SHOULD THERE BE RAGE AGAINST THE MACHINE?

TESTING THE ROUTINISATION HYPOTHESIS WITH INDIVIDUAL LEVEL DATA

ILARIA MASELLI AND MIROSLAV BEBLAVÝ

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Abstract

The objective of this paper is to analyse the impact of routine on jobs using the European Working Condition Survey dataset. Statistics indicate that the share of routine jobs decreased between 2000 and 2010, from 49% to 43% of total jobs, consistently with the task-biased technological change theory by Autor et al. (2003). Yet, it is unlikely that the process consists of pure destruction: routine may affect workers also by hitting on wages either because they are not as productive and efficient as a robot would be, or because they share the dividend of their productivity with the owner of the technology. Results of the ordered logit estimation indicate that not only routine tasks are associated to a wage penalty, but also that in half of Western European countries this penalty increases over the decade. Results are robust to the definition of routine adopted.

JEL classification: J24, J31.

Keywords: routinisation hypothesis, routine tasks, task-biased technological change.

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CONTENTS

1. Introduction.....	1
2. Literature review: routinisation.....	2
3. Conceptualisation and descriptive statistics.....	4
3.1 Descriptive statistics	6
4. Methodology and results.....	8
4.1 Do routine workers earn less than other workers?	8
4.2 Did routine workers earn less in 2010 than in 2000?	10
5. Conclusions	12
References.....	14

List of Figures

Figure 1. labour-capital substitution in a long-term perspective.	4
Figure 2. share of routine workers in total in 2010.	6

List of Tables

Table 1. Incidence of routine tasks across occupations.....	7
Table 2. Estimation output – EU15 countries pooled – 2010 data	9
Table 3. Regression output by country – 2010 data (only routine variable reported).	10
Table 4. Estimation output by country (only routine variable reported).	11

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1. Introduction

A great share of studies in labour economics focus on returns from education. In this paper we show that returns from different type of tasks rather than skills also deserve considerable attention, given the interaction between the labour market and technological change. It is argued in Autor, Levi and Murnane (2003) that tasks are the key to understand the process of capital-labour substitution that occurred in the past decade, more specifically, the three authors observe that technology tends to replace routine-type of tasks because they can be codified and therefore ‘taught’ to a robot or a software. What a machine cannot do (yet?) is to replace tasks that require interaction, at the low skilled level (a janitor) or at the high skilled one (an architect). This is called task-biased technological change or routinisation hypothesis. However, the introduction of robots and software can also generate new routines meaning that the outcome of routine tasks does not simply result in job destruction, but can materialise via a re-organisation of tasks. In such re-organisation, the outcome of the work unit needs to be split between the worker and the owner of the capital. On a very aggregate level, such shift would be consistent with the (observed) decrease in labour share in total output. A third (non mutually exclusive) possibility is that routine workers are penalised because they are less productive than a robot or a computer at performing a routine task.

Our objective is to verify whether data from the 2000-2010 decade confirm or not this story. For this purpose, we rely on the European Working Condition Survey (EWCS) which contains a vast number of details on the characteristics of jobs and estimate returns from routine tasks. We perform the same analysis with 2000 and 2010 data to observe whether these returns deteriorate over time confirming our research question. Western European member states (EU15 countries) are considered.

This paper is innovative in two ways compared to the previous literature. First, it provides information about routine workers: how many they are and in which occupations and sectors they are employed. Second, it investigates whether routinisation pervades the demand for work by sticking to the micro/individual dimension of the data.

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The remaining pages are organised as follows: section two summarises the main findings from the literature in relation to task-biased technological change. In section three we provide descriptive statistics on routine workers. In section four, methodology and results are described. In the concluding section, we summarise main findings from this work.

2. Literature review: routinisation

According to Autor, Levy and Murnane (2003), the driving force behind the polarisation of jobs, which consists in the increase of highly paid and low paid jobs at the expense of the middling one, is technological change. Technology manifests itself by replacing tasks that by being repetitive, rules-based and therefore codifiable, can be more easily replaced by machines and software. This is also called ‘the routinisation hypothesis’. The basic idea is that jobs characterised by routine tasks tend to disappear, while non-routine jobs – whether cognitive and therefore highly skilled or manual and therefore lower skilled, expand at the same time. A number of clarifying examples can be found in Levy (2010). For instance, the task of selling tickets at a train station which is more and more often performed by self-service kiosks or the cargo operations at a seaport. The computer can basically substitute for a human processing when the process can be described by a rule but cannot replace complex communication and expert thinking (ibid). Such approach entails a fundamental conceptual shift: the unit of observation is not the level of education (and the subsequent return from it) but the task, where “a task is a unit of work activity that produces output” (Autor and Dorn 2010). The authors observe indeed that “skills do not directly produce output” but that they are “applied to tasks to produce output” (ibid). The routinisation hypothesis is considered one of the explanations for job and income polarisation according to which growth in employment and wages occurred at the tails of the earnings distribution while shrinking in the middle².

The main empirical work to tests this model has been carried out by Goos and Manning (2007) and Goos, Manning and Salomons (2009). Data for the UK confirm the changes theorised by Autor, Levy and Murnane (2003): employment shares grow in bottom and top of earning distribution, which coincide with, respectively, non routine-manual and non-routine cognitive tasks. However, this is not mirrored in earnings because low paid jobs deteriorate, probably because of institutional factors like falling unionisation and lower minimum wages. Autor et al. (2006) find, instead, that there is co-movement of employment and wages in the US. Goos et al. (2009) extend the test to other European countries and find that job growth is concentrated in lowest and highest-paying occupation, while the middling category squeezes. Furthermore, this trend is positively associated with the importance of abstract (non-routine and cognitive) and service (non-routine and manual) task and negatively with routine ones. Michaels et al. (2010) test the model (only for the employment aspects) using industry level data from EU KLEMS on the US, Japan, and nine European countries 1980-2004 and find evidence consistent with ICT-based polarisation in the sense that industries with faster growth of ICT had greater increases in relative demand for high educated workers and bigger falls in relative demand for middle educated workers.

² See Maselli (2012) for a review.

A very recent paper sheds new light on the phenomenon: Jaimovich and Siu (2012) argue that the loss of middling jobs is concentrated during recessions and the fact that these jobs do not recover in the upturns explain the phenomenon of jobless growth observed after the 1990s. This means that job polarisation happens during recessions and is responsible for jobless growth afterwards. As such, job polarisation and routine-biased technological change are both a structural and cyclical phenomena.

The routinisation hypothesis is not the only potential explanation to the observed polarisation of jobs and wages. Autor and Dorn (2010) observe that part of the findings from the routinisation hypothesis model are also valid for the offshorability one: many of the jobs that can be replaced by machines and software are similarly replaceable by a less expensive worker in a developing country (more on this below).

However, routinisation may also contribute to income inequality and work re-organisation via a second channel: a shift from labour to capital income. The introduction of robots and software can not only substitute routines, but also generate new ones meaning that the outcome of routine tasks does not simply result in job destruction, but can materialise via a re-organisation of tasks. In such re-organisation, the outcome of the work unit needs to be split between the worker and the owner of the capital. On a very aggregate level, such shift would be consistent with the (observed) decrease in labour share in total output. Our approach to the empirical analysis of this problem via wages aims at testing precisely this hypothesis which, to our knowledge, has not yet been explored in the literature, with exception of Brynjolfsson and McAfee who argue in their book “Race Against the Machine” (2011), that: “According to bargaining theory, the wealth they generate is divided according to relative bargaining power, which in turn typically reflects the contribution of each input. If the technology decreases the relative importance of human labor in a particular production process, the owners of capital equipment will be able to capture a bigger share of income from the goods and services produced. To be sure, capital owners are also humans—so it’s not like the wealth disappears from society—but capital owners are typically a very different and smaller group than the ones doing most of the labor, so the distribution of earnings will be affected. In particular, if technology replaces labor, you might expect that the shares of income earned by equipment owners would rise relative to laborers—the classic bargaining battle between capital and labor”.

It is interesting to observe that the TBTC is just the last phase of a long-term transformation in the organisation of work: in the early phases of industrial capitalism, thanks to (or because of) production lines, production was rationalised and fragmented in small tasks that could be performed by low-skilled workers. Such type of production, progressively replaced the more knowledge intensive but less efficient work of craftsmen³. Now the same fragmented task are replaced, not only in the manufacturing work but in every sector where a routine can be detected thanks to computers.

³ The main reference in the literature is the famous book by Braverman (1974): *Labor and Monopoly Capital: The Degradation of Work in the Twentieth Century*, New York: Monthly Review Press.

Figure 1. labour-capital substitution in a long-term perspective.

Source: Authors' elaboration.

3. Conceptualisation and descriptive statistics

In this paper, we present two types of research outputs. The first one is based on descriptive analysis of data about routine workers. This might not seem very innovative or sophisticated, but we found that already this fairly simple work can show valuable results. Additionally, we conduct an econometric analysis of data about routine workers to answer the question whether routine work is being penalized in terms of wages compared to non-routine work.

Our work is based on the European Working Condition Survey (EWCS), which is a survey carried out every five years by Eurofound. With five waves having been implemented since 1990, it enables monitoring of long-term trends in working conditions in Europe. Themes covered include employment status, working time duration and organisation, work organisation, learning and training, physical and psychosocial risk factors, health and safety, worker participation, work-life balance, earnings and financial security, as well as work and health. The selection of variables limits the number of waves exploitable for this research to 2000 and 2010. EU15 countries are considered, each with, on average, a sample size of 1000 observations in 2000 and 1500 in 2010⁴.

Although the dataset does present some problems, such as fewer observations compared to the European Labour Force Survey and the number of changes between one wave and the other, it is in this case preferable to others in light of the detailed information asked to workers on their task and type of work.

⁴ Once the data are cleaned, meaning that the following observations are eliminated: people with less than 30 or more than 75 working hours per week, people who did not agree to declare their salaries, all "i don't know" answers are dropped.

Previous studies based their categorization of routine and non-routine jobs on tasks information collected in ONET (Goos, Manning and Salomons 2010) or DOT (Autor, Levy and Murnane 2003). The former is a database, which collects comprehensive and detailed information on the characteristics of occupations under the sponsorship of the US Department of Labor. DOT stands for Dictionary of Occupational Titles and is the older version of ONET. From this point of view, the EWCS is not too different from ONET: like in ONET, questions asked to workers intend to really understand the features of tasks that characterise each occupation.

An important part of the analysis comes from the choice of the categorisation. Possible classifications used in previous studies are:

- Skilled manual, skilled non-manual, unskilled manual and unskilled non-manual,
- non-routine cognitive, non-routine interactive, routine cognitive, routine manual and non-routine manual (Autor, Levy and Murnane 2003)
- Routine, manual, abstract (Autor and Dorn 2010)
- Routine, manual and service (Goos, Manning, Salomons 2010)
- Interactional, transformational and transactional (McKinsey 2011)
- Physical, cognitive and psychosocial (Eurofound⁵)

Our choice is to consider the basic option distinguishing routine from non-routine jobs given that this is the main starting point to understand the relationship between technology and tasks. An ad hoc dummy variable is created for this purpose based on the following questions: “does your job involve short repetitive tasks of less than 10 minutes?”

The concept of repetitive task is closely related to the idea of routine. According to the Longman dictionary of contemporary English, something repetitive is “done many times in the same way”. Likewise, routine means “the usual or normal way in which you do things”.

Under this definition and pooling all countries together, 48% of jobs are defined as routine in 2000 and 43% in 2010 indicating that the balance between routine and non-routine jobs shifted towards the latter by the end of the decade. This is a partial indication that routinisation has actually materialised since routine jobs tend to disappear as they are replaced by robots and software. It is worth stressing, that the definition of routine used here is strict in the sense that includes workers who carry on repetitive tasks of *less than 10 minutes* but not exclusive because these jobs *involve* short repetitive tasks but are not characterised exclusively by this. As a robustness check, we consider two more variables/questions:

- Does your job involve short repetitive tasks of less than 1 minute?
- Does your main paid job involve repetitive hand or arm movements?

This section presents descriptive statistics on both dynamic and comparative aspects of routine work in Western Europe. It is organised in two parts. In the first part, features of routine work are observed over time pooling the 15 countries together. In the second part, only data from 2010 are considered in order to observe cross-country divergences.

⁵ This is the categorisation used on the website where aggregate data can be downloaded.

3.1 Descriptive statistics

The very first question an interested reader may want to ask is: how many workers are concerned by routine tasks? Figures indicate that on average in Western Europe, every 100 workers, 43 conduct repetitive tasks of less than 10 minutes and 29 of less than one minute, with relatively limited cross-country variation. What is common across countries is also the fact that there are fewer workers performing very short repetitive tasks, perhaps because these are the easiest to be replaced by technology. It is also worth observing that the high share of routine-tasks reported by workers surveyed indicates that the TBTC is far from complete.

Figure 2. share of routine workers in total in 2010.

Source: Authors' elaboration on EWCS.

Common sense would suggest that routine work is synonymous of low-skilled tasks, but the truth is that reality is far more complex than this. For instance, it is extremely difficult for a robot to perform tasks that are relatively easy for a human being, such as vacuum cleaning. It took years for engineers to produce Roomba, the robot that execute this task on its own. And yet, the robot cannot be blamed if a precious vase is broken because someone forgot to remove it from the floor. At the same time, computers can achieve very complicated calculus in fractions of seconds. Such complexity also emerges from the EWCS data.

If no occupation can be excluded from routine, there are obviously large differences. Categories less concerned are corporate managers, legislators and senior officials, teachers and armed forces. On the opposite side can be found machine operators, labourers in mining, food processing workers, office and customer care clerks.

When it comes to manual routine, very hit are also precision handicrafts x, other craft and related x, stationary-plant & x, agricultural fishery x, machine operators and x, sales and services x, labourers in mining.

Table 1. Incidence of routine tasks across occupations

	Below 20%	From 20% to 30%	From 30% to 40%	From 40% to 50%	Above 50%
Routine _10 min	Legislators and senior officials	Armed forces, physical, mathematical x, teaching and other professionals	Corporate & general managers, physical and engineer x, teaching & other associate professionals, drivers and mobile-plx	Life science and health x & x, office and customer service clerks, personal and protection x, models and salepersons, market-oriented x, metal machinery x, stationary-plant & x, agricultural fishery x.	Extraction and buildings x, precision handicrafts x, other craft and related x, machine operators and x, sales and services x, labourers in mining.
Routine _1 min	Armed forces, Legislators and senior officials, corporate managers, teaching and other professionals, physical & mathematical x.	General managers, life science and healthx, physical and engineer x, office clerks, Life science and health x & x, teaching & other associate professionals.	Personal and protection x, models and salepersons, market-oriented x, metal machinery x, stationary-plant & x, agricultural fishery x, sales and services elxx.	Customer service clerks, precision handicrafts x, other craft and related x, machine operators, labourers in mining.	
Routine _manual		Armed forces, Legislators and senior officials, corporate managers, teaching professionals and associate.	General managers, physical, matemaltical x, life science and health x, other professionals, physical and engineer, life science and health x, other associate professionals., models & salespersons.	Office clerks, personal and protection x, market-oriented skill x,	Customer service clerks, Extraction and buildings x, metal machinery x, precision handicrafts x, other craft and related x, stationary-plant & x, agricultural fishery x, machine operators and x, sales and services x, labourers in mining..

Source: Authors' elaboration based on 2010 EWCS data.

As far as sectors are concerned, routine tasks of less than one minute are detected more often in hotels and restaurants, and least often in education.

What may seem more surprising is that there is at least some routine across all sectors and occupation. Although part of the reason lies in the way the question is asked, it cannot be excluded that future capital-labour substitution will not kill jobs as such but open to way for a re-organisation of work based on a further rationalisation of tasks.

For instance, in the direction of what was called by Braverman the Babbage principle, that is a only high-skill tasks are signed to high-cost workers and only low-skilled tasks to low-skilled workers. Such development would surely be productivity-enhancing.

4. Methodology and results

The bulk of the methodology consists in estimating the returns from a routine job. This entails that wages constitute the dependent variable. In the survey, the variable is categorical and includes 21 categories in the 2010 wave and 4 in the 2000 one⁶. As a consequence, our preferred tool for the analysis is an ordered logistic regression.

This approach is radically different from previous studies on TBTC, where microdata have also been used but transformed from a dataset of people into a dataset of occupations. In previous studies, workers were grouped by occupation and growth of employment/wages measured for each occupation over the time period considered. This methodology is not applicable to the EWCS data because of the relatively limited number of observation per country⁷.

We estimate a wage equation that conceptually does not differ from a Mincer equation which computes the returns from education. However, in this case, we are interested in the returns from a routine job and therefore our main interest is the coefficient associated with this variable. In other words, wage categories are regressed on a routine dummy equal to one if the person is involved short repetitive tasks. The reference equation is the following:

$$wage^* = \beta_0 + \beta_1 routine + \beta_2 X + \varepsilon$$

As wages are not directly observed but embedded in categories, we denote them as $wage^*$, the latent variable. A set of control variables is added because likely to influence wages. Education enters the list of controls, which also includes: experience and its square, gender, sector of employment, size of the company and type of contract.

The working hypothesis is that if routinization occurred in European labour markets, the coefficient associated to the routine variable should become 'more negative' over time.

4.1 Do routine workers earn less than other workers?

As a very first step, we pool all 2010 observations together for the 15 countries in order to verify which sign is associated with the routine variables⁸. This gives an overall sample of 13,538 individuals.

⁶ In order to compare returns in 2000 and 2010, we create similar earnings categories.

⁷ Once the dataset is transformed from a dataset of individuals to a dataset where the basic unit is the ISCO 2/3 digits categorisation, the number of observation in each would be limited and heterogeneous and therefore cannot be considered representative of the group.

⁸ Results in this section are based on 2010 data and 21 wage categories.

Table 2. Estimation output – EU15 countries pooled – 2010 data

VARIABLES	(1)	(2)	(3)
wage			
Routine_10min	-0.174*** (0.0307)		
Odds-ratio	[0.84]		
Routine_1min		-0.291*** (0.0339)	
Odds-ratio		[0.75]	
Routine_manual			-0.366*** (0.0309)
Odds-ratio			[0.69]
Isced	0.528*** (0.0225)	0.529*** (0.0224)	0.520*** (0.0224)
Experience	0.00514* (0.00310)	0.00563* (0.00310)	0.00604* (0.00310)
Exper_sq	-2.59e-05 (3.15e-05)	-2.91e-05 (3.15e-05)	-3.15e-05 (3.17e-05)
Exp*educ	0.00647*** (0.000851)	0.00634*** (0.000850)	0.00625*** (0.000851)
Female	-1.058*** (0.0318)	-1.058*** (0.0318)	-1.055*** (0.0318)
CDIcontract	0.558*** (0.0376)	0.549*** (0.0376)	0.550*** (0.0376)
Company_size	0.160*** (0.00863)	0.161*** (0.00864)	0.161*** (0.00863)
Sector_ind	-0.0685 (0.0462)	-0.0639 (0.0462)	-0.0543 (0.0461)
Sector_tert	-0.0649** (0.0330)	-0.0520 (0.0331)	-0.0584* (0.0330)
Observations	13,538	13,538	13,538

Source: Authors' elaboration based on 2010 EWCS data.

The output of the ordered logit estimation indicates that all routine variables are significant at 1% level and associated to a negative sign meaning that, ceteris paribus, a routine job comes with a negative return⁹. Interestingly enough, as the definition of routine becomes more stringent, from routines of 10 minutes to routines of one minute and manual-routine, coefficients become 'more negative'. In terms of magnitude, they go to up to 70% of the coefficient attributed to a higher level of education, which makes it far from negligible. Moreover, most control variables are significant at 1% level.

⁹ A Wald test is run. It confirms that adding 'routine' improves the model.

Education¹⁰ and experience are positive and the square of experience negative. This is reassuring in the sense that results are strongly in line, not only with expectations but especially with the consolidated literature indicating that data used are trustable. The same is true for gender: the data confirm that there is a wage gap between women and men.

As a second step we run the same regression for each of the EU15 countries. In this case, only the sign, the coefficient and the significance level of the routine variables are reported.

Table 3. Regression output by country – 2010 data (only routine variable reported).

2010	BE	DK	DE	EL	ES	FR	IE	IT	LX	NL	AT	PT	FI	SE	UK	EU15
Routine_10 minutes	-0.26 ***	-0.24 *	-0.36 ***	+	-0.68 ***	-0.31 ***	-0.16	+	-0.57 ***	-0.44 ***	-0.31 **	-0.22	-	-0.37 ***	-	-
Routine_1 minutes	-0.17 **	-0.21	-0.34 ***	+	-0.44 ***	-0.49 ***	+	+	-0.05	-0.19	-0.15	+	-	-	-0.58 ***	-
Routine_manual	-0.19 **	-0.38 ***	-0.56 ***	-0.12	-0.53 ***	-0.34 ***	-0.11	-0.24 *	-0.44 ***	-0.21	-0.37 **	-0.39 ***	-	-0.45 ***	-0.23*	-

Source: Authors' elaboration based on EWCS survey data.

The returns from a routine job are negative in a great majority of cases, exception being Italy and Greece for the 10 minutes definition and Italy, Greece, Ireland and Portugal for the 1 minute definition. In more than half of the cases the three variables are significant at least at the 5% level (28 out of 48). This is consistent with the hypothesis of routine workers sharing a part of their productivity with the owner of the capital or earning less, *ceteris paribus*, because they are less productive than a robot or a computer in a routine task.

However, the pattern of the wage penalty increasing as the definition of routine becomes more stringent (from 10 to 1 minutes and from 1 to routine-manual work) is not confirmed in all countries.

4.2 Did routine workers earn less in 2010 than in 2000?

In order to test whether returns from routine jobs changed over time the analysis in section 5 is repeated using the 2000 wave of the EWCS. The assumption is the following: if a technological (demand) shock occurred, employment and/or relative wages must have decreased for these workers¹¹. In terms of overall jobs the dataset indicates that the share of routine jobs decreased between 2000 and 2010, from 49% to 43% of total jobs, meaning that by the end of the decade and consistently with the routinisation hypothesis, fewer workers had a job characterised by routines of ten

¹⁰ Education is present in the dataset in terms of ISCED classification, which goes from 0 (no education) to 6 (phd programme).

¹¹ One could argue that a decrease in wages could be triggered by an increase in the supply of these workers. However, this possibility is ruled out by the fact that activity rates increased only marginally in Western Europe throughout the decade.

minutes. Yet, it is unlikely that the process consists of pure destruction: the advent of computerisation replaces routine tasks but it may, at least temporarily, create new ones. Accounting software can, for instance, replace the number of many accountants but for the person that is left to work with it, may imply a number of routines, such as data entry or tests. All in all, therefore, routine may affect workers in three ways:

- By replacing them (job destruction)
- By hitting on wages because they are not as productive and efficient as a robot would be,
- Or by creating new routines that are a complement to the technology and for which the worker is hit by a wage penalty because he/she shares the dividend of his/her productivity with the owner of the capital.

Any of the three possibilities entail not only a negative impact on wages (which we find checking the 2010 data) but also a deterioration throughout the decade. In order to verify that, we compare coefficients across years: if routinisation occurred over the decade, returns from routine jobs must have become 'more negative'.

Table 4 replicates the result from Table 3, but this time including 2000 results. In order to make the three waves of the survey comparable, the earnings variable includes in this section only four categories¹², like in the 2000 dataset.

Table 4. Estimation output by country (only routine variable reported).

2000	BE	DK	DE	EL	ES	FR	IE	IT	LX	NL	AT	PT	FI	SE	UK	EU15
Routine_10 minutes	-0.25***	-0.44***	-0.05	-0.42**	+0.15	-0.54***	-0.32*	-0.03	-0.35	-0.63***	-0.23**	-0.14	-0.16	-0.55***	-0.43***	-0.21***
Routine_1 minutes	-0.45***	-0.56**	-0.03	-0.29**	-0.14	-0.33***	-0.09	+0.05	-0.15	-0.59**	-0.58**	-0.15	-0.1	-0.37***	-0.58***	-0.23***
Routine_manual	-0.59***	-0.45***	-0.39***	-0.37**	+0.05	-0.67***	-0.54**	-0.43***	-0.95***	-0.52**	-0.51***	-0.11	-0.22***	-0.34***	-0.55**	-0.32***

2010	BE	DK	DE	EL	ES	FR	IE	IT	LX	NL	AT	PT	FI	SE	UK	EU15
Routine_10 minutes	-0.29***	-0.23**	-0.39***	-0.09	-0.60***	-0.28***	-0.15	-0.25	-0.49***	-0.29*	-0.33*	-0.17	-0.04	-0.39***	-0.44***	-0.17***
Routine_1 minutes	-0.19**	-0.27	-0.38***	+0.21	-0.46***	-0.44***	+0.09	+0.09	-0.00	-0.03	-0.14	+0.06	-0.18	-0.58***	-0.63***	-0.31***
Routine_manual	-0.22***	-0.34*	-0.60***	-0.25*	-0.48**	-0.34***	-0.10	-0.25*	-0.51***	-0.13	-0.37***	-0.18	-0.10	-0.40***	-0.27*	-0.36***

Source: Authors' elaboration based on EWCS survey data.

We find evidence that a deterioration in routine-workers' wages is confirmed in half of the countries considered. Results remain rather consistent across time and different

¹² This explains the slightly different results compared to Table 3.

definitions of routine. However, what was found for Western Europe as a whole – that returns become more negative as the definition of routine becomes more stringent – is not confirmed in the different countries.

Ordered logit regressions imply an important limitation, which is called the parallel lines assumption: the estimated coefficients indicate that, in this case, the impact of routine is the same across different income groups (Williams 2006). We verify whether the “parallel lines assumption” assumed is respected and find that it is not. This means that the impact of routine is not the same across different income groups. Nevertheless, in almost all cases¹³ this is only a matter of magnitude: routine has always a negative impact but to different extent in different income groups.

5. Conclusions

In this paper, we explored the nature of routine work in Western Europe and tested the routinisation hypothesis in a comparative and dynamic perspective. The routinisation hypothesis states that the impact of technology on the labour market materialises via a substitution of repetitive-types of jobs. Previous empirical work has shown that these jobs are less and less in demand, especially in comparison with unskilled manual (but not routine) occupations and high skilled cognitive ones. It is unlikely however, that the impact of routine manifests only via a job destruction due to capital-labour substitution. Although, we find evidence of it: the share of workers that declares performing repetitive tasks of less than ten minutes decreases from 48% in 2000 to 43% in 2010. It is also possible that routine tasks affect the labour market in two more ways: the introduction of robots and software can also generate new routines meaning that the outcome of routine tasks can materialise via a re-organisation of tasks. In such re-organisation, the outcome of the work unit needs to be split between the worker and the owner of the capital. On a very aggregate level, such shift would be consistent with the (observed) decrease in labour share in total output. A third (non mutually exclusive) possibility is that routine workers are penalised because they are less productive than a robot or a computer at performing a routine task.

In all three cases, the demand shock provoked by technological change would translate hit wages in a negative way. In our econometric analysis, we find confirmation that being a routine worker imposes a wage penalty. We also find that, in half of the countries considered this penalty increases over time, meaning that returns from routine jobs become more negative between 2000 and 2010. This is consistent with the routinisation hypothesis and, at a very aggregate level, with a decrease of labour share in total output.

EWCS statistics also showed that a certain degree of routine is present in all occupations, although to very different extent: most touched are extraction and buildings x, precision handicrafts x, other craft and related x, machine operators and x, sales and services x, labourers in mining, whereas legislators and senior officials are the most shielded.

¹³ With the exception Portugal and Luxembourg in 2000 and Ireland in 2010.

In our opinion, research on this issue should continue to explore the impact of technology on job: the task approach is essential to understand how labour organisation will evolve in the next decade. If still in 2010P approximately 40% of workers surveyed declared having a form of routine in their job, they will be the one potentially touched by further labour market adjustments.

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ABOUT NEUJOBS

“Creating and adapting jobs in Europe in the context of a socio-ecological transition”

NEUJOBS is a research project financed by the European Commission under the 7th Framework Programme. Its objective is to analyse likely future developments in the European labour market(s), in view of four major transitions that will impact employment - particularly certain sectors of the labour force and the economy - and European societies in general. What are these transitions? The first is the **socio-ecological transition**: a comprehensive change in the patterns of social organisation and culture, production and consumption that will drive humanity beyond the current industrial model towards a more sustainable future. The second is the **societal transition**, produced by a combination of population ageing, low fertility rates, changing family structures, urbanisation and growing female employment. The third transition concerns **new territorial dynamics** and the balance between agglomeration and dispersion forces. The fourth is a **skills (upgrading)** transition and its likely consequences for employment and (in)equality.

Research Areas

NEUJOBS consists of 23 work packages organised in six groups:

- **Group 1** provides a conceptualisation of the **socio-ecological transition** that constitutes the basis for the other work-packages.
- **Group 2** considers in detail the main drivers for change and the resulting relevant policies. Regarding the drivers we analyse the discourse on **job quality**, **educational** needs, changes in the organisation of production and in the employment structure. Regarding relevant policies, research in this group assesses the impact of changes in **family composition**, the effect of **labour relations** and the issue of financing transition in an era of budget constraints. The regional dimension is taken into account, also in relation to **migration** flows.
- **Group 3** models economic and employment development on the basis of the inputs provided in the previous work packages.
- **Group 4** examines possible employment trends in key sectors of the economy in the light of the transition processes: energy, health care and goods/services for the **ageing** population, **care services**, housing and transport.
- **Group 5** focuses on impact groups, namely those vital for employment growth in the EU: **women**, the **elderly**, immigrants and **Roma**.
- **Group 6** is composed of transversal work packages: implications NEUJOBS findings for EU policy-making, dissemination, management and coordination.

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