Chapter 3

Measuring trends: the work complexity paradox

This chapter assesses the trends of work characteristics associated with learning organisations over 1995, 2000 and 2005 for EU15 countries. Finding an average decreasing trend in EU15, driven by results in Germany, Great Britain, Italy and Spain, it then tries to uncover this work complexity paradox by taking into account structural factors influencing work complexity at the individual and country level. Four possible culprits that are not measured in the available databases are discussed: standardisation, job polarisation, organisational change and self-reported overqualification. The first two explanations make the assumption that the decreasing trend in work complexity is an objective phenomenon; the two others explore how it could be related to subjective assessments of persons in employment.

Chapter 3 mapped the spread of learning organisations across Europe using the European Working Conditions Survey (EWCS). Relying on the different waves on the same data source, this chapter is dedicated to assessing the trends of work characteristics associated with learning organisations over 1995, 2000 and 2005 for EU15 countries. It will give a detailed account of results found in Greenan *et al.* (2010).

Data and measurement frame

The European Foundation for the Improvement of Living and Working Conditions has carried out four surveys on the working conditions in Europe (in 1990-91, 1995-96, 2000 and 2005), and also surveyed the acceding and candidate countries in 2001-02[1]. Greenan, Kalugina and Walkowiak (2007 and 2010) have analysed trends for EU15 over 1995-2005 and for EU27 over 2000-05. They did not use the first waves of the survey because the formulation of the core set of questions for describing work organisation has strongly evolved between the first and second waves of the survey. They report on trends in three different dimensions of work experience in Europe: quality of working conditions, work intensity and work complexity.

In this chapter, we focus on the results found about trends in work complexity in EU15 over a 10-year period, between 1995 and 2005. Data coverage is different from the one retained in Chapter 1 as the sample used is representative of persons in employment, defined in the Labour Force Surveys as including "those who did any work for pay or profit during the reference week (the reference week varied from country to country) or those who were temporarily absent from their jobs". Thus, in addition to the sample used in the work presented in the first part of Chapter 1 (8 081 salaried employees in 2000 and 9 986 salaried employees in 2005), we include the self-employed, salaried employees in establishments with fewer than 10 employees and salaried employees in agriculture and fishing, public administration and social security, education, health and social work and private domestic employees. As the sample is restricted to EU15, we exclude new member states (Bulgaria, Czech Republic, Cyprus, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia and Slovenia) and Norway. The total sample used includes 15 986 persons in 1995, 21 703 persons in 2000 and 14 952 persons in 2005.

In order to characterise work organisation in Europe, the authors select a set of 12 primary variables capturing the experience of persons in employment about how their work is organised and co-ordinated. These questions are formulated in a simple and objective way, using a yes/no scale. This contributes to the international comparability of answers by lowering country differences in the way questions are understood and answered. However, this does not wear away heterogeneity in legal and cultural norms across country that could still generate country patterns or effects.

Work organisation is a latent multidimensional variable which is not directly observable. Each of the 12 primary variables that are selected contributes to the construction of an overall picture of work organisation, but none of them alone is sufficient to describe it effectively. Multiple correspondence analysis (MCA) is a useful technique as it aims at producing a simplified low-dimensional representation of the information in a large frequency table (Greenacre and Blasius, 2006). First, each item response of the twelve qualitative work organisation variables are coded as a dummy. The Multiple Correspondence Analysis generates quantitative scores, called dimensions, which maximise the average correlation among these dummy-coded qualitative variables. These dimensions are linear combinations of the dummy variables that play an active role in the analysis. They can be considered as synthetic indicators whose interpretations rely on the variables that take a prominent part in their construction. The survey weights are used in the analysis in order to draw an overall picture of work organisation in Europe, taking into account the differences in sampling frames across countries. An interesting result from this Multiple Correspondence Analysis, which we will discuss further below, is that the first key dimension arising from the analysis summarises how individual and organisational knowledge is involved in the work process. This is why it is interpreted as work complexity.

The longitudinal dimension of the data is limited, consisting of three cross sections in 1995, 2000 and 2005. Greenan, Kalugina and Walkowiak (2010) measure trends in the synthetic indicator of work complexity applying the method proposed by Greenan and Mairesse (2006). They run a Multiple Correspondence Analysis for the starting year of the time period, 1995 and retain the first dimension. The linear combination of variables underlying this dimension is then applied to the distribution of individual characteristics measured in 2000 and 2005 to build up indicators that are comparable across time. A core assumption in this method is that it is meaningful to apply the structural relationships observed in 1995 to 2000 and 2005.

A decreasing trend in work complexity

The 12 primary variables of the work organisation analysis provides some detailed information on the characteristics of tasks (are they monotonous? are they complex?), on how they are performed (with precise quality standards? with self-assessment of quality? with discretion for changing the order of tasks? with discretion for changing the methods of work?), on how they are co-ordinated (with task rotation involving colleagues? with assistance from colleagues? with freedom to take breaks? with freedom to take days off or holidays?) and on the associated learning process (learning new things at work? solving unforeseen problems on your own?).

In Table 3.1, column 1 gives the exact formulation of the corresponding question in the European Working Conditions Survey (EWCS). The first factor of the work organisation Multiple Correspondence Analysis for 1995, accounting for 22% of total inertia[2], results from a linear combination whose coefficients are given in column 2. The bold coefficients indicate that the item response has a high contribution to the inertia of the dimension. The dimension measures an opposition between complex jobs involving opportunities of learning and routine jobs: on one side jobs involving complex tasks also entail discretion on how the work is carried out and learning new things, while on the opposite persons in employment declare that their work is not complex, that they are not able to change or choose their methods of work and order of task, that they do not solve unforeseen problems or assess themselves the quality of their work, that they are not free to take breaks or days off when they wish to and that they do not feel that they learn new things. As mentioned in the previous chapter, the fact that complexity, discretion and learning goes hand in hand with one another supports the idea of the existence of a learning model of organisation. This interaction has already been identified in work based on an employee level survey at a national level and connected with economic performance issues at the employer level (Greenan and Guellec, 1998). However, in this analysis, complexity, discretion and learning make up a dimension of their own, weakly connected with other features of work organisation like quality standards, task monotony, job rotation, or support from colleagues. This result echoes findings of Lorenz and Valeyre (2005), based on the previous wave of the EWCS and presented in Chapter 2, where the discretionary learning model is only weakly connected to the use of teams, job rotation and quality norms. We label this synthetic indicator *work complexity*, knowing that high work complexity is conducive to high learning opportunities.

Table 3.1. Indicators of work complexity in EU15

Questions in EWCS	Synthetic indicators	EU15 1995 (%)	EU15 2000 (%)	EU15 2005 (%)
(1)	(2)*	(3)	(4)	(5)
Intercept	-0.411			
Does your main paid job involve…?				
…meeting precise quality standards				
Yes	0.066	71.07	68.23	73.52
No	-0.066	28.93	31.77	26.48
…assessing yourself the quality of your own work				
Yes	0.089	75.58	74.04	71.44
No	**-0.089**	24.42	25.96	28.56
…solving unforeseen problems on your own				
Yes	0.145	83.77	81.97	80.93
No	**-0.145**	16.23	18.03	19.07
…monotonous tasks				
Yes	-0.019	43.72	38.78	41.39
No	0.019	56.28	61.22	58.61
…complex tasks				
Yes	**0.101**	58.55	55.51	58.18
No	**-0.101**	41.45	44.49	41.82
…learning new things				
Yes	**0.122**	75.79	70.41	69.56
No	**-0.122**	24.21	29.59	30.44
…rotating tasks between yourself and colleagues				
Yes	0.049	54.68	43.23	42.87
No	-0.049	45.32	56.77	57.13
Are you able, or not, to choose or change…?				
…your order of tasks				
Yes	**0.123**	65.7	64.17	63.44
No	**-0.123**	34.3	35.83	36.56
…your methods of work				
Yes	**0.128**	72.09	70.4	67.71
No	**-0.128**	27.91	29.6	32.29
Can you get assistance from colleagues if you ask for it?				
Yes	0.039	83.48	82.45	81.63
No	-0.039	16.52	17.55	18.37
Can you take your break when you wish?				
Yes	0.081	63.12	60.46	63.34
No	**-0.081**	36.88	39.54	36.66
Are you are free to decide when to take holidays or a day off?				
Yes	0.072	56.97	55.35	66.91
No	**-0.072**	43.03	44.65	33.09

Note: The coefficients in column 2 are computed so that their sum over item responses of each variable equals to zero. A coefficient in bold indicates a high contribution of the variable to the inertia of the synthetic indicator. *The underlying multiple correspondence analysis has been computed using the 1995 wave of the survey.* Sample coverage: salaried and self-employed individuals from EU15 in private and public sectors. Descriptive statistics are weighted. *Source:* European Working Conditions Survey 1995, 2000 and 2005, European Foundation for the Improvement of Living and Working Conditions, analysis and table from Greenan *et al.* (2010).

In Table 3.2, columns 1, 2 and 3 give the rank of each EU15 country in term of the average level of work complexity in 1995, 2000 and 2005. Generally speaking, it is in Scandinavian countries (Denmark, Sweden and Finland) that workers frequently perform complex tasks, but other countries also offer high learning opportunities and complex tasks. Indeed, the Netherlands is ranked in the third position in 1995 and 2005. Routine jobs are more frequent in Mediterranean countries, but they are also frequent in the British Isles (ranking 10th for United Kingdom and 9th for Ireland) and in Germany (ranking 13th in 2005). These results are in line with the distribution of the discretionary learning form of work organisation presented in Chapter 2.

In Table 3.1, columns 3, 4 and 5 give the weighted distributions of the 12 primary variables in 1995, 2000 and 2005 for EU15. These descriptive statistics are somewhat surprising: most of the variables under scrutiny show a slight downward trend over the ten years time period. For example, the percentage of EU15 persons in employment declaring that their jobs involved learning new things decreased from 76% in 1995 to 70% in 2005, for task rotation, the percentage decreased from 55% to 43% and for discretion in the choice of methods of work the percentage decreased from 72% to 68%. There are only two exceptions to this general picture: a small increase in quality standards (71% in 1995, 74% in 2005) and a large increase in freedom to take holidays or days off (57% in 1995, 67% in 2005).

How do these trends translate in the work complexity indicator? In Table 3.2, trends in the work complexity indicator are computed in two different ways. Columns V1 (variation 1) give the sign of the variation of the EU15 or country average work complexity indicator over 1995-2000 (column 4), 2000-05 (column 6) and 1995-2005 (column 8). In EU15, average work complexity has first decreased significantly over 1995-2000, and then it has increased over 2000-05 without compensating the initial decrease so that a significant overall decrease is measured over the ten years period. However, work complexity has significantly decreased over 1995-2005 in three countries only, Great Britain, Spain and Germany which have a strong weight in EU15 average trend. On the opposite, it has significantly increased over the ten years in Austria, Belgium, Denmark, Greece, Ireland and Luxembourg.

Table 3.2. Change in work complexity between 1995 and 2005

	1995	2000	2005	Variation, 2000-1995		Variation, 2005-2000		Variation, 2005-1995	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Rank 1995	Rank 2000	Rank 2005	V1	V2	V1	V2	V1	V2
EU15 average				-***		+***		-***	
Nordic countries									
Denmark	2	1	1	-	+**	+***	+	+***	+***
Finland	5	4	4	-***	-**	+***	+***	+	+
Sweden	1	3	2	-***	-***	+***	+***	+	+
British Isles									
Ireland	11	9	9	-	+	+***	+	+***	+**
Great Britain	4	5	10	-***	-***	-***	-***	-***	-***
Western Europe									
Austria	10	6	5	+***	+***	+**	-	+***	+***
Belgium	7	8	7	-	+	+***	+	+**	+
Germany	9	10	13	-**	+	-	-***	-***	-***
France	6	7	8	-*	+	+**	-	+	+
Luxembourg	12	12	6	-	+	+***	+*	+***	+***
Netherlands	3	2	3	-	+**	+*	-	+	+
Mediterranean countries									
Greece	15	15	14	-***	-	+***	+***	+***	+**
Italy	8	11	11	-***	-*	+***	-	-	-**
Portugal	13	14	12	-***	-***	+***	+***	-	+
Spain	14	13	15	-**	+	-	-***	-***	-***

*Significant at 10%. **Significant at 5%. ***Significant at 1%. Sample coverage: salaried and self-employed individuals from EU15 in private and public sectors. *Source:* European Working Conditions Survey 1995, 2000 and 2005, European Foundation for the Improvement of Living and Working Conditions, analysis and table from Greenan, Kalugina, Walkowiak (2010).

Columns V2 (variation 2) give the sign of the variation once they have been purged of the structural effect of sectors and occupations. More precisely, the authors run regression at the individual level where work complexity is explained by occupation, sector and year dummies. Then, they retrieve the residuals which provide the value of each indicator when the occupation and the sector are controlled for and they test the significance of its average variation over 1995-2000 (column 5), 2000-05 (column 7) and 1995-2005 (column 9). Column V1 results appear robust to the inclusion of occupation and sector structures. Belgium and Italy are the only countries for which a change in the significance of the variation is observed. In Belgium the increase in work complexity is no longer significant, which indicates that the proportion of sectors or/and occupations implying more complex jobs increased but that the degree of work complexity within jobs did not change. In Italy, shifts in occupations and sector structures were hiding a general decreasing trend in job complexity.

To understand how organisations adopt new ideas and behavioural patterns, and how workers absorb and exploit knowledge to innovate, the evolutionary economic literature (Cohen and Levinthal, 1990; Winter and Zollo, 2002) analyses the micro-dynamics of routines, capabilities and learning. It is now largely admitted that the way co-ordination takes place at workplaces has some important consequences in terms of learning processes. We also know that patterns of work co-ordination differ substantially across employers, sectors and countries. A widespread idea is that to adapt the fordist and the Taylorist models of production, where co-ordination rests on standardisation of products and processes, to more rapid changes in the environment of firms there is a movement towards a model where co-ordination rests on mutual adjustments, allowing for a learning process that is more prevalent, less concentrated on a small fraction of the work force.

If this is true, the negative average work complexity trend in EU15 is puzzling. It is unexpected as the knowledge base of the core of the European economy is most of the time described as expanding. How can an increased dependency of the economy on the generation of new knowledge fit with an average decreasing trend of work complexity experienced by EU15 workers? It is also at odds with the groupings of countries from the literature on the variety of capitalism or welfare regimes. Strong decreasing trends in work complexity are observed in countries from different institutional and cultural backgrounds: Germany, Italy, Spain and United Kingdom. If Scandinavian countries appear to be preserved over 1995-2005, it is because the initial and significant decreasing trends they registered over the 1995-2000 period was counterbalanced by a subsequent significant growth in 2000-05. Greenan *et al.* (2010) try to uncover this work complexity paradox by taking into account structural factors influencing work complexity in a multilevel model.

Taking into account structural factors in a multilevel model

Greenan *et al.* (2010) use multilevel analysis to identify the role of structural factors, at the individual level (level 1) as well as at the country level (level 2) in the decreasing trend of work complexity. The multilevel analysis is a relevant econometric approach if the answers of persons in employment of a same country are correlated. In that case, the variance in answers can be decomposed into a within-country variance and a between-country variance. This decomposition requires estimating a basic two-level regression model called the intercept-only model, which contains no explanatory variables. This decomposition of variance will serve as a benchmark with which other, more complicated models are compared (see Annex 3.A).

Table 3.3 reports the results of the weighted intercept-only model for work complexity in 1995, 2000 and 2005. The intra-country correlation is non negligible indicating that it is worth while analysing a country effect in work complexity. This result supports the application of a multilevel model on the pooled data from the different waves of the European Working Conditions survey to identify the influence of structural factors in the decreasing work complexity trend.

Table 3.3. Heterogeneity in work complexity across EU15 over 1995-2005

Degree in complexity in work	1995	2000	2005
Intercept	-0.01	-0.049*	0.012
Random part			
Variance of the country level residual errors	0.015***	0.017***	0.017***
Variance of the individual level residual errors	0.206***	0.217***	0.220***
Intra country correlation in percentage	7.0%	7.1%	7.1%

Significant at 10%. **Significant at 5%. ***Significant at 1%. Sample coverage: salaried and self-employed individuals from EU15 in private and public sectors.

Source: European Working Conditions Survey 1995, 2000 and 2005, European Foundation for the Improvement of Living and Working Conditions, analysis and table from Greenan, Kalugina, Walkowiak (2010).

Four different models are estimated (Annex 3.A), going from the simplest to the most elaborated one. The first model is the intercept only model. As the regressions are ran on the pooled data from the three survey waves, results are different from the ones displayed in Table 3.3. Model 2 includes year 2000 and 2005 dummies. As 1995 is the reference date, the coefficient associated with year 2000 gives the 1995-2000 trend, while the one associated with 2005 gives the 1995-2005 trend. A central objective in

the modelling is to identify the sensitivity of these coefficients to the inclusion of individual level and country level variables. Thus model 3 includes year dummies and individual level variables. Model 4 is the complete model, including country level variables in addition to time dummies and individual level variables. What are the structural factors that enter the model at the individual and country levels?

At the individual level, the need for variables that are consistently measured over the three waves of the European Working Conditions survey imposes strong constraints on the information. Hence, we are able to measure demographic information (gender and age), occupation (nine categories), employment status (contract duration, self-employed or salaried employee), sector of the workplace (five categories), use of a computer and management position. Indeed, all these characteristics have a potential influence on work complexity.

We would have liked to have explicitly taken into account educational attainment and work experience as proxies for skills, in reference to human capital theory, but this information is not available over the three waves of the survey. However, a broader conception of skills is now widely acknowledged where skills' accumulation also takes place in work experience, through learning by doing and on the job training. This broader conception highlights the relevance of the occupational dimension in the measurement of human capital. Furthermore, age, management position and computer use complement occupation in the indirect assessment of skills.

When individual variables are introduced in model 3 the meaning of the intercept changes. In model 2, the intercept gives the average EU15 level work complexity in 1995. In model 3, it becomes the average EU15 level of work complexity for a reference individual with the following characteristics: he is a young (between 15 and 24) plant and machine operator working in the manufacturing sector on an unlimited contract, using no computer and with no supervisory role. In 1995, this reference employee experiences a low degree of work complexity

The availability of time series for EU15 also imposes strong constraints on what can be measured at the country level. OECD and Eurostat databases are privileged as they provide high quality time series for EU15. Eight major country level variables which are potentially related to work complexity are retained. A first variable, which is consistently measured over time, is real annual GDP growth which gives an indication of the position in the business cycle. International trade in goods and services as a percentage of GDP is an indicator of globalisation. The development of the knowledge base of economic activity is another important country level dimension which is captured. The (log) number of patent applications to the European Patent Office (EPO) is a first indicator. According to the *Canberra Manual* (OECD

and Eurostat, 1995) persons having graduated at the tertiary level of education are part of the human resources in science and technology. Education levels are not available at the individual level in the EWCS, but they are at the country level. The share of persons between 25 and 64 years old with tertiary attainment is the retained indicator of education. In an ageing Europe where labour force is becoming more opened to women, gender and age perspectives are needed and taken into account through the gender and age composition of the workforce. Finally, two variables characterise the state of the labour market: the unemployment rate and the part-time employment rate in total employment. In model 4, country level variables are centred on the European average. Thus the interpretation of the intercept does not vary much when country level variables enter the model: it gives the average level of each indicator for our reference employee in an 'average' EU15 country, which is a country where macroeconomic variables take the EU15 average. Parts of these country level variables are highly correlated with one another. In order to mitigate multi-collinearity problems in the regressions, we have identified two different bundles of predictors which limiting redundancy and leading to estimations (4) and (4').

Results of the five models are reported in Table 3.4. The estimation of model 1 shows that there is a significant country effect in work complexity, but that the variance is considerably higher among individuals. The estimated intra-country correlation is 6.55%. In model 2, 3 and 4 dummy variables for years 2000 and 2005, individual controls for workers characteristics and country controls for macroeconomic factors are successively and respectively introduced. The impacts of these controls on the different components of variance are first analysed. In model 2 statistically significant negative coefficients for both years are found but the coefficient for year 2005 is smaller in absolute value compared to that for year 2000 (-0.055 and -0.038). This finding supports and confirms the descriptive statistics on trends over the two sub-periods of time displayed in Table 3.2 and discussed earlier. When individual characteristics only are introduced (model 3), the years' dummies remain significant with the same relation between 1995 and 2000 and 1995 and 2005 pointing out that structural factors measured at the individual level do not account for observed average EU 15 changes in work complexity. Compared to the intercept-only-model the addition of individual variables explains 25%[3] of the individual variance of work complexity. In model 4, country level indicators centred on the European average are introduced in addition to the year dummies, which remain significant but their absolute level increases and in model 4, the year 2005 dummy is greater in absolute value than the year 2000 dummy (-0.062 *versus* -0.051).

Table 3.4. Degree of work complexity in EU15 over 1995-2005: multilevel analysis

	Model 1	Model 2	Model 3	Model 4	Model 4'
Intercept	0.017	0.016	-0.425***	-0.415	-0.395***
Trend analysis					
Year 1995	*Reference*				
Year 2000		-0.055***	-0.048***	-0.051***	-0.089***
Year 2005		-0.038***	-0.038***	-0.062***	-0.079***
Individual level (n = 52248)					
Individual is female			-0.066***	-0.066***	-0.066***
Individual's age is between 15 and 24	*Reference*				
Individual's age is between 25 and 34			0.101***	0.101***	0.100***
Individual's age is between 35 and 44			0.102***	0.102***	0.103***
Individual's age is between 45 and 54			0.082***	0.082***	0.082***
Individual's age is between 55 and +			0.058***	0.059***	0.059***
Individual is self-employed			0.171***	0.171***	0.171***
Individual is on a fixed term contract			-0.060***	-0.060***	-0.059***
Individual's main job involves working with computers			0.216***	0.216***	0.215***
Individual has people under his/her supervision			0.174***	0.174***	0.174***
Agriculture			0.027*	0.026*	0.026**
Manufacturing	*Reference*				
Services			0.018***	0.018***	0.018***
Construction			0.064***	0.064***	0.064***
Public sector			0.058***	0.058***	0.058***
Legislators (and senior officials) and managers			0.256***	0.256***	0.257***
Professionals			0.311***	0.311***	0.312***
Technicians (and associate professionals)			0.301***	0.301***	0.301***
Clerks			0.159***	0.159***	0.160***
Service workers and (shop and market) sales workers			0.143***	0.143***	0.143***
(Skilled) agricultural and fishery workers			0.206***	0.206***	0.209***
Craft and related trades workers			0.228***	0.228***	0.229***

Table 3.4. Degree of work complexity in EU15 over 1995-2005: multilevel analysis *(continued)*

	Model 1	Model 2	Model 3	Model 4	Model 4'
Plant and machine operators	*Reference*				
Elementary occupations			0.003	0.003	0.002
Country level (n = 45)					
Real annual GDP growth				-0.005	-0.000
% trade in goods and services in GDP				0.001	0.002***
Ln of number of patent applications to the EPO per million inhabitants					0.046***
% tertiary attainment for age group 24-64				0.006***	
% aged 50 and more in economically active population				-0.004**	
Unemployment rate				0.003*	
% part-time employment in total employment					-0.008***
% females in economically active population					0.012**
Random components					
Variance of the country level residual errors	0.015***	0.015***	0.011***	0.011**	0.010**
Variance of the individual level residual errors	0.216***	0.216***	0.162****	0.162***	0.162***
Intra-country correlation in percentage	**6.55%**	**6.55%**	**6.52%**	**6.37%**	**5.94%**

*Significant at 10%. **Significant at 5%. ***Significant at 1%. Coverage: salaried and self employed individuals from EU15 private and public sectors.

Source: European working conditions survey 1995, 2000 and 2005, European Foundation for the Improvement of Living and Working Conditions, country level variables are from OECD and Eurostat data bases, analysis and table from Greenan *et al*. (2010).

What does the complete model (model 4) indicate? First of all, work complexity reacts very strongly to the individual characteristics of workers. At the individual level, the typical worker having the most routine job is a young woman (15 to 24 years old), working as a salaried employee with a temporary contract. She does not work with a computer and does not have any management position. She is a plant or machine operator (or in elementary occupation) in the manufacturing sector. It is interesting to look more closely at the occupation and sector coefficients in the regressions. They are quite stable when model 3 is compared with models 4 and 4'. Occupations with the highest degree of work complexity are first professionals, second

technicians and associate professionals and third legislators, senior officials and managers. These occupations are considered as high skills. The medium skills occupations with the highest degree of work complexity are craft and related trade workers and skilled agricultural and fishery workers. Finally, the degree of work complexity is the lowest in low skills occupations and in particular for plant and machine operators. In terms of sectors, construction appears as the sector with the highest degree of work complexity, followed by the public sector, agriculture, services and last manufacturing.

The inclusion of country level variables in model 4 explains about 10% of the country level variance remaining when individual factors are taken into account. As expected, in models 4 and 4', variables that are positively linked to the development of the knowledge base of the economy are positively correlated with the degree of work complexity: tertiary attainments in model 4, log number of patents in model 4'. In both models, the percentage of international trade in GDP is positively linked, to the degree of work complexity, but only significant in model 4'. Countries that are more opened to international trade seem to specialise in activities that entail more complex work. An ageing economically active population implies a lower degree of work complexity, whereas on the opposite, female participation in the labour market is positively linked with it. Countries with higher unemployment rates have a higher degree of work complexity. This could reflect the fact that less complex jobs are the first to be destroyed in economic downturns, when unemployment rates become higher. Conversely, when the activity expands again, the degree of work complexity should fall because less complex jobs are being created, the negative (but non-significant) relationship with economic growth could echo such a mechanism. Lastly, countries where work complexity is high have a smaller share of part-time workers in total employment.

Overall, this multilevel analysis makes the work complexity paradox even deeper. When potential structural factors are taken into account at the individual and country levels, the residual decrease in work complexity becomes larger. This is because many structural forces should drive an increase in work complexity. At the individual level, occupations with higher educational attainments, age as a proxy of accumulated work experience, computer use are associated with higher levels of work complexity. At the country level the development of international trade and of the knowledge base of the economy, as well as the expansion of third level education and an increased female participation favour work complexity. Thus, taking into account these structural factors, we should have observed an increase in work complexity when we observe a slight decrease in simple descriptive statistics. If econometric modelling allows identifying a clear negative residual trend in the average EU15 degree of work complexity once structural factors are taken into account, it does not allow going any deeper into the analysis

because of a lack of data. The next section explores alternative possible explanations of this "work complexity paradox".

Uncovering the work complexity paradox

First, looking more closely at the results of the model some possible structural drivers of a decrease in work complexity can be identified connected with gender, part time, limited contracts, and aging.

There is a vast body of literature, theoretical and empirical, stretching back over more than two decades, on gender and work and the ways in which patterns of segregation are reinforced or challenged. Some positive assumption about changes in work organisation as regards to women are made, such as the idea that new career profiles offer more opportunities for women to follow a successful professional trajectory. Traditional forms of organisation, particularly bureaucracy, where learning opportunities are weaker, would have strictly defined gender roles, while new forms of organisation, would favour more porous gender roles. However, the empirical research often contradicts this assumption (Greenan and Walkowiak, 2005, Liff and Ward, 2001). Results in Table 3.4 show that, all things being equal, women perform more routine jobs. One reason could be that more female-type jobs have moved from the non-market to the market sector and they are often organised in a traditional way with a low level of employee discretion. But this negative result is however mitigated by our positive country level result on female participation.

Countries with a greater percentage of part-time employment are characterised by a lower degree of work complexity. This indicator could reflect the degree of flexibility of the labour market and the quality of jobs, but it is also positively correlated with the percentage of females in economically active population. Like part-time work at the macro level, fixed term contracts at the micro level are associated with lower levels of work complexity. Precarious employment relationship does not favour work complexity but routine jobs with less learning opportunities and competence developments. This result is in line with the one obtained in Table 3.3 for year 2005. Using employee level data from an Italian nationwide survey on skills, Leoni and Gaj (2008) find negative impacts of gender, temporary contracts and part-time contracts on employee level indicators of competences measured through a job requirement approach and in particular problem solving skills. They show that these negative impacts reflect three lacks: lack of experience accumulation at the workplace for the temporary contract effect, lack of continuing vocational training for the part-time effect and lack of access to jobs with innovative organisational characteristics for the gender effect.

Finally, models 3 to 4' show an inverted U-shape profile for work complexity related with age. The younger workers experience the more routine jobs. Then work complexity increases between 24 and 44 and decreases slightly afterwards, remaining at a higher level after 55 than for younger workers. This effect finds a country level counterpart in the negative effect of the share of aged 50 and more in the economically active population. However, as the regression results show it, these factors taken together do not exhaust the decrease in work complexity. Other forces are at play, which are not captured in our measurement frame.

Searching in the literature for alternative explanations, we identified four other possible culprits: growing standardisation, job polarisation, organisational change and skill mismatch. The first two explanations rely on the idea that there is an objective and concrete decreasing trend in work complexity, whereas the third and fourth explanations discuss the fact that this trend is measured through a subjective assessment.

Growing standardisation

In his classic work on the structure of organisations, Mintzberg (1979) identifies two modes of co-ordination involving some standardisation in how work is performed: the standardisation of work processes when the content of tasks can be specified and programmed by means of rules and procedures to secure acceptable outcomes and the standardisation of output when tasks options are uncertain and when expected results can be clearly identified. These two types of co-ordination are associated to bureaucratic forms of organisation. Over the past two decades, much emphasis in the literature has been put on other forms of organisations than the bureaucratic one as responses to the increased complexity and uncertainty in business environment and to the growing importance of knowledge in economic activity. These forms of organisation are more organic and decentralised and involve less standardisation than bureaucratic types of organisation. For example, according to Mintzberg (1979), the archetype of the innovative organisation is the adhocracy, a typical learning organisation where workers are organised in multidisciplinary project teams, with liaison devices to encourage mutual adjustment as the central co-ordination mechanism. Theoretically, as the adhocracy tries to break out from established patterns to innovate, it does not rely on standards.

However, since the mid-1990s, as a response to globalisation and backed up by the availability of ICT that transformed communication costs and drastically reduced the cost of distant co-ordination, many organisations opened up their external boundaries, resulting in a restructuring of value chains. Drawing on material from four case studies on outsourcing practices in the United Kingdom, Grugulis, Vincent and Hebson (2003) come to the conclusion that "in every instance, the process of contracting meant that tasks were more strictly defined and monitored and employees were able to exercise less discretion". Relying on fifty-six organisational case studies of restructuring processes across Europe conducted in the EC funded WORKS project, Greenan, Kocoglu *et al.* (2008) point out that the main change in work organisation associated with ICT diffusion is a higher standardisation of work and an increase in work control through electronic devices. When organisations decide to outsource or offshore some of their activities, they face a problem of loss of control that they partially master through the use of ICT like Enterprise Resource Planning Software, workflow management technologies or supply chain management technologies which allow a quasi integration of business partners. A prerequisite of ICT use is then a standardisation process which generates routine tasks and specified products and services that can be easily outsourced or offshored. ICT then plays a role at two levels in the inter-organisation relationship: they embed standards and they structure the flow of information about the outsourced activity between business partners. If ICT involves codification of knowledge and standards, many new management concepts also contribute to the generation of standards: quality certification (like the International Organisation for Standardisation certification), traceability tools, Service Level Agreements, performance tracking systems, etc.

Moreover, as pointed by Ellström (2001), the links between formalisation of work processes through the use of standards and organisational learning needs further investigation. Formalisation appears to be a double-edged sword. By reducing variations in task performance and inducing a focus on solutions that fit established procedures, standards are likely to cut some learning opportunities. However, standards save time and attention that may be reallocated to more creative tasks and by codifying previously tacit knowledge and best practices and creating more transparency they may contribute to organisational learning. Thus there is indeterminacy and employers need to strike the right balance between standardisation and mutual adjustment which are two different modes of co-ordination.

There could also well be a specific time frame in developments of work complexity in a given workplace or industry: cycles between more complexity and less complexity could alternate with the development of technical progress. Innovation is favoured by the higher work complexity that characterise learning organisations, but once it has taken place, new knowledge and

practices are codified and embedded into new standards and routines that contribute to lowering the degree of work complexity. The decrease in work complexity over 1995-2005 would then reflect a cycle of standardisation following a learning phase connected to the massive diffusion of ICT.

A last point worth noting is that moving up the value chain does not necessarily imply greater work complexity. In other words, the relationship between the complexity of the product and the complexity of work is not necessarily positive and linear. According to the available technology, segments of the value chain can become easy to standardise and thus outsource and these segments can be situated at the top as well as at the bottom of the value chain. For example, in the automobile industry, the key business processes that have been standardised are product design, product planning, inventory and logistic control and various stages of the production (Sturgeon, 2008). Unfortunately, the lack of data on business practices and work organisation does not allow assessing and analysing the trend towards growing standardisation connected to the diffusion of specific ICT.

Job polarisation

The decrease in work complexity appears to be strongest in the United Kingdom, Germany, Spain and Italy and this result holds once industrial structures have been accounted for. It is interesting to note that in the United Kingdom and Germany, a case for growing job polarisation linked with ICT diffusion has been made (Goos and Manning, 2007; Spitz-Oener, 2006).

To understand the interplay between computerisation and job skill demands, Autor, Levy and Murnane (2003) built up measures of tasks performed in particular jobs and their change over time between 1960 and 1998 based on the Dictionary of Occupational Titles and applied to the census occupation codes. Five different types of tasks are identified within jobs: non-routine analytic, non-routine interactive, routine cognitive, routine manual and non-routine manual. In the case of the United States, the documented task shift towards non-routine cognitive tasks, pervasive in gender, education and occupation groups, is positively associated with the adoption of computer technology. Decreasing trends in both routine cognitive and routine manual tasks are the other side of the coin. Autor, Levy and Murnane also argue that technology cannot replace human labour in non-routine manual tasks requiring the flexible use of the brain, eye, hands and legs.

Goos and Manning (2007) revisit this finding for the United States, showing that jobs requiring non-routine tasks tend to be at the top and at the bottom of the wage distribution, while the jobs that require routine tasks tend to be in the middle, leading to a job polarisation pattern which they also

find in the United Kingdom between 1975 and 1999. Thus middling jobs, that are mainly clerical jobs, like book keepers or bank employees and skilled manual jobs have become less numerous. Spitz-Oener (2006) replicates Autor, Levy and Murname's research using West Germany data and also observes a hollowing out of middle class occupations between 1979 and 1999. We may also note that Polavieja (2005) mentions a polarisation process in Spain over the 1987-1997 period, but he connects it with labour market reforms rather than with technology. Using the harmonised European Union Labour Force Survey, Goos *et al.* (2009) map occupational changes in 16 European countries over the period 1993-2006 show that on average, the low and high paying occupations increase their employment shares by six and two percentage points respectively, whereas the middling occupations decrease their employment share by 8%. This polarisation trend is particularly strong in the UK, Germany and close to the EU average in Spain.

The positive correlation we find in Table 3.4 between computer use and work complexity at the worker level is in line with the positive correlation between computer use and non-routine cognitive tasks. The tasks performed by computer users are complex and they involve discretion, learning and problem solving abilities. The negative trend in work complexity could however reflect the displacement of workers from middling jobs to non-routine manual jobs. According to Spitz-Oener, examples of such occupations are waiters, domestic staff, blacksmiths, or transport equipment operatives. Moreover, standardisation and polarisation could well be connected and indirectly linked to technological progress. ICT contributes to the global restructuring of value chain. In this process, outsourced or offshored tasks and work processes are standardised. If these tasks were previously performed by occupations with intermediate skills, global value chain restructuring would induce both polarisation and decreased work complexity. This would reflect a "power biased" use of ICT in value chain restructuring, in line with the increased intensity of work effort, which has been empirically documented by Green (2005) in the United Kingdom and with the theoretical model proposed by Guy and Skott (2007) where the use of ICT allows firms to monitor low skill workers more closely and may drive a simultaneous occurrence of lower wages, higher unemployment and higher work effort for the lower skills.

This thesis would require further assessment both theoretically and empirically. In particular, it would be important to understand why some countries face higher decrease in work complexity than others. If the explanation has something to do with technical progress, we need to identify some heterogeneity in the way it is embodied in work processes at the national level. Chapter 2 has made a step in this direction by showing a spread across Europe of different forms of work organisation. If the lean production model implies more standardisation than mutual adjustment, then this could explain the sharp decrease in work complexity in the United Kingdom where it is prevalent. In Spain and Italy, traditional and Taylorist forms of organisation are more frequent, with some implications probably on the way ICT enter the work process. The German case is more difficult to analyse in the light of the work organisation typology as it is a country where the discretionary model is rather frequent.

Organisational change and feeling of overqualification

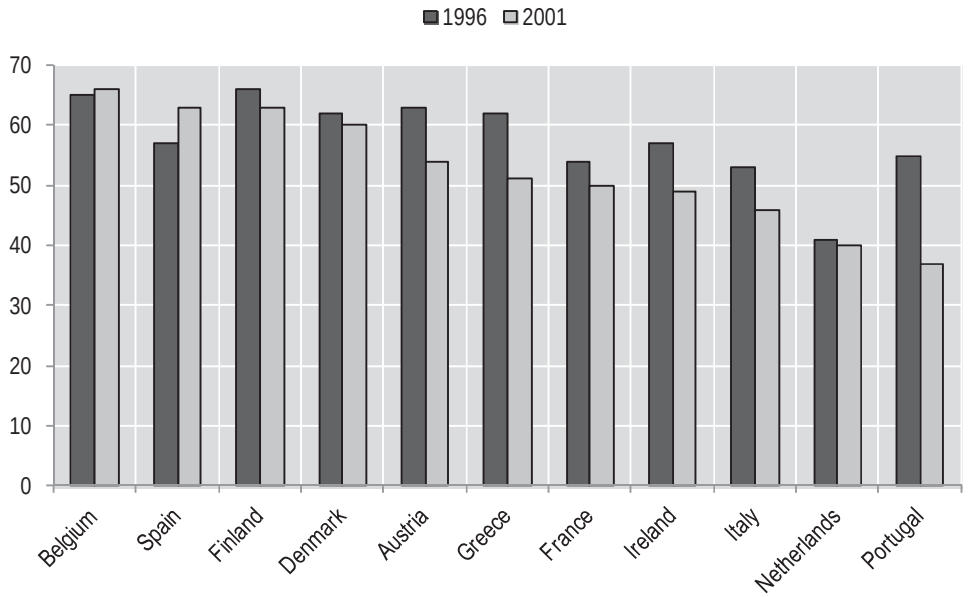
Up to now, we have considered that the decreased work complexity reflected a hard fact. However, in trying to explain the work complexity paradox, we need to consider the fact that even though questions in the European Working Conditions Survey are formulated in a simple and objective way, work assessments provided in employee declarations remain subjective in nature. Thus the average European workers could feel that his job is becoming less complex over time, even though, objectively, it is difficult to observe a decrease in skill content. Two main causes could generate such a feeling: organisational change and overqualification.

Case study evidence shows that organisational changes put into question the way employees view and assess the content of their jobs. If organisational changes have some deep consequences on task content, they can be viewed as deskilling, even when new skills are involved. The past trajectories of workers have an influence on how they value the content of their work. If some positively valued dimensions of work disappear, the new dimensions may be negatively considered, even when they incorporate new skills. For example, Dahlman (2007) describes the restructuring of an IT help desk in a British local government involving an IT workflow management system. More interpersonal skills are required from the staff transferred to this help desk. However, IT staff with experience of the previous work organisation have a technical background. They feel that they have less discretion because the new IT system requires logging every work-related task and scheduling work to be carried out when before work tended to be carried out on an *ad hoc* basis. Even if some training has been provided to update their skills and develop inter-personal skills, IT staff report that they do not feel they have learned more or developed new skills. Moreover, skill obsolescence

may arise from repeated change, driving a feeling of loss and of work becoming less enriching.

Overqualification is a last culprit for the decrease in work complexity. The feeling of overqualification is quite widespread across Europe (Brunello *et al.*, 2007; Brynin and Longhi, 2009). The European Community Household panel provides a self-reported measure through the question "do you feel to have skills or qualifications to do a more demanding job than the current one?". In 2001, the proportion of workers who feel overqualified varies from 40% in the Netherlands to 66% in Belgium. It reached 46% in Italy and 63% in Spain (Figure 3.1). Unfortunately this measure is not available for the United Kingdom and Germany.

Figure 3.1. Percentage of workers who feel overqualified



Source: European Household Community Panel, 1996 and 2001.

Overqualification is a puzzle for human capital theory, and it does not fit well with the skill bias technological change evidence. Machin and McNally (2007) rule out the explanation in terms of over-supply of tertiary-educated graduates. Other possible causes can be related to specific employment practices such as flexible employment, to the fact that employers cannot discriminate easily between different skill levels (Brynin and Longhi, 2009), to design problems in the educational system making it difficult to provide the skills needed by the market and to the interplay between institutions,

educational choices and the labour market in matching the supply and demand of skills (Brunello *et al.*, 2007). Like for organisational change, overqualification could drive a relative negative assessment of work content: the worker compares his situation, not to a past one like for organisational change, but to a virtual one corresponding to his alleged level skill. A discrepancy between the two assessments could drive an underestimation of the level of work complexity.

Summary

This chapter has reviewed results obtained by Greenan, Kalugina and Walkowiak (2010) about trends in work organisation over 1995-2005 using the European Working Conditions survey. They measure a synthetic indicator of the degree of work complexity that is comparable over time, using Multiple Correspondence Analysis and find an average decreasing trend in EU15, driven by results in Germany, Great Britain, Italy and Spain. They then try to uncover this work complexity paradox by taking into account structural factors influencing work complexity at the individual and country level using a multilevel modelling approach. Once structural factors are taken into account, the work complexity paradox becomes deeper: they estimate a negative residual trend that is even stronger than what is measured in descriptive statistics. This is because, many structural factors should have contributed to an increase in work complexity and in particular, the development of the knowledge base of the economy shifts in industrial structures and ICT diffusion. However, the model identifies five variables that are negatively connected with work complexity: at the individual level, women appear to have lower access than men to jobs with innovative work characteristics; there is an inverted U-shape profile for work complexity in relation with age and limited contracts are associated to less work complexity, at the country level, the share of part-timers and the ageing of the workforce drive a decrease in work complexity. Then four possible culprits that are not measured in the available databases are discussed: standardisation, job polarisation, organisational change and overqualification. The first two explanations make the assumption that the decreasing trend in work complexity is an objective phenomena, the two other ones explore how it could be related to subjective assessments of persons in employment.

Notes

1. The full descriptive report of the Fourth European Working Conditions Survey is available on the European Foundation website: *http://eurofound.europa.eu/ewco/surveys/EWCS2005/index.htm.*

2. Inertia in multiple correspondence analysis is an indicator of heterogeneity, analogous to variance in factor analysis.

3. More precisely, by comparing variance of the individual level residual errors in models 1 and 3, we have (0.216-0.162)/0.216 = 0.25.

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Annex 3.A

Multilevel model used in Chapter 3

A benchmark regression to identify within-country and between-country variance

Respondents in the EWCS are persons in employment from each EU country. Thus the dataset is hierarchical, with a level 1 (the individual, indexed by *i*) nested in a level 2 (the country, indexed by *j*). Multilevel modelling is adequate for that type of data structure, and in particular when there is a "level 2 effect", that is when the answers given by individuals at level 1 are correlated. In our case, the "level 2 effect" is a country effect.

The first step in multilevel modelling is to identify within-country and between-country variance through a benchmark regression: the intercept only model. If there are no explanatory variables at level 1, the model equation can be formulated as follows:

$$Y_{ij} = \beta_{0j} + r_{ij}, \quad \text{where } r_{ij} \sim N\left(0, \sigma^2\right) \tag{1}$$

In traditional models, β_{0j} is an intercept and r_{ij} a random term. In the presence of a country effect, there is a correlation between observations within countries, resulting in differences in country intercepts, which may be expressed as follows:

$$\beta_{0j} = \gamma_{00} + u_{0j}, \quad \text{where } u_{0j} \sim N\left(0, \tau_{00}\right) \tag{2}$$

The full model is specified by substituting (2) in (1):

$$Y_{ij} = \gamma_{00} + u_{0j} + r_{ij} \quad \text{where } u_{0j} \sim N\left(0, \tau_{00}\right) \text{and} \quad r_{ij} \sim N\left(0, \sigma^2\right) \tag{3}$$

This model allows decomposing the total variance into two independent components: the variance of individual-level errors (r_{ij}) and the variance of the country-level errors (β_{0j}). The intra-country correlation can be expressed as:

$$\hat{\rho} = \frac{\hat{\tau}_{00}}{\hat{\tau}_{00} + \hat{\sigma}^2}$$

It indicates the proportion of the variance explained by the grouping structure in the sample. It can also be interpreted as the expected correlation between two randomly chosen units that are in the same country. In other words, this intra-country correlation measures the share of the total variance that occurs between countries. In Table 3.3, the EU15 intra-country correlation of the degree of work complexity is computed for each of the three waves of the EWCS (1995, 2000 and 2005).

Four models

In the following modelling steps in Chapter 3, the three waves of the EWCS are pooled. The intercept only model on the pooled data set (model 1) is computed first. Then the model is enriched with year 2000 and year 2005 dummies (model 2). As year 1995 is the reference year, the coefficient associated with each time dummy gives the EU15 average trends in the degree of work complexity between 1995 and 2000 and 1995 and 2005. An aim in this modelling is to check the sensitivity of computed trends to the inclusion of individual level and country level structural variables. In model 3, there are time dummies and individual level variables. Finally, model 4 is the complete model, with time dummies, individual level variables and country-level variables. Two versions of model 4 (4 and 4') are estimated, using two different sets of country level variables.

Model 1. Intercept-only model

$$Y_{ij} = \beta_{0j} + r_{ij} \text{ where } r_{ij} \sim N\left(0, \sigma^2\right)$$
$$\beta_{0j} = \gamma_{00} + u_{0j} \text{ where } u_{0j} \sim N\left(0, \tau_{00}\right)$$
$$Y_{ij} = \gamma_{00} + u_{0j} + r_{ij} \text{ where } u_{0j} \sim N\left(0, \tau_{00}\right) \text{ and } r_{ij} \sim N\left(0, \sigma^2\right)$$

Model 2. Inclusion of time dummy

$$Y_{ij} = \beta_{0j} + T_1 Year2000 + T_2 Year2005 + r_{ij} \text{ where } r_{ij} \sim N\left(0, \sigma^2\right)$$
$$\beta_{0j} = \gamma_{00} + u_{0j} \text{ where } u_{0j} \sim N\left(0, \tau_{00}\right)$$

$Y_{ij} = \gamma_{00} + T_1 Year2000 + T_2 Year2005 + u_{0j} + r_{ij}$ where $u_{0j} \sim N(0, \tau_{00})$ and $r_{ij} \sim N(0, \sigma^2)$

Model 3. Inclusion of only individual variables

$Y_{ij} = \beta_{0j} + T_1 Year2000 + T_2 Year2005 + \beta_{ij} Ind_{ij} + r_{ij}$ where $r_{ij} \sim N(0, \sigma^2)$

$\beta_{0j} = \gamma_{00} + u_{0j}$ where $u_{0j} \sim N(0, \tau_{00})$

$Y_{ij} = \gamma_{00} + T_1 Year2000 + T_2 Year2005 + \beta_{ij} Ind_{ij} + u_{0j} + r_{ij}$ where $u_{0j} \sim N(0, \tau_{00})$ and $r_{ij} \sim N(0, \sigma^2)$

Model 4. Full model with individual and macroeconomic determinants

$Y_{ij} = \beta_{0j} + T_1 Year2000 + T_2 Year2005 + \beta_{ij} Ind_{ij} + r_{ij}$ where $r_{ij} \sim N(0, \sigma^2)$

$\beta_{0j} = \gamma_{00} + \gamma_{0j} Macro_j + u_{0j}$ where $u_{0j} \sim N(0, \tau_{00})$

$Y_{ij} = \gamma_{00} + \gamma_{0j} Macro_j + T_1 Year2000 + T_2 Year2005 + \beta_{ij} Ind_{ij} + u_{0j} + r_{ij}$ where $u_{0j} \sim N(0, \tau_{00})$ and $r_{ij} \sim N(0, \sigma^2)$