REDEFINING VS. REALLOCATING. TASK-DRIVEN JOB SEGMENTATION IN POLAND

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Redefining vs. reallocating. Task-driven job segmentation in Poland

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May 2015

Abstract

In this paper we analyse task content intensity changes in Poland between 1996 and 2014. We apply the Autor, Levy & Murnane (2003) and Acemoglu and Autor (2011) approach using the O*NET 2003 and 2014 data and Polish LFS at 4-digit occupation classification level. We find increasing intensity of both non-routine and routine cognitive tasks, and decreasing intensity of both routine and non-routine manual tasks, mainly due to between-occupation shifts in employment structure. The cohorts born after 1970 underwent large shifts in the task intensity structure and contributed most to the overall changes in task contents, while almost no adjustments occurred in cohorts born before 1970. The growth of non-routine cognitive tasks among workers born after the 1970 was largely driven by the tertiary education boom in Poland, although in some cases rising supply of tertiary graduates was accompanied by a relative reduction of non-routine content of jobs.

Keywords: occupational tasks, routinisation, skill-biased technological change

JEL: J24, J23, I25

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Introduction

Since early 1990s transition economies in Central Eastern Europe have joined the global trade and production networks and their economic structures have largely converged to those of the most developed countries. In most of CEE economies the share of services in GDP and employment increased, while that of agriculture declined. New types of services and businesses emerged and grew. Industry remained important source of jobs, but its structure has changed as comparative advantages of CEE countries evolved: heavy industry and textiles declined, while vehicles, machinery, appliances and electronics, but also furniture and chemicals production rose. These developments changed the demand for labour and its structure in terms of occupation and skills (IBS, 2014). Moreover, technological progress has influenced the nature of jobs in particular industries (Acemoglu and Autor, 2011; Goos et al., 2013), as well as content of particular occupations (Spitz-Oener, 2006; Levy and Murnane, 2013) across the world. Jointly, these processes have shaped the requirements faced by workers in CEE. Economic and productivity growth translated into wage growth, but employment gains were often modest, also in the early reforming countries which joined the EU in 2004 or 2007. Arias et al. (2014) show that as late as in 2010, CEE countries suffered from many years of potential employment lost, especially among older workers and women.[1] The demographic dimension was of crucial importance as labour market participation of older workers has been relatively low, and participation in life-long learning has remained limited in CEE. Still, CEE labour markets have so far had relatively young workforce, with good and rising enrolment in education (especially tertiary). Nevertheless, according to the EBRD–World Bank Business Environment and Enterprise Performance Surveys (BEEPS), since 2005 skilled labour shortages have become one of the most commonly reported constraints to firm growth in the region (Sondergaard et al., 2012).

In this paper we focus on Poland, which from macroeconomic viewpoint has been one of the most successful CEE economies, but its labour market has embodied most of developments and challenges described above. We apply the "skills and tasks" approach popularised by Autor et al. (2003) and Acemoglu and Autor (2011) to shed a new light on parallel developments of labour demand and supply in Poland between 1996 and 2014. We follow Aedo et al. (2013) and Arias et al. (2014) and use (US) O*net data to quantify task content of jobs by occupation.[2] We use Polish LFS data and apply 4-digit occupation classification (approx. 400 occupations) which allows us much more detailed measurement of task contents than earlier work based on 3-digit or 2-digit occupations. Moreover, we utilise the widest range of O*NET data possible (2003 and 2014) which allows us to quantify the role of between occupation and within-occupation shifts on the evolution of task content of jobs. To the best of our knowledge, so far in the task content context this has been done only once – Spitz-Oener (2006) showed that the task structure in Germany followed similar patterns to those in the US, and that within-occupation changes took place in the last few decades of the XX century.

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[1] Arias et al. (2014) calculate years of potential employment lost as employment rates by age group minus the total potential working life.

[2] While the implicit assumption of task content equivalence between middle-income Poland and high-income US is unlikely to hold strictly, Handel (2012) shows that US occupation-based and non-US skill-survey based measures lead to very similar outcomes also for European countries. Thus, even though the task content of particular occupations in the US and Poland may differ, O*net shall allow consistent tracking of task content changes over time.

Our analysis extends beyond this point by considering the evolution of task content structure of various birth cohorts in Poland. We are able to identify intergenerational divisions in content of jobs and its evolution over time which so far have been overlooked by the literature. Finally, we focus on the evolution of tasks within education attainment groups, bearing in mind the change occurring within the education structure itself. Other than considering general task-intensity differences between workers of different education levels, few authors analysed the role of education in economy-wide task structure changes. Autor et al. (2003) showed that although the task content changes might be the same within all education levels, the demand for particular education levels might change as jobs become more computerised, as confirmed by a later study of Spitz-Oener (2006). Although this undermines the necessity to decompose the overall changes to those within specific educational levels (as the changes are in essence comparable), it offers new questions as well, namely: how are the changes of education attainment related to future (task-described) career paths of the workers? Is there an age cohort effect connected to the growing number of education attainment possibilities? We try to answer these questions for Poland by decomposing cohort-specific results into factors driven by education, technology and labour matching.

The paper is organised as follows. First section outlines the evolution of labour demand and labour supply structure in Poland between 1996 and 2014. Second section introduces data and methodology. Third section presents our findings. The final section concludes.

1. Evolution of labour demand and supply in Poland

Polish labour market has experienced substantial changes in labour demand and supply size and structure since the transition to market economy started in 1989. After the initial transition shock and declining employment,[3] since the middle 1990s the labour demand has been affected by short-term (cyclical)[4] and medium-term developments typical for emerging economies. Sector structure of employment in converged to that in the EU15, but not completely. In 2014 it differed mainly in terms of employment shares of agriculture and industry sectors, both being higher in Poland. In 2014, the share of employment in industry in Poland stood at 23% (down from 25.5% in 1996), a level similar to other countries of the region, i.e. Czech Republic, Slovakia and Hungary, but above the EU average of 15%.[5] The industrial structure has also evolved. Since middle 1990s, Poland has lost a revealed comparative advantage especially in the production of apparel and certain textile articles, while it gained advantages in the production of furniture, wood, boats and yachts, copper mining, and in many branches of agricultural and food production, as well as paper and consumer chemicals and cosmetics (IBS, 2014). Thus, in 2014, the four branches of Polish manufacturing with the highest share in employment were: food and beverages (17.2%), basic metals and fabricated metal products (13.3%), motor vehicles (10.8%) and furniture (7.5%) (see Figure 9 in Appendix 2).[6] An exceptionally

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[3] According to ILO, between 1988 and 1992 employment in Poland fell from 18.5 million to 15.5 million, mainly in manufacturing, mining and construction (altogether by 1.62 million people).

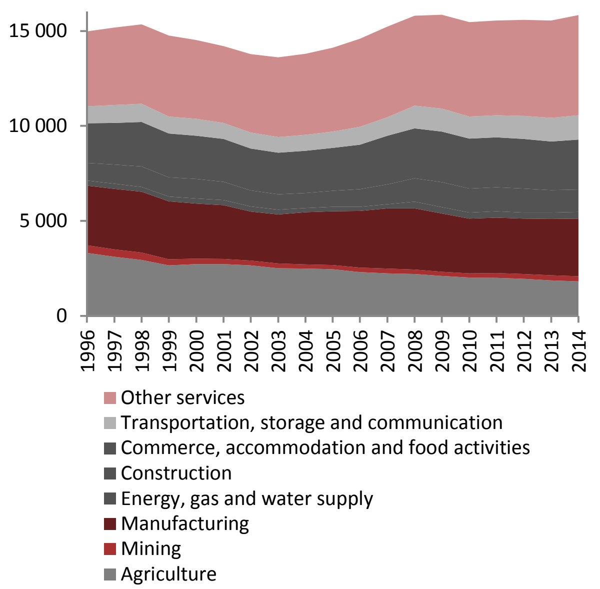
[4] Total employment fluctuated between 13.6 in 2002 and 15.8 million people in 2009 and 2014.

[5] In the EU 15, only Germany and Italy exhibit industry employment shares close to 20%.

[6] IBS (2014) shows that the dominant role of industries which are not highly advanced technologically, are moderately labour-intensive and moderately capital-intensive, distinguishes Poland from its southern

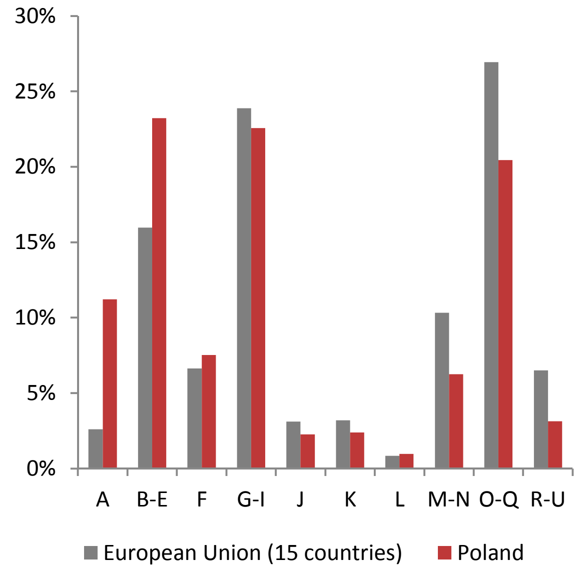
strong rise has occurred in services, as employment in that sector increased by 2.25 million between 1996 and 2004. Professional, scientific and technical activities; administration and support service activities; information and communication; finance and insurance as well as accommodation and food service activities were (in terms of employment) the fastest growing services branches in Poland, especially after the EU accession in 2004. However, the share of professional, scientific, technical, administrative and support services in 2014 was still lower than in the EU15. The same applied to education and health care (see Figure 10 in Appendix 2).

Figure 1. Employment by sector in Poland 1996-2014 (thousands of people).



Note: Some differences in the number of employees in the sectors may result from changes in classification. Since 1994 classification was ISIC Rev. 3 and in 2008 to ISIC Rev. 4.
Source: Own elaboration on LABOURSTA, ILO and Eurostat data.

Figure 2. Structure of employment by sector in Poland and the European Union in 2014 (%).



Note: A - Agriculture, forestry and fishing; B-E - Industry; F - Construction; G-I - Wholesale and retail trade, transport, accommodation and food service activities; J - Information and communication; K - Financial and insurance activities; L - Real estate activities; M-N - Professional, scientific and technical activities; administrative and support service activities; O-Q - Public administration, defence, education, human health and social work activities; R-U - Arts, entertainment and recreation; other service activities; activities of household and extra-territorial organizations and bodies.
Source: Own elaboration on Eurostat data.

On the other hand, the demographic and educational structure of the workforce has changed dramatically. Tertiary enrolment of the 20-24 year olds doubled between late 1990s and 2010s, and as a result, the share of people with tertiary education level attained in the workforce from 11.4% in 1996 to 20.3% in 2004 to 32.4% in 2014, the highest increase in the EU.[7] Changes in the educational choices of Poles are reflected in Figure 3 which shows the evolution of educational attainment of

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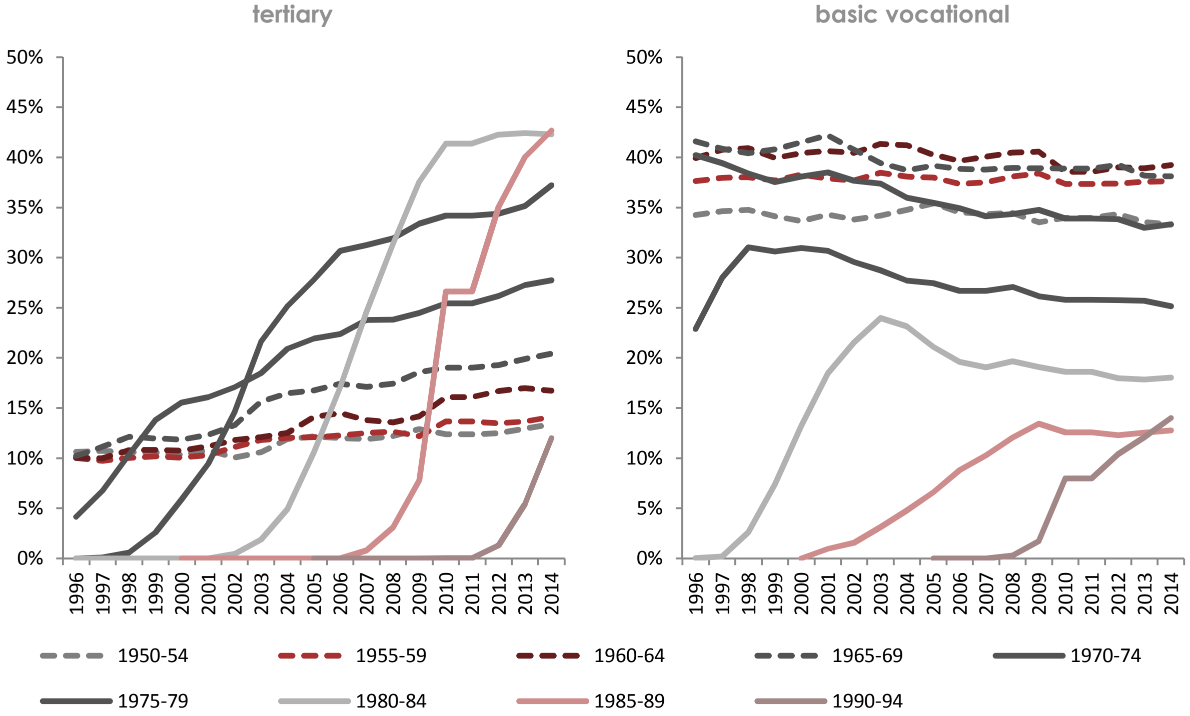
neighbours (Czech Rep., Slovakia, Hungary) which have begun to specialise in the production of vehicles, machinery, equipment and electronics.

[7] A strong improvement in educational indicators has also been experienced by other countries in the region (particularly Lithuania, Latvia, Czech Rep., Slovakia and Slovenia), but it was not as pronounced as in Poland.

selected cohorts since the mid-1990s.[8] Compared to the older generations, younger cohorts, i.e. those born from 1970 on, have increasingly often pursued education at university level. High schools have become the most popular type of secondary school, as they allow university application, but the share of youth obtaining general secondary or secondary vocational education has remained stable. On the other hand, the enrolment in basic vocational education (which gives no right to continue education at university level) has decreased from 34.2% of the workforce in 1996 to 26.2% in 2014.

Figure 3. Educational attainment of by cohort in Poland, 1996-2014 (share of people with a given level of education)



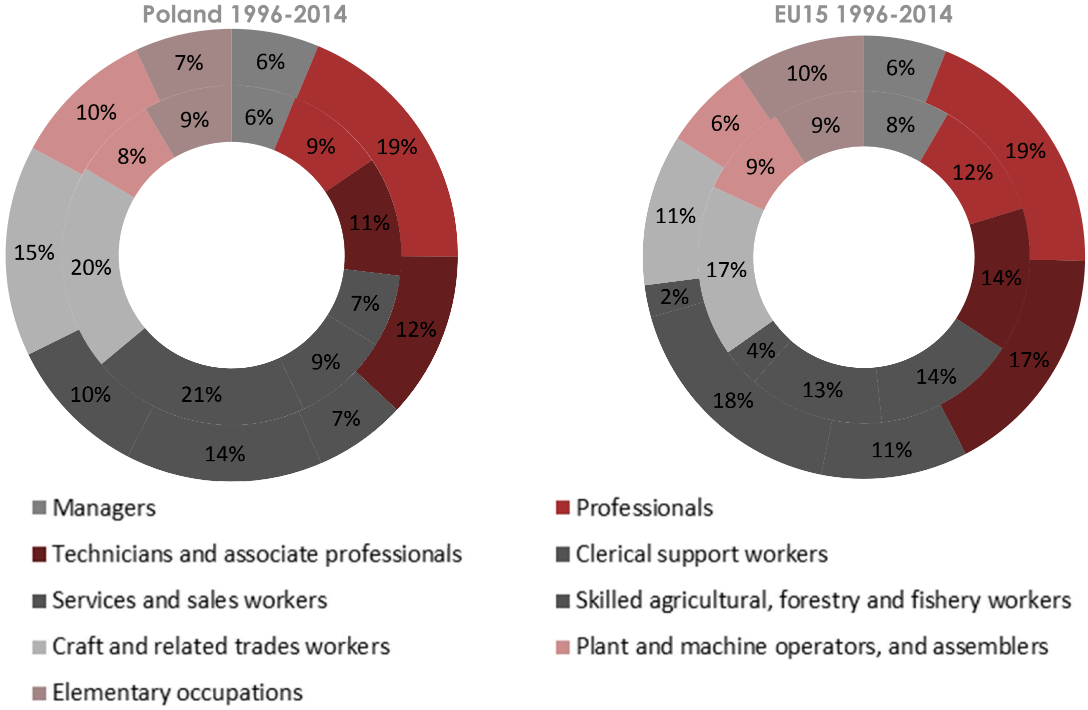
Note: The legend gives the cohort's year of birth. Minor fluctuations may result from the selection bias.
Source: Own elaboration based on LFS data.

The evolution of economic structure has influenced demand for occupations and skills (Arias et al., 2014; IBS, 2014). Moreover, we may expect that technological progress has been inducing shifts in the structure of skills and content of jobs within sectors (Autor et al., 2003). On the other hand, changes in the educational choices have affected the composition of skills of labour market entrants. As a result, since middle 1990s, the share of skilled workers in total employment in Poland has increased, mainly due to rising share of professionals (from 9% in 1996 to 19% in 2014, see Figure 4). The share of managers and officials has been stable at around 6%, and that of technicians – at 11%. The proportion of workers in low- or middle-skilled non-manual occupations, e.g. office clerks and personal services workers, has also been increasing. The share of office clerks in total employment in Poland stood at around 7% from 1996 to 2014 (it was higher but declining in the EU15), whereas the share of personal services workers rose in Poland from 9% in 1996 to 14% in 2014 (similarly co other EU countries). On the other hand, employment in manual jobs (agricultural workers, plant and

[8] We focus on tertiary and basic vocational education as the attainment in these two levels of education changed most. In other levels (junior high, primary or without primary; general secondary; post-secondary and secondary vocational) changes were minimal, for details see IBS (2014).

machine operators, assemblers, elementary occupations) has been falling, from 49% of total employment in 1995 to 37% in 2012 (comparable decrease by an average of 12 pp., down to 18% in 2012, was recorded in the EU15). In general, changes in the occupational structure in Poland were consistent with the polarisation hypothesis (Goos et al., 2009).

Figure 4. Occupational structure of employment in Poland and EU15, 1996 vs. 2014.



Note: The inner circle presents the structure in 1996, the outer circle in 2014.
Source: Own elaboration based on Eurostat data.

2. Data & Methodology

2.1. O*NET Data Sets

The Occupational Information Network (O*NET) database was used a source of information on task content of jobs. The O*NET data has been collected in the US since 2003 for approximately 1000 occupations (consistent with the Standard Occupational Classification) and so far has been updated fifteen times (the last time in July 2014).[9] Following the approach of Acemoglu and Autor (2011) we utilise four O*NET datasets: Skills, Work Activities, Work Context and Abilities, to create routine vs. non-routine task contents of occupations. Each of the O*NET questionnaires contains different descriptors, which are measured using different scales (such as Importance, Level or Extent of the

[9] The O*NET database is a successor of the DOT (Dictionary of Occupational Titles) database which is no longer being updated. The first O*NET was launched in 1998, but was created on the basis of the BLS Occupational Employment Statistics codes, later changed to Standard Occupational Classification (SOC).

activity).[10] Since the Importance and Level scales are highly correlated (the correlation coefficient is 0.93), we follow Acemoglu and Autor (2011) and use only the Importance scale. We use the earliest and the latest data sets available (2003 and 2014), in order to capture the within-occupation change of tasks content over time.[11] Table 1 summarises information on data sets used – number of their descriptors, number of scales etc.

Table 1. O*NET datasets used

O*NET Data Set	No. of descriptors	No. of scales per descriptor	Types of scales	Data source
Skills	35	2	Importance and Level	Analysts
Generalized Work Activities	41	2	Importance and Level	Job incumbents / Experts
Work Context	57	1	Importance	Job incumbents / Experts
Abilities	52	2	Importance and Level	Analysts

*Source: own elaboration based on the O*NET website.*

The O*NET database has been gradually updated over time and the number of occupations surveyed has been increasing (and changing due to modifications of the occupation classifications – see Section 2.2). For some datasets the number of descriptors measured in 2003 is notably smaller than in 2014. In particular, one of the descriptors ("Structured vs. Unstructured Work" in the Work Context data) essential for creation of the routine cognitive task content measure was estimated for merely 54 SOC occupations in 2003, compared with 941 in 2014. Thus, for all occupations lacking this descriptor in 2003 O*NET dataset we assigned the first value available. Table 2 shows the ONET updates necessary to fill the missing values in O*NET 2003 database. In general, the 2005 values were enough to achieve almost 50% completion, 2006 – more than 80% and 2008 almost 100%.

Table 2. Numbers of occupations with complete information in 2003 O*NET, after imputation from subsequent O*NETs

Imputation from:	Number of complete occupations	Percent of complete occupations
Only O*NET 2003	54	6%
O*NET 2004	266	30%
O*NET 2005	441	49%
O*NET 2006	752	83%
O*NET 2007	877	97%
O*NET 2008	900	~100%

*Source: own elaboration based on the O*NET website.*

2.2. Connecting O*NET Tasks to Polish LFS

We use the Labour Force Survey data from 1996 to 2014. The Polish LFS is conducted on a quarterly basis.[12] Between 1996 and 2009 45 thousand individuals were surveyed each quarter, since 2010 the sample is 100 thousand individuals per quarter. To estimate task content of jobs in Poland we

10 Each scale is defined with a different range (e.g. the Importance scale takes values from 1 to 5, while the Level scale from 0 to 7).

11 While first data collected in the O*NET programme dates back to 1998, consistent task content measures can be calculated since 2003.

12 The Polish LFS has the form of a rotational panel. Individuals are surveyed for two consecutive quarters, then have a two-quarter break, and are then interviewed again in two successive quarters.

mapped O*NET task items to the corresponding four-digit Polish Classifications of Occupations and Specializations (1995, 2002, 2004 and 2010) and combined them with individual LFS data. As a result, all individuals in the LFS had task items assigned corresponding to their occupation.[13]

Polish LFS contains a Poland-specific version of the International Standard Classification of Occupations (KZiS – *Klasyfikacja Zawodów i Specjalności*), while O*NET occupation classification follows a modified version of the Standard Occupational Classification system (ONET-SOC). Combining the two datasets – i.e. ascribing appropriate occupational attributes to the LFS data – required developing a link between these two distinct classifications. Both ONET-SOC and KZiS have been modified over the years. ONET-SOC has undergone three revisions since 2000, with the major one taking place in 2010 (following the supersession of SOC2000 by SOC2010). KZiS underwent several revisions, three of them affecting the 4-digit level codes: two smaller revisions in 2002 and 2004 and a major one in 2010 (following the supersession of ISCO-88 by ISCO-08). In order to utilize the earliest and latest O*NET datasets possible and the 1996-2014 Polish LFS data, we collected crosswalks that allowed connecting the O*NET data (both with ONET-SOC2000 and ONET-SOC2010) to the evolving codes of KZiS. The full list of sources of the crosswalks is available in Appendix 1.

For the transition of ONET-SOC2000 into KZiS we carried out the following steps:

1) changing the ONET-SOC2000 data to simple SOC2000 (this step only involves dropping a numerical suffix from the ONET variant),
2) connecting the resulting SOC2000 data to ISCO-88 data,
3) connecting the resulting ISCO-88 data to KZiS 2004 data (LFS 2005-2010),
4) connecting the resulting KZiS 2004 data to KZiS 2002 data (LFS 2003-2004),
5) connecting the resulting KZiS 2002 data to KZiS 1995 data (LFS 1996-2002),
6) mapping ONET-SOC2000 to ONET-SOC2010 using the crosswalk provided at the O*NET website,
7) changing the ONET-SOC2010 data to SOC2010 (this only involves dropping a numerical suffix from the ONET variant),
8) connecting the resulting SOC2010 data to ISCO-08 data,
9) connecting the resulting ISCO-08 data to KZiS 2010 data (LFS 2011-2014).

For the transition of ONET-SOC2010 the steps were analogous, with the starting point constituting the only difference.

In some cases the crosswalks do not provide unambiguous connections between two classifications. Four situations can be distinguished. First, that one original (i.e. from source or already compiled classification) occupation code is connected to only one target occupation code (i.e. in a target classification) – in such case we imputed the original values of attributes to the target code. Second, that one occupation code is connected to several target occupation codes – in such case we imputed the same original values of attributes to each of the target codes. Third, that several occupation codes are connected to only one target occupation code – in such case we imputed the mean values

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[13] Although Polish LFS has been conducted since 1992, the occupational classifications before 1996 has been reported only at a 3-digit level. Moreover, the first change in the occupational classification was developed a few years later in 1995 (and not immediately introduced). We therefore take 1996 as the beginning of our analyzed period not to include unnecessary heterogeneity due to changes in both the level of detail and list of occupations.

of each attribute within the original codes to the one target occupation code. Fourth, that several occupation codes are connected to several target occupation codes – in such case we imputed the mean value of each attribute among the original codes to each of the target connected codes.

Table 3 presents the final numbers of occupations for which we could assign O*NET attribute and job characteristics values, within each step.

Table 3. Resulting numbers of occupations in each classification, by starting points

To: Occupation Classification	From: ONET-SOC 2000	From: ONET-SOC 2010
ONET-SOC 2000	902	-
ONET-SOC 2009	-	940
ONET-SOC 2010	748	942
SOC 2000	679	757
SOC 2010	680	770
ISCO-88	359	371
ISCO-08	399	422
KZiS 1995	**349**	**356**
KZiS 2002	**358**	**368**
KZiS 2004	**359**	**370**
KZiS 2010	**407**	**424**

Note: It was not necessary to map ONET-SOC 2010 as far as into ONET-SOC 2000. This is because the transition between ONET-SOC 2000 and SOC 2000 is the same as it is for ONET-SOC 2009. Therefore we chose the more detailed ONET-SOC 2009 for the crosswalk.

2.3. Calculating Task contents

We standardised the task intensity values (in line with Acemoglu and Autor, 2011) throughout analysed period to make them comparable over time. The standard score of each task intensity *t* for each observation was calculated using the formula:

$$\bigwedge i \bigwedge j \in J \quad t_{i,j}^{std} = \frac{t_i - \mu_j}{\delta_j}, \quad (1)$$

where J is the set of 16 task items listed in Table 4 for i observation in LFS data and μ_j and δ_j are the weighted average and standard deviation of j task item, respectively, calculated as:

$$\bigwedge j \in J \ \mu_j = \frac{\sum_{i=1}^{N} t_{i,j} w_i}{\sum_{i=1}^{N} wi}, \quad (2)$$

$$\bigwedge j \in J \ \delta_j = \left(\frac{\sum_{i=1}^{N} w_i (t_{i,j} - \mu_j)}{\sum_{i=1}^{N} w_i} \right)^{1/2}, \quad (3)$$

where w_i is an ascribed weight of i observation in the LFS data.

Secondly, following the Acemoglu and Autor (2011) approach, we constructed five main task content measures: non-routine cognitive analytical and personal, routine cognitive and manual, non-routine manual physical. Each of these task content measures was created by summing appropriate standardised task items (listed in Table 4) and subsequent standardisation of each of resulting (five) task content measures.

Table 4. Construction of task contents measures

Task content measure (*T*)	Task items (*J*)
Non-routine cognitive analytical	Analysing data/information Thinking creatively Interpreting information for others
Non-routine cognitive interpersonal	Establishing and maintaining personal relationships Guiding, directing and motivating subordinates Coaching/developing others
Routine cognitive	Importance of repeating the same tasks Importance of being exact or accurate Structured vs. unstructured work
Routine manual	Pace determined by speed of equipment Controlling machines and processes Spend time making repetitive motions
Non-routine manual physical	Operating vehicles, mechanized devices, or equipment Spend time using hands to handle, control or feel objects, tools or controls Manual dexterity Spatial orientation

Source: own elaboration based on Acemoglu and Autor (2011).

Due to several changes in the Polish occupation classification, KZiS, we observed slight deviations in the calculated task structures in the years following the 2002 and 2010 KZiS revisions. We applied a rescaling method to correct for these revisions impact on task measures. Firstly, we standardised task measures in each of the three subperiods between major classification changes (i.e. 1996-2002, 2003-2010 and 2011-2014) separately, again following the formulas (1)-(3). Secondly, we rescaled the 2003-2010 data so that the mean and standard deviation of each task in 2003 was the same as in 2002. Third, we rescaled the 2011-2014 data analogously, equating the 2011 mean and standard deviation to the analogous values in the (rescaled) 2010 sample. This approach allowed comparing the trends in the time series over the whole range of data, by eliminating any potential heteroscedasticity resulting solely from the change in classifications.[14]

3. Task content of jobs in Poland between 1996 and 2014

3.1. Overall trends

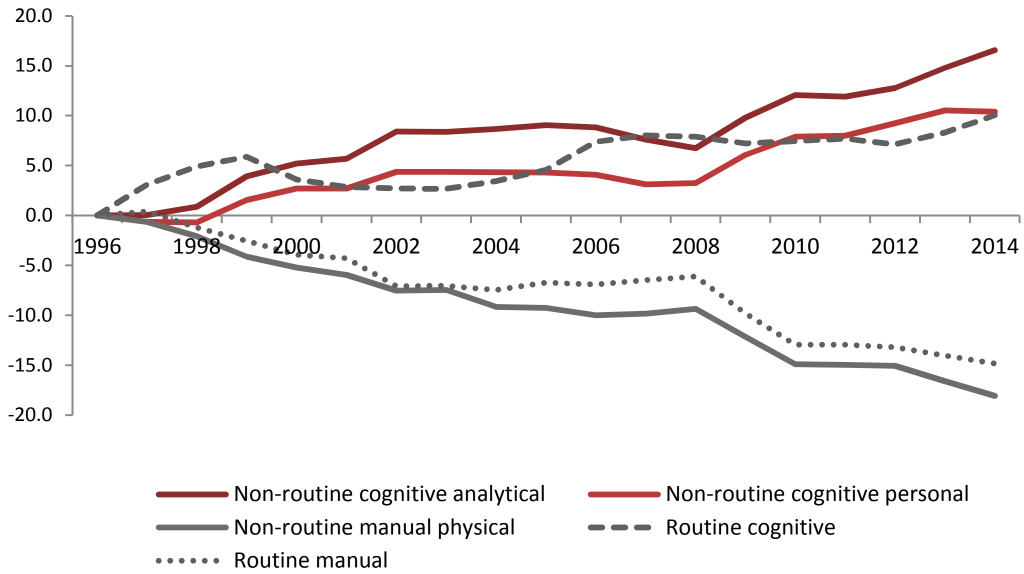
Our results show the general trend of increasing intensity (a number of tasks performed by an average worker) of non-routine cognitive tasks in Poland, mostly in line with findings for the US (Acemoglu and Autor, 2011; Autor et al., 2003), or Germany (Spitz-Oener, 2006). The relative increase in analytical tasks was higher than in personal ones, as shown on the Figure 5, which presents the estimated task content intensities in 1996-2014.[15] The gap between analytical and

[14] We ran panel OLS regressions to validate this approach. We used means and standard deviations of task contents as dependent variables and dummies indicating whether the observation was after each of the years in the 1996-2014 period as the explanatory variables. For the uncorrected data we found a shift in both means and standard deviations after 2010 (the coefficient for "after 2010" significant at the 1% level), and no significant shift in the rescaled data.

[15] We used the moving average to combine task content intensities obtained from 2003 and 2014 O*NET. From 1996 to 2003 we use task indices based on O*NET 2003, for any year t in 2004-2014 period we assign a weight

personal tasks' growth emerged relatively early – in 2003 the average intensity of non-routine cognitive analytical tasks per worker had already accounted for more than the half of the 2014 value, while for non-routine cognitive personal tasks the proportion in question was 40%. On the other hand, manual tasks, both routine and non-routine ones, were declining in the 1996-2014 period. The observed drop was 1.2 times greater for the non-routine tasks. Interestingly, we find that the intensity of routine cognitive tasks was gradually increasing in Poland, except the 2000-2002 period. This result differs from previous findings for the most developed countries, like the US or Germany (Autor et al., 2003; Spitz-Oener, 2006), although Jaimovich and Siu (2012) and Acemoglu and Autor (2011) show that the trend in routine cognitive tasks might be dependent on the analysed period and workers' gender. Nevertheless, the relative increase in the routine cognitive tasks intensity between 2003 and 2014 was comparable to that of the non-routine cognitive personal tasks.

Figure 5. Evolution of task content intensities in Poland during 1996-2014 (multiplied by 100).



*Note: Moving average was used to combine obtained mean task content measures from 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 is 0.*
*Source: own calculations based on LFS & O*NET data.*

In the next step, for every task i we decompose the change (between 1996 and 2014) of the average task intensity per person employed, T_i, into three factors: (i) the contribution of the between-occupation changes, i.e. changes of the (occupational) structure of employment, BO_i; (ii) the contribution of shifts in the task contents within particular occupations over time, WO_i;[16] and (iii) the

$\frac{2014-t}{11}$ to task indices based on O*NET 2003, and a weight $\frac{t-2003}{11}$ to task indices based on O*NET 2014. To make results comparable we rescaled the task indices so that the initial value of all of them is 0.

[16] Changes in task contents of particular occupations can be interpreted as driven by technology (Levy and Murnane, 2013).

contribution of the interaction between changes in employment structure and shifts in task intensities, INT_i.[17] The decomposition was calculated according to formulas below:

$$\bigwedge i \in T \ \ (T_i^{2014} - T_i^{1996}) = (\sum_{j \in E} t_{i,j}^{14} e_j^{14} - \sum_{j \in E} t_{i,j}^{03} e_j^{96}) = BO_i + WO_i + INT_i, \ \ (4)$$

$$\bigwedge i \in T \ \ BO_i = \sum_{j \in E} t_{i,j}^{03} (e_j^{14} - e_j^{96}), \ \ (5)$$

$$\bigwedge i \in T \ \ WO_i = \sum_{j \in E} e_j^{96} (t_{i,j}^{14} - t_{i,j}^{03}), \ \ (6)$$

$$\bigwedge i \in T \ \ INT_i = \sum_{j \in E} (t_{i,j}^{14} - t_{i,j}^{03})(e_j^{14} - e_j^{96}), \ \ (7)$$

where:

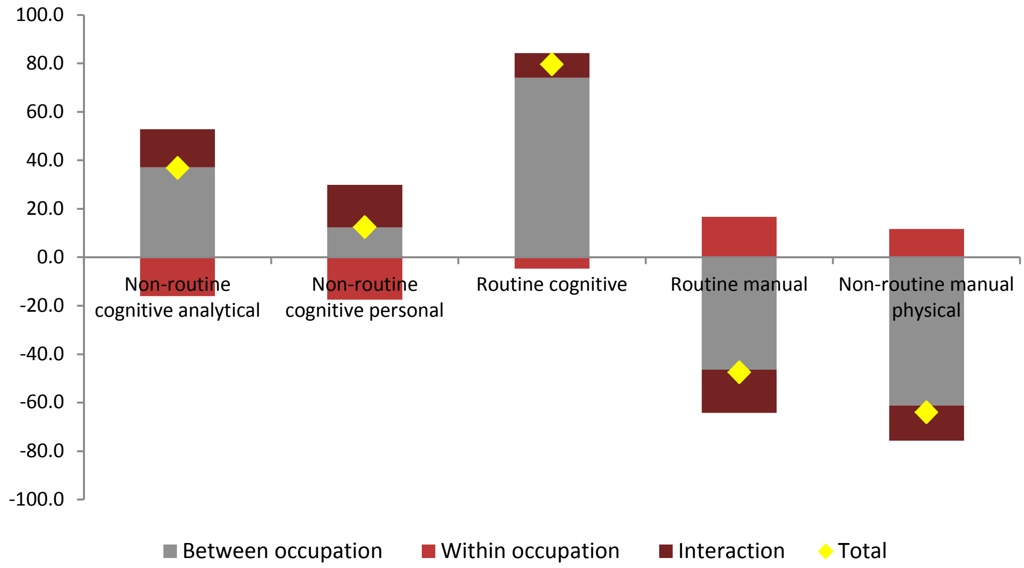
- T is the set of five task content measures described in Table 4, and T_i^{1996}, T_i^{2014} is average intensity of a given task content measure task i per worker in 1996 and 2014, respectively,
- $t_{i,j}^{14}$ and $t_{i,j}^{03}$ are the average estimated values of task i for a worker j using the O*NET datasets from 2014 and 2003, respectively,
- e_j^{14} and e_j^{96} are the weighted (with LFS weights) shares of a worker j in total employment in 2014 and 1996, respectively, and E is the total set of individuals observed either in 1996 or 2014.[18]

For all five tasks measures considered, the between-occupation factor, i.e. shifts in employment structure with respect to task composition of occupations, accounted for most of the total change in task content intensity between 1996 and 2014 (see Figure 6). According to our results, 98% of total increase in the average intensity of non-routine cognitive analytical tasks can be attributed to an increase in employment in occupations with relatively high intensity of these tasks (the between-occupation factor). In the case of (also growing) non-routine cognitive personal and routine cognitive tasks, it is 96% and 64% respectively. On the other hand, 98% of the decrease in the average intensity of routine manual tasks can be attributed to the decrease in employment in the occupations with relatively high intensity of manual tasks. In the case of non-routine manual physical tasks, which declined even more, the respective number is 86%.

[17] Which for a given task i is positive if the employment share of occupations with rising task i intensities increases as well, and negative if it decreases (and vice versa).

[18] As we observe different individuals in 1996 and 2014, each worker surveyed in 1996 has a 0 weight assigned in the 2014 sample, and each worker surveyed in 2014 has a 0 weight assigned in the 1996 sample.

Figure 6. Decomposition of the task content intensity changes in Poland between 1996 and 2014 (multiplied by 100).



*Source: own calculations based on LFS & O*NET data.*

The within-occupation effect played a minor role. Only in the case of non-routine cognitive analytical occupations its contribution was noticeable. We find that 13% of the total increase in average intensity of these tasks can be attributed to the increase in non-routine cognitive analytical content of particular occupations. At the same time, the interaction effect for these tasks was negative. This means that employment growth, which drove the overall growth in these tasks, was encompassing jobs which had lower average non-routine cognitive analytical content than jobs behind the non-routine cognitive analytical tasks in 1996. On the other hand, in the case of routine cognitive tasks, the interaction term was positive and contributed 36% of the total growth in these tasks. Thus, employment was increasing in occupations which on the average had higher routine cognitive content than jobs behind the routine cognitive tasks in 1996 (which is consistent with an increase in the share of workers in low- or middle-skilled non-manual occupations, see Figure 4). For manual tasks (both routine and non-routine) the opposite was true – employment in jobs encompassing these tasks was declining, and these still performed in 2014 on the average had lower manual task content than those performed in 1996.

3.2. Intergenerational dimension of task content changes

In this subsection we look at the evolution of task content of jobs in Poland from the intergenerational perspective. A striking difference emerges between patterns observed for younger cohorts – who experienced task content evolution typical for most developed countries – and older cohorts – who did not. Figure 7 presents the evolution of task content by 5-year birth cohorts between 1996 and 2014. For all types of tasks we find a substantial difference between changes of task content intensities among people born between 1950 and 1969, and among people born between 1970 and 1994. The former were aged between 27 and 46 years in 1996 and mostly already on the labour market, the latter were aged up to 26 years in 1996 and largely entering the labour market in the period studied. In absolute terms, the change of the average tasks intensity was the lowest for the oldest cohorts studied (i.e. for people born in 1950-69) and the highest for the youngest ones. For cohorts born between 1950 and 1969, all five task content intensities were relatively stable over time,[19] especially those regarding the routine cognitive and non-routine manual tasks. Moreover, the evolution of task content intensities was virtually identical for all four 5-year cohorts born in the 1950s and 1960s. The same applies to variance of task indices.

The picture is considerably different for younger cohorts.[20] As shown in Figure 7, people born after 1970 experienced rapid shifts in the task content intensities.[21] Workers born 1970-1974 constituted the first cohort entering the labour market after the transition shock. They were also the first cohort experiencing substantial growth of non-routine cognitive tasks and a noticeable decline in non-routine manual as well as routine tasks (both cognitive and personal). The cohort born within 1975-1979 experienced such developments to an even higher extent. Moreover, for all 5-year cohorts born after 1970, the average intensity of non-routine cognitive (both analytical and personal) tasks was rising over time within these cohorts after the age of 20.

We find that the younger the cohort, the higher the intensity of non-routine cognitive analytical tasks among workers aged between 25 and 39, i.e. every subsequent 5-year cohort born between 1970 and 1989 had a greater average non-routine cognitive analytical task intensity at a given age than the previous cohort had had at the same age. Table 5 sheds more light on developments experienced by people born after 1970, as it compares the cognitive task intensities of various cohorts at the same stage of the life cycle. People born between 1975 and 1984 experienced the largest shifts in both non-routine cognitive and manual tasks intensities. Between the age of 20 and 39, workers in these cohorts underwent changes in the content of their jobs which were so potent that they leapfrogged the older cohorts regarding non-routine cognitive tasks, and ended up having less manual tasks than older workers (see Figure 7).[22]

The situation concerning routine cognitive tasks was slightly different. Although the tendency of increasing average intensity of these tasks for subsequent cohorts also appears, it relates only to people aged between 20 and 29 years old. For other age groups, i.e. people aged between 30 and 34 years old, no clear trend persists between cohorts. Nevertheless, workers from all 5-year cohorts born between 1970 and 1984 experienced decreasing intensity of routine cognitive tasks as they grew older. This finding suggests that labour market entrants in Poland turn out to be employed in the highly routine cognitive occupations, but over time jobs and tasks they perform tend to become to a larger extent non-routine cognitive. Table 5 confirms that for every next cohort entering the labour market in 1996-2014 this phenomenon was increasingly pronounced. On the other hand, the manual task content of the jobs (routine as well as non-routine) was also decreasing with age, but in contrast to cognitive tasks, no common pattern of changes between cohorts emerged.

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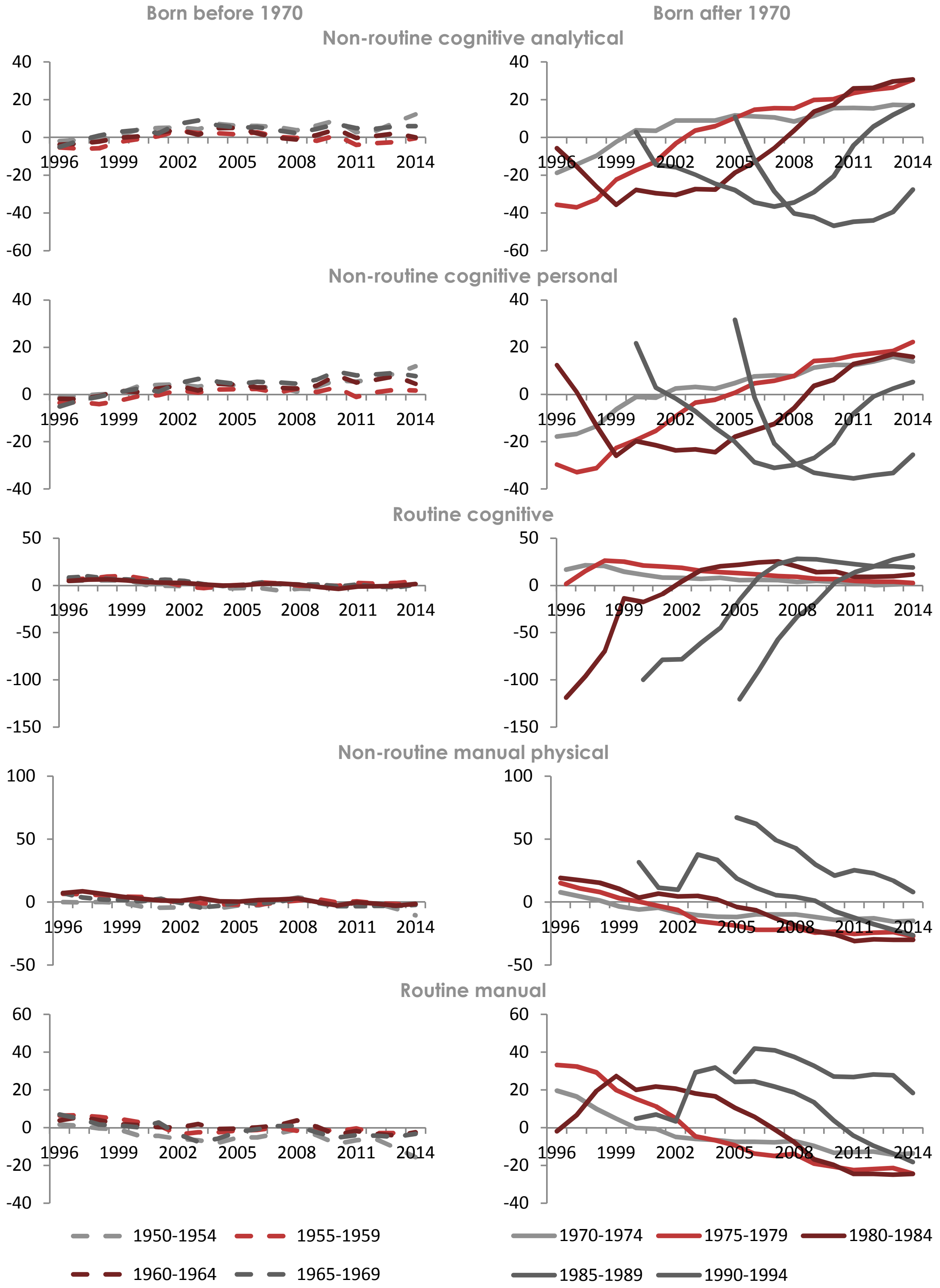
[19] Standard deviations of all five task content measures were lower than 4.2% for all 5-year cohorts born between 1950 and 1969.

[20] Our findings are consistent with Arias et al. (2014) results for several European and Central Asian countries in the 2002-2010 period.

[21] For all 5-year cohorts born between 1970 and 1994, standard deviations of all non-routine and routine task content measures were higher than 10% and 6%, respectively.

[22] Due to lack of data, we are not able to analyse people born before 1970 in their 20s (and 30s in case of workers born before 1969). However, we think that they hadn't experience such pronounced growth in non-routine cognitive tasks at that age, because intensity of non-routine cognitive tasks among them in the 1990s turned out lower than intensities quickly achieved by workers born after 1970 (see Figure 7).

Figure 7. Evolution of task content intensity in Poland by year of birth cohorts.



*Source: own calculations based on LFS & O*NET data*

Table 5. Average intensity of tasks for subsequent cohorts by age group (multiplied by 100)

Non-routine cognitive analytical				
Age / cohort	1970-74	1975-79	1980-84	1985-89
20-24	na	-22.3	-26.1	-24.8
25-29	-2.3	6.4	15.0	17.4
30-34	9.0	18.5	27.4	na
35-39	9.9	27.5	na	na
Routine cognitive				
Age / cohort	1970-74	1975-79	1980-84	1985-89
20-24	na	25.1	20.7	27.4
25-29	14.6	14.1	11.3	13.3
30-34	7.8	3.8	3.2	na
35-39	5.0	-0.5	na	na

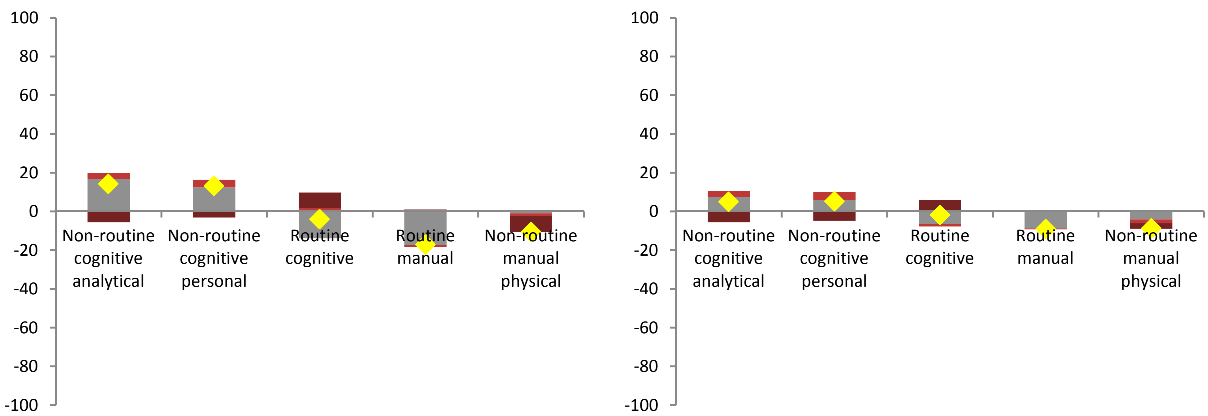
Note: Due to the data availability the mean values of task contents presented in the table are calculated for the following years: 1999, 2004, 2009 and 2014.
*Source: own calculations based on LFS & O*NET data.*

We also find that most of changes in the task content intensities within cohorts occurred due to evolution of occupational structure. There are, however, some notable exceptions. Figure 8 shows changes of average task intensities between 1996 and 2014 (between 2004 and 2014 for cohorts born after 1980) decomposed in line with equations (4)-(7). The contribution of within-occupation changes to change of non-routine cognitive tasks was exceptionally strong and negative for the youngest cohorts studied (1980-1989), suggesting that occupations often performed by young workers were to larger extent affected by routinisation. On the other hand, within-occupation factor increased manual task intensities for the 1985-1989 cohort. These effects, however, were offset by the interaction terms, implying that within these cohorts employment shifted away from the occupations with decreasing cognitive tasks and increasing manual tasks.

Figure 8. Decomposition of the task content intensity changes in Poland for 5-year cohorts, 1996/2004–2014.

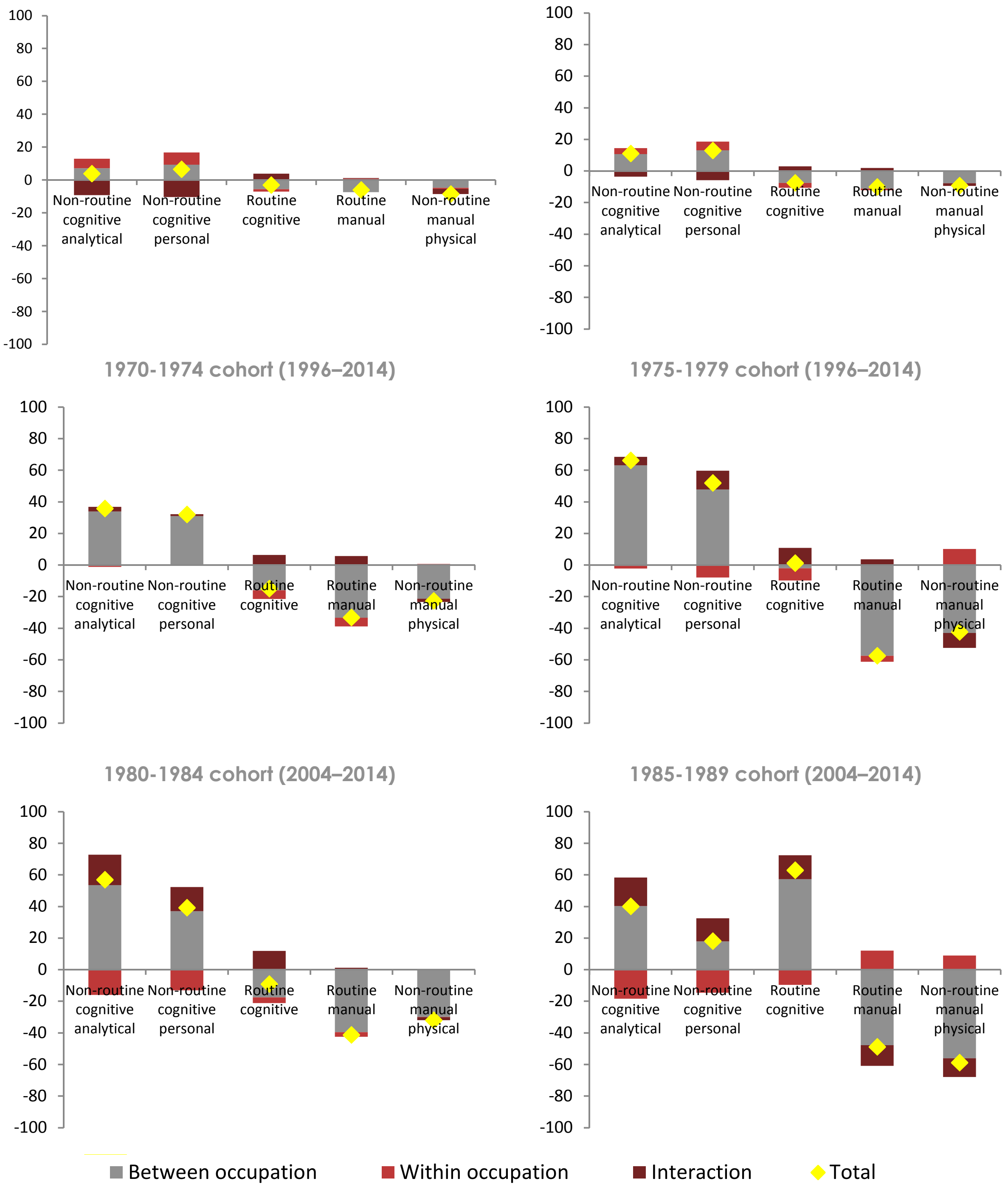
1950-54 cohort (1996–2014)

1955-59 cohort (1996–2014)



1960-1964 cohort (1996–2014)

1965-69 cohort (1996–2014)



Note: For cohorts born between 1960 and 1979 the decomposition is performed for the 1996-2014 period. For cohorts born between 1980 and 1989 – for the 2004-2014 period.
*Source: own calculations based on LFS & O*NET.*

Workers born in 1975-1979 and 1980-1984 were not only experiencing the largest growth in non-routine cognitive tasks, they also contributed most to the overall increase of these tasks in Poland. Table 6 presents contributions of subsequent cohorts to the total change of task intensities between 1996 and 2014, divided into two subperiods: 1996-2004 and 2004-2014. We focus on people born in the 1950-1989 period, who constituted 74%, 91% and 92% of the total working population in 1996, 2004 and 2014, respectively.[23] Regarding non-routine cognitive tasks, in the 1996-2004 period their growth was driven mainly by people born between 1970 and 1974, who were entering the labour market in the 1990s. The 1975-1979 cohort, to a large extent graduating in that period, contributed less but still more than people born in the 1960-64 and 1965-69, who mostly graduated before 1995. In the 2004-2014 period the increase in non-routine cognitive tasks was driven by workers born in 1975-1979 and 1980-1984. In absolute terms, they contributed respectively 3.7 and 6.5 of the overall 11.9 task intensity growth in population born between 1950 and 1994.[24] Similar pattern emerges in the case of non-routine cognitive personal tasks. However, in contrast to analytical tasks, in 1996-2004 the cohort born in 1965-1969 contributed more to growth of these tasks than the cohort 10 years younger (i.e. born 1975-1979). Moreover, in 2004-2014 cognitive personal tasks were growing less than analytical tasks among workers born between 1975 and 1989, while among workers born between 1950 and 1974 the opposite was true.

Table 6. Contributions of subsequent cohorts to task content intensity changes in Poland, 1996-2004 and 2004-2014 (multiplied by 100)

	1996-2004								
	1950-54	1955-59	1960-64	1965-69	1970-74	1975-79	1980-84	1985-89	Total
Non-routine cognitive analytical	1.2	1.2	1.2	1.4	3.3	2.3	-2.0	-0.2	8.3
Non-routine cognitive personal	0.8	0.9	0.9	1.3	2.2	0.9	-1.8	-0.1	5.1
Non-routine manual physical	-0.6	-1.4	-0.9	-1.2	-2.5	-3.0	0.1	0.3	-9.1
Routine cognitive	-1.2	-1.2	-0.7	-1.0	-0.7	1.9	1.7	-0.4	-1.6
Routine manual	-8.0	-2.4	-0.7	-5.9	-6.5	-6.7	16.6	31.8	18.2
	2004-2014								
	1950-54	1955-59	1960-64	1965-69	1970-74	1975-79	1980-84	1985-89	Total
Non-routine cognitive analytical	-0.3	-0.4	-0.7	-0.2	0.9	3.7	6.5	2.3	11.9
Non-routine cognitive personal	0.0	-0.2	-0.1	0.2	1.5	3.6	4.1	0.8	9.8
Non-routine manual physical	0.1	0.0	-0.3	0.1	-0.3	-1.6	-4.5	-3.5	-9.9
Routine cognitive	0.4	0.6	0.2	0.2	-0.9	-1.6	0.2	2.7	1.7
Routine manual	0.2	0.1	-0.2	0.4	-0.8	-2.6	-4.8	-2.5	-10.3

*Source: own calculations based on LFS & O*NET data.*

The findings are different for the routine cognitive tasks. Firstly, the total change of intensity of these tasks in the population born between 1950 and 1989 was relatively small – between 1996 and 2004 it amounted to -1.6, and between 2004 and 2014 to 1.7. In both subperiods studied, the cohorts which have the largest contribution to the total change of routine cognitive tasks were labour market

[23] We ignore people born before 1950 as they reached statutory retirement age before 2014 and tended to exit the labour market due to retiring. On the other hand, individuals born after 1989 were only entering the labour market in the last few year of the period studied.

[24] The absolute change weighted by the shares of cohorts in total employment in given years.

entrants – cohort born between 1975 and 1979 in the 1996-2004 period, and the cohort born between 1985 and 1989 in the 2004-2014 period. Interestingly, in the 2004-2014 period, the 1975-1979 cohort which by that time had established situation on the labour market, contributed most negatively to the change of routine cognitive tasks' intensity.

Moreover, the changes experienced by cohorts born between 1975 and 1989 were of crucial importance for the evolution of manual tasks, both routine and non-routine. The decrease in manual tasks intensities accelerated in 2004-2014 and according to results shown in Table 6, this can be attributed to a persistent decline of these tasks among workers born in the 1970s, and substantial decline occurring among workers born in the 1980s, but only in the 2004-2014 period.[25]

3.3. Education, job content and labour matching

In this subsection we analyse to what extent different task content developments experienced by various cohorts can be explained by changes in their educational structure which, as discussed in Section 1, have been significant in Poland. To this aim, for every task i we decompose the change (between 1996 and 2014) of the average task intensity in the cohort c, $T_{i,c}$, into contributions of three different factors: (i) changes in educational structure of workers in the cohort, interpreted as a labour supply factor, $LS_{i,c}$; (ii) changes in the task contents within particular education group, interpreted as a job content factor, $TC_{i,c}$; and (iii) the interaction term between shifts in employment structure of a given cohort and changes in task intensities affecting it, interpreted as a labour matching factor, $LM_{i,c}$.[26]

For each 5-year cohort c born between 1950 and 1984, the decomposition was calculated according to formulas below:

$$\bigwedge i \in T \ (T_{i,c}^{2014} - T_{i,c}^{1996}) = (\sum_{j \in H} t_{i,j,c}^{14} h_{j,c}^{14} - \sum_{j \in H} t_{i,j,c}^{03} h_{j,c}^{96}) = LS_{i,c} + TC_{i,c} + LM_{i,c}, \quad (8)$$

$$\bigwedge i \in T \ \ LS_{i,c} = \sum_{j \in H} t_{i,j,c}^{03} (h_{j,c}^{14} - h_{j,c}^{96}), \quad (9)$$

$$\bigwedge i \in T \ \ TC_{i,c} = \sum_{j \in H} h_{j,c}^{96} (t_{i,j,c}^{14} - t_{i,j,c}^{03}), \quad (10)$$

$$\bigwedge i \in T \ \ LM_{i,c} = \sum_{j \in H} (t_{i,j,c}^{14} - t_{i,j,c}^{03})(h_{j,c}^{14} - h_{j,c}^{96}), \quad (11)$$

where:

- $t_{i,j,c}^{14}$ and $t_{i,j,c}^{03}$ are the average estimated values of task i for workers with an education level j in cohort c, using the O*NET datasets from 2014 and 2003, respectively,

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[25] In the 2004-2014 period, the total change in both manual task contents intensities stood at approx. -10.3, of which -4.8 was due to contribution of the 1980-1984 cohort.

[26] Which for a given task i and the cohort c is positive (negative) if the task content i increases more (less) than would be implied by changes in the educational attainment of the cohort c and changes in the task content of jobs held by cohort c in the initial year studied.

- $h_{j,c}^{14}$ and $h_{j,c}^{96}$ are the shares of workers with education level j among all workers in cohort c in 2014 and 1996, respectively (with exception of the 1980-1984 cohort for which we analyse 2014 and 2003),
- T is the set of five task content measures described in Table 4,
- and H is a set of five different education levels: junior high, primary or without primary; basic vocational; general secondary; post-secondary and secondary vocational; tertiary education.

We find that evolution of educational attainment, in particular improvement in education structure of subsequent cohorts, was crucial for the evolution of task content of jobs held by workers of particular cohorts. It was especially dominant factor for non-routine cognitive analytical tasks (see Table 7).[27] Again, the three youngest cohorts stand out. The education structure effect in the 1970-74 cohort was 2.3 times greater, and in the 1975-79 cohort approx. 2.9 times greater than in the 1965-1969 cohort. In fact, people born in the 1970s were the first to participate in the educational boom in Poland, and experienced the biggest increase in the share of persons with tertiary education level attained during the analysed period (25 pp. for the 1970-74 cohort between 1996 and 2014, and 37 pp. for the 1975-79 cohort between 1999 and 2014). On the other hand, the intensity of non-routine analytical tasks in the 1970-74 and 1975-79 cohorts increased much less between 1996 and 2014 than would be implied by improvement in the educational attainment. We interpret this as a negative labour matching effect – the demand for non-routine analytical tasks turned out noticeably lower than the supply provided by workers willing to deliver these tasks (rising due to the large shifts in the education structure). In the case of the 1980-84 cohort, the labour matching effect was also noticeable (in 2004-2014), but contrary to the 1975-79 cohort it was positive. This suggests that workers born between 1980 and 1984 were moving up the occupational ladder to jobs with more non-routine analytical tasks demanded, which confirms our previous findings. The task content effect played a negative role, especially for people born in the 1950-1964 period which suggests that older workers were more affected by routinisation occurring within occupations. At the same time, the labour matching effect was virtually irrelevant for older cohorts.

The decomposition of the non-routine cognitive personal task content change provides similar results, however on average the contributions of all three described effects were smaller. Once again, the cohort 1975-79 stands out in terms of the relatively large and negative labour matching effect, thus suggesting that in relation to demand, the overschooling effect may have occurred.

Routine cognitive tasks were in decline mainly due to the education structure effect. For workers born in the 1970, the task content effect was as important, which suggests that workers at a given level of education were moving to jobs with less routine cognitive tasks. In the case of 1980-1984 cohort (analysed here in 2004-2014) intensity of these tasks decreased as well, but the education structure effect was slightly positive and cancelled out by the matching effect.[28]

[27] For workers born before 1960 improvements in education structure were rather due to labour market exits of low-skilled people, for younger workers – due to increasing enrolment in tertiary education.

[28] In 2004, tertiary graduates constituted just 8% of workers in the 1980-1984 cohort and hey performed quite routine cognitive jobs (their average relative intensity of these task amounted to 24.6). With time their share in employment in this cohort increased to 46%, so the decomposition formula would imply an increase in routine

Contrary to cognitive tasks, manual tasks were depressed by the negative education structure effect for all cohorts considered. Supposedly, the sources of this negative effect were different for younger and older workers. Older workers, i.e. those born after 1950 but before 1970, with relatively low education level attained were exiting the labour market earlier than the better educated ones (IBS, 2010), therefore the education structure impact on manual tasks in these cohorts was negative. In the case of individuals born after 1970, the observed pattern was driven rather by the educational boom in Poland. As the share of university graduates grew and the share of basic vocational education graduates declined within cohorts,[29] significant shifts from highly manual jobs towards more cognitive ones appeared in the cohort-specific structure of employment.

Table 7. The decomposition of cohort-specific task content intensity changes (multiplied by 100) in Poland into contributions of education structure evolution, job content and labour matching factors, 1996 vs. 2014

Cohort	Factors	Non-routine cognitive analytical	Non-routine cognitive personal	Routine cognitive	Routine manual	Non-routine manual physical
1950-54	Education structure	20.8	17.7	-3.3	-17.3	-17.8
	Job content	-9.9	-3.0	-1.1	1.5	9.8
	Labour matching	2.4	-1.0	1.5	0.1	-1.0
1955-59	Education structure	12.2	9.6	-1.9	-9.9	-10.0
	Job content	-7.4	-3.6	-1.2	2.4	2.6
	Labour matching	0.4	0.5	0.5	-0.4	-1.0
1960-64	Education structure	12.9	9.2	-2.4	-10.8	-10.8
	Job content	-7.4	-1.7	-0.4	7.5	4.6
	Labour matching	0.2	2.0	-1.2	-0.6	-1.0
1965-69	Education structure	18.9	12.7	-3.7	-15.5	-15.4
	Job content	-5.1	0.6	-5.8	6.2	8.4
	Labour matching	-2.1	1.5	0.0	0.2	-0.6
1970-74	Education structure	42.5	26.0	-10.8	-37.6	-36.0
	Job content	-5.4	0.0	-10.4	0.7	17.4
	Labour matching	-4.0	4.2	2.9	1.9	-1.8
1975-79*	Education structure	54.6	43.3	-10.4	-49.1	-48.9
	Job content	-3.4	2.7	-13.8	4.9	25.3
	Labour matching	-3.5	-4.2	0.2	-0.8	-4.6
1980-84**	Education structure	36.9	24.1	2.1	-31.5	-35.9
	Job content	10.9	8.9	0.2	8.5	21.5
	Labour matching	8.8	6.3	-11.0	-16.3	-15.6

Note: for the 1975-79 and 1980-84 cohorts decomposition is calculated for 1999-2014 and 2004-2014 period, respectively.
*Source: own calculations based on LFS & O*NET.*

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cognitive intensity. However, the intensity of routine cognitive tasks in this group declined to -0.01 in 2014, thus the negative matching effect.

[29] In the 1975-79 cohort the share of workers with basic vocational education amounted to 51% in 1996, while in 2014 it stood at 24%.

Conclusions

In this paper we applied the task-based approach of Autor, Levy & Murnane (2003) to analyse the interplay between the evolution of labour demand, transformation of labour supply, and evolving nature of occupations in Poland between 1996 and 2014. We combined O*NET data from 2003 and 2014 with Polish LFS at 4-digit occupation classification level (approx. 400 occupations) to analyse overall, between-occupation and within-occupation changes of task content of jobs. The economy-wide findings mostly fall in line with previous literature (e.g. Acemoglu and Autor, 2011; Autor et al., 2003; Spitz-Oener, 2006). We found a rise in intensity of non-routine cognitive analytical and personal tasks, and a decrease of routine and non-routine manual tasks. The only notable divergence from previous findings is a growth in routine cognitive tasks. We find that the between-occupation shifts contributed more than within-occupation changes to the total change in all task content intensities considered. In general, Poland progressed in a similar direction like the US or Germany, but contrary to those economies increased the number of medium-skilled, non-manual jobs.

We identify stark intergenerational differences with respect to the evolution of task content of jobs. Within the 1996-2014 period, task content intensities underwent dynamic changes among those born after 1970, while hardly any changes occurred among those born before 1970. Moreover, every next cohort entering labour market since the middle 1990s had the average intensity of non-routine cognitive (both analytical and personal) tasks rising after the age of 20. After the age of 25, every next cohort reached higher intensities of non-routine cognitive analytical tasks than that achieved by the previous cohort at the same age. Thus, the younger generations might be increasingly likely to work in computerised jobs (in line with the interpretation of Levy and Murnane, 2013). On the other hand, after a dozen or so years of declining intensities of manual tasks, in 2014 workers born between 1970 and 1989 exhibited lower average intensities of manual tasks than workers born between 1950 and 1969, who have barely experienced any change since middle 1990s. As a result, the developments among the younger group accounted for most of the overall change in task contents recorded between 1996 and 2014. We attribute most of these intergenerational differences to distinct educational paths followed by younger cohorts, starting with that born in the 1970s and increasingly pursued by next generations. We find that, from the task content point of view, labour demand has largely accommodated these growing inflows of better educated entrants without deteriorating their job prospects – in 2014 intensities of non-routine analytical tasks in cohorts participating in the educational boom were over 90% of what could be predicted by the evolution of educational attainment of these cohorts, and task changes affecting occupations per se.

Our findings have potentially important implications for countries at comparable or lower level of development. Older workers can be left behind by technological progress and emergence of new types of jobs, especially in countries with undeveloped life-long learning systems. At the same time, younger and older workers might not be competing for the same types of jobs. On the one hand, this makes implementation of policies aimed at prolonging working lives easier, but on the other, older workers in more routine and more manual jobs may face larger obstacles to working longer than they would if they had more non-routine and cognitive jobs. Finally, although relatively fast changes in educational attainment are often accompanied by complaints about fading quality and relative degradation of graduates' labour market situation, the Polish experience shows that if the economy is able to take advantage of new opportunities created by openness and technology, such risks might not be large.

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Appendix

Appendix 1. List of crosswalks used

ISCO-08 to KZiS 2010: Wortal Publicznych Służb Zatrudnienia MPiPS

http://psz.praca.gov.pl/rynek-pracy/bazy-danych/klasyfikacja-zawodow-i-specjalnosci [2015-04-15]

ISCO-88 to SOC-00: National Crosswalk Service Center

http://www.xwalkcenter.org/index.php/downloads [2015-04-15]

ISCO-88 to KZiS-04: WageIndicator; Project *EurOccupations;* State-of-the-art report (First Reporting Period – D35)

http://www.wageindicator.org/main/Wageindicatorfoundation/projects/euroccp/euroccupations#euroccupations-deliverables [2015-04-15]; with own modifications to match the remaining occupations from the full occupational lists (available upon request).

KZiS-02 to KZiS-95 – Own work, based on minister's regulation (available upon request).

KZiS-04 to KZiS-02 – Own work, based on minister's regulation (available upon request).

O*NET SOC-10 to O*NET SOC-09 – O*NET cross walk

http://www.onetcenter.org/taxonomy.html [2015-04-15]

O*NET SOC-09 to O*NET SOC-06 – O*NET cross walk

http://www.onetcenter.org/taxonomy.html [2015-04-15]

O*NET SOC-06 to O*NET SOC-00 – O*NET cross walk

http://www.onetcenter.org/taxonomy.html [2015-04-15]

SOC-10 to SOC-00 – U.S. Bureau of Labor Statistics

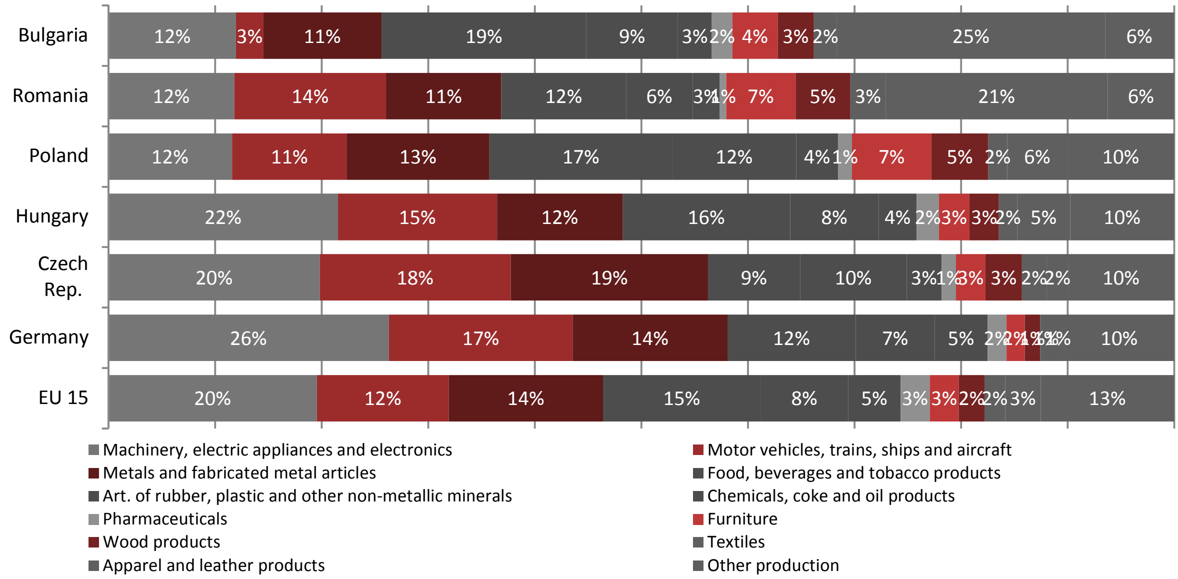
http://www.bls.gov/soc/soccrosswalks.htm [2015-04-15]

SOC-10 to ISCO-08 – U.S. Bureau of Labor Statistics

http://www.bls.gov/soc/soccrosswalks.htm [2015-04-15]

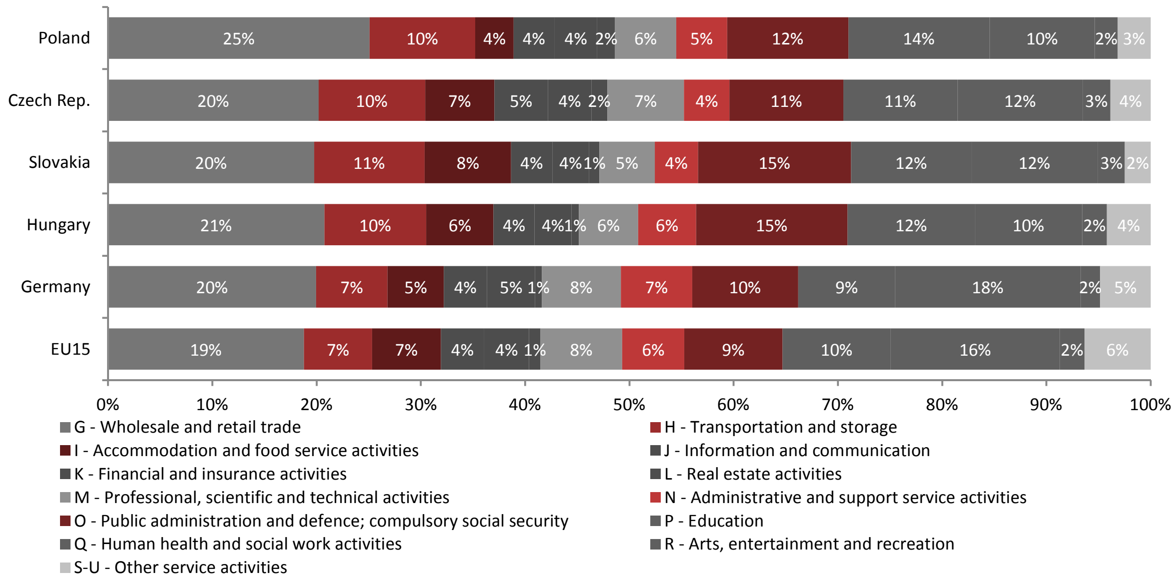
Appendix 2. Structure of employment by branches in Poland and selected European countries

Figure 9. Structure of employment in the manufacturing by branches in Poland and selected European countries in 2014



Source: Own elaboration based on Eurostat data.

Figure 10. Structure of employment in the services by branches in Poland and selected European countries in 2014.



Source: Own elaboration based on Eurostat data.

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