0.29***	0.49***	0.79	0.25***	0.43***	0.51**	0.59***	0.66	0.27***	0.47***	0.45***
Primary	1.99***	1.27	1.22	1.75***	1.68***	1.41	2.21***	1.60**	3.88***	1.54*	2.07***	0.76	0.55	0.82	3.00***	1.44*
Female	1.45**	1.34**	1.19	1.35**	1.25**	1.19	0.84	0.81	1.37*	0.99	1.06	1.42***	1.2	1.34***	0.94	1.13
Age																
15-24	1.44	1.19	0.91	0.33***	0.79	0.34	0.38***	1.09	0.6	0.8	0.33**	0.96	1.26	0.73	0.45	0.30**
35-44	2.37***	1.94**	2.07**	1.52	2.18***	3.44***	0.88	0.63**	2.13***	1.55**	2.00*	1.08	1.94**	1.16	3.25***	1.84**
45-54	2.78***	3.71***	1.37	2.24***	2.74***	5.46***	1.82***	0.74	1.24	1.80***	3.18***	0.92	1.39	1.49***	4.08***	3.53***
55-64	2.76***	7.25***	1.8	3.85***	2.52***	10.00***	1.87***	0.29***	1.11	1.43*	4.55***	0.66	2.57***	1.80***	6.62***	2.73***
Computer at work	0.61**	0.64***	0.47***	0.42***	0.77**	1.12	0.67**	1.07	1.63**	0.75**	0.37***	0.94	1.04	0.69***	0.40***	0.40***
Constant	0.02***	0.05***	0.10***	0.08***	0.06***	0.01***	0.11***	0.31***	0.03***	0.24***	0.04***	0.10***	0.03***	0.24***	0.04***	0.08***
Observations	3,735	3,366	3,616	5,261	5,319	3,858	4,067	2,459	3,647	3,189	3,904	5,113	3,310	3,015	3,312	5,850

Note: Problem solving skills assessment is not available for Cyprus, France, Italy and France.

*** p < 0.01; ** p < 0.05; * p < 0.1.

*Source: own estimations based on PIAAC data.*

# 5. Part time and temporary employment by age

5.1. Part-time employment

The part time employment is the most prevalent among the youngest age group. However, there are significant differences across country groups. The EU15 North and EU15 Continental countries place consequently with the highest share of part-time employment. In the EU15 North countries almost the half of 15-24 workers work part-time. It stands in the stark contrast with all NMS countries where the share of part-time employment in the 15-24 age group is as low as 10-15%. The low incidence of part-time employment among the youngsters might mitigate education-employment transition.

The relative position of country groups in different age groups is very similar. It is The EU15 countries have experienced an increasing trend in part-time employment over last two decades. The increase was especially large in the EU15 South region. In EU15 South countries showed very low share of part-time employment in the early 2000s, but the share increased substantially in the subsequent years. Hence, levels and changes in part-time employment are mostly country-specific and less age-specific. It means that differences in part-time employment must arise from country-wide regulations.

Figure 21. Part-time employment shares by age group in European countries (in %)

55-64
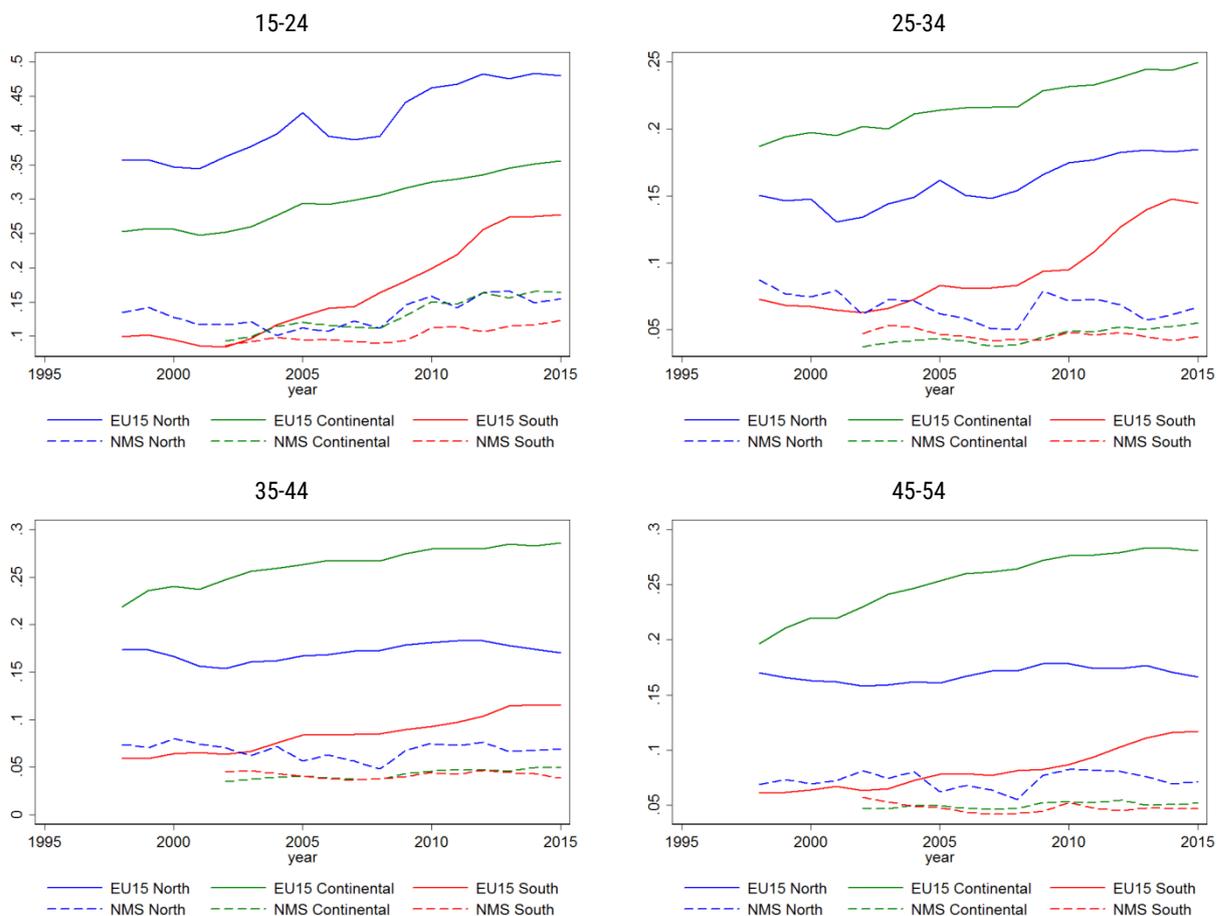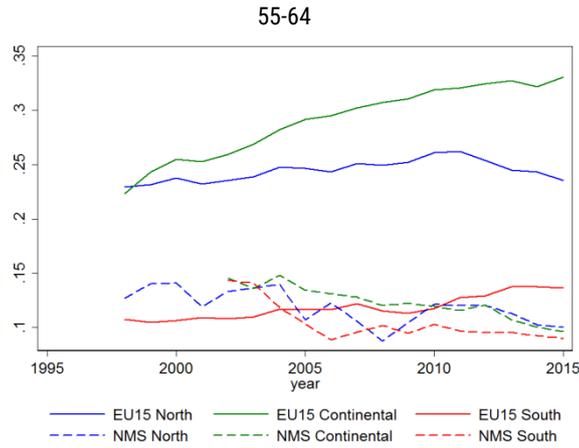
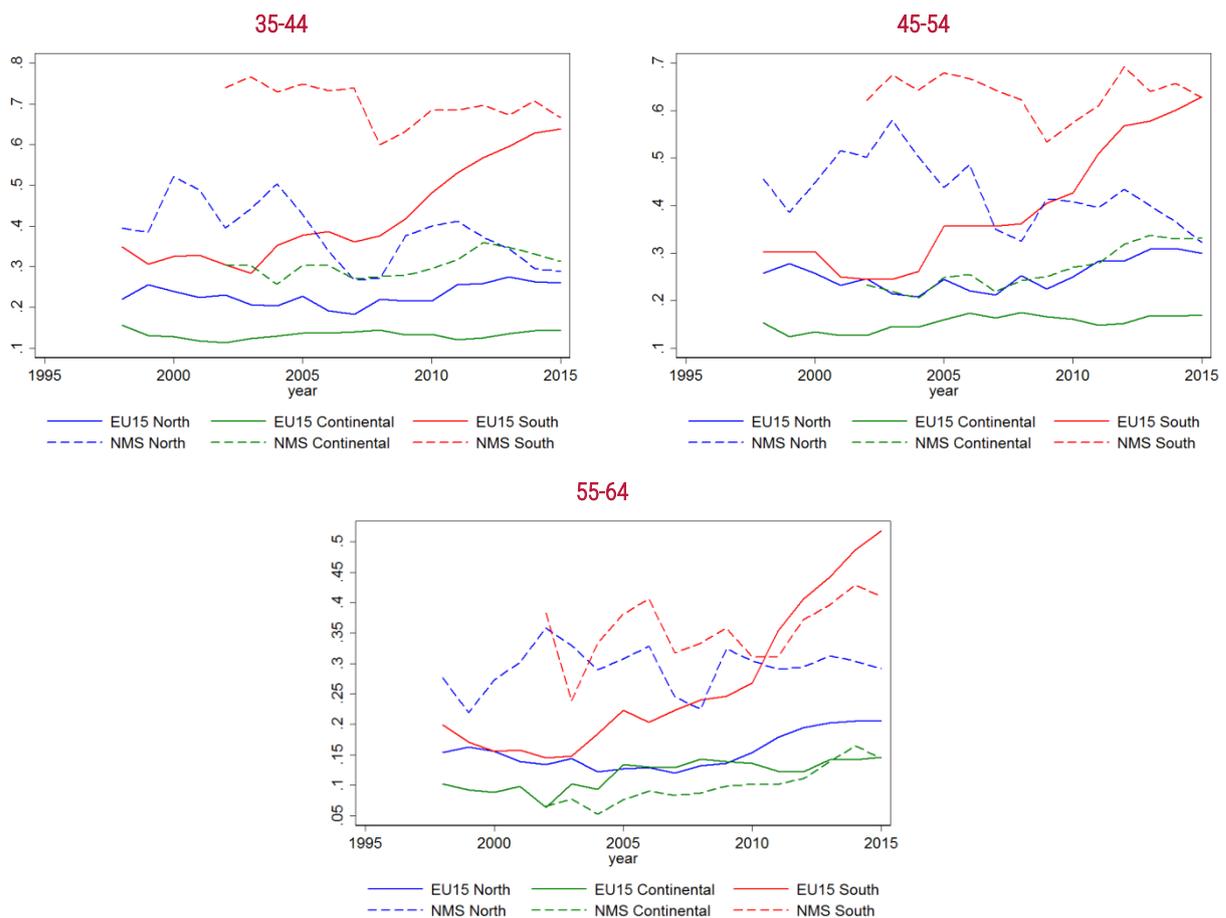*Source: Own calculations based on EU-LFS data.*

The involuntary part-time employment has expanded in the EU15 South countries, which can be easily identified as a consequence of the Great Recession. The increase has been especially intensified in older age groups (35-64). The share of involuntary part-time employment has doubled in this age group. The recent levels of involuntary part-time shares are very high in the EU15 with 60-70% of part-time workers. However, the share is somewhat lower in case of people aged 55-64, which suggests that they are relatively less prone to involuntary part-time.

The very high levels of involuntary part-time are observed also in the NMS South countries. Unlike the EU15 South, the NMS South countries have a persistently high share of involuntary part-time employment, also before the crisis. However, in the absolute numbers it is not a large phenomenon as the incidence of part-time employment in these countries is the lowest among the EU states.

The EU15 North and NMS Continental countries have also experienced an increase in involuntary part-time in the aftermath of the crisis. The change is about 10pp., so it is much smaller compared to the EU15 South countries. The elevated levels of involuntary part-time have not returned to the per-crisis lows.

Figure 22. Involuntary part-time employment shares by age group in European countries (in %)

15-24

25-34
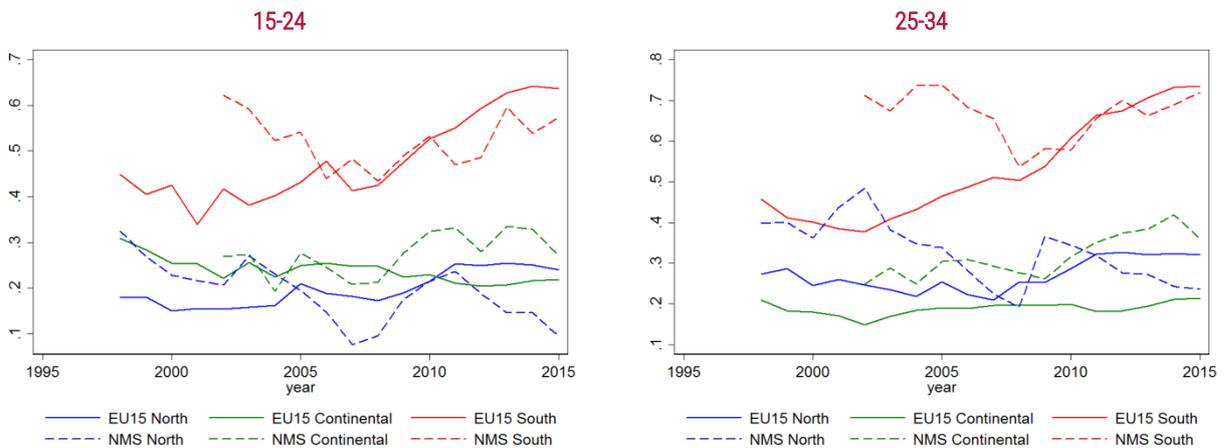
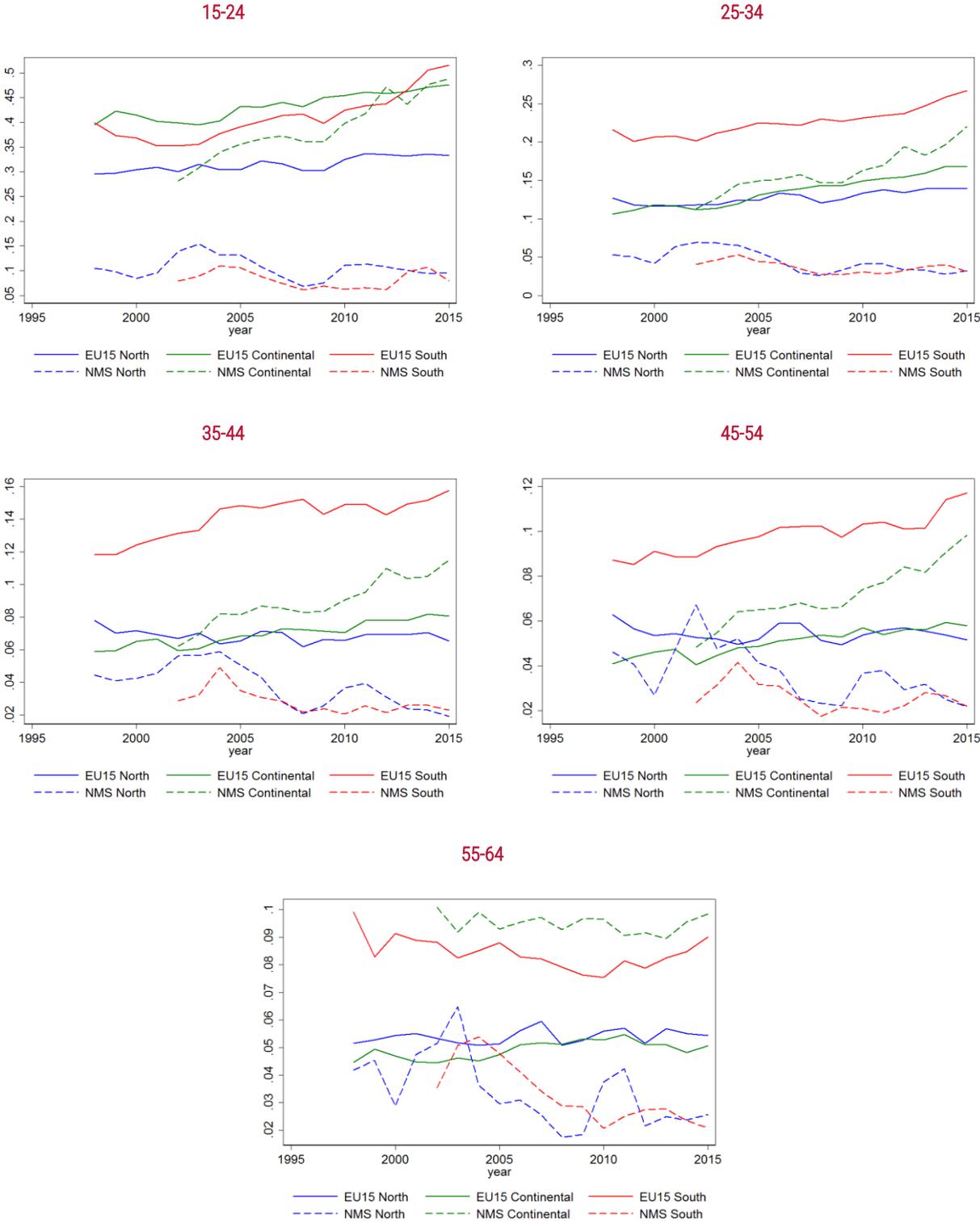*Source: Own calculation based on EU-LFS data.*

5.2. Temporary employment and work time

Temporary employment was prevalent among workers who were at the beginning of career. In the 15-24 age group the share of temporary employment reached 50% in the EU15 Continental, EU15 South and NMS Continental. Those countries have also experienced an increased in temporary employment in the last decade.

The incidence of temporary employment falls with the age. In the age groups 35-64 the record high shares of temporary employment were around 15%, but most countries having much lower shares. The EU15 South countries rank on the first place in temporary employment across almost all age groups.

The temporary expansion was especially large in the NMS Continental countries. The change was especially immense for the youngest workers aged under 24, and to less extent those aged 25-34. The increase was much smaller for people aged 35-54 and negligible for those aged 55-64. It suggests that there is the rising inequality of temporary employment risk across age groups, with the youngest being burdened the most.

Figure 23. Temporary employment shares by age group in European countries (in %)

Source: Own calculation based on LFS data.

The average weekly hours worked have been decreasing steadily over last two decades. It is a general pattern across the EU member states and people of different age groups. The highest average weekly hours are observed in the NMS Continental countries. The second highest apply to the EU15 South countries. The EU15 North and the EU15 Continental countries constantly placed at the lowest weekly hours worked. Workers aged 35-54 tend to work longer hours than workers of younger and older age groups. What is interesting, the relative country group ranking is more or less the same across all age groups.

Figure 24. Weekly hours of work (as usually worked) by age group in European countries (in %)
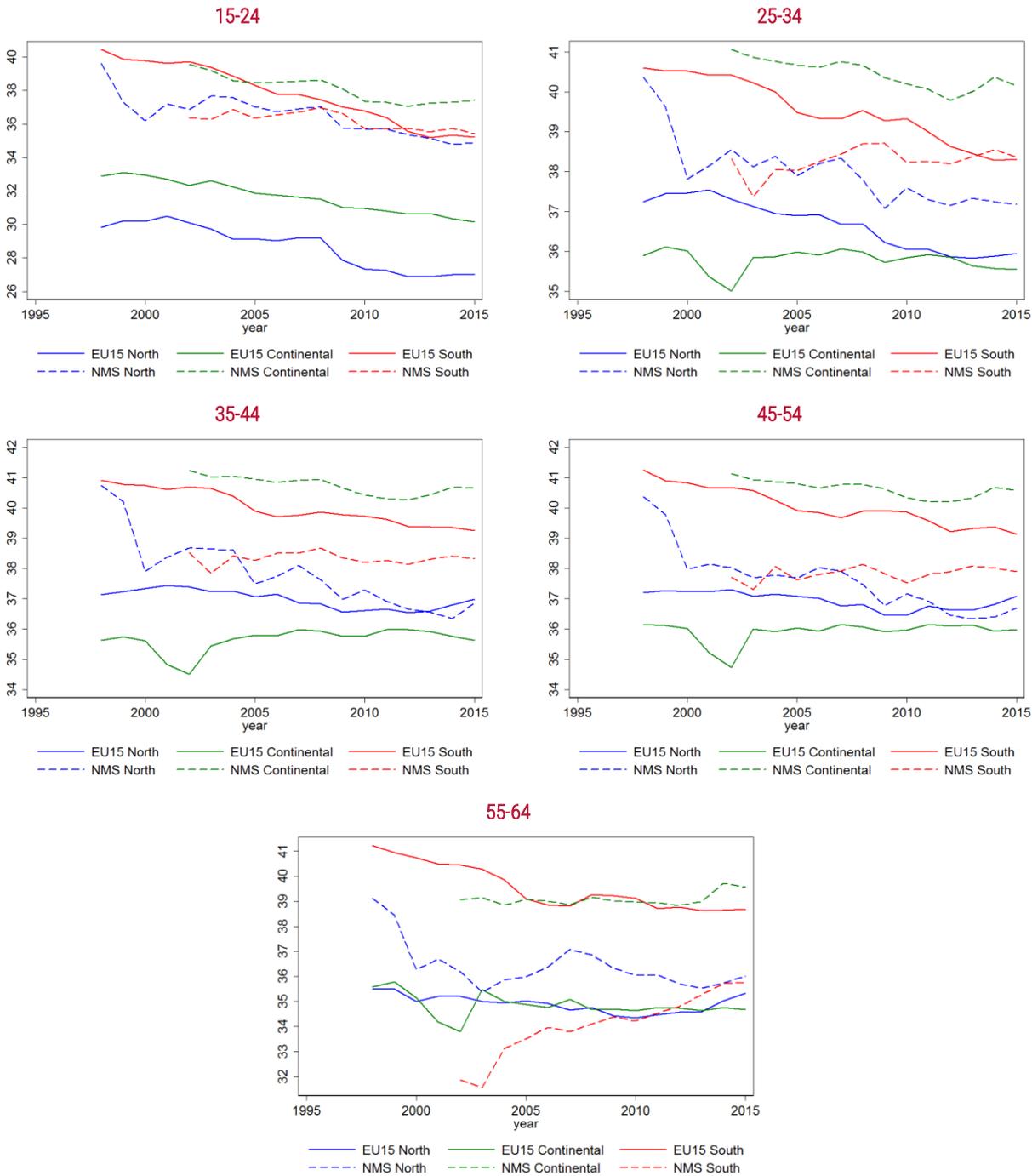
Source: Own calculation based on LFS data.

6. Conclusions

In this paper we have analysed the age and cohort dimension of the evolutions of task composition of jobs in European labour markets between the late 1990s and the middle 2010s. We have also studied age differences in skill proficiency. Age was a key dimension behind the prevailing shift away from manual tasks and routine cognitive tasks, and towards non-routine cognitive tasks. These developments occurred to a largest extent among prime-aged workers, in particular those between the ages of 25 and 44. The task contents of jobs performed by older and younger workers changed less. In that particular period the age divided was related to a pronounced cohort divide. While the task contents have barely changed among the workers born before 1970, every next cohort recorded a more dynamic increase in the intensity of non-routine cognitive tasks, and a faster decline in the intensity of manual tasks. In other words, individuals entering the labour markets in the 1990s and 2000s were at the forefront of the transition from manual to cognitive work and from routine to non-routine work. The age structures of workforce in the most routine jobs were ageing faster, while the age structures workforce in the least routine jobs were ageing slower than average in particular countries.

Differences in the evolution of the task content among particular cohorts can be traced back to the evolution of education structure of particular cohorts. In the first background paper we have shown that workforce upgrading and the increase in tertiary attainment were important drivers of the overall changes in the task composition. Here we have shown that workforce upgrading was embodied in the younger cohorts, especially in the NMS countries. We have also shown that the age and cohort differences in the evolution of routine cognitive tasks were less substantial than in the case of other task contents. Moreover, the relationship of these changes with workforce upgrading within cohorts was less visible. This result is in line with our finding in the first paper which stated that the cross-country differences in how the intensity of routine cognitive tasks changed can be attributed to different patterns of structural change in various economies rather than to changes in the educational structure of the workforce.

The ability to perform non-routine cognitive tasks is related to skills. In the first paper we have used PIAAC data to show that workers with higher skills are more likely to perform non-routine cognitive tasks and less likely to perform manual tasks. In this paper we have found that older workers are much less likely to be highly proficient in all types of skills, and they are more likely to have low skill proficiency (even if education is accounted for). To aspects are crucial here. First, although the differences vis-à-vis workers aged 25-34 are the most common and the largest among individuals aged 55-64, they are also widespread and noticeable among workers aged 45-54. In many European countries, the median age of population will soon exceed 45 years, so one cannot treat the 45-54 age group as "older". Moreover, older workers exhibit the largest gap in the case of problem solving skills. Further increase in the importance of non-routine cognitive tasks may leave these workers behind.

At the same time, older workers enjoyed more secure jobs (lower incidence of temporary contracts) than young workers, but they were also more affected by the increase in incidence involuntary part-time employment after the Great Recession. However, the trends in temporary employment and involuntary part-time of particular age groups were rather driven by the overall trends in given European regions rather than divergence between age groups in particular countries.

References

Acemoglu, D., Autor, D. H. (2011). *Skills, Tasks and Technologies: Implications for Employment and Earnings*. In: Card, D. and Ashenfelter, O. (eds). Handbook of Labor Economics. Amsterdam: Elsevier, 1043–1171.

Aedo, C., Hentschel, J., Moreno, M., Luque, J. (2013). From occupations to embedded skills: a cross-country comparison. *World Bank Policy Research Working Paper*.

Arias, O.S., Sánchez-Páramo, C., Dávalos, M.E., Santos, I., Tiongson, E.R., Gruen, C., de Andrade Falcão, N., Saiovici, G., Cancho, C.A. (2014). Back to work: growing with jobs in Eastern Europe and Central Asia, *Europe and Central Asia reports*. Washington, DC.: The World Bank.

Autor, D. H., Levy, F., Murnane, R. (2003). The Skill Content of Recent Technological Change: An Empirical Exploration. *Quarterly Journal of Economics* 118, 4.

Cedefop (2013). *Quantifying skill needs in Europe occupational skills profiles: methodology and application*. Thessaloniki: Cedefop.

Dicarlo, E., Bello, S. L., Monroy-Taborda, S., Oviedo A. M., Sanchez-Puerta, M. L., Santos, I. (2016). The Skill Content of Occupations across Low and Middle Income Countries: Evidence from Harmonized Data. *IZA Discussion Paper* No. 10224.

European Commission, Eurostat (2016). European Union Labour Force Survey 1998-2014. Brussels: European Commission, Eurostat.

Eurofound, Upgrading or polarisation? Long-term and global shifts in the employment structure: European Jobs Monitor 2015, Publications Office of the European Union, Luxembourg, 2015

Eurostat. (2014). EU Labour Force Survey Database User Guide.

Gimpelson, V., Kapeliushnikov, R. (2016). Polarization or Upgrading? Evolution of Employment in Transitionary Russia. *Russian Journal of Economics* 2 (2), 192–218.

Goos, M., Manning, A., Salomons, A. (2014). Explaining Job Polarization: Routine-Biased Technological Change and Offshoring. *American Economic Review* 104, 2509–2526.

Handel, M.J. (2012) *Trends in Job Skill Demands in OECD Countries*, OECD Social, Employment and Migration Working Papers No. 143.

Hardy, W., Keister, R., Lewandowski, P. (2016). Do entrants take it all? The evolution of task content of jobs in Poland. *Ekonomia. Rynek, gospodarka, społeczeństwo* 47, 23-50.

Hardy, W., Keister, R., Lewandowski, P. (2018). Educational upgrading, structural change and the task composition of jobs in Europe. *Economics of Transition* 26(2), 201-231.

Hummels D., Munch J., Xiang C. (2016). Offshoring and Labor Markets, *NBER Working Papers* No. 22041, National Bureau of Economic Research, Inc.

OECD. (2013). Chapter 17: Scaling PIAAC Cognitive Data. In: Technical Report of the Survey of Adult Skills (PIAAC). By: Yamamoto, K., Khorramdel L. and von Davier M. OECD.

Oesch D. (2013). *Occupational Change in Europe. How Technology and Education Transform the Job Structure*. Oxford University Press.

Razzu G. (2017). *Gender Inequality in the Eastern European Labour Market Twenty-five years of transition since the fall of communism*. Routledge.

Salvatori, A. (2015). The Anatomy of Job Polarisation in the UK. *IZA Discussion Papers* 9193.

Spitz-Oener, A. (2006). Technical Change, Job Tasks, and Rising Educational Demands: Looking outside the Wage Structure. *Journal of Labor Economics* 24, 235–270.