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# Has the Quality of Work Improved in the EU-15 between 1995 and 2005 ?


## Abstract

This paper provides a mapping of quality of work and measures its evolution between 1995 and 2005 by using European Working Conditions Surveys. With a multilevel modelling, we assess the sensitivity of observed trends to "composition effects" and "country effects". Results suggest a decreasing trend in the quality of work: working conditions have deteriorated, while work has become more intense and less complex. In Germany and Italy all indicators have worsened while other European countries have more mixed results.



**Key words: quality of work, working conditions, work intensity, work complexity, European comparison, multilevel modelling.**

**JEL Codes: J81, O52, L23**

# 1) INTRODUCTION

Improving quality of working life is an important goal in the European strategy which contributes both to the promotion of sustainable work and to workplace innovation. The relation between quality of work and innovativeness has been described as a missing link in Europe 2020 (European Economic and Social Committee, SC/034, 2011), but research results point to the fact that some configurations of working conditions and work organisation only are conducing to a "high road" model, able to enhance both competitiveness and job quality. It appears thus necessary to assess progress in the field of work organisation. The European Foundation for the Improvement of Living and Working Conditions (EFILWC) and the European Commission both published in 2008 a report concluding on the existence of an improvement in job quality in Europe between 1995 and 2004-2006. In the first report job quality is approximated by the median hourly wage. The second report uses a large set of country-level indicators (socio-economic security, education and training, gender balance etc.) but only two variables out of the twelve included are related to work: non-standard hours and work accidents. These reports thus clearly measure evolution of the quality of employment rather than that of quality of work.

This paper focuses on the measurement of quality of work with three main objectives: provide a general mapping of quality of work across European countries, analyse trends over 1995-2005 and test whether results obtained through descriptive statistics hold when controlling for individual-level and country-level structural factors. Our assessment is based on the European Working Conditions Survey (EWCS) produced by the EFILWC. We use the surveys of 1995, 2000 and 2005 for EU-15 countries. In this survey, employees describe their work by answering a series of questions that are formulated in a simple and objective way. Even though the information collected is subjective, as employees self-report on their work experiences, the questions are formulated to de-emphasize individual opinions and enable international comparisons. The EWCS is the only survey that allows measuring the organisational design of workstations across different European countries. The characteristics of the work environment the way work is structured in time, divided into sub-tasks and coordinated are analysed separately and contribute to measure different dimensions of quality of work. More precisely, we measure four indicators: one indicator of the quality of working conditions, two indicators of work intensity and an indicator of work complexity.

In terms of policy issues, quality of work is important because it directly relates to health and safety risks. Workers exposed to poor quality of work face increased hazards in the forms of work accidents and work-related illnesses. In economic downturns, the quality of work is affected by restructuring processes, which have long-term health implications for both displaced employees and those who remain employed. Monitoring work trends is also important in the context of an aging workforce with increased participation by women. Active aging policies stress the need to adapt professional training and conditions of work to older workers. The progressive replacement of the "male breadwinner" model by the "dual wage earner" model implies that work-life balance issues are becoming more strongly connected to work characteristics. The quality of work is a central feature of job satisfaction, and it tends to become more central over time as the educational attainment of the workforce increases (Clark, 2009). Finally, as already stressed, the innovative ability and competitiveness of an economy lies in the fact that employees at, all level in organisations, are encouraged to use and develop their skills and creativity.

Economic analysis has few tools to investigate and understand work characteristics as compared to employment characteristics. As summarised by Kalmi and Kauhanen (2008), empirical results that analyse recent changes in the organisational design of workstation have been somewhat conflicting, with one view arguing for mutual improvements for employers and employees and another one being more critical. The mutual gain literature emphasises the increase in discretion and the resulting monetary and psychological benefits (Black et al., 2004; Freeman and Kleiner, 2000). In contrast, the critical view argues that the limited gains accrued by employees are outweighed by increased stress, workload intensification and work injury (Godard, 2001; Green, 2004, 2006; Ramsay et al., 2000). Furthermore, the way in which workplaces are coordinated has some important consequences in terms of learning processes (Winter and Zollo, 2002) and patterns of work coordination differ substantially across employers, sectors and countries (Lorenz and Valeyre, 2005). To adapt the Fordist and the Taylorist models of production, where coordination rests on standardisation of products and processes, to more rapid changes in the environment of firms, there is a movement towards a model where coordination rests on mutual adjustments. Such adaptation would allow for a learning process that is more widespread and less concentrated on a small fraction of the workforce (Lorenz and Lundvall (eds), 2006). As a result, bureaucratic structures involving complex organisations and simple jobs should evolve towards simpler structures

with more complex jobs (de Sitter et al., 1997). Thus, in the view of this literature, we would expect increased quality of working conditions, work intensity and work complexity.

The empirical evidence we find on the evolutions in quality of work do not corroborate the recent job quality reviews we referred to above and are rather worrying in terms of ability to realise Europe 2020 targets. We observe in the EU-15 over 1995-2005, an average increase in work intensity, a deterioration in the quality of physical working conditions and a decrease in work complexity. These empirical results are in line with other empirical evidence. Using British data, Green (2004 and 2006) finds that the work has become more intense and there has been a decline in work discretion between 1992 and 2002. The intensification of work in Europe in the nineties is also pointed out by Green and McIntosh (2001), OECD Employment Outlook (2003) and for the period between 1995 and 2005 by Eurofound (2009). Peña-Casas and Pochet (2008) report that the number of jobs offering poor learning opportunities is increasing in almost all countries of the EU- 15 over the 1995-2005. Finally, these negative trends in quality of work are confirmed by the observed decrease in job satisfaction in the nineties in some OECD countries (Clark, 2005): increased stress and high incidence of hard work seem to be the most plausible explanations of such evolution.

To move one step further, we investigate country-level and individual-level heterogeneity in quality of work indicators using multilevel modelling. This allows measuring the sensitivity of descriptive trends to composition effects, testing the significance of "country effects". The paper is organized as follows. We present our measurement strategy and map European trends in quality of work (section 2). Then, we investigate individual and country-level heterogeneity in quality of work (section 3). Section 4 concludes the paper.

# 2) MAPPING EUROPEAN TRENDS IN WORKING CONDITIONS AND WORK ORGANISATION OVER 1995-2005

## 2.1 Data

The EWCS (1995, 2000 and 2005) provides a rich set of partial indicators about working conditions and work organization. EFILWC released in 2005 a database in which the formats of prior surveys are harmonized over time. This dataset identifies questions that are comparable over time. Approximately 1,500 employed persons in each country were

interviewed at the respondent's principal residence, with the exception of Luxembourg (500 interviews). The sample is weighted according to region, city size, gender, age, economic activity (NACE) and occupation (ISCO) as benchmarks[1]. It is representative of the total employed population. Our sample includes self-employed individuals, private and public sectors employees from establishments of all sizes across the EU-15. The total survey population is 15,986 persons in 1995, 21,703 persons in 2000 and 14,952 persons in 2005.

We selected a set of variables capturing the experience of employed persons regarding their work and how it is organised and coordinated. These variables are based on questions that are expressed in a simple and objective way using yes/no responses or frequency scales. As comparable data were not always available over time, frequency scales have been dichotomised into yes/no scales. Furthermore, the set of questions indicating whether the individual was subjected to different forms of violence and discrimination at work has been transformed into a single dummy indicating the existence of at least one "yes" answer. This simplification contributes to the international comparability by reducing country differences in the way questions are understood. However, this does not reduce the heterogeneity in legal and cultural norms across countries, which contributes to the generation of country-level patterns or effects.

## 2.2 Measurement strategy

Working conditions and work organization are latent multidimensional variables that are not directly observable. Each variable contributes to the construction of an overall picture of work experience, but none of them alone is sufficient to describe work experience effectively. Multiple Correspondence Analysis (MCA) is a useful technique in this situation as it aims at producing a simplified low-dimensional representation of the information in a large frequency table (Greenacre and Blasius, 2006). First, each qualitative variable is coded as a dummy. The MCA generates quantitative scores, called dimensions, which maximise the average correlation among these dummy variables. These dimensions are linear combinations of the dummy variables and can be considered as synthetic indicators. Their interpretation relies on the variables that play a prominent part in their construction.

We consider three groups of variables capturing, respectively, the work environment, how work is organised in time and how it is divided up and coordinated. We run a weighted MCA

for each group over the year 1995 and select factors that are efficient at synthesising information. We derive synthetic indicators of the quality of working conditions, work intensity and work complexity. The linear combinations of variables underlying these dimensions are then applied to the distribution of individual characteristics measured in 2000 and 2005 to build up indicators that are comparable across time[2].

## 2.3 Three key dimensions of work

### *2.3.1 Quality of working conditions*

In this paper, we focus on the traditional definition of working conditions, focused on physical working conditions: exposure to nuisances, dangerous products, radiation, vapours or fumes etc. Questions about physical working conditions are central to understanding the features of an industrial working environment, but they are more peripheral in the service sector, which is marked by stress and mental strain. We also include a variable indicating whether the individual was subjected to different forms of violence or discrimination at work, a topic that was included in the questionnaire in 1995.

Appendix 1 presents all questions used to construct the indicator on quality of working conditions. This indicator synthesizes 31% of inertia, which is a measure of the association between variables that it includes[3]. . Physical nuisances are especially important in the construction of this indicator: being exposed to vibrations from hand tools or machinery, to noise so loud that one would have to raise one's voice to talk to people, to high or low temperatures, to breathing in vapours, to handling and touching chemical products or substances or to radiation as well as having to wear personal protective equipment make a large contribution to the synthetic indicator.

Quality of work includes other dimensions of work environment besides physical working conditions. Psychosocial risks at work and their consequences in terms of health and safety are another important piece of the puzzle, as are work organization, learning and development opportunities, and work-life balance. The longitudinal dimension of the EWCS does not cover these different dimensions thoroughly. However, two important dimensions of work experience can be approached in an effective way: work intensity and work complexity.

### *2.3.2 Work intensity*

Despite its centrality in the determination of work quality, work intensity is not among the social indicators that the European Union collects in its synthesis of work quality indicators (Green, 2006), perhaps due to problems with its definition and measurement. Work intensity generally refers to labour effort expended while at work. Green (2006) defines work effort as the rate of physical and/or mental input to work tasks during the working day. We distinguish two types of intensity measures.. Work effort can be measured through exposure to high working speeds or to tight deadlines (Green and McIntosh, 2001; Green, 2004). The weakness of this measure is the absence of information on the source of intensity. It is also possible to use questions about factors on which the pace of work depends. This kind of measure captures the variety of constraints that influence the work rhythm, such as demands from colleagues, demands from customers, speed of machines, numerical production targets or direct control by a manager.

Using information about a worker's exposure to high working speed or to tight deadlines, we can measure his or her work intensity. The main advantage of self-report is that the workers themselves are likely to have the best understanding of the demands of their jobs. However, the potential for biased reporting of contested features as work effort is clear. The replies to these questions clearly depend on what employees regard as "high" speed or "tight" deadlines. However, these are measurements of psychological comfort or suffering, and as such, their subjective nature is not necessarily a defect.

Appendix 1 provides the distributions in 1995, 2000 and 2005 for the EU-15 of the questions used to construct synthetic indicators of work intensity. Our analysis shows that work intensity has two main independent components: the intensity of technical constraints and the intensity of market constraints[4] (which respectively account for 26% and 15% of inertia). The intensity of technical constraints is driven by the automatic speed of machines or movement of products, the existence of numerical production targets and dependence on work done by colleagues. It also reflects the direct control by the boss exerting pressure to maintain a rapid pace of work. The intensity of market constraints reflects the dependence of the pace of work on direct demands from people such as customers, passengers, pupils or patients,, as well as the absence of direct supervision. Intensity of technical constraints and of market constraints are both strongly and positively correlated with working at a very high speed and with tight

deadlines. Thus, internal regulators of the work process and market demande represent two different sources of high work intensity.

### *2.3.3 Work complexity*

Information on the characteristics of tasks, how they are performed, how they are coordinated and the associated learning process provides a measure of work complexity. Appendix 1 gives the list of questions used to compute our synthetic indicator of work complexity, which accounts for 22% of inertia. It shows an opposition between complex jobs and routine jobs. Jobs involving complex tasks also entail discretion in how to carry out the work and learning opportunities. On the opposite, another part of the workforce reports the performance of simple tasks, without any discretion in the choice of method of work, of the time to break or take days-off, without any problem solving or quality assessment activities. Therefore, these workers also report that they do not feel that they learn new things at work. The fact that complexity, discretion and learning go hand in hand supports the idea of the existence of an organizational learning model. In our 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 EWCS, where teams, job rotation and quality norms can be organised in different models offering different learning opportunities for employees.

### *2.3.4 A general assessment of quality of work across EU-15 countries*

Let us now describe the situation and the changes experienced in recent decades by the average EU-15 worker and the average worker in each country. Table 1 summarises our main findings by mapping quality of working conditions, intensity of technical constraints, intensity of market constraints and work complexity. It gives the rankings of each country according to average values of each indicator in 2005 and the sign of the variation of the EU-15 or country average indicators over 1995-2005. The reported countries' variations are purged of the structural effects of sectors and occupations. More precisely, we run regressions at the individual level in which the quality of working conditions is explained by occupation and sector in 1995 and 2005. Then, we retrieve the residuals, which provide the value of each

indicator when the occupation and the sector are controlled for, and we test the significance of their average variation over 1995-2005.

What are the observed trends in quality of work in EU-15 countries? In Table 1,the average EU-15 trends over 1995-2005 combine decreasing quality of working conditions with increased work intensity and decreased degree of work complexity. This is a rather negative general assessment with some implications in terms of health at work, and possibly in terms of workplace innovation. The job demand-control model (Karasek and Theorell, 1990) indicates that a high level of job demand associated with a low level of decision latitude is a good predictor of stressful work experiences and subsequent physical illness. If we refer to our synthetic indicators of work organization, this kind of work experience would be characterised by high work intensity combined with low work complexity. This is exactly what we find. On the other hand, Arundel et *al*. (2007) show, using the 2000 EWCS and the third Community Innovation survey aggregated at the country level, that in nations where work is organised to support high levels of discretion in solving complex problems, firms tend to be more active in terms of innovations developed through their own in-house creative efforts.

What about country situations? It is interesting to examine both levels in 2005 and trends over 1995-2005. The Netherlands and United Kingdom are characterised by the best average quality of working conditions in the EU-15. On the other hand, Greece and Finland show low levels of quality of working conditions. These two countries are also characterised by the highest intensity of technical constraints. The intensity of market constraints and the degree of work complexity are high in the three Scandinavian countries. Routine jobs are frequent in Spain and Greece. The lowest intensity of technical constraints is observed in Ireland while in Portugal it is the market constraints that are not prevalent. Finally, we observe significant variety in the models of work organisation in Europe. National groupings are quite difficult to discern. These results are at odds with the literatures on the variety of capitalism (Amable, 2003) and “welfare regimes” (Esping-Andersen, 1990). Overall, a country which is a leader in terms of work intensity and which lags behind in terms of quality of working conditions and of work complexity would be characterised by a low level of work quality compared with other European countries. Greece and Portugal combine all of these features. In other countries, evidence is more mixed as the different dimensions tend to compensate for each other in determining work quality. For example, in the United Kingdom, the quality of

working conditions was high in 2005, and it was combined with low intensities of technical and market. The most negative feature in this general assessment for the United Kingdom is the low level of work complexity.

In terms of trends, we observe the improved performance of the Anglo-Saxon countries in quality of working conditions and intensity of technical constraints. Six European countries exhibit a significant increase in technical constraints. The intensity of market constraints has considerably decreased only in three countries (United Kingdom, Austria and Portugal). Finally, work complexity significantly decreased in United Kingdom, Germany, Italy and Spain. Overall, only Germany and Italy register deteriorating trends in all three dimensions: there is a decrease in the quality of working conditions combined with an increase in the intensities of technical and market constraints and a decrease in work complexity. In other European countries, trends tend to counterbalance each other in the general assessment of changes in quality of work.

# 3) INVESTIGATING EU-15 AND COUNTRY-LEVEL HETEROGENEITY IN QUALITY OF WORK

We now analyse individual-level and country-level structural factors that shape quality of work. At the individual level, the key question is whether work quality has changed because of changes in the type of people sorting into particular jobs, in the nature of the relationships between job holders and employers, or in the type of technology used while performing the job. At the country level, the key question is whether differences between countries exist when individual factors are taken into account and whether these differences are purely idiosyncratic or can be explained by common factors such as the state of economic development or the characteristics of the labour market. This analysis aims to contribute to the policy debate by identifying channels by which policy may influence quality of work. To answer these questions we identify individual and country effects with multilevel models.

## 3.1 Taking into account structural factors in a multilevel model

Respondents in the EWCS are employed persons 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, 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. We estimate four models (cf. Box 1 and Appendix II) that assess these effects. We run them on the pooled data from the different surveys.

The first model identifies within-country and between-country variance. If there are no explanatory variables at level 1, the model equation is:

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

In traditional models, $\beta_{0j}$ 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 that may be expressed as follows:

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

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

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

This model decomposes the total variance into two independent components: the variance ($\hat{\sigma}^2$) of individual-level errors ($r_{ij}$) and the variance ($\hat{\tau}_{00}$) of the country-level errors ($u_{0j}$). The intra-country correlation can be expressed as:

$$\hat{\rho} = \frac{\hat{\tau}_{00}}{\hat{\tau}_{00} + \hat{\sigma}^2} \qquad (4)$$

This correlation indicates the proportion of the variance explained by the grouping structure in the sample. It is the expected correlation between two randomly chosen units that are in the same country. This intra-country correlation measures the share of the total variance that occurs between countries.

Model 2 includes year 2000 and 2005 dummies (noted *Year2000* and *Year2005*). As 1995 is the reference date, the coefficient associated with the year 2000 gives the 1995-2000 trend,

while the one associated with 2005 gives the 1995-2005 trend. A central objective in the model 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 (noted $Ind_{ij}$), and Model 4 includes year dummies, individual-level variables and country-level variables (noted $Country_j$).

**Box 1 Four models**

**Model 1**. Intercept-only model

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

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

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

**Model 2**. Inclusion of time dummies

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

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

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

**Model 3**. Inclusion of time dummies and individual-level 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 time dummies and individual- and country-level variables

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

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

$Y_{ij} = \gamma_{00} + \gamma_{0j} Country_j + T_1 Year2000 + T_2 Year2005 + \beta_{ij} Ind_{ij} + u_{0j} + r_{ij}$

where $u_{0j} \sim N(0, \tau_{00})$ and $r_{ij} \sim N(0, \sigma^2)$

At the individual level, the need for variables that are consistently measured over time imposes strong constraints on the information. We are able to measure gender, age, occupation (nine categories), employment status (fixed term or open-ended contract, self-employment or salaried work), sector of the workplace (it is the only information on the employer that is available over time) and two features of the employee's job description, the use of a computer and a supervisory role.

These characteristics may influence quality of work. We would have liked to explicitly take into account educational attainment and work experience as proxies for skills, in reference to human capital theory, but this information is not available in all surveys. However, a broader conception of skills in which they develop through work experience, learning by doing and on-the-job training is now widely accepted. In this sense, occupation is considered as a relevant measure of human capital. Furthermore, age, management position and computer use complement occupation in the indirect assessment of skills.

The availability of time series for the EU-15 also limits what we measure at the country level. The OECD (2002, 2003, 2004, 2005, and 2006) and Eurostat (2005) databases are our central sources for country-level variables. We retained ten major country-level variables that may be related to the quality of work:

- Real annual GDP growth 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 (log) number of patent applications to the European Patent Office (EPO) and the share of persons between 25 and 64 years old with tertiary educational attainment capture the development of the knowledge base of economy

- The shares of particular industries (ISIC 10-45) and services (ISIC 50-99) in civilian employment measure countries' industrial structures

- The share of women in active population and the share of 50 (or more) years old workers in active population capture demographic trends.

- The unemployment rate and the part-time employment rate in total employment characterise the state of the labour market

We rely on limited country-level information: 45 observations in total. Moreover, some of the country-level variables that we consider are strongly correlated with one another: percentage of females in the economically active population, percent part-time employment, log number of patent applications, percent tertiary educational attainment and percent employed in services sector. It is thus not efficient to enter the nine country-level variables at the same time in model 4. We select the combination of country-level variables that minimizes the

intra-country correlation in model 4 when we compare it to model 3. We have chosen two different models (model 4 and model 4') for work complexity.

## 3.2 The results

### *3.2.1 Multi-level models*

Summary results of the models for the four quality of work indicators are reported in Table 2 and Table 3 and complete estimations of multilevel models are given in Appendix 3. Table 2 summarises the intercept and trend coefficients from multi-level models and table 3 depicts the complete model with the random country effect, year dummies, individual variables and country-level variables (model 4). When more than one model 4 is estimated, the results for country-level variables in Table 3 pool coefficients from the various regressions.

In model 2, the intercept gives the average EU-15 level of each synthetic indicator in 1995. In model 3, it becomes the average EU-15 level of each synthetic indicator for the reference individual: he is a young plant and machine operator working in the manufacturing sector on an unlimited contract, using no computer and with no supervisory role (Appendix II). 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: the intercept gives the average level of each indicator for our reference employee in an "average" EU-15 country, which is a country where macroeconomic variables take the EU-15 average.

The central objective of our modelling is to identify the sensitivity of trend coefficients to the inclusion of individual-level and country-level variables. In other words, the aim of these regressions is to reveal whether quality of work has evolved over time, holding individual-level and country-level variables constant. We report the results of work quality trends from the complete model in the last column of the table 2 and in the trend analysis part of table 3. They confirm that, in the EU-15 over 1995-2005, there has been a decrease in the quality of working conditions, an increase in the intensity of technical and market constraints and a decrease in the degree of work complexity. By comparing models 2, 3 and 4 (in table 2), the trend coefficients remain significant and of the same sign.

By comparing models 2 and 3, we identify how much individual variance is explained by the eight individual variables introduced in model 3 (Table 3). Quality of working conditions and

degree of work complexity are the best explained indicators: individual variables explain, respectively, 30% and 25% of total individual variance. Work intensity indicators are more difficult to explain using individual variables. The shares of explained individual variance amount, respectively, to 16% and 11% (Table 3).

At the individual level, sectors and occupations are marked by strong specificities: construction is characterised by low-quality working conditions and a high degree of work complexity; manufacturing has a high intensity of technical constraints and low intensities both in market constraints and in work complexity; services are characterized by a high intensity of market constraints; and the public sector has high-quality working conditions and a low intensity of technical constraints. The quality of working conditions is the highest for clerks and the lowest for craftspeople and related trade workers. The highest intensity of market constraints is observed for service providers and sales workers, and the highest intensity of technical constraint is observed for plant and machine operators. Lastly, the degree of work complexity is the highest for professionals and the lowest for elementary occupations and plant and machine operators.

Women experience higher-quality working conditions and intensity of market constraints compared to men, who experience higher technical constraints and degree of work complexity. Age increases the quality of working conditions and decreases technical and market constraints as well as work complexity after the threshold age of 44. However, the work complexity is the lowest for the youngest workers (between ages 15 and 24), who also experience the highest technical constraints. Compared with employees, self–employed individuals enjoy a higher quality of working conditions, a higher degree of work complexity and lower intensity of technical constraints, but they also face higher market pressures. An employee with a fixed-term contract experiences a higher intensity of technical constraints and a lower intensity of market constraints and degree of work complexity than an employee with an open-ended contract, but there are no significant differences in the quality of working conditions. Finally, the use of a computer has an impact on the quality of work that is similar to that of a supervisory role: a higher intensity of work from both technical and market sources and a higher degree of work complexity. Surprisingly, individuals having a supervisory role experienced lower-quality working conditions.

Country-level variables explain an uneven share of country-level variance. At the country level, work intensities are the best explained indicators: the log number of patents explains

33% of the country-level intensity of market constraints, and the share of manufacturing in employment explains 23% of the intensity of technical constraints. Innovative activity at the country level is a clear and powerful driver of the intensity of market constraints. As it is easier to patent a new product than new processes, we speculate that market constraints at the country level are driven by product innovation.

For the intensity of technical constraints, country-level results are less intuitive because the relationship with the share of the manufacturing sector in civil employment is negative. We need to keep in mind, however, that at the individual level, the highest intensity of technical constraints is observed in manufacturing. Thus, what our model 4 tells us is that in countries with a larger manufacturing sector in terms of employment, employees experience relatively less intense technical constraints than do employees in countries where the manufacturing sector occupies a smaller share of the workforce. One explanation could be that larger manufacturing sectors are specialised in traditional industries with lower capital intensity and less work standardisation. Mediterranean countries like Portugal, Italy and Spain are in this situation.

Only 4% of the country-level variance in the quality of working conditions is explained by the country-level variables selected in model 4. The unemployment rate and the share of females in the economically active population are negatively correlated with the quality of working conditions. The relationship between the quality of working conditions and the unemployment rate is quite straightforward, but it is difficult to explain why higher female participation is negatively correlated with the quality of working conditions when the relationship at the individual level is, as we have already stressed, positive. Could this finding be a consequence of the correlation between low participation in the workforce by women and a labour-intensive manufacturing sector?

As far as the degree of work complexity is concerned, the inclusion of country-level variables in model 4 explains about 10% of the country-level variance remaining when we take into account individual factors. 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 and log number of patents in model 4'. The percentage of international trade in GDP is also positively linked to the degree of work complexity. Countries that are more opened to international trade seem to specialise in activities that entail more complex work. An aging economically active population implies a lower degree of work

complexity, whereas conversely, female participation in the labour market is positively linked with work complexity. 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 cut in economic downturns, when unemployment rates become higher. Conversely, when economic activity expands again, the degree of work complexity should fall because less complex jobs are being created; the negative (but not 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.

### *3.2.2 Discussion*

Low-quality working conditions associated with high levels of work intensity and a low degree of work complexity may increase the incidence of work-related health problems. What is the distribution of such risks across European workers and countries? In terms of occupations, plant and machine operators, craftspeople and related trade workers and unskilled labourers are the most exposed to low-quality working conditions. The population of young workers also appears to be more exposed to poor working conditions, although the risks tend to be shared between the youngest workers, aged between 15 and 24 years, who experience intense technical constraints, a low degree of work complexity and a rather low quality of work, and the workers aged between 24 and 34 years, who experience low-quality working conditions and high work intensity from market sources. Furthermore, computer use must be closely monitored for its positive impact on both sources of work intensity. We know that computer use is a rather poor indicator of ICT diffusion. It is important to be able to distinguish between varying uses of computers and to identify whether some uses combine high intensity with high standardisation, leading to low work complexity. Finally, a gender perspective also proves necessary. At the individual level, women face higher intensity of market constraints and experience lower degrees of work complexity; at the country level, female participation is positively correlated with lower quality of working conditions. As a result, in countries with high female participation, women are more exposed to low-quality working conditions.

The complexity paradox is another result that demands further discussion. Strong structural forces drive an increase in work complexity. At the individual level, occupations with higher educational attainment, age as a proxy of accumulated work experience and computer use are associated with higher levels of work complexity. At the country level, globalisation,

increasing female participation in the workforce and the development of the knowledge base of the economy tend to favour increased work complexity. Thus, taking into account the evolution of these structural factors, we expected to capture an increase in work complexity instead of the slight decrease we observe in simple descriptive statistics. Looking closely at model 4's results, some possible drivers of a decrease in work complexity can be identified that are connected with gender, part-time work, fixed-term contracts, supervisory roles and aging. A strand of literature on gender and work discusses the ways in which patterns of segregation have recently been reinforced or challenged. Some positive assumptions 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, have strictly defined gender roles, while new forms of organisation should favour more porous gender roles. However, the empirical research often contradicts this assumption (Liff and Ward, 2001). Results in Tables 3 show that, all things being equal, women perform more routine jobs than men. One reason for this finding could be that more stereotypically female jobs have moved to the market sector, where they are often organised in a traditional way with a low level of employee discretion. However, this negative result is mitigated by our positive country-level result on female participation. Countries with greater percentages of part-time employment are characterised by lower degrees 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 the 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. A precarious employment relationship does not favour work complexity, but routine jobs with fewer opportunities for learning and competence development. Using employee-level data from an Italian nationwide skills survey, 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, in particular problem-solving skills. They show that these negative impacts reflect three problems: a lack of experience accumulation at the workplace for the temporary contract effect, a lack of further training for the part-time effect and a lack of access to jobs with innovative organisational characteristics for the gender effect. It is also worth noting that the share of employees with people under their supervision tends to decrease with time in many EU-15 countries. As the work of supervisors and managers is more complex, this decrease could contribute to lower work complexity. Finally, our estimations reveal an inverted U-shaped

profile for work complexity according to age. The younger workers are employed in the more routine jobs. Then, work complexity increases between ages 24 and 44 and decreases slightly afterwards, remaining at a higher level after 55 than the level for younger workers. This effect finds a country-level counterpart in the negative effect of the share of individuals aged 50 and over in the economically active population. However, as the regression results show, 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.

## 4) CONCLUSION

Two main contributions are made in this paper in terms of methodology. First, quality of work is not measured through a unique indicator but by a set of four synthetic indicators measuring the quality of working conditions, the intensity of technical constraints, the intensity of market constraints and the degree of work complexity. We find that the spread of synthetic indicators across individuals and countries and their evolution through time are such that negative and positive aspects of the quality of work tend to balance out each other. This result confirms the usefulness of working with a set of indicators rather than with a single unique indicator. In order to monitor risks at work, it is important to follow up different sources of risks separately to be able to identify both work contexts where one risk becomes more prevalent and work situations where risk factors tend to be cumulative. Second, we use multilevel modelling to analyse observed trends in quality of work. Multilevel analysis has two interesting properties: it allows taking into account composition effects behind the observed trends, and it provides tools to quantify and explain the "country effect" embedded into the individual-level data.

We find evidence of a decreasing trend in the quality of work in the EU-15 over 1995-2005. Over that period, quality of working conditions deteriorated, while at the same time technical and market constraints became more intense and work complexity decreased. We know that work contexts that are very demanding, with high work intensity and low decision latitude, generate stress. Thus, we may infer from the work intensity and complexity trends that mental strain has been on the rise in Europe, while physical working conditions failed to improve. Green and McIntosh (2001) and Green (2006) analysed an intensification of the rhythm of work in Europe between 1991 and 1995 as indicated by longer hours spent at work and greater work effort during a given period of time. In this paper, we build on these results by

distinguishing two sources of work intensity. The first measures the accumulation of technical constraints (linked to machines and to the production process), and the second measures market constraints (linked to customers' demands).

Our statistical analysis leaves the complexity paradox unresolved. The decrease in work complexity appears to be strongest in the United Kingdom, Germany, Spain and Italy. In the United Kingdom and Germany, increasing polarisation of work has also been observed (Goos and Manning, 2007; Spitz-Oener, 2006). The two phenomena could well be connected and indirectly linked to technological progress. As argued by Greenan *et al.* (2009), computer and Internet use are positively correlated with work complexity. However, ICTs also contribute to the global restructuring of the value chain. In this process, outsourced or offshored tasks and work processes are standardised. If these tasks were previously performed by individuals in occupations requiring intermediate skills, global value chain restructuring could play a central role both in work polarisation and in decreasing work complexity. This puzzling result requires further investigation.

Varying shares of individual-level variance and country-level variance were explained through multilevel analysis. Our eight individual-level variables more effectively explain the quality of working conditions and the degree of work complexity than work intensity indicators. Further analysis would require more detailed information. First, employer-level variables were unavailable. It would be very useful to know more about the structure and management practices of the employer unit to assess its impact on the quality of work. Second, to separate "people effects" from "sorting effects" (the fact that employees with certain personal characteristics are selected for or self-select into specific jobs), panel information is required. Multilevel analysis identifies and measures country effects in our four indicators. Unlike at the individual level, work intensity indicators are better explained at the country level than quality of working conditions or degree of work complexity. Indicators of the development of the knowledge base of the economy, demographic trends and the state of the labour market are significantly correlated with our quality of work indicators at the country level. Quality of work is not only a matter of people and jobs. It is also sensitive to the country environment and to the framing effect of institutional settings. It would be interesting to develop indicators of work policies at the country or regional level to assess their influence on quality of work. However, the present research is constrained by the availability of data as well as by the number of countries and available waves of the survey.

Finally, we identified increased risks due to the trends in the quality of work in Germany and Italy, that could well be associated in the long run with lower innovativeness. Compared to other EU-15 countries, Greece and Portugal are the countries where risks are the highest, combining low-quality working conditions, high work intensity and low work complexity.

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## Table 1. Quality of work in EU15 between 1995 and 2005: a summary

| | Quality of working conditions | | Intensity of technical constraints | | Intensity of market constraints | | Degree of work complexity | |
|---|---|---|---|---|---|---|---|---|
| | **Rank 2005** | **Trend 95-05** | **Rank 2005** | **Trend 95-05** | **Rank 2005** | **Trend 95-05** | **Rank 2005** | **Trend 95-05** |
| *EU-15 average* | | (-) | | (+) | | (+) | | (-) |
| *Scandinavian countries* | | | | | | | | |
| Denmark | 3 | 0 | 6 | (+) | 3 | (+) | 1 | (+) |
| Finland | 14 | (-) | 1 | 0 | 2 | 0 | 4 | 0 |
| Sweden | 9 | 0 | 7 | (-) | 1 | (+) | 2 | 0 |
| *British Isles* | | | | | | | | |
| Ireland | 4 | (+) | 15 | (-) | 11 | 0 | 9 | (+) |
| United Kingdom | 2 | (+) | 9 | (-) | 14 | (-) | 10 | (-) |
| *Western Europe* | | | | | | | | |
| Austria | 8 | (+) | 5 | (-) | 6 | (-) | 5 | (+) |
| Belgium | 5 | (-) | 8 | (+) | 10 | 0 | 7 | 0 |
| Germany | 10 | (-) | 4 | (+) | 5 | (+) | 13 | (-) |
| France | 11 | 0 | 13 | 0 | 13 | 0 | 8 | 0 |
| Luxembourg | 6 | 0 | 11 | (+) | 12 | (+) | 6 | (+) |
| Netherlands | 1 | 0 | 10 | 0 | 4 | (+) | 3 | 0 |
| *Mediterranean countries* | | | | | | | | |
| Greece | 15 | (+) | 2 | 0 | 8 | 0 | 14 | (+) |
| Italy | 7 | (-) | 12 | (+) | 7 | (+) | 11 | (-) |
| Portugal | 13 | (-) | 3 | (+) | 15 | (-) | 12 | 0 |
| Spain | 12 | (0) | 14 | (-) | 9 | (+) | 15 | (-) |

Note: + indicates an increase and – a decrease. Significant changes (at least at 10% level) are indicated in brackets.

## Table 2. Intercept and trend coefficients from multi-level models.

| | Model 1 | Model 2 | Model 3 | Model 4 (Model 4') |
|---|---|---|---|---|
| **Quality of working conditions** | | | | |
| Intercept | -0,026 | -0,007 | -0,446*** | -0,453*** |
| Year2000 | | -0,027*** | -0,045*** | -0,049*** |
| Year2005 | | -0,028*** | -0,080*** | -0,047*** |
| **Intensity of technical constraints** | | | | |
| Intercept | 0,034** | 0,003 | 0,447*** | 0,457*** |
| Year2000 | | 0,024*** | 0,037*** | 0,029*** |
| Year2005 | | 0,076*** | 0,101*** | 0,080*** |
| **Intensity of market constraints** | | | | |
| Intercept | 0,042 | 0,010 | -0,243*** | -0,225*** |
| Year2000 | | 0,043*** | 0,044*** | 0,019*** |
| Year2005 | | 0,051*** | 0,046*** | 0,018** |
| **Degree of work complexity** | | | | |
| Intercept | -0,017 | 0,016 | -0,425*** | -0,415***(-0,395***) |
| Year2000 | | -0,055*** | -0,048*** | -0,051***(-0,089***) |
| Year2005 | | -0,038*** | -0,038*** | -0,062***(-0.079***) |

Note: * significant at 10%, ** significant at 5%, *** significant at 1%

## Table 3. Quality of work in EU15 between 1995 and 2005: a summary of results

| | Quality of working conditions | Intensity of technical constraints | Intensity of market constraints | Degree of work complexity |
|---|---|---|---|---|
| **Trend analysis** | | | | |
| 1995-2000: | -0,049 | 0,029 | 0,019 | -0,051 |
| 1995-2005: | -0,047 | 0,080 | 0,018 | -0,062 |
| **Individual level (n=52248)** | | | | |
| **Female** | + | - | + | - |
| **Age** | | | | |
| **Min** | 25-34 | 55+ | 55+ | 15-24 |
| **Max** | 55+ | 15-24 | 25-34 | 35-44 |
| **Self employed** | + | - | + | + |
| **Fixed term contract** | | + | - | - |
| **Computer use** | + | + | + | + |
| **Supervisory role** | - | + | + | + |
| **Sector** | | | | |
| **Min** | Construction | Public | Agriculture and manufacturing | Manufacturing |
| **Max** | Public | Manufacturing | Services | Construction |
| **Occupation** | | | | |
| **Min** | Craft and related trades workers | Professionals | Elementary occupations | Plant and machine operators and Elementary occupations |
| **Max** | Clerks | Plant and machine operators | Services and sales workers | Professionals |
| **Country level (n=45)** | | | | |
| **Ln of number of patents** | | | + | **[+]** |
| **% tertiary attainment** | | | | + |
| **% trade in GDP** | | | | **[+]** |
| **% manufacturing** | | - | | |
| **% ages 50 and more** | | | | - |
| **Unemployment rate** | - | | | + |
| **% part time** | | | | **[-]** |
| **% female** | - | | | **[+]** |
| **% intracountry correlation** | | | | |
| **Model 1** | 2,54% | 1,18% | 5,86% | 6,55% |
| **Model 2** | 2,53% | 1,19% | 5,92% | 6,55% |
| **Model 3** | 2,70% | 1,95% | 6,12% | 6,52% |
| **Model 4** | 2,10% | 1,50% | 4,16% | 6,37% |
| **Model 4'** | | | | 5,94% |
| **% individual variance explained by individual level variables** | | | | |
| **Model 3 vs. model 2** | 30% | 16% | 11% | 25% |
| **% country variance explained by country level variables** | | | | |
| **Model 4 vs. model 3** | 4% | 23% | 33% | 10% |

Note: This table summarises multilevel regressions. Indicated results correspond to coefficients which are significant at least at a 10% level. When effects are in between brackets, they come from model 4' (only for the degree of work complexity), other results being linked to model 4.

# Appendix I: Synthetic indicators

| 1995 | 2000 | 2005 | Quality of working conditions | Synthetic Indicator* |
|---|---|---|---|---|
| (%) | (%) | (%) | Intercept | -0.630 |
| | | | *Are you exposed at work to:* | |
| | | | -Vibrations from hand tools, machinery, *etc.*? | |
| 21.72 | 22.43 | 23.03 | Yes | **-0,123** |
| 78.28 | 77.57 | 76.97 | No | 0,123 |
| | | | -Noise so loud that you would have to raise your voice to talk to people? | |
| 26.26 | 27.46 | 28.65 | Yes | **-0,112** |
| 73.74 | 72.54 | 71.35 | No | **0,112** |
| | | | -High temperatures which make you perspire even when not working? | |
| 18.56 | 21.83 | 23.35 | Yes | **-0,105** |
| 81.44 | 78.17 | 76.65 | No | 0,105 |
| | | | -Low temperatures whether indoors or outdoors? | |
| 23.17 | 20.37 | 20.29 | Yes | **-0,100** |
| 76.83 | 79.63 | 79.71 | No | 0,100 |
| | | | -Breathing in smoke, fumes, powder or dust, *etc*? | |
| 22.3 | 21.36 | 17.49 | Yes | **-0,125** |
| 77.7 | 78.64 | 82.51 | No | 0,125 |
| | | | -Handling or being in skin contact with chemical products or substances? | |
| 13.68 | 14.78 | 13.82 | Yes | **-0,127** |
| 86.32 | 85.22 | 86.18 | No | 0,127 |
| | | | -Radiation such as W rays, radioactive radiation, welding light, laser beams? | |
| 5.23 | 5.22 | 4.64 | Yes | **-0,121** |
| 94.77 | 94.78 | 95.36 | No | 0,121 |
| | | | *Does your main job involve* | |
| | | | -Painful or tiring positions | |
| 43.55 | 45.24 | 44.27 | Yes | **-0,083** |
| 56.45 | 54.76 | 55.73 | No | **0,083** |
| | | | -Carrying or moving heavy loads | |
| 32.34 | 36.29 | 33.76 | Yes | **-0,099** |
| 67.66 | 63.71 | 66.24 | No | **0,099** |
| | | | -Repetitive hand or arm movements | |
| 55.59 | 56.47 | 61.19 | Yes | -0,066 |
| 44.41 | 43.53 | 38.81 | No | 0,066 |
| | | | -Wearing personal protective equipment | |
| 23.87 | 27.88 | 31.83 | Yes | **-0,104** |
| 76.13 | 72.12 | 68.17 | No | 0,104 |
| | | | *Individual has been subjected to some forms of violence or discrimination* | |
| 12.43 | 13.3 | 12.42 | Yes | -0,032 |
| 87.57 | 86.7 | 87.58 | No | 0,032 |

| | | | Work intensity | Technical* | Market* |
|---|---|---|---|---|---|
| | | | Intercept | 0.249 | -0.241 |
| | | | *Does your job involve?* | | |
| | | | -Short repetitive tasks of less than 10 minutes | | |
| 35.46 | 45.61 | 39.28 | Yes | **0,110** | 0,036 |
| 64.54 | 54.39 | 60.72 | No | -0,110 | -0,036 |
| | | | -Working at very high speed | | |
| 53.39 | 55.26 | 60.66 | Yes | **0,141** | **0,161** |
| 46.61 | 44.74 | 39.34 | No | **-0,141** | **-0,161** |
| | | | -Working to tight deadlines | | |
| 55.28 | 58.64 | 61.87 | Yes | **0,136** | **0,171** |
| 44.72 | 41.36 | 38.13 | No | **-0,136** | **-0,171** |
| | | | *On the whole, is your pace of work dependent, or not on…* | | |
| | | | -The work done by colleagues? | | |
| 36.95 | 42.15 | 41.71 | Yes | **0,133** | -0,052 |

| | | | | | |
|---|---|---|---|---|---|
| 63.05 | 57.85 | 58.29 | No | -0,133 | 0,052 |
| | | | -Direct demands from people such as customers, passengers, pupils, patients, *etc.?* | | |
| 68.77 | 69.66 | 70.4 | Yes | -0,022 | **0,206** |
| 31.23 | 30.34 | 29.6 | No | 0,022 | **-0,206** |
| | | | -Numerical production targets? | | |
| 33.98 | 30.11 | 42.09 | Yes | **0,163** | -0,073 |
| 66.02 | 69.89 | 57.91 | No | **-0,163** | 0,073 |
| | | | -Automatic speed of a machine or movement of a product? | | |
| 20.83 | 19.15 | 18.27 | Yes | **0,190** | -0,111 |
| 79.17 | 80.85 | 81.73 | No | -0,190 | 0,111 |
| | | | -The direct control of your boss? | | |
| 34.41 | 31.39 | 33.45 | Yes | **0,112** | **-0,140** |
| 65.59 | 68.61 | 66.55 | No | -0,112 | 0,140 |
| | | | **Work complexity** | | **Synthetic indicators*** |
| **(%)** | **(%)** | **(%)** | Intercept | | -0.411 |
| | | | *Does your main paid job involve…?* | | |
| | | | -Meeting precise quality standards | | |
| 71.07 | 68.23 | 73.52 | Yes | | 0.066 |
| 28.93 | 31.77 | 26.48 | No | | -0.066 |
| | | | -Assessing yourself the quality of your own work | | |
| 75.58 | 74.04 | 71.44 | Yes | | 0.089 |
| 24.42 | 25.96 | 28.56 | No | | **-0.089** |
| | | | -Solving unforeseen problems on your own | | |
| 83.77 | 81.97 | 80.93 | Yes | | 0.145 |
| 16.23 | 18.03 | 19.07 | No | | **-0.145** |
| | | | -Monotonous tasks | | |
| 43.72 | 38.78 | 41.39 | Yes | | -0.019 |
| 56.28 | 61.22 | 58.61 | No | | 0.019 |
| | | | -Complex tasks | | |
| 58.55 | 55.51 | 58.18 | Yes | | **0.101** |
| 41.45 | 44.49 | 41.82 | No | | **-0.101** |
| | | | -Learning new things | | |
| 75.79 | 70.41 | 69.56 | Yes | | **0.122** |
| 24.21 | 29.59 | 30.44 | No | | **-0.122** |
| | | | -Rotating tasks between yourself and colleagues | | |
| 54.68 | 43.23 | 42.87 | Yes | | 0.049 |
| 45.32 | 56.77 | 57.13 | No | | -0.049 |
| | | | *Are you able, or not, to choose or change…?* | | |
| | | | -Order of tasks | | |
| 65.7 | 64.17 | 63.44 | Yes | | **0.123** |
| 34.3 | 35.83 | 36.56 | No | | **-0.123** |
| | | | -Methods of work | | |
| 72.09 | 70.4 | 67.71 | Yes | | **0.128** |
| 27.91 | 29.6 | 32.29 | No | | **-0.128** |
| | | | *For each of the following statements, please answer yes or no:* | | |
| | | | -You can get assistance from colleagues if you ask for it | | |
| 83.48 | 82.45 | 81.63 | Yes | | 0.039 |
| 16.52 | 17.55 | 18.37 | No | | -0.039 |
| | | | -You can take your break when you wish | | |
| 63.12 | 60.46 | 63.34 | Yes | | 0.081 |
| 36.88 | 39.54 | 36.66 | No | | **-0.081** |
| | | | -You are free to decide when to take holidays or day off | | |
| 56.97 | 55.35 | 66.91 | Yes | | 0.072 |
| 43.03 | 44.65 | 33.09 | No | | **-0.072** |

Note: *coefficients of synthetic indicators 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 item response to the inertia of the synthetic indicator. The underlying multiple correspondences analyses has been conducted using the EWCS of 1995.

# Appendix II. Variables used in multilevel analysis

| | Model 1 | Model 2 | Model 3 | Model 4 | | | | |
|---|---|---|---|---|---|---|---|---|
| Intercept | ● | ● | ● | ● | | | | |
| **Trend analysis** | | | | | | | | |
| *Year 1995* | *Reference* | | | | | | | |
| Year 2000 | | ● | ● | ● | | | | |
| Year 2005 | | ● | ● | ● | | | | |
| **Individual level (n=52248)** | | | | | | | | |
| Individual is female | | | ● | ● | | | | |
| *Individual's age is between 15 and 24* | *Reference* | | | | | | | |
| Individual's age is between 25 and 34 | | | ● | ● | | | | |
| Individual's age is between 35 and 44 | | | ● | ● | | | | |
| Individual's age is between 45 and 54 | | | ● | ● | | | | |
| Individual's age is between 55 and + | | | ● | ● | | | | |
| Individual is self-employed | | | ● | ● | | | | |
| Individual is on a fixed term contract | | | ● | ● | | | | |
| Individual' main job involves working with computers | | | ● | ● | | | | |
| Individual has people under his/her supervision | | | ● | ● | | | | |
| Agriculture | | | ● | ● | | | | |
| *Manufacturing* | *Reference* | | | | | | | |
| Services | | | ● | ● | | | | |
| Construction | | | ● | ● | | | | |
| Public sector | | | ● | ● | | | | |
| Legislators (and senior officials) and managers | | | ● | ● | | | | |
| Professionals | | | ● | ● | | | | |
| Technicians (and associate professionals) | | | ● | ● | | | | |
| Clerks | | | ● | ● | | | | |
| Service workers and (shop and market) sales workers | | | ● | ● | | | | |
| (Skilled) agricultural and fishery workers | | | ● | ● | | | | |
| Craft and related trades workers | | | ● | ● | | | | |
| *Plant and machine operators* | *Reference* | | | | | | | |
| Elementary occupations | | | ● | ● | | | | |
| **Country level (n=45)** | | | | **Q.W.C.** | **I.T.C.** | **I.M.C.** | **D.W.C.** | |
| Real annual GDP growth | | | | ● | | | ● | ◊ |
| Unemployment rate | | | | ● | | | ● | |
| % Females in economically active population | | | | ● | | | | ◊ |
| % Services sector in civil employment | | | | | ● | | | |
| % Manufacturing sector in civil employment | | | | | ● | | | |
| Ln of nb of patent applications to the EPO per million inhbts | | | | | | ● | | ◊ |
| % Part-time employment in total employment | | | | | | | | ◊ |
| % Trade in goods and services in GDP | | | | | | | ● | ◊ |
| % Tertiary attainment for age group 24-64 | | | | | | | ● | |
| % Aged 50 and more in economically active population | | | | | | | ● | |

Note: Q.W.C. – quality of working conditions; I.T.C. – intensity of technical constraints; I.M.C. – intensity of market constraints; D.W.C. – degree of work complexity

● – variable is present in the model; ◊ - model 4' for degree of work complexity (the individual variables are the same as in model 4, only country-level variables change)

# Appendix III: Multilevel regressions (cf. Table 2 and 3 in the paper)

## Table A1. Quality of working conditions: multilevel analysis

| | **Model 1** | **Model 2** | **Model 3** | **Model 4** |
|---|---|---|---|---|
| Intercept | -0,026 | -0,007 | -0,446*** | -0,453*** |
| **Trend analysis** | | | | |
| *Year 1995* | *Reference* | | | |
| Year 2000 | | -0,027*** | -0,045*** | -0,049*** |
| Year 2005 | | -0,028*** | -0,080*** | -0,047*** |
| **Individual level (n=52248)** | | | | |
| Individual is female | | | 0,093*** | 0,093*** |
| *Individual's age is between 15 and 24* | *Reference* | | | |
| Individual's age is between 25 and 34 | | | -0,017** | -0,017** |
| Individual's age is between 35 and 44 | | | 0,003 | 0,002 |
| Individual's age is between 45 and 54 | | | 0,018** | 0,018** |
| Individual's age is between 55 and + | | | 0,086*** | 0,086*** |
| Individual is self-employed | | | 0,035*** | 0,035*** |
| Individual is on a fixed term contract | | | -0,002 | -0,003 |
| Individual' main job involves working with computers | | | 0,098*** | 0,099*** |
| Individual has people under his/her supervision | | | -0,045*** | -0,045*** |
| Agriculture | | | -0,073*** | -0,076*** |
| *Manufacturing* | *Reference* | | | |
| Services | | | 0,138*** | 0,138*** |
| Construction | | | -0,137*** | -0,139*** |
| Public sector | | | 0,147*** | 0,147*** |
| Legislators (and senior officials) and managers | | | 0,464*** | 0,463*** |
| Professionals | | | 0,480*** | 0,480*** |
| Technicians (and associate professionals) | | | 0,420*** | 0,420*** |
| Clerks | | | 0,528*** | 0,528*** |
| Service workers and (shop and market) sales workers | | | 0,358*** | 0,358*** |
| (Skilled) agricultural and fishery workers | | | -0,025 | -0,021 |
| Craft and related trades workers | | | -0,097*** | -0,097*** |
| *Plant and machine operators* | *Reference* | | | |
| Elementary occupations | | | 0,168*** | 0,169*** |
| **Country level (n=45)** | | | | |
| Real annual GDP growth | | | | 0,007 |
| Unemployment rate | | | | -0,008*** |
| % Females in economically active population | | | | -0,019*** |
| **Random components** | | | | |
| Variance of the country level residual errors | 0,008*** | 0,008*** | 0,006*** | 0,006** |
| Variance of the individual level residual errors | 0,323*** | 0,323*** | 0,224*** | 0,224*** |
| Intra country correlation in percentage | **2,54%** | **2,53%** | **2,7%** | **2,10%** |

Note: * significant at 10%, ** significant at 5%, *** significant at 1%.

## Table A2. Intensity of technical constraints: multilevel analysis

| | Model 1 | Model 2 | Model 3 | Model 4 |
|---|---|---|---|---|
| Intercept | 0,034** | 0,003 | 0,447*** | 0,457*** |
| **Trend analysis** | | | | |
| *Year 1995* | *Reference* | | | |
| Year 2000 | | 0,024*** | 0,037*** | 0,029*** |
| Year 2005 | | 0,076*** | 0,101*** | 0,080*** |
| **Individual level (n=52248)** | | | | |
| Individual is female | | | -0,044*** | -0,044*** |
| *Individual's age is between 15 and 24* | *Reference* | | | |
| Individual's age is between 25 and 34 | | | -0,037*** | -0,037*** |
| Individual's age is between 35 and 44 | | | -0,082*** | -0,082*** |
| Individual's age is between 45 and 54 | | | -0,116*** | -0,116*** |
| Individual's age is between 55 and + | | | -0,188*** | -0,188*** |
| Individual is self-employed | | | -0,189*** | -0,189*** |
| Individual is on a fixed term contract | | | 0,014* | 0,013* |
| Individual' main job involves working with computers | | | 0,078*** | 0,078*** |
| Individual has people under his/her supervision | | | 0,123*** | 0,123*** |
| Agriculture | | | -0,029 | -0,027 |
| *Manufacturing* | *Reference* | | | |
| Services | | | -0,231*** | -0,230*** |
| Construction | | | -0,070*** | -0,069*** |
| Public sector | | | -0,301*** | -0,301*** |
| Legislators (and senior officials) and managers | | | -0,286*** | -0,286*** |
| Professionals | | | -0,370*** | -0,370*** |
| Technicians (and associate professionals) | | | -0,293*** | -0,294*** |
| Clerks | | | -0,242*** | -0,242*** |
| Service workers and (shop and market) sales workers | | | -0,299*** | -0,299*** |
| (Skilled) agricultural and fishery workers | | | -0,161*** | -0,164*** |
| Craft and related trades workers | | | -0,073*** | -0,073*** |
| *Plant and machine operators* | *Reference* | | | |
| Elementary occupations | | | -0,184*** | -0,184*** |
| **Country level (n=45)** | | | | |
| Unemployment rate | | | | |
| % Services sector in civil employment | | | | -0,003 |
| % Manufacturing sector in civil employment | | | | -0,010*** |
| % Females in economically active population | | | | |
| **Random components** | | | | |
| Variance of the country level residual errors | 0,003*** | 0,003*** | 0,004*** | 0,003*** |
| Variance of the individual level residual errors | 0,264*** | 0,263*** | 0,2198*** | 0,2197*** |
| Intra country correlation in percentage | **1,18%** | **1,19%** | **1,95%** | **1,5%** |

Note: * significant at 10%, ** significant at 5%, *** significant at 1%.

## Table A3. Intensity of market constraints: multilevel analysis

| | Model 1 | Model 2 | Model 3 | Model 4 |
|---|---|---|---|---|
| Intercept | 0,042 | 0,010 | -0,243*** | -0,225*** |
| **Trend analysis** | | | | |
| *Year 1995* | *Reference* | | | |
| Year 2000 | | 0,043*** | 0,044*** | 0,019*** |
| Year 2005 | | 0,051*** | 0,046*** | 0,018** |
| **Individual level (n=52248)** | | | | |
| Individual is female | | | 0,015*** | 0,014*** |
| *Individual's age is between 15 and 24* | *Reference* | | | |
| Individual's age is between 25 and 34 | | | 0,017*** | 0,017*** |
| Individual's age is between 35 and 44 | | | 0,004 | 0,004 |
| Individual's age is between 45 and 54 | | | -0,001 | -0,001 |
| Individual's age is between 55 and + | | | -0,036*** | -0,036*** |
| Individual is self-employed | | | 0,168*** | 0,168*** |
| Individual is on a fixed term contract | | | -0,034*** | -0,034*** |
| Individual' main job involves working with computers | | | 0,071*** | 0,070*** |
| Individual has people under his/her supervision | | | 0,056*** | 0,056*** |
| Agriculture | | | 0,006 | 0,006 |
| *Manufacturing* | *Reference* | | | |
| Services | | | 0,152*** | 0,152*** |
| Construction | | | 0,124*** | 0,123*** |
| Public sector | | | 0,076*** | 0,076*** |
| Legislators (and senior officials) and managers | | | 0,106*** | 0,107*** |
| Professionals | | | 0,097*** | 0,098*** |
| Technicians (and associate professionals) | | | 0,079*** | 0,079*** |
| Clerks | | | 0,061*** | 0,061*** |
| Service workers and (shop and market) sales workers | | | 0,120*** | 0,120*** |
| (Skilled) agricultural and fishery workers | | | 0,001 | 0,003 |
| Craft and related trades workers | | | 0,059*** | 0,059*** |
| *Plant and machine operators* | *Reference* | | | |
| Elementary occupations | | | -0,030*** | -0,030*** |
| **Country level (n=45)** | | | | |
| Ln of number of patent applications to the EPO per | | | | 0,045*** |
| % Part-time employment in total employment | | | | |
| % Females in economically active population | | | | |
| **Random components** | | | | |
| Variance of the country level residual errors | 0,009*** | 0,009*** | 0,008*** | 0,006*** |
| Variance of the individual level residual errors | 0,144*** | 0,143*** | 0,127*** | 0,127** |
| Intra country correlation in percentage | **5,86%** | **5,92%** | **6,12%** | **4,16%** |

Note: * significant at 10%, ** significant at 5%, *** significant at 1%.

## Table A4. Degree of work complexity: 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*** | 0,170*** | 0,171*** |
| Individual is on a fixed term contract | | | -0,060*** | -0,060*** | -0,059*** |
| Individual' 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*** | 0,228*** |
| *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%** |

Note: * significant at 10%, ** significant at 5%, *** significant at 1%.

**Footnotes**

[1] The detailed information on the EWCS is available in Eurofound (2007)

[2] We assume that it is meaningful to apply the structural relationships observed in 1995 to 2000 and 2005. We have checked that our main results are robust to the choice of the reference year for computing synthetic indicators. As we are dealing with trend analysis, 1995 is a "natural" reference year.

[3] Inertia in a MCA is an indicator of heterogeneity, analogous to variance in factor analysis.

[4] They result from two first dimensions of the MCA. By construction, these two dimensions are orthogonal. As a consequence, the intensity of technical constraints is independent of the intensity of market constraints.

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