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ABSTRACT

Work Effort in the UK: Trends and Explanations*

This paper links detailed 24-hour diary surveys in the United Kingdom (UK) over the last four decades to provide evidence on the increase in work effort in three specific dimensions: timing, nature, and composition. We rule out possible explanations behind these trends, finding that the decrease in the frequency of on-the-job leisure is more pronounced for workers in routine task-intensive occupations. Alternative supply- and demand-side explanations, such as changes in the relative preference for leisure, or the increase in offshoring, or competition for jobs, cannot explain our results. Our findings posit the amount and the frequency of on-the-job leisure as a measure of work effort, and the routine-biased technological change experienced during this period lies at the root of the increase in work effort in the UK.

JEL Classification: D63, J22, J23, J24, J31, J62

Keywords: labor supply, time-use, work effort, routine-biased technological change

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1. Introduction

In recent decades, labor markets have witnessed an unprecedented polarization of employment, as workers in middle-wage occupations experienced a decrease in the share of overall employment, particularly in the 1980s and 1990s in the US (Autor, Katz and Kearney, 2006; 2008; Acemoglu and Autor, 2011; Autor and Dorn, 2013) and in Europe (Goos and Manning, 2007; Goos, Manning and Salomons, 2009; 2014). One reason for the disappearance of many middle-wage occupations has been technological change (e.g., automation of routine job tasks), where the introduction of technologies that reduce the real cost of automating many of the routine tasks characteristic of these jobs creates strong economic incentives for firms to substitute ever cheaper and more powerful computing power for relatively expensive human labor (Autor, Levy and Murnane, 2003; Autor 2015, Acemoglu and Restrepo, 2019,2020).[1] But whereas the theoretical predictions and empirical implications of the effects of automation on aggregate employment, wages, inequality, and productivity are well understood, little is known about how automation and technological change affect the work process. This paper looks beyond the aggregate employment effects of technological change/automation to present new empirical evidence on the relationship between technological change and the structure of work, the latter serving as a measure of work effort.

Our proposed economic framework follows the recently developed task-content model for technological change/automation (Acemoglu and Restrepo, 2019,2020). The economic principles of this framework predict that technological change/automation affects the composition of tasks for those workers who remain employed, reducing the relative contribution of workers to routine tasks – now performed by computers/robots – and increasing the relative contribution of workers to abstract tasks. Given the changing nature of the tasks towards abstraction, with a high degree of complementarity to the tasks done by robots and computers, this may represent a change in the structures of work, affecting the levels of work effort. Prior evidence has shown that technological change/automation leads to a more efficient allocation of job tasks due to increased

[1] Tasks characteristic of craft workers are repetitive and relatively easy for a machine to replicate, and the required ability to do arithmetic fast and accurately of bank clerks has been replaced by computers that can do calculations faster and without error. As a result, demand for both types of jobs has been falling. However, management practices are difficult to automate, as computers may be bad substitutes of managers in terms of motivating and managing workers, and so managers have a comparative advantage over machines. Similarly, services are expensive to computerize, as it is very difficult to create dishwashers that can empty themselves, and vacuum cleaners that climb stairs (Pinker, 2007).

efficiency in all stages of the production process, by reducing unscheduled downtime and stoppage periods (Ichniowski, Shaw and Prennushi, 1997), as well as by shortening setup times, run times, and inspection times (Bartel, Ichniowski and Shaw, 2007). Furthermore, technological change/automation changes the content of the tasks performed by workers in traditionally routine, task-intensive occupations, and creates many new tasks (e.g., programming, design, maintenance of high-tech equipment, such as software and app development, database design and analysis, and computer-security-related tasks) that are highly relevat to the functioning of robots/machines. Thus, workers in routine task-intensive occupations may have experienced larger changes in the structure of their work, ending up with a work process characterized by a distribution of work effort that more closely resembles the work process of workers in non-routine, task-intensive occupations.

We link six UK time use surveys between the mid-1980s and the late 2010s, containing detailed activity reported during 24-hour periods, and construct two measures of work effort, following Hamermesh (1990). Despite that total hours of work have been used to measure work effort, normal weekly hours of work can only be a crude proxy for hours actually worked (Barrett and Hamermesh, 2019) and may miss important information on what workers do while on the job (Hamermesh, 1990). Dickinson (1999) extends the traditional model of work-leisure choice to explicitly consider the consumption of on-the-job leisure, in order to get a better picture of hours of work. Following this line of research, we define the consumption of on-the-job leisure as time spent in non-work-related activities while at work (see Hamermesh, 1990; Gimenez-Nadal, Molina and Velilla, 2018; Burda, Genadeck and Hamermesh, 2020). First, we measure the consumption of on-the-job leisure, characterized as the time spent in non-work activities while at work. Second, we measure the frequency of on-the-job leisure, since the sequence information in the diary provides a clear picture of the distribution of effort throughout the work process.

We first show an increase in the work effort of workers in the UK, as we observe a decrease in both the amount and the frequency of on-the-job leisure. Second, we observe that, at the beginning of the period, workers in a routine task-intensive occupation had a higher frequency of on-the-job leisure than workers in non-routine, task-intensive occupations. However, at the end of the period, the number of on-the-job leisure episodes and the uninterrupted time worked before consuming on-the-job leisure were the same

for workers in both routine and abstract task-intensive occupations. These results point to the fact that workers in routine task-intensive occupations experience larger changes in the structure of job tasks, that is, experience higher increases in work effort, measured as the frequency of on-the-job leisure, in comparison to workers in abstract task-intensive occupations. These results are consistent with the task-content model where technological change/automation produces changes in the structure of work, with larger increases for workers in routine task-intensive occupations.

We rule out competing explanations for the decrease in the consumption and frequency of on-the-job leisure. We explore alternative demand-side explanations, which include offshoring of jobs, the competition for jobs, and the role of unionization. Alternatively, we rule out supply-side explanations, looking at changes in the education of workers and the role of children. Overall, none of the alternative theories appear to account for the key aspects of the evidence presented.

This paper contributes to recent developments in the literature of routine-biased technological change by moving beyond employment effects and looking at how automation relates to work effort. Prior literature on automation technology and the organization of work processes focuses on the firm's production function and firm-level outcomes, and generally adopts a case-study analysis of one or more workplaces in narrowly defined industries. This literature finds that automation technology leads to a more efficient allocation of job tasks, leading in turn to greater efficiency in all stages of the production process, for example by reducing unscheduled downtime and stoppage periods (Ichniowski, Shaw and Prennushi, 1997), as well as by shortening setup times, run times, and inspection times (Bartel, Ichniowski and Shaw, 2007). We use large, worker-level representative surveys to document increases in work effort following the new and more specialized tasks resulting from technological change/automation.

The remainder of the paper is organized as follows. Section 1 describes the time diary data used in this paper, the conceptualization of work effort, and the evolution of work effort over time. Section 2 describes the data and the work effort indicators, and shows the trends in work effort in the UK. Section 3 analyzes supply-side and demand-side explanations underlying the observed trends in work effort. Section 4 concludes.

2. Work Effort in UK Time Use Surveys

2.1. The data

We use large representative time-diary surveys in the UK, where respondents record what they are doing for consecutive 24-hour periods. Specifically, we use surveys from 1983, 1987, 1995, 2000, 2005, and 2015, which provide a unique opportunity to look at how activities at work vary by occupation and other socio-economic characteristics over long periods of time.[2] Such surveys have become the preferred method of gathering information on time spent on market work, non-market work, and leisure, in the same way that money expenditure diaries have become the gold standard in the consumption and expenditure literature. Diaries are completed by a given respondent on selected days of the week, and are divided into episodes (Table A1 in the Appendix provides a detailed description of the surveys used here.)

We follow the literature and restrict the sample to non-retired/non-student individuals between the ages of 21 and 65 inclusive (see Aguiar and Hurst, 2007; Gimenez-Nadal and Sevilla, 2012) who devote at least one hour to market work activities during the diary day, excluding commuting, and report to work full-time.[3]

On-the-job leisure (consumption)- The classical measure of worker productivity is calculated as the total number of work hours divided by the produced output (Acemoglu et al., 2016), and thus work hours are key to productivity considerations. Work effort is traditionally measured as the number of hours of work, which is normally gathered from national representative labor force surveys that ask respondents about normal work hours per week, month or year. However, normal weekly/monthly/yearly hours of work can only be a crude proxy for hours actually worked (Barrett and Hamermesh, 2019) and may miss important information on what workers do while on the job (Hamermesh, 1990). The labour supply literature has extended the traditional model of work-leisure choice to explicitly consider the consumption of on-the-job leisure, in order to get a better picture of hours of work (Dickinson, 1999). Following this tradition, we construct the consumption of on-the-job leisure as time spent in non-work-related activities while at

[2] From the Multinational Time Use Study (MTUS) at https://www.timeuse.org/mtus.

[3]Around 1% of workers who report positive market work spend less than 60 minutes in market work during the diary day. Results including both full-time and part-time workers are consistent with our main results and are available upon request.

work (Hamermesh, 1990; Gimenez-Nadal, Molina and Velilla, 2018; Burda, Genadeck and Hamermesh, 2020).[4] We follow Hamermesh (1990) and divide the consumption of on-the-job leisure into leisure-related activities and other non-work activities. Leisure-related activities include social leisure, active leisure (e.g., going to the gym), passive leisure (e.g., reading and watching TV), and meals at work. Other non-work activities include housework-related activities, personal care activities, and commuting activities (Table A2 in the Appendix provides a description of all activities included in each of the categories of on-the-job leisure).[5]

The *frequency of on-the-job leisure* has not previously been analyzed in the literature. We construct two indicators: the number of on-the-job leisure episodes, and working time until consuming on-the-job leisure. A higher number of on-the-job leisure episodes indicates a greater frequency of on-the-job leisure, whereas a longer working time until consuming on-the-job leisure indicates a lower frequency of on-the-job leisure. This second indicator is computed by dividing the total amount of time spent working by the number of work spells in a given diary day.

Table 1 shows an example of a working day from a worker in the UK. The diarist spent 8 hours and 40 minutes at work, starting at 8:00 am, when the first episode of paid work was recorded in the diary (after commuting), and finishing at 4:40 pm when the last episode of paid work was recorded in the diary. Out of the 8 hours and 40 minutes that the respondent spent at work, 7 hours and 30 minutes were spent working. There were 3 work spells of 3 hours, 2 hours and 10 minutes, and 2 hours and 20 minutes. The first work spell begins at 8:00 am and lasts until 11:00 am. From 11:00 am to 11:20 am the respondent records having a snack, followed by relax/do nothing from 11:20 am to 12:00 pm. The respondent goes back to work again at 12:00 pm, finishing this second work spell, for lunch, at 2:10 pm. The third work spell begins at 2:20 pm and lasts until 4:40 pm.

The consumption of on-the-job leisure is 1 hour and 10 minutes (e.g., 1.16 hours). Out of this time, the respondent spent 40 minutes in leisure activities (relax/do nothing), while

[4] *While at work* is defined as the time from the moment the respondent first begins work until the moment in which the respondent records the last work episode of the diary day. We do not consider commuting episodes as market work time.

[5] We use the term 'on-the-job leisure' in a broad sense, as time spent in an activity different from paid work during the time the respondent is at work (i.e., time spent not working while on the job).

the remaining 30 minutes were spent in meals at work. Turning our attention to the frequency of on-the-job leisure, there are two on-the-job leisure episodes during the (total) 1 hour and 10 minutes of on-the-job leisure: a first episode of on-the-job leisure between 11:00 and 12:00, with one passive leisure activity and a meal at work, and a second on-the-job leisure episode between 14:10 and 14:20. Similarly, the respondent works for an average of two and a half hours before consuming on-the-job leisure, which is calculated by dividing the 7 hours and 30 minutes that the respondent is working over the 3 work spells recorded in the diary.

Figure 1 shows the percentage of workers in our sample who are either at work or at leisure, for every hour of the diary day (see Table A3 in the Appendix for values). For example, at 1 pm 90% of full-time workers are present, 51% working and 39% consuming on-the-job leisure. The proportion of workers who are working increases from about 6 am, reaching a maximum of 81% at around 11 am, and gradually decreasing afterwards. The consumption of on-the-job leisure increases until 12:30 pm, peaking between 12:30 pm and 1:00 pm. After 1:00 pm, the proportion of workers consuming on-the-job leisure gradually decreases. Most of the on-the-job leisure activities are taken up by meals at work (see Table A4 in the Appendix).

2.2. Trends in work effort

Columns (1) to (4) in Table 2 show trends of the time at work, split between the time working and the time spent at leisure, and the frequency of on-the-job leisure. Columns (5) and (6) show the changes in the consumption and frequency of on-the-job leisure between the 1980s and the 2010s, and the p-values of the difference, respectively. We use the demographic weighting used in Aguiar and Hurst (2007) and Gimenez-Nadal and Sevilla (2012), to ensure a constant representation of types of individuals and days of the week.[6] The demographic composition of workers is likely to differ over time, with implications for time-use patterns, including the consumption and frequency of on-the-job leisure. For example, increases in education have been documented to be linked to

[6] We divide the sample into demographic cells defined by five age groups (21–29, 30–39, 40–49, 50–59, 60–65), three education categories (uncompleted secondary or less, completed secondary, above secondary education), two gender categories (male and female), and whether or not there is a child under 18 in the household. We do not create separate cells distinguishing child status for respondents aged sixty to sixty-five due to the small number who have children present in the home at that age.

increases in the number of hours worked. It is thus important to keep constant the demographic composition of the population, to be able to run meaningful comparisons over time within a given country.

Trends in working time- Table 2 shows that time spent working in the UK increased by one hour from the 1980s until the 1990s, from around 7 hours and 24 minutes per day, returning to 1980s' levels during the 2000s and 2010s. Our results for trends in work hours are in line with prior analyses of survey data based on questions about weekly hours of work. Ohaian, Raffo and Rogerson (2008) document trends in total work hours in the UK, noting an increase in work hours between the 1980s and 2000s, followed by a smooth decrease in work hours in the 2000s. Rogerson and Shimer (2011) compute annual hours per worker, and show a peak in the number of work hours around 1990.

Trends in on-the-job leisure- Against the background of non-increasing working time, workers reduced the amount of time they spent in non-work activities while at work. The consumption of on-the-job leisure declined by 15%, from about one hour and 22 minutes per working day at the beginning of the period to one hour and 10 minutes per working day by the end of the period. The frequency of on-the-job leisure also decreased over this period. The number of on-the-job leisure episodes decreased by around 22% in the UK, from 1.69 episodes per working day in the 1980s to 1.31 episodes at the end of the period. The time spent working before the consumption of on-the-job leisure also increased. Whereas in the 1980s, working time until consuming on-the-job leisure was around 3 hours and 19 minutes, by the end of the period workers had increased this measure by 17% (35 minutes).[7]

3. Possible explanations for trends in work effort

3.1. Demand-side explanations

Here we analyze a range of factors that may help to explain the observed trends in work effort in the UK. These demand-side explanations include routine-biased technological change (RBTC), offshoring, unionization, and competition for jobs. We also discuss some other potential channels that we are not able to explain with the current data.

[7] The fact that diaries are distributed randomly across days in a given week rules out a simplistic explanation for our results based on workers simply shifting their leisure within days.

Routine-biased technological change

Prior literature on job polarization has documented the polarization of employment as a consequence of routine-biased technological change, in the UK (and also in the US and Europe, see Autor, Katz and Kearney, 2006; 2008; Goos and Manning, 2007; Goos, Manning and Salomons, 2009, 2014; Acemoglu and Autor, 2011, Autor and Dorn, 2013). This job polarization has led to a decrease in the share of employment of middle-wage occupations, and the explanation commonly given for this phenomenon is the "Routine-Biased Technological Change" (RBTC) framework proposed by Autor, Levy and Murnane (2003), that predicts a displacement of workers engaged in routine, task-intensive occupations as new technologies substitute for traditional tasks. These workers pertain to the group of middle-wage occupations.

An additional implication of the theory of automation and technological change is that robots and software that perform and aid tasks, following well-defined procedures, affect the processes of workers performing the majority of routine tasks (Autor, 2015, Acemoglu and Restrepo, 2020). The existing literature finds that automation technology leads to a more efficient allocation of job tasks, leading in turn to greater efficiency in all stages of the production process (Ichniowski, Shaw and Prennushi, 1997; Bartel, Ichniowski and Shaw, 2007). Thus, apart from the polarization of the labor market in the UK, technological change may be behind the reported increase in work effort. We analyze whether routine-biased technological change is also related to an increase in work effort, using the composition of the changes in work effort, comparing the consumption and frequency of on-the-job leisure for workers in routine task-intensive and non-routine task-intensive occupations. In doing so, we test whether the proportion of routine tasks for a given occupation is correlated with changes in work effort.

We link the diary information to a worker's occupation-specific Routine Task Intensity (RTI) index, originally developed by Autor and Dorn (2013) and Autor, Dorn and Hanson (2015) and adapted by Goos, Manning and Salomons (2014), to the UK context.[8] In particular, Goos, Manning and Salomons (2014) report the RTI index for 21 2-digit

[8] The RTI index uses the O*NET program, which gathers information at the occupation level. There are alternative task measures collected at the level of the individual worker, see DiNardo and Pischke (1997), Spitz-Oener (2006), Dustmann, Ludsteck and Schönberg (2009), and Gathmann and Schönberg (2010) among others.

ISCO88 occupational codes. We use the 1983, 2000, and 2015 UK TUS samples that have information on a worker's occupation.[9]

Table 3 shows summary statistics of market-work time and on-the-job leisure indicators by occupation, according to their values of the RTI index. Workers in non-routine, task-intensive occupations spend comparatively more time working until consuming on-the-job leisure. Panel A of Table 3 shows the results of comparing the occupations in the low 10% and the high 90% percentiles of the RTI index distribution, and Panel B shows occupations in the low 25% and the high 75% percentiles of the RTI index distribution. We first show that workers in non-routine, task-intensive occupations (i.e., higher RTI) spend more time in market-work time and work longer before consuming on-the-job leisure. Workers in the 25(10)% percentiles of the RTI index distribution devote 0.24 more hours per day to market work than those in the 75(90)% percentiles of the RTI index distribution, with this difference being statistically significant. Whereas workers in the 25(10) % percentiles of the RTI index distribution work 4.54 (4.36) hours before consuming on-the-job leisure, workers in the 75(90)% percentiles of the RTI index distribution work about 7% less before consuming on-the-job leisure (i.e. 4.23 (4.02) hours).

We now estimate OLS regression models for each measure of on-the-job leisure, as follows:

$$E_i = \mu + \beta_1 X_i + \beta_2 RTI_i + \beta_3 D_{t,i} + \beta_4 D_{t,i} * RTI_i + \varepsilon_i \qquad (1)$$

where E_i represents our measures of the consumption and frequency of on-the-job leisure for respondent *i*. The vector X_i includes person-specific, socio-demographic characteristics: gender (ref.: male), age, dummy for secondary and university education (ref.: primary education), dummy for living in couple (ref.: not in couple), the number of children under 18 in the household, hours worked during the diary day, and the total number of activities reported by the individual in the diary day.[10] Additionally we control for the RTI index of the worker's occupation (β_2). β_3 is a vector of dummy variables for the years 2000 and 2015 to capture changes in the on-the-job leisure measures between

[9] We cannot use the 1995 and 2005 surveys for the analysis as information on occupation is not available. See Appendix B for an in-depth description of the RTI index.

[10] For the regression on the working time until on-the-job leisure, we exclude the hours of market work in the day, given the high correlation between the indicator and this variable. Results are consistent to the inclusion of this variable.

the two surveys, and β_4 is the interaction between the vector of year dummies and the RTI index. ε_i is the error term. The coefficient of interest is β_4, which is the coefficient of the interactions between the year dummies and the RTI index. The higher the values of the RTI index, the more routine-intensive an occupation is. Thus, a greater magnitude in these coefficients indicates a larger decrease in work effort for workers in routine task-intensive occupations, compared to workers in non-routine, task-intensive occupations during this period.

Table 4 shows the results of estimating Equation (1) on the consumption and frequency of on-the-job leisure, respectively. The coefficients on the 2000 and 2015 dummies in Table 4 shows trends in the consumption of on-the-job leisure that are consistent with the results in Table 2. There is a decrease in the consumption and frequency of on-the-job leisure, given that the decade dummies are statistically significant at the 99 percent level. The decade dummies are negative in the case of the consumption of on-the-job leisure and the number of breaks for on-the-job leisure, and positive for time working before consuming on-the-job leisure.

More importantly, the coefficients on the interactions between the RTI index and the decade dummies are statistically significant for the frequency of on-the-job leisure, indicating that workers in routine task-intensive occupations decreased the frequency of on-the-job leisure to a greater extent than workers in non-routine, task-intensive occupations. In other words, the decreases in the frequency of on-the-job leisure were comparatively larger for workers in routine task-intensive occupations with higher values of the RTI index. These results can be interpreted as supporting the notion that technological change may be behind the observed trends in work effort in the UK.[11]

In the 1980s, routine task-intensive occupations had a higher frequency of on-the-job leisure than non-routine task-intensive occupations, although by the end of the period differences across occupations had diminished or even reversed regarding the frequency of on-the-job leisure. In particular, the coefficient on the RTI index indicates that at the beginning of the period "office clerks" (RTI=2.24), the occupation with the highest RTI

[11] One factor that may explain the increase in work effort, as part of the technological change, is the monitoring of jobs. Technological change has allowed a reduction in the costs of monitoring jobs using computers, which can affect the effort of workers because greater monitoring reduces the chances that workers may shy away from their tasks. However, we have found no statistical information on the level of monitoring of the different occupations, and thus we cannot explore what part of the observed trends in work effort are due to greater monitoring. We leave this issue for future research.

index, had 0.71 more on-the-job leisure episodes, and spent one hour and 39 fewer minutes at work before consuming on-the-job leisure than "managers of small enterprises" (RTI=-1.52), the occupation with the lowest RTI index. During this period, the coefficients on the interaction of the 2000 and 2015 dummies with the RTI index, in Table 9, indicate that office clerks experienced monotonic decreases in the frequency of on-the-job leisure, relative to managers.

In particular, the interaction coefficient between the 2015 dummy and the RTI index shows that the number of on-the-job leisure episodes decreased by 0.83 (3.76*0.22) more for office clerks than for managers, and the time working before consuming on-the-job leisure increased by one hour and 39 minutes (3.76*0.44), with respect to managers.[12] Thus, at the end of the period office clerks were relatively worse off than managers as they have 0.12 fewer on-the-job leisure episodes, and worked the same time before consuming on-the-job leisure.

Offshoring of jobs

Prior literature has argued that the degree of offshoring of jobs could also explain employment losses for middle-wage occupations as their job tasks are outsourced to workers in countries with lower labor costs (Acemoglu and Autor, 2011; Autor and Handel, 2013; Baumgarten, Geishecker and Görg, 2014; Goos, Manning and Salomons, 2014; Michaels, Natraj and Van Reenen, 2014; Wright, 2014).[13] The fear that their work will be offshored to other places with lower labor costs can make workers increase their effort in order to increase their productivity, and thus avoid such offshoring. In those jobs that are more likely to be offshored we should expect to find larger increases in work effort, in comparison to jobs with lower risks of being offshored.

Here we analyze trends in the consumption and frequency of on-the-job leisure, using an occupation-specific offshoring index (BK index), which uses professional coders'

[12] The differences in the RTI index values for "office clerks" and "managers of small enterprises" is 3.76 [2.24- (-1.52)]. Multiplying this figure by the RTI index coefficient in Table 6 yields a difference at the beginning of the period between workers in the two occupations of 0.71 (3.76*0.19) in the number on-the-job leisure episodes and of one hour and 39 minutes (3.76*0.44=1.65 hours per day) in the time working before consuming on-the-job leisure. Similarly, given the coefficient on the interaction between the 2015 dummy and the RTI index in Table 6, the relative decrease in the consumption and frequency of on-the-job leisure for office clerks, with respect to managers, is calculated as follow: 0.83 (3.76*0.22) fewer on-the-job leisure episodes and one hour and 39 more minutes (3.76*0.44=1.65 hours per day) of working before consuming on-the-job leisure.

[13] See Hummels, Munch and Xiang (2018) for a review of the effects of offshoring on labor markets.

assessment of the ease with which a given occupation can be potentially offshored. This index is obtained from Blinder and Krueger (2013) and adapted to the ISCO-88 occupational classification by Goos, Manning and Salomons (2014). Given that the BK index is obtained from the same source as the RTI index, the sample of workers is the same as that of the RTI analysis and the codes used to match occupations with values of the BK index are the same as for the RTI measure. Higher values of the offshoring index indicate a higher probability of being offshored (see Table B2 in Appendix for a description of the values of the offshoring index for all occupations).

Equation (2) estimates a similar model to Equation (1) with the BK index, as follows:

$$E_i = \mu + \beta_1 X_i + \beta_2 BK_i + \beta_3 D_{t,i} + \beta_4 D_{t,i} * BK_i + \varepsilon_i \quad (2)$$

where E_i represents our measures of the consumption and frequency of on-the-job leisure for respondent *i.* The vector $X_{i,t}$ includes person-specific characteristics, as in Equation (1). β_3 is a vector of dummy variables for the years 2000 and 2015 to capture changes in on-the-job leisure between the two surveys, β_4 is the interaction between the vector of year dummies and the BK index, and ε_i is the error term.[14]

Table 5 shows that the interaction coefficients between the offshoring index and the decade dummies indicate that offshoring did not have a differential effect on the consumption or frequency of on-the-job leisure for workers in occupations with different degrees of offshoring. Columns (1), (2) and (3) show that the degree of offshoring in a given occupation does not successfully explain the evolution of either consumption or the frequency of on-the-job leisure.

The lower explanatory power of offshoring versus routine task intensity is in line with recent work that compares the explanatory power of offshoring versus job-specific routine task content in explaining cross-region, cross-industry, and cross-national trends in employment and wage polarization (Autor and Dorn, 2013; Goos, Manning and Salomons, 2010; Michaels, Natraj and Van Reenen, 2014). A general finding of this set

[14] We also run Equation (2) including the RTI and offshoring indices, together with their interactions with the time dummies, as in Goos, Manning and Salomons (2014). There is still enough variation across the offshoring and the RTI index, which allows us to separate the relationship between on-the-job leisure, on the one hand, and RBTC and offshoring on the other. The correlation coefficient between the RTI and BK index is 0.46. Results are robust to the results shown here.

of papers is that offshoring plays a comparatively small or negligible explanatory role when considered alongside other potential causes.

Competition for jobs and labor market conditions

The established "Routine-Biased Technological Change" (RBTC) framework proposed by Autor, Levy and Murnane (2003) predicted a displacement of workers engaged in routine, task-intensive occupations as new technologies substitute for the tasks that these workers traditionally performed. This theoretical framework argues that robots and software that perform and aid tasks following well-defined procedures can result not only in job losses, but also in increases in work effort for workers who remain employed as a result of increased competition. We alternatively test whether it is the mere threat of losing the job (because of automation) that affects on-the-job leisure. To test this hypothesis, we use the occupational change in employment for each occupation, computed as the percentage change in the share of employment that each occupation represents in comparison to the reference year (i.e., 1985), and estimate Equation (1), adding the change in employment and its interaction with the RTI measure. Table 6 shows that the interaction terms between the RTI and the change in employment are not statistically significant for the consumption or frequency of on-the-job leisure, indicating that this channel is not behind the observed trends in work effort.

Another alternative explanation is related to local labor market conditions and the business cycle, which in general exert effects on the incentives to engage in non-work at work (Burda, Hamermesh, and Genadek, 2020). Lazear, Shaw and Stanton (2013) use data for a large firm to show that lower worker bargaining power, as a result of the recent financial crisis in the US, resulted in increases in work effort (measured as output per hour on the job) of workers who remained employed. This may represent cyclical tolerance of the employer (labor hoarding) or local unemployment (efficiency wages). One way to analyze this factor would be to control for labor market slack by using detailed local information and pooling the data. Unfortunately, some of the surveys used here do not contain detailed information on location of the worker, and thus we cannot explore this channel.

Trends in unionization in the UK

The decreasing power of unions has been suggested as underlying the intensification of work effort in the 1990s and 2000s in the UK (Green, 2004). With the decline of unionisation rates observed in the UK in recent decades, workers may have become less protected and therefore employers can exert more pressure on their workers, which can lead to demanding more effort from them (e.g., more working hours, shorter and fewer breaks, and more controlled breaks). To measure the power of unions in the different occupations, we construct a measure of unionization rate (UR) as the percentage of workers who respond "yes" in the survey to the question on union membership in the 2005 UK Labor Force Survey, and we estimate Equation (1) substituting the RTI and its interaction with year dummies by the unionization rate at the occupational level and its interactions with the year dummies. Table 7 shows that unionization rates cannot explain the trends by occupation in the consumption and frequency of on-the-job leisure.

3.2. Supply-side explanations

We now rule out supply-side explanations related to workers' characteristics, which may have led to the observed changes in the consumption and frequency of on-the-job leisure. In doing so, we consider education and the presence of children as possible driving forces of the observed patterns in work effort. Furthermore, we explore the composition of leisure outside the workplace (i.e., out-of-job leisure) to see if the observed trends in on-the-job leisure contrast with the trends in out-of-job leisure, and whether it may be related to changing preferences.

The role of education of workers

We explore whether the decreases in the consumption and frequency of on-the-job leisure stem from changes in the educational level of workers. Aguiar and Hurst (2007) and Gimenez-Nadal and Sevilla (2012) show increases in leisure time across industrialized countries, particularly for the least educated. Increases in leisure on the part of less educated workers, who tend to work in middle-wage occupations, is consistent with less educated workers decreasing the consumption and frequency of on-the-job leisure, in order to have more leisure outside their workplaces.

To test this hypothesis, we estimate OLS equation models similar to Equation (1):

$$E_i = \mu + \beta_1 X_i + \beta_2 SF_i + \beta_3' D_{t,i} + \beta_4' D_{t,i} * Educ_i + \varepsilon_i \qquad (3)$$

where E_i is a measure of work effort (either the consumption or frequency of on-the-job leisure) for respondent i, and $Educ_i$ represents dummy variables to control for the education of workers. β_3' is a vector of dummy variables for decades. The coefficients of interest are the vector β_4' on the interaction of survey dummies $D_{t,i}$ with the dummy variables of education. We consider three levels of education: workers with primary education (less than 12 years of education) as reference group, comparing them with workers with secondary education (12 years of education) and university education (more than 12 years of education).

Panel A of Table 8 presents the results of estimating Equation (2) for individuals by differences in educational attainment. There is no evident correlation between educational attainment or the presence of children, on the one hand, and the documented trends in on-the-job leisure during this period.

The role of children

Another alternative explanation of the patterns observed for on-the-job leisure is the rise in parental time investments (Guryan, Hurst and Kearney, 2008; Ramey and Ramey, 2010). Increases in parental time spent in human capital-enhancing activities is mainly viewed as a result of increases in returns to investment in children over time (Ramey and Ramey, 2010; Chiappori, Salanié and Weiss, 2017; Doepke and Zilibotti, 2017). It is thus possible that parents work harder to have more time available for their children, and if so, parents may have experienced larger decreases in the consumption and frequency of on-the-job leisure in comparison to non-parents.

To test this hypothesis, we estimate OLS equation models similar to Equation (1):

$$E_i = \mu + \beta_1 X_i + \beta_2 SF_i + \beta_3' D_{t,i} + \beta_4' D_{t,i} * Children_i + \varepsilon_i \qquad (4)$$

where E_i is a measure of work effort (either the consumption or frequency of on-the-job leisure) for respondent i, and $Children_i$ represents a dummy variable to control for the presence of children in worker's household (e.g., value "1" if there is a child under age 5 in the household and value "0" otherwise). β_3' is a vector of dummy variables for decades.

The coefficients of interest are the vector $\beta_4^{'}$ on the interaction of survey dummies $D_{t,i}$ with the dummy variable controlling for the presence of children.

Panel B of Table 8 presents the results of estimating Equation (4) for individuals by the presence of children. There is no evident correlation between the presence of children, and the documented trends in on-the-job leisure during this period.

Changes in the composition of leisure outside the job place

We also test if our results are driven by secular declines in leisure outside of work, particularly for those in routine task-intensive occupations. We develop a more complete picture of how workers allocate their work and leisure, and we consider whether there are any potentially off-setting effects of work during leisure hours. These off-setting effects of work during leisure hours could have increased more for workers in some high-paying, non-routine professional occupations, which could have affected work satisfaction differently. Sevilla, Gimenez-Nadal and Gershuny (2012) show decreases in leisure overall in the US between the 1960s and the 2000s, but more so for the highly educated. Thus, we look at whether declines in leisure outside of work have been less so for routine task-intensive occupations.

To that end, we compute the time devoted to off-the-job leisure, where off-the-job is defined as the period before and after work. The definition of leisure is similar to the definition of on-the-job leisure (social leisure, active leisure, and passive leisure), although restricted to activities that are done before the first work episode or after the last work episode. Table A5 in the Appendix shows the evolution of the time devoted to off-the-job leisure, off-the-job meals, and off-the-job leisure and meals. We observe a decrease in off-the-job leisure and meals between the 1980s and the 2000s, consistent with prior research showing decreases in leisure time in the UK (Gimenez-Nadal and Sevilla, 2012; Fang and McDaniel, 2017).

We estimate Equation (1) where the dependent variable is the time devoted to off-the-job leisure during working days. Table A6 in Appendix shows the results, and we find that the non-routine task-intensity of the occupation is not related, nor is the time devoted to off-the-job leisure. We also focus on the time devoted to off-the-job meals, looking at whether declines in off-the-job meals have been less so for routine task-intensive

occupations. We estimate the time devoted to off-the-job meals as in Equation (1), and Column (2) shows that the decrease in off-the-job meals is not affected by non-routine task-intensity. Finally, we combine both off-the-job leisure and meals (Column (3) of Table A6), and results are consistent to the use of this alternative definition of off-the-job free (leisure and meals) time.

4. Conclusion

This paper shows that, compared to the 1980s, the consumption and frequency of on-the-job leisure decreased in the UK. Using detailed diary information on what workers do while at work, we document decreases in the daily amount of time spent in the consumption of on-the-job leisure in the UK, which dropped from around one hour and 20 minutes per day in the 1980s to around one hour and 10 minutes per day in the 2010s. The number of on-the-job leisure spells also decreased, and workers worked for longer before taking a break. We also show that the decrease in the frequency of on-the-job leisure is much greater for workers in routine task-intensive occupations. All in all, the results are consistent with the automation of job tasks as a factor underlying the increase in worker's effort during the analyzed period.

While it is possible to consider alternative theories based on preferences and constraints facing workers over this period, to be persuasive such theories must account for the key elements of the evidence that we document here, such as the nature, the timing, and the composition of the changes in work effort. We rule out standard supply-side factors, such as higher relative preference for leisure, and other demand-side factors, as drivers of the increase in job intensity, such as offshoring and changes in employment (competition for jobs). Finally, it could also be that RBTC had the largest impact in the monitoring technology available to firms to reduce on-the-job leisure.

By revealing increases in work effort, our results add to the losses from routine-biased technological change for workers in middle-wage occupations, beyond the increases in wage inequality and unemployment.

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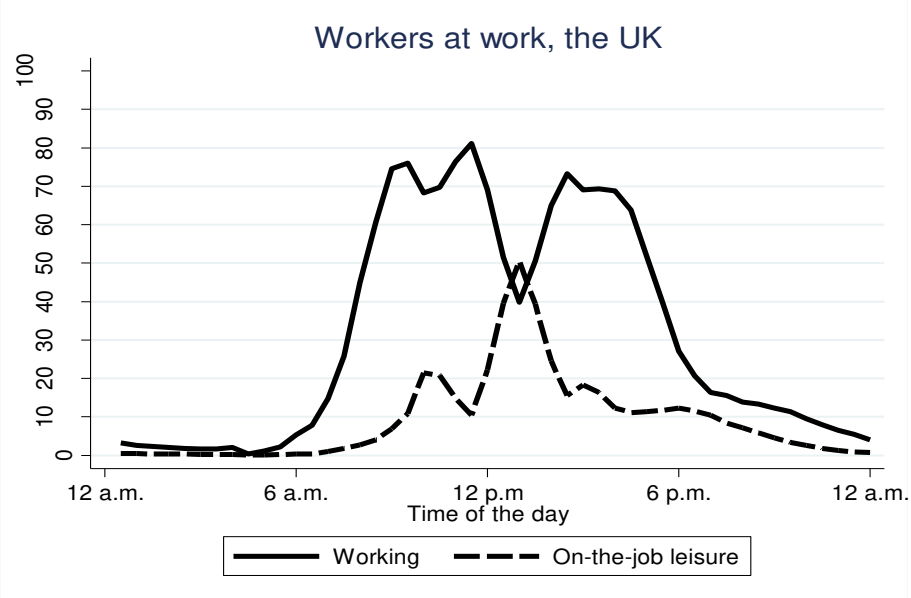
Figure 1. Frequency of on-the-job leisure



Notes: Data come from the 1983, 1987, 1995, 2000, 2005 and 2015 UK time diary surveys. The sample are full-time workers aged 21-65. We select working days in which there are at least 60 minutes of market work activities, excluding commuting. *Time at work* measures the time from the moment a worker starts to work until the time a worker stops working in a given diary day. *Time working* measures the time that the worker spends in market work activities while at work. *Consumption of on-the-job leisure* is the amount of time the respondent spends not working while at work. See Appendix Table A2 in Appendix A for a description of the activities included in the variables of on-the-job leisure. See Table A3 in Appendix A for the percentage of workers in each activity at every point in time that generates this figure.

Table 1. Example of the consumption and frequency of on-the-job leisure

(1) Start time	(2) Finish time	(3) Activity type	(4) Duration
8:00 a.m.	11:00 a.m.	Paid work	3.00
11:00 a.m.	11:20 a.m.	Meals or snacks in other places	0.33
11:20 a.m.	12:00 p.m.	Relax/do nothing	0.66
12:00 p.m.	2:10 p.m.	Paid work	2.16
2:10 p.m.	2:20 p.m.	Work breaks	0.16
2:02 p.m.	4:40 p.m.	Paid work	2.33
Time at work (hours)			8.67
Time working (hours)			7.50
Consumption of on-the-job leisure (hours)			1.16
Number of on-the-job leisure episodes			2.00
Working time until consuming on-the-job leisure (hours)			2.50

Notes: *Time at work* measures the time from the moment a worker starts to work until the time a worker stops working in a given diary day. *Time working* measures the time that the worker spends in market work activities while at work. *Consumption of on-the-job leisure* is the amount of time the respondent spends not working while at work. See Table A2 in Appendix A for a description of the activities included in the variables of on-the-job leisure. The *number of on-the-job leisure episodes* is constructed as the number of spells spent on non-work activities while at work. *Working time until consuming on-the-job leisure* is computed by dividing the total amount of time spent working by the number of work spells in a given diary day.

Table 2. Consumption and frequency of on-the-job leisure over time, the UK

	(1)		(2)		(3)		(4)		(5)	(6)
	Decade 1980s		**Decade 1990s**		**Decade 2000s**		**Decade 20010s**		**Diff 2010s-1980s**	**P-value diff**
Time at work	8.76	(0.06)	9.44	(0.14)	8.81	(0.05)	8.39	(0.08)	-0.37	(<0.01)
Working Time	7.40	(0.04)	8.43	(0.12)	7.80	(0.04)	7.23	(0.07)	-0.17	(0.05)
Consumption of on-the-job leisure	1.36	(0.03)	1.00	(0.07)	1.00	(0.02)	1.16	(0.04)	-0.20	(<0.01)
Frequency of on-the-job-leisure										
Number of on-the-job leisure episodes	1.69	(0.02)	1.08	(0.05)	1.10	(0.02)	1.31	(0.03)	-0.38	(<0.01)
Working time until consuming on-the-job leisure	3.31	(0.04)	5.03	(0.14)	4.62	(0.04)	3.89	(0.07)	0.58	(<0.01)
Number of diaries	2,836		494		4,810		1,692			
Number of workers	618		494		4,138		1,381			

Notes: Data come from the 1983, 1987, 1995, 2000, 2005 and 2015 UK time diary surveys. The sample are full-time workers aged 21-65. We select working days in which there are at least 60 minutes of market work activities, excluding commuting. *Time at work* measures the time from the moment a worker starts to work until the time a worker stops working in a given diary day. *Time working* measures the time that the worker spends in market work activities while at work. *Consumption of on-the-job leisure* is the amount of time the respondent spends not working while at work. See Table A2 in Appendix A for a description of the activities included in the consumption of on-the-job leisure. The *number of on-the-job leisure episodes* is constructed as the number of spells spent on non-work activities while at work. *Working time until consuming on-the-job leisure* is computed by dividing the total amount of time spent working by the number of work spells in a given diary day.

Table 3. Sum Stats of work hours and on-the-job leisure occupations, by RTI

	(1)		(2)		(3)	(4)
	Panel A: The UK 1985-2000-2015 (Low 10 % pct-High 90% pct)					
	Low 10% percentile		**High 90% percentile**		**Diff low-high**	**p-value Diff**
Market work	7.54	(2.94)	7.33	(1.93)	0.22	(0.18)
Consumption of on-the-job leisure	1.14	(1.81)	0.92	(1.07)	0.23	(0.02)
Number of breaks for on-the-job leisure	1.12	(1.11)	1.15	(0.90)	-0.03	(0.68)
Working time until consuming on-the-job leisure	4.36	(2.87)	4.02	(2.23)	0.34	(0.05)
Number of Observations	415		486			
	Panel B: The UK 1985-2000-2015 (Low 25% pct-High 75% pct)					
	Low 25% percentile		**High 25% percentile**		**Diff low-high**	**p-value Diff**
Market work	7.82	(2.89)	7.58	(2.13)	0.24	(0.02)
Consumption of on-the-job leisure	1.13	(1.74)	0.86	(1.21)	0.28	(<0.01)
Number of breaks for on-the-job leisure	1.15	(1.14)	1.22	(1.07)	-0.07	(0.14)
Working time until consuming on-the-job leisure	4.54	(2.96)	4.23	(2.54)	0.31	(<0.01)
Number of Observations	1,041		1,272			

Notes: Data come from the 1983, 1987, 1995, 2000, 2005 and 2015 UK time diary surveys. The sample are full-time workers aged 21-65. We select working days in which there are at least 60 minutes of market work activities, excluding commuting. Consumption of on-the-job leisure is the amount of time the respondent spends not working while at work. See Table A2 in Appendix for a description of the activities included in the consumption of on-the-job leisure. The number of on-the-job leisure episodes is constructed as the number of spells spent on non-work activities while at work. Working time until consuming on-the-job leisure is computed by dividing the total amount of time spent working by the number of work spells in a given diary day.

Table 4. Consumption and frequency of on-the-job leisure over time: the role of RBTC

	(1)	(2)	(3)
	Amount	*Frequency*	
	Consumption of on-the-job leisure	*Number of breaks for on-the-job leisure*	*Working time until consuming on-the-job leisure*
RTI	0.03	0.19***	-0.44***
	(0.05)	(0.05)	(0.08)
Decade's 2000's	-0.37***	-0.60***	1.32***
	(0.07)	(0.06)	(0.12)
Decade's 2010's	-0.27***	-0.35***	0.64***
	(0.08)	(0.06)	(0.13)
RTI *Decade 2000's	-0.08	-0.15***	0.27***
	(0.06)	(0.05)	(0.09)
RTI*Decade 2010's	-0.09	-0.22***	0.44***
	(0.07)	(0.06)	(0.11)
Number of observations	4,926	4,926	4,926
Number of workers	3,817	3,817	3,817
R-Squared	0.03	0.11	0.20

Notes: Robust standard errors in parenthesis. Data come from the 1983, 2000 and 2015 UK time diary surveys. The sample are full-time workers aged 21-65. We select working days in which there are at least 60 minutes of market work activities, excluding commuting. *Consumption of on-the-job leisure* is the amount of time the respondent spends not working while at work. See Table A2 in Appendix A for a description of the activities included in the consumption of on-the-job leisure. The *number of on-the-job leisure episodes* is constructed as the number of spells spent on non-work activities while at work. *Working time until consuming on-the-job leisure* is computed by dividing the total amount of time spent working by the number of work spells in a given diary day. We estimate the following OLS regression: $E_i = \mu + \beta_1 X_i + \beta_2 RTI_i + \beta_3 D_{t,i} + \beta_4 D_{t,i} * RTI_i + \varepsilon_i$, where E_i represents either the consumption or the frequency of on-the-job leisure (either the number of on-the-job leisure episodes or work time before consuming on-the-job leisure) for respondent i. The vector X_i includes person-specific socio-demographic characteristics: gender (ref.: male), age, dummy for secondary and university education (ref.: primary education), dummy for living in couple (ref.: not in couple), the number of children under 18 in the household, hours at work during the diary day, and the total number of activities reported by the individual in the diary day. RTI_i is the Routine Task index measure. *Significant at the 10% level; **significant at the 5% level; ***Significant at the 1% level.

Table 5. Consumption and frequency of on-the-job leisure over time: the role of offshoring

	(1)	(2)	(3)
	Amount	*Frequency*	
	Consumption of on-the-job leisure	*Number of breaks for on-the-job leisure*	*Working time until consuming on-the-job leisure*
Offshoring Index	-0.01	0.13**	-0.11
	(0.11)	(0.06)	(0.11)
Decade's 2000's	-0.36***	-0.57***	1.25***
	(0.07)	(0.06)	(0.12)
Decade's 2010's	-0.22***	-0.26***	0.50***
	(0.08)	(0.07)	(0.14)
Offshoring Index*Decade 2000's	-0.02	-0.09	-0.06
	(0.11)	(0.07)	(0.13)
Offshoring Index*Decade 2010's	0.07	0.00	-0.08
	(0.12)	(0.08)	(0.14)
Number of observations	4,926	4,926	4,926
Number of workers	3,817	3,817	3,817
R-Squared	0.03	0.11	0.20

Notes: Robust standard errors in parenthesis. Data come from the 1983, 2000 and 2015 UK time diary surveys. The sample are full-time workers aged 21-65. We select working days in which there are at least 60 minutes of market work activities, excluding commuting. *Consumption of on-the-job leisure* is the amount of time the respondent spends not working while at work. See Table A2 in Appendix A for a description of the activities included in the consumption of on-the-job leisure. The *number of on-the-job leisure episodes* is constructed as the number of spells spent on non-work activities while at work. *Working time until consuming on-the-job leisure* is computed by dividing the total amount of time spent working by the number of work spells in a given diary day. We estimate the following OLS regression: $E_i = \mu + \beta_1 X_1 + \beta_2 BK_i + \beta_3 D_{t,i} + \beta_4 D_{t,i} * BK_i + \varepsilon_i$, where E_i represents either the consumption or the frequency of on-the-job leisure (either the number of on-the-job leisure episodes or work time before consuming on-the-job leisure) for respondent i in period t. The vector X_i includes person-specific socio-demographic characteristics: gender (ref.: male), age, dummy for secondary and university education (ref.: primary education), dummy for living in couple (ref.: not in couple), the number of children under 18 in the household, hours at work during the diary day, and the total number of activities reported by the individual in the diary day. BK_i is the offshorability index. *Significant at the 10% level; **significant at the 5% level; ***significant at the 1% level.

Table 6. Consumption and frequency of on-the-job leisure over time: RBTC and change in employment

	(1)	(2)	(3)
	Amount	*Frequency*	
	Consumption of on-the-job leisure	*Number of breaks for on-the-job leisure*	*Working time until consuming on-the-job leisure*
RTI	0.03	0.19***	-0.27***
	(0.05)	(0.05)	(0.08)
Change in Employment	-0.73	-1.16*	1.58
	(0.91)	(0.66)	(1.35)
Decade's 2000's	-0.35***	-0.58***	1.05***
	(0.07)	(0.06)	(0.11)
Decade's 2010's	-0.24***	-0.30***	0.58***
	(0.09)	(0.07)	(0.13)
RTI *Decade 2000's	-0.08	-0.15***	0.16*
	(0.06)	(0.05)	(0.09)
RTI *Decade 2000's*Change in Employment	2.01	1.01	-2.56
	(1.53)	(1.01)	(2.37)
RTI*Decade 2010's	-0.11	-0.26***	0.29***
	(0.08)	(0.06)	(0.11)
RTI*Decade 2010's*Change in Employment	0.61	0.78	-0.84
	(0.82)	(0.56)	(1.06)

Notes: Robust standard errors in parenthesis. Data come from the 1983, 2000 and 2015 UK time diary surveys. The sample are full-time workers aged 21-65. We select working days in which there are at least 60 minutes of market work activities, excluding commuting. *Consumption of on-the-job leisure* is the amount of time the respondent spends not working while at work. See Table A2 in Appendix A for a description of the activities included in the consumption of on-the-job leisure. The *number of on-the-job leisure episodes* is constructed as the number of spells spent on non-work activities while at work. *Working time until consuming on-the-job leisure* is computed by dividing the total amount of time spent working by the number of work spells in a given diary day. We estimate the following OLS regression: $E_i = \mu + \beta_1 X_i + \beta_2 RTI_i + \beta_3 D_{t,i} + \beta_4 D_{t,i} * RTI_i + \beta_5 D_{t,i} * RTI_i * Change\ in\ Employment_i + \varepsilon_i$, where E_i represents either the consumption or the frequency of on-the-job leisure (either the number of on-the-job leisure episodes or work time before consuming on-the-job leisure) for respondent i. The vector X_i includes person-specific socio-demographic characteristics: gender (ref.: male), age, dummy for secondary and university education (ref.: primary education), dummy for living in couple (ref.: not in couple), the number of children under 18 in the household, hours at work during the diary day, and the total number of activities reported by the individual in the diary day. RTI_i is the Routine Task index measure for occupation "i", and *Change in Employment*$_i$ measures the percent change in employment share for occupation "i" in comparison to 1985. *Significant at the 10% level; **significant at the 5% level; ***Significant at the 1% level.

Table 7. Unionization and on-the-job consumption of leisure

	(1)	(2)	(3)
	Amount	*Frequency*	
	Consumption of on-the-job leisure	*Number of breaks for on-the-job leisure*	*Working time until consuming on-the-job leisure*
Unionization Rate	-0.05	-0.36	1.30**
	(0.41)	(0.35)	(0.60)
Decade's 2000	-0.44***	-0.78***	1.82***
	(0.14)	(0.11)	(0.21)
Decade's 2010's	-0.43***	-0.48***	1.12***
	(0.14)	(0.12)	(0.22)
Unionization Rate*Decade 2000's	0.19	0.49	-1.57**
	(0.45)	(0.37)	(0.68)
Unionization Rate*Decade's 2010's	0.41	0.29	-1.03
	(0.46)	(0.37)	(0.66)
Number of observations	4,678	4,678	4,678
Number of workers	3,327	3,327	3,327
R-Squared	0.04	0.13	0.20

Notes: Robust standard errors in parenthesis. Data come from the 1983, 2000 and 2015 UK time diary surveys. The sample are full-time workers aged 21-65. We select working days in which there are at least 60 minutes of market work activities, excluding commuting. *Consumption of on-the-job leisure* is the amount of time the respondent spends not working while at work. See Table A3 in Appendix A for a description of the activities included in the consumption of on-the-job leisure. The *number of on-the-job leisure episodes* is constructed as the number of spells spent on non-work activities while at work. *Working time until consuming on-the-job leisure* is computed by dividing the total amount of time spent working by the number of work spells in a given diary day. We estimate the following OLS regression: $E_i = \mu + \beta_1 X_i + \beta_2 UR_i + \beta_3 D_{t,i} + \beta_4 D_{t,i} * UR_i + \varepsilon_i$, where E_i represents either the consumption or the frequency of on-the-job leisure (either the number of on-the-job leisure episodes or work time before consuming on-the-job leisure) for respondent i. The vector X_i includes person-specific socio-demographic characteristics: gender (ref.: male), age, dummy for secondary and university education (ref.: primary education), dummy for living in couple (ref.: not in couple), the number of children under 18 in the household, hours at work during the diary day, and the total number of activities reported by the individual in the diary day. Ur_i is the unionization rate. *Significant at the 10% level; **significant at the 5% level; ***Significant at the 1% level. *Significant at the 10% level; **significant at the 5% level; ***significant at the 1% level.

Table 8. Consumption of on-the-job leisure over time, by educational attainment and presence of children <5

	(1)	(2)	(3)
	Amount	*Frequency*	
	Consumption of on-the-job leisure	*Number of breaks for on-the-job leisure*	*Working time until consuming on-the-job leisure*
	Panel A: Analysis by education		
Decade 1990s	-0.51***	-0.61**	1.41*
	(0.19)	(0.28)	(0.72)
Decade 2000s	-0.51***	-0.69***	1.48***
	(0.07)	(0.05)	(0.11)
Decade 2010s	-0.47**	-0.51***	0.28
	(0.19)	(0.16)	(0.33)
Decade 1990s* Secondary educ.	0.27	0.08	-0.49
	(0.21)	(0.28)	(0.74)
Decade 2000s* Secondary educ.	0.50*	0.22	-0.59
	(0.26)	(0.30)	(0.77)
Decade 2010s* Secondary educ.	0.11	0.02	0.06
	(0.09)	(0.07)	(0.14)
Decade 1990s* University educ.	0.15	0.07	-0.25*
	(0.10)	(0.07)	(0.14)
Decade 2000s* University educ.	0.02	-0.09	0.98***
	(0.20)	(0.17)	(0.35)
Decade 2010s* University educ.	0.23	0.17	0.35
	(0.21)	(0.17)	(0.34)
Number of observations	9,832	9,832	9,832
Number of workers	6,631	6,631	6,631
R-Squared	0.04	0.13	0.20
	Panel B: Analysis by the presence of children <5		
Decade 1990s	-0.16***	-0.52***	0.94***
	-0.02	-0.05	-0.16
Decade 2000s	-0.39***	-0.66***	1.38***
	(0.04)	(0.06)	(0.18)
Decade 2010's	-0.26***	-0.43***	0.92***
	(0.01)	(0.04)	(0.10)
Decade 1990s*Children <5	-0.11***	0.32***	-0.73**
	-0.03	-0.04	-0.20
Decade 2000s*Children <5	(0.06)	(0.02)	(0.12)
	(0.10)	(0.07)	(0.23)
Decade 2010's*Children<5	-0.30***	-0.01	-0.19
	(0.04)	(0.05)	(0.21)
Number of observations	9,832	9,832	9,832
Number of workers	6,631	6,631	6,631
R-Squared	0.04	0.13	0.20

Notes: Robust standard errors in parenthesis. Data come from the 1983, 1987, 1995, 2000, 2005 and 2015 UK time diary surveys. The sample are full-time workers aged 21-65, and in working days defined as those with at least 60 minutes to market work activities, excluding commuting. *Consumption of on-the-job leisure* is the amount of time the respondent spends not working while at work. See Table A2 in Appendix A for a description of the activities included in the consumption of on-the-job leisure. The *number of on-the-job leisure episodes* is constructed as the number of spells spent on non-work activities while at work. *Working time until consuming on-the-job leisure* is computed by dividing the total amount of time spent working by the number of work spells in a given diary day. We estimate the following OLS regression: $E_i = \mu + \beta_1 X_i + \beta_2 SF_i + \beta_3' D_{t,i} + \beta_4' D_{t,i} * SF_i + \varepsilon_1$, where E_i represents either the consumption or the frequency of on-the-job leisure (either the number of on-the-job leisure episodes or work time before consuming on-the-job leisure) for respondent i in period t. The vector $X_{i,t}$ includes person-specific socio-demographic characteristics (gender (ref.: male), age, dummy for living in couple (ref.: not in couple), the number of children under 18 in the household, and working time (hours) during the diary day. Additionally, we control for the total number of activities reported by the individual in the diary day. SF refers to the level of education. *Significant at the 10% level; **significant at the 5% level; ***significant at the 1% level.

Appendix for
"Trends in Effort at Work in the UK"

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DATA APPENDIX AND ADDITIONAL ANALYSIS

Table A1. Survey description for the UK

Study aims, target populations, and sample restrictions

Survey years	*Organizing Aims and Considerations*	*Target Population*	*Sampling Restrictions*
1983-87	Aimed to monitor time use by people aged 14+ living in randomly sampled households in the UK	People aged 14+ living in randomly sampled households in the UK.	None
1995	Aimed to facilitate future studies using time budgets which would not unduly burden respondents	Multi- purpose survey for the people in age 16 or over	None
2000	This study collects the UK contribution to the Harmonized European Time Use Studies (HETUS) data. The results of the main survey will be used by government departments, academics, and other policy makers to monitor how people use their time and help shape policies	Multi- purpose survey for the people in age 8+	The survey aimed to collect 24,000 diaries (2 diaries for each of the 12,000 individuals taking part). Each participant was asked to complete two diaries. Children aged 8 to 13 completed child diaries. Child diaries covered one day.
2005	This study builds on lessons for collecting national time use data from the UK HETUS study in 2000-2001	One person aged 16 or older was selected for the interview and the diary	None
2015	The survey follows the Harmonized European Time Use Survey (HETUS) guidelines, with a few alterations. While the HETUS guidelines recommend collecting diaries from all household members age 10 and older, this survey, like the 2000-01 first UK HETUS contribution, collects diaries from all household members aged 8 and older.	One household member will complete the household roster and questionnaire, then each individual member aged 8 and older will be asked to complete a separate personal interview, as well as two diaries (one week day, one weekend day) covering 24 hour periods from 4AM until 4AM the next day	None

Relevant points in time from the sample designs

Survey years	*Fieldwork Period*	*Sampling of Days of the Week*	*When Activities Were Recorded*
1983-87	November-December 1983, January-February 1984; 6 March-29 June 1987	All household members aged 14+ asked to complete a 7-day diary, specifying main activity and secondary activities	On the day of observed activities
1995	May-95	All household members aged 16+ asked to complete 1 diary, specifying main activity and secondary activities	Respondents completed the diaries themselves with the assistance of interviewer. Recall
2000	June 2000 - August 2001	2 days, 1 weekend and 1 weekday	Self-completed in own words with pen and paper. Same day as activities
2005	21 March - 13 April 2005; 20 June - 16 July 2005; 19 September - 15 October 2005; 21 November - 17 December 2005	1 day	Previous day (with some diaries covering up to three days previously)
2015	April 2014-March 2015	2 diaries (one weekday, one weekend day) covering 24-hour periods from 4AM until 4AM the next day	Self-completed in own words with pen and paper. Same day as activities

Sample designs and response rates

Survey years	*Sample Frame*	*How Sample Drawn*	*Response Rate*
1983-1987	Private households	Stratified national random sample of addresses; prior to diaries commencing, one household member interviewed with extensive household questionnaire	40%
1995	Private households	OPCS Omnibus sample frame: interview 2,000 households per month randomly selected from 100 post code sectors, stratified by region, proportion of households renting from local authorities and proportion of heads of households in	93%

		SEGs 1-5 (professionals, employers, and managers)	
2000	Private households	The sample of addresses is selected from the Postcode Address File (PAF). One household per address is randomly selected	45%
2005	Private households	An independent cross-sectional multi-stage stratified random sample of private households in Great Britain (England, Wales and Scotland) is drawn for each month of the Omnibus survey, and the diary served as the module accompanying the core of basic survey details collected with every Omnibus survey.	59% across the four waves
2015	Private households	The survey draws a random national sample of households across the United Kingdom	61% for households, 81% for individuals

Source: Authors' compilation.

Table A2. Classification of on-the-job leisure activities

Commuting	Travel to/from work
Leisure-related activities	
Meals at work	meals at work
Meal Related activities	meals or snacks in other places
Social leisure	voluntary, civic, organizational act; worship and religion; other public event, venue; restaurant, café, bar, pub; party, social event, gambling; receive or visit friends; voluntary/civic/religious travel
Active leisure and exercise	work breaks, leisure & other education or training; pet care (not walk dog); general out-of-home leisure; attend sporting event; cinema, theatre, opera, concert; general sport or exercise; walking; cycling; other outside recreation; gardening/pick mushrooms; walk dogs; general indoor leisure; art or music; knit, crafts or hobbies; no activity, imputed or recorded transport; other travel; no recorded activity
Passive leisure	conversation (in person, phone); games (social & solitary)/other in-home social; correspondence (not e-mail); relax, think, do nothing; read; listen to music or other audio content; listen to radio; watch TV, video, DVD; computer games; e-mail, surf internet, computing; travel to and from work
Other non-work activities	
Personal Care	imputed personal or household care; sleep and naps; imputed sleep; wash, dress, care for self; consume other services
Housework	regular schooling, education; homework; food preparation, cooking; set table, wash/put away dishes; cleaning; laundry, ironing, clothing repair; maintain home/vehicle, including collect fuel; other domestic work; purchase goods; consume personal care services; physical, medical child care; teach, help with homework; read to, talk or play with child; supervise, accompany, other child care; adult care; education travel; child/adult care travel; shop, person/hhld care travel

Notes: Data come from 1983, 1987, 1995, 2000, 2005 and 2015 UK time diary surveys

Table A3. Timing of market work episodes and on-the-job leisure consumption

Time of the day	Working	On-the-job leisure
12:00 am-12:30 am	3.26%	0.49%
12:30 am-1:00 am	2.54%	0.43%
1:00 am-1:30 am	2.32%	0.33%
1:30 am-2:00 am	2.00%	0.30%
2:00 am-2:30 am	1.84%	0.32%
2:30 am-3:00 am	1.69%	0.27%
3:00 am-3:30 am	1.67%	0.16%
3:30 am-4:00 am	2.01%	0.14%
4:00 am-4:30 am	0.39%	0.02%
4:30 am-5:00 am	1.16%	0.08%
5:00 am-5:30 am	2.14%	0.15%
5:30 am-6:00 am	5.38%	0.30%
6:00 am-6:30 am	7.77%	0.36%
6:30 am-7:00 am	14.72%	0.93%
7:00 am-7:30 am	25.75%	1.78%
7:30 am-8:00 am	44.97%	2.72%
8:00 am-8:30 am	60.69%	4.05%
8:30 am-9:00 am	74.55%	6.86%
9:00 am-9:30 am	75.94%	10.88%
9:30 am-10:00 am	68.20%	21.40%
10:00 am-10:30 am	69.72%	20.86%
10:30 am-11:00 am	76.43%	14.90%
11:00 am-11:30 am	81.09%	10.44%
11:30 am-12:00 am	69.08%	22.28%
12:00 pm-12:30 pm	51.45%	39.52%
12:30 pm-1:00 pm	39.85%	50.46%
1:00 pm-1:30 pm	50.53%	39.46%
1:30 pm-2:00 pm	65.01%	24.57%
2:00 pm-2:30 pm	73.24%	15.53%
2:30 pm-3:00 pm	69.00%	18.25%
3:00 pm-3:30 pm	69.38%	16.29%
3:30 pm-4:00 pm	68.80%	12.32%
3:00 pm-4:30 pm	63.77%	11.14%
4:30 pm-5:00 pm	51.58%	11.35%
5:00 pm-5:30 pm	39.48%	11.73%
5:30 pm-6:00 pm	27.12%	12.33%
6:00 pm-6:30 pm	20.72%	11.55%
6:30 pm-7:00 pm	16.38%	10.48%
7:00 pm-7:30 pm	15.55%	8.42%
7:30 pm-8:00 pm	13.85%	7.14%
8:00 pm-8:30 pm	13.28%	5.84%
8:30 pm-9:00 pm	12.22%	4.51%
9:00 pm-9:30 pm	11.37%	3.39%
9:30 pm-10:00 pm	9.53%	2.53%
10:00 pm-10:30 pm	8.01%	1.83%
10:30 pm-11:00 pm	6.51%	1.27%
11:00 pm-11:30 pm	5.45%	0.82%
11:30 pm-12:00 pm	4.03%	0.69%

Notes: Data come from the 1983, 1987, 1995, 2000, 2005 and 2015 UK time diary surveys. The sample are full-time workers aged 21-65, and in working days defined as those with at least 60 minutes of market work activities, excluding commuting. *Working* includes the proportion of the workers that report doing market work activities. *On-the-job leisure* includes the proportion of workers that report consuming of on-the-job leisure. See Table A2 for a description of the activities included in the variable of on-the-job leisure

Table A4. Consumption of on-the-job leisure

	(1)	(2)	(3)
	Mean (hours per day)	**Standard Deviation**	**% of on-the-job consumption of leisure**
Time at work	8.75	(2.94)	
Time working	7.62	(2.47)	
On-the-job consumption of leisure	1.13	(1.58)	
Leisure	0.33	(0.84)	29.09%
Social leisure	0.14	(0.37)	11.96%
Active leisure and exercise	0.04	(0.23)	3.53%
Passive leisure	0.15	(0.51)	13.31%
Meals at work and related	0.45	(0.55)	39.45%
Other non-work	0.24	(0.74)	20.88%
Housework	0.05	(0.38)	4.47%
Personal Care	0.19	(0.58)	16.41%
Commuting	0.12	(0.44)	10.58%
Number of observations	9,832		
Number of workers	6,631		

Notes: Data come from the 1983, 1987, 1995, 2000, 2005 and 2015 UK time diary surveys. The sample are full-time workers aged 21-65. We select working days in which there are at least 60 minutes of market work activities, excluding commuting. Means and standard deviations are computed for the pool of data. *Time at work* measures the time from the moment a worker starts to work until the time a worker stops working in a given diary day. *Time working* measures the time that the worker spends in market work activities while at work. *Consumption of on-the-job leisure* is the amount of time the respondent spends not working while at work. See Table A2 for a description of the activities included in the variables of on-the-job leisure.

Table A5. Trends in off-the-job leisure and eating

	(1)		(2)		(3)		(4)		(5)	(6)
	Decade 1980s		**Decade 1990s**		**Decade 2000s**		**Decade 2010s**		**Diff 2010s-1980s**	**P-value diff**
Leisure in non-work time	3.98	(0.05)	3.79	(0.12)	3.76	(0.03)	3.51	(0.06)	-0.47	(<0.01)
Meals in non-work time	0.77	(0.01)	0.61	(0.02)	0.72	(0.01)	0.79	(0.02)	0.02	(0.52)
Leisure + meals in non-work time	4.75	(0.05)	4.40	(0.12)	4.48	(0.04)	4.30	(0.06)	-0.45	(<0.01)
Number of diaries	2,836		494		4,810		1,692			
Number of workers	618		495		4,138		1,380			

Notes: Data come from the 1983, 1987, 1995, 2000, 2005 and 2015 UK time diary surveys. The sample are full-time workers aged 21-65. We select working days in which there are at least 60 minutes of market work activities, excluding commuting. *Leisure in non-work time* includes the time devoted to social leisure, active leisure, and passive leisure, but outside the job.

Table A6. Consumption of off-the-job leisure over time

	(1) *Leisure*	(2) *Meals*	(3) *Leisure+Meals*
RTI	-0.010	0.000	-0.010
	(0.089)	(0.032)	(0.083)
Decade's 2000's	-0.110	-0.07**	-0.19**
	(0.096)	(0.036)	(0.094)
Decade's 2010's	-0.39***	-0.08**	-0.47***
	(0.108)	(0.041)	(0.108)
RTI *Decade 2000's	0.050	-0.030	0.020
	(0.094)	(0.033)	(0.088)
RTI*Decade 2010's	0.120	-0.020	0.100
	(0.106)	(0.037)	(0.104)
Number of observations	4,926	4,926	4,926
Number of workers	3,817	3,817	3,817
R-Squared	0.326	0.106	0.379

Notes: Robust standard errors in parenthesis. Data come from the 1983, 2000 and 2015 UK time diary surveys. The sample are full-time workers aged 21-65. We select working days in which there are at least 60 minutes of market work activities, excluding commuting. *Consumption of on-the-job leisure* is the amount of time the respondent spends not working while at work. See Table A3 in Appendix A for a description of the activities included in the consumption of off-the-job leisure. The *number of on-the-job leisure episodes* is constructed as the number of spells spent on non-work activities while at work. *Working time until consuming on-the-job leisure* is computed by dividing the total amount of time spent working by the number of work spells in a given diary day. We estimate the following OLS regression: $E_i = \mu + \beta_1 X_i + \beta_2 RTI_i + \beta_3 D_{t,i} + \beta_4 D_{t,i} * RTI_i + \varepsilon_i$, where E_i represents either off-the-job leisureor off-the-jog meals, or the sum of the two categories for respondent i. The vector X_i includes person-specific socio-demographic characteristics: gender (ref.: male), age, dummy for secondary and university education (ref.: primary education), dummy for living in couple (ref.: not in couple), the number of children under 18 in the household, hours at work during the diary day, and the total number of activities reported by the individual in the diary day. RTI_i is the Routine Task Index measure. *Significant at the 10% level; **significant at the 5% level; ***Significant at the 1% level.

APPENDIX B: ON-THE-JOB LEISURE AND RBTC

Original occupation codes for the UK TUS use the SOC80 and SOC90 codes, while we use the Camsis Project to do the crosswalk between the SOC codes and ISCO88 codes (http://www.camsis.stir.ac.uk/). The final samples are 186, 2,382 and 1,249 workers for the years 1983, 2000, and 2014 respectively, selected using the same criteria as in Section 1. In the conversion of the SOC codes to the ISCO88 codes, we lose 1,815 observations, representing 19.69% of the observations used in Tables 3 and 3, because ISCO08 codes are not as detailed as SOC codes. The RTI covers 21 occupations out of the 26 occupations in the ISCO88. We thus additionally lose 532 observations belonging to these occupations, representing 5.77% of our main sample in Tables 2 and 3. Table B1 shows detailed information on RTI values assigned to each occupation code.

Table B2 shows the values of the RTI index for each two-digit ISCO88 code, where occupations are sorted in ascending values of the RTI index. Following Acemoglu and Autor (2011) and the classification in Goos, Manning and Salomons (2014), the RTI index of workers in occupations such as managers, professionals, and services is low, suggesting that these are non-routine task-intensive occupations. In contrast, workers in other occupations such as clerks, sales, and laborers in mining, construction and manufacturing have relatively high values of the RTI index, suggesting that workers in these occupations perform a majority of routine tasks.

To see the validity of the RTI index for our sample of UK workers, Table B3 uses the 1983, 2000, and 2015 UK sample to replicate Table 1 in Goos, Manning and Salomons (2014), who employ the 1993-2010 European Labor Force Survey to show that RBTC decreased the share of employment in middle-paying occupations, while increasing the share of employment in high-paying and low-paying occupations in the UK, also documented by Acemoglu and Autor (2011) using the May/ORG Current Population Survey for the years 1979-2009.

There is a strong resemblance between the figures shown in Table B3 and those obtained in Goos, Manning and Salomons (2014) for the UK. In particular, whereas at the beginning of the period the share of employment of workers in middle occupations was 17 percentage points higher than the share of employment of workers in high-paying occupations, by the end of the period, the share of employment for workers in middle occupations was 17 percentage points lower than the share of employment of workers in high-paying occupations. The reason for this reversal is that, while the percentage of workers in high- and low-paying occupations increased during this period, the percentage of workers in middle-paying occupations decreased. In particular, between 1983 and 2000 the percentage of workers in high-paying occupations increased from 34.95% to 44.71%, and to 49.08% in 2015. Similarly, the percentage of workers in low-paying occupations increased by 5.77% between 1983 and 2000, and by an additional 3.51% between 2000 and 2015. In contrast, the percentage of workers in middle-paying occupations decreased from 51.61% in 1983 to 39.59% in 2000, and to 31.71% in 2015.

Table B1. Classification of occupations according to the RTI index, UKTUS 1983, 2000 and 2015

UK SOC 1983 codes	*RTI index*	*UK SOC 2000 codes*		*RTI index*
103 General administrators; national government (HEO to Seni	-0.732465	1112	Directors and chief executives of major organizations	-0.7469759
110 Production, works and maintenance managers	-0.7469759	1121	Production, works and maintenance managers	-0.7469759
113 Managers in mining and energy industries	-0.7469759	1122	Managers in construction	-0.7469759
120 Treasurers and company financial managers	-0.7469759	1131	Financial managers and chartered secretaries	-0.7469759
121 Marketing and sales managers	-0.7469759	1132	Marketing and sales managers	-0.7469759
122 Purchasing managers	-0.7469759	1133	Purchasing managers	-0.7469759
125 Organization and methods and work study managers	-0.7469759	1134	Advertising and public relations managers	-0.7469759
126 Computer systems and data processing managers	-0.7469759	1135	Personnel, training and industrial relations managers	-0.7469759
132 Civil service executive officers' government	-0.732465	1136	Information and communication technology managers	-0.7469759
140 Transport managers N.E.C.	-0.7469759	1137	Research and development managers	-0.7469759
141 Stores controllers	-0.7469759	1141	Quality assurance managers	-0.7469759
142 Managers in warehousing and other materials handling	-0.7469759	1142	Customer care managers	-0.7469759
169 Other managers in farming, forestry, and fishing N.E.C.	-1.522734	1151	Financial institution managers	-0.7469759
170 Property and estate managers	-0.4424283	1152	Office managers	-0.7469759
171 Garage managers and proprietors	-1.522734	1161	Transport and distribution managers	-0.7469759
174 Restaurant and catering managers	-1.522734	1162	Storage and warehouse managers	-0.7469759
176 Entertainment and sports managers	-1.522734	1163	Retail and wholesale managers	-0.7469759
179 Managers and proprietors in service industries N.E.C.	-1.522734	1172	Police officers (inspectors and above)	-0.4424283
201 Biological scientists and biochemists	-1.000168	1174	Security managers	-0.7469759
202 Physicists, geologists, and meteorologists	-0.8220372	1181	Hospital and health service managers	-0.7469759
210 Civil, structural, municipal, mining, and quarrying engin	-0.8220372	1183	Healthcare practice managers	-1.522734
213 Electronic engineers professional	-0.8220372	1184	Social services managers	-0.7469759
214 Software engineers professional	-0.8220372	1185	Residential and day care managers	-1.522734
216 Design and development engineers	-0.8220372	1211	Farm managers	-1.522734
217 Process and production engineers	-0.8220372	1219	Managers in animal husbandry, forestry, and fishing N.E.C.	-1.522734
219 Other engineers and technologists N.E.C.	-0.8220372	1221	Hotel and accommodation managers	-1.522734
220 Medical practitioners	-1.000168	1222	Conference and exhibition managers	-0.7469759
223 Dental practitioners	-1.000168	1223	Restaurant and catering managers	-1.522734
242 Solicitors public	-0.732465	1224	Publicans and managers of licensed premises	-1.522734
250 Chartered and certified accountants	-0.732465	1225	Leisure and sports managers	-1.522734
251 Management accountants	-0.732465	1226	Travel agency managers	-1.522734
253 Management consultants, business analysts	-0.732465	1231	Property, housing, and land managers	-1.522734
260 Architects landscape	-0.8220372	1232	Garage managers and proprietors	-1.522734
262 Building, land, mining and 'general practice' surveyors	-0.8220372	1233	Hairdressing and beauty salon managers and proprietors	-1.522734

290	Psychologists	-0.732465
293	Social workers, probation officers	-0.732465
300	Laboratory technicians	-0.3973301
301	Engineering technicians	-0.3973301
303	Architectural and town planning technicians	-0.3973301
310	Draughts persons	-0.3973301
312	Quantity surveyors	-0.8220372
342	Medical radiographers	-0.3973301
345	Dispensing opticians	-0.3327664
360	Estimators, valuers	-0.4424283
361	Underwriters, claims assessors, brokers, investment anal	-0.4424283
380	Authors, writers, journalists	-0.732465
384	Actors, entertainers, stage managers, producers and dire	-0.732465
386	Photographers, camera, sound, and video equipment operator	-0.3973301
387	Professional athletes, sports officials	-0.4424283
390	Information officers and technical librarians	-0.732465
400	Civil administrative assistants taxation	2.240688
421	Library assistants/clerks press	2.240688
440	Stores dispatch production control clerks warehouse	2.240688
441	Storekeepers, warehousemen/women	2.240688
451	Legal secretaries	2.240688
452	Typists and word processor operators	2.240688
460	Receptionists general office dental	1.406782
461	Receptionists/telephonist	1.406782
462	Telephone operators exchange	1.406782
463	Radio and telegraph operators, other office communication	-0.3973301
490	Computer operators, data processing operators, other off	2.240688
500	Bricklayers, masons fixer	-0.1854081
501	Roofers, slaters, tilers, sheeters, cladders	-0.1854081
504	Builders, building contractors	-0.1854081
507	Painters and decorators	-0.1854081
509	Other construction trades N.E.C. building	-0.1854081
510	Centre, capstan, turret and other lathe setters and sett	0.4568464
515	Tool makers tool fitters markers out metal foreman	0.4568464
516	Metal working production and maintenance fitters	0.4568464
517	Precision instrument makers and repairers	1.588948
1234	Shopkeepers and wholesale/retail dealers	-1.522734
1239	Managers and proprietors in other services N.E.C.	-1.522734
2111	Chemists	-0.8220372
2112	Chemists	-1.000168
2113	Physicists, geologists, and meteorologists	-0.8220372
2121	Civil engineers	-0.8220372
2122	Mechanical engineers	-0.8220372
2123	Electrical engineers	-0.8220372
2124	Electronics engineers	-0.8220372
2126	Design and development engineers	-0.8220372
2128	Planning and quality control engineers	-0.8220372
2129	Engineering professionals N.E.C.	-0.8220372
2131	IT strategy and planning professionals	-0.8220372
2132	Software professionals	-0.8220372
2211	Medical practitioners	-1.000168
2212	Medical practitioners	-0.732465
2213	Pharmacists/pharmacologists	-1.000168
2214	Ophthalmic opticians	-1.000168
2215	Dental practitioners	-1.000168
2321	Scientific researchers	-0.8220372
2322	Social science researchers	-0.732465
2411	Solicitors and lawyers, judges, and coroners	-0.732465
2421	Chartered and certified accountants	-0.732465
2422	Management accountants	-0.732465
2423	Management consultants, actuaries, economists and statiscians	-0.732465
2431	Architects	-0.8220372
2433	Quantity surveyors	-0.8220372
2434	Chartered surveyors (not quantity surveyors)	-0.8220372
2442	Social workers	-0.732465
2443	Probation officers	-0.732465
2444	Clergy	-0.732465
2451	Librarians	-0.732465
3111	Laboratory technicians	-0.3973301
3112	Electrical/electronics technicians	-0.3973301
3113	Engineering technicians	-0.3973301
3114	Building and civil engineering technicians	-0.3973301

519 Other tool setters operators shaper foreman auto	0.4568464
520 Production fitters (electrical/electronic)	0.4568464
521 Electricians, electrical maintenance fitters	0.4568464
523 Telephone fitters	0.4568464
526 Computer engineers, installation, and maintenance	0.4568464
532 Plumbers, heating, and ventilating engineers and related	-0.1854081
534 Metal plate workers, shipwrights, riveters	0.4568464
535 Steel erectors	0.4568464
537 Welding trades	0.4568464
540 Motor mechanics, auto engineers (inc. road patrol engine	0.4568464
544 Tyre and exhaust fitters	0.4568464
552 Warp preparers, bleachers, dyers, and finishers	0.4925116
553 Sewing machinists, menders, darners, and embroiderers	1.237669
555 Shoe repairers, leather cutters and sewers, footwear las	1.237669
557 Clothing cutters, milliners, furriers	1.237669
560 Originators, compositors, and print preparers	1.588948
562 Book binders and print finishers specialized	1.588948
563 Screen printers	1.588948
570 Carpenters and joiners	-0.1854081
610 Police officers (sergeant and below)	-0.5976907
620 Chefs, cooks hotel supervisor	-0.5976907
621 Waiters, waitresses	-0.5976907
622 Bar staff	-0.5976907
640 Assistant nurses, nursing auxiliaries	-0.3327664
641 Hospital ward assistants	-0.5976907
642 Ambulance staff	-0.5976907
651 Playgroup leaders	-0.5976907
652 Educational assistants	-0.5976907
660 Hairdressers, barbers coiffeur	-0.5976907
670 Domestic housekeepers and related occupations	-0.5976907
672 Caretakers school	0.027381
691 Bookmakers manager	1.406782
710 Technical and wholesale sales representatives	-0.4424283
719 Other sales representatives N.E.C.	-0.4424283
720 Sales assistants merchants car	0.0534066
722 Petrol pump forecourt attendants	0.0534066

3119 Science and engineering technicians N.E.C..	-0.3973301
3122 Draughts persons	-0.3973301
3131 IT operations technicians	-0.3973301
3211 Nurses	-0.3327664
3212 Midwives	-0.3327664
3213 Paramedics	-0.3327664
3214 Medical radiographers	-0.3973301
3218 Medical and dental technicians	-0.3327664
3221 Physiotherapists	-0.3327664
3222 Occupational therapists	-0.3327664
3229 Therapistsn.e.c.	-0.3327664
3231 Youth and community workers	-0.4424283
3232 Housing and welfare officers	-0.4424283
3312 Police officers (sergeant and below)	-0.5976907
3313 Fire service officers (leading fire officer and below)	-0.5976907
3314 Prison service officers (below principal officer)	-0.5976907
3319 Protective service associate professionals N.E.C.	-0.5976907
3411 Artists	-0.732465
3412 Authors, writers	-0.732465
3414 Dancers and choreographers	-0.4424283
3415 Musicians	-0.4424283
3421 Graphic designers	-0.4424283
3422 Product, clothing, and related designers	-0.4424283
3431 Journalists, newspaper, and periodical editors	-0.732465
3432 Broadcasting associate professionals	-0.4424283
3434 Photographers and audio-visual equipment operators	-0.3973301
3441 Sports players	-0.4424283
3442 Sports coaches, instructors, and officials	-0.4424283
3513 Ship and hovercraft officers	-0.3973301
3520 Legal associate professionals	-0.4424283
3531 Estimators, valuers, and assessors	-0.4424283
3533 Insurance underwriters	-0.4424283
3534 Finance and investment analysts/advisers	-0.4424283
3536 Importers, exporters	-0.4424283
3539 Business and related associate professionals N.E.C..	-0.4424283
3541 Buyers and purchasing officers	-0.4424283

731	Roundsmen/women and van salespersons	0.027381	3542	Sales representatives	-0.4424283
800	Bakery confectionery process hand foreman	0.4925116	3543	Marketing associate professionals	-0.4424283
809	Other food, drink, and tobacco process operatives N.E.C..	0.4925116	3544	Estate agents, auctioneers	-0.4424283
812	Spinners, doublers, twisters fly	0.4925116	3551	Conservation and environmental protection officers	-0.3327664
814	Other textiles processing operatives hydro	0.4925116	3552	Countryside and park rangers	-0.3327664
820	Chemical, gas and petroleum process plant operatives	0.3230704	3561	Public service associate professionals	-0.4424283
825	Plastic process operatives, moulders extruders goods	0.4925116	3562	Personnel and industrial relations officers	-0.732465
829	Other chemicals, paper, plastics, and related operatives	0.3230704	3564	Careers advisers and vocational guidance specialists	-0.732465
842	Metal polishers	0.4568464	3565	Inspectors of factories, utilities, and trading standards	-0.3973301
850	Assemblers/lineworkers (electrical/electronic goods)	0.4925116	3567	Occupational hygienists and safety officers (health and safety)	-0.3973301
851	Assemblers/lineworkers vehicles metal nutter	0.4925116	3568	Environmental health officers	-0.3973301
860	Inspectors, viewers testers examiners insulation	0.4925116	4111	Civil Service executive officers	2.240688
862	Packers, bottlers, canners, fillers	0.4486654	4112	Civil Service administrative officers and assistants	2.240688
864	Rutine laboratory testers paint soil	0.4925116	4113	Local government clerical officers and assistants	2.240688
872	Drivers of road goods vehicles	-1.495965	4121	Credit controllers	2.240688
873	Bus and coach drivers	-1.495965	4122	Accounts and wages clerks, book-keepers, other financial clerks	2.240688
874	Taxi, cab drivers and chauffeurs	-1.495965	4123	Counter clerks	1.406782
885	Mechanical plant drivers and operatives (earth moving an	-1.495965	4131	Filing and other records assistants/clerks	2.240688
891	Printing machine minders and assistants	0.4925116	4132	Pensions and insurance clerks	2.240688
896	Construction and related operatives insulator foreman	-0.1854081	4133	Stock control clerks	2.240688
897	Woodworking machine operatives	0.4925116	4134	Transport and distribution clerks	2.240688
899	Other plant and machine operatives N.E.C.	0.4925116	4135	Library assistants/clerks	2.240688
910	Coal mine laborers	0.4486654	4136	Database assistants/clerks	2.240688
912	Laborers in engineering and allied trades	0.4486654	4141	Telephonists	1.406782
919	Other laborers in making and processing industries N.E.C.	0.4486654	4150	General office assistants/clerks	2.240688
923	Road construction and maintenance workers	0.4486654	4211	Medical secretaries	2.240688
929	Other building and civil engineering laborers N.E.C.	0.4486654	4212	Legal secretaries	2.240688
930	Stevedores, dockers	0.4486654	4213	School secretaries	2.240688
933	Refuse and salvage collectors	0.027381	4215	Personal assistants and other secretaries	2.240688
940	Postal workers, mail sorters	2.240688	4216	Receptionists	1.406782
952	Kitchen porters, hands	0.027381	4217	Typists	2.240688
953	Counterhands, catering assistants help	-0.5976907	5211	Smiths and forge workers	0.4568464
954	Shelf fillers	0.0534066	5213	Sheet metal workers	0.4568464
956	Window cleaners	0.027381	5214	Metal plate workers, shipwrights, riveters	0.4568464
959	Other occupations in sales and services N.E.C.	0.027381	5215	Welding trades	0.4568464
990	All other laborers and related workers	0.4486654	5216	Pipe fitters	-0.1854081

5221	Metal machining setters and setter-operators	0.4568464
5222	Tool makers, tool fitters and markers-out	0.4568464
5223	Metal working production and maintenance fitters	0.4568464
5224	Precision instrument makers and repairers	1.588948
5231	Motor mechanics, auto engineers	0.4568464
5232	Vehicle body builders and repairers	0.4568464
5234	Vehicle spray painters	-0.1854081
5241	Electricians, electrical fitters	-0.1854081
5242	Telecommunications engineers	0.4568464
5243	Lines repairers and cable jointers	0.4568464
5245	Computer engineers, installation, and maintenance	0.4568464
5249	Electrical/electronics engineers N.E.C.	0.4568464
5311	Steel erectors	0.4568464
5312	Bricklayers, masons	-0.1854081
5313	Roofers, roof tilers and slaters	-0.1854081
5314	Plumbers, heating, and ventilating engineers	-0.1854081
5315	Carpenters and joiners	-0.1854081
5316	Glaziers, window fabricators and fitters	-0.1854081
5319	Construction trades N.E.C.	-0.1854081
5321	Plasterers	-0.1854081
5322	Floorers and wall tillers	-0.1854081
5323	Painters and decorators	-0.1854081
5411	Weavers and knitters	1.237669
5412	Upholsterers	1.237669
5413	Leather and related trades	1.237669
5414	Tailors and dressmakers	1.237669
5419	Textiles, garments, and related trades N.E.C.	1.237669
5422	Printers	1.588948
5423	Bookbinders and print finishers	1.588948
5424	Screen printers	1.588948
5431	Butchers, meat cutters	1.237669
5432	Bakers, flour confectioners	1.237669
5433	Fishmongers, poultry dressers	1.237669
5434	Chefs, cooks	-0.5976907
5491	Glass and ceramics makers, decorators, and finishers	1.588948
5492	Furniture makers, other craft woodworkers	1.237669

5493	Pattern makers (moulds)	1.237669
5496	Floral arrangers, florists	-0.4424283
5499	Hand craft occupations N.E.C.	1.588948
6111	Nursing auxiliaries and assistants	-0.5976907
6113	Dental nurses	-0.5976907
6114	Houseparents' and residential wardens	-0.5976907
6115	Care assistants and home carers	-0.5976907
6121	Nursery nurses	-0.5976907
6122	Childminders and related occupations	-0.5976907
6123	Playgroup leaders/assistants	-0.5976907
6124	Educational assistants	-0.5976907
6131	Veterinary nurses and assistants	-0.3327664
6139	Animal care occupations N.E.C.	-0.3327664
6211	Sports and leisure assistants	-0.5976907
6212	Travel agents	1.406782
6213	Travel and tour guides	-0.5976907
6214	Air travel assistants	-0.5976907
6221	Hairdressers, barbers	-0.5976907
6222	Beauticians and related occupations	-0.5976907
6231	Housekeepers and related occupations	-0.5976907
6232	Caretakers	0.027381
6291	Undertakers and mortuary assistants	-0.5976907
6292	Pest control officers	-0.1854081
7111	Sales and retail assistants	0.0534066
7112	Retail cashiers and check-out operators	0.0534066
7113	Telephone salespersons	0.027381
7121	Collector salespersons and credit agents	0.027381
7122	Debt, rent and other cash collectors	0.027381
7123	Roundsmen/women and van salespersons	0.027381
7124	Market and street traders and assistants	0.0534066
7125	Merchandisers and window dressers	-0.4424283
7129	Sales related occupations N.E.C.	-0.4424283
7212	Customer care occupations	1.406782
8111	Food, drink, and tobacco process operatives	0.4925116
8112	Glass and ceramics process operatives	0.3230704
8113	Textile process operatives	0.4925116

8114	Chemical and related process operatives	0.3230704
8115	Rubber process operatives	0.4925116
8116	Plastics process operatives	0.4925116
8117	Metal making and treating process operatives	0.3230704
8118	Electroplaters	0.4925116
8119	Process operatives N.E.C.	0.3230704
8121	Paper and wood machine operatives	0.3230704
8124	Energy plant operatives	0.3230704
8125	Metal working machine operatives	0.4925116
8126	Water and sewerage plant operatives	0.3230704
8129	Plant and machine operatives N.E.C.	0.4925116
8131	Assemblers (electrical products)	0.4925116
8132	Assemblers (vehicles and metal goods)	0.4925116
8133	Rutine inspectors and testers	0.4925116
8134	Weighers, graders, sorters	0.4925116
8135	Tyre, exhaust and windscreen fitters	0.4568464
8136	Clothing cutters	0.4925116
8137	Sewing machinists	0.4925116
8139	Assemblers and routine operatives N.E.C.	0.4925116
8141	Scaffolders, stagers, riggers	-0.1854081
8149	Construction operatives N.E.C.	0.4486654
8211	Heavy goods vehicle drivers	-1.495965
8212	Van drivers	-1.495965
8213	Bus and coach drivers	-1.495965
8214	Taxi, cab drivers and chauffeurs	-1.495965
8215	Driving instructors	
8216	Rail transport operatives	-1.495965
8217	Seafarers (merchant navy); barge, lighter and boat operatives	-1.495965
8218	Air transport operatives	0.4486654
8221	Crane drivers	-1.495965
8222	Fork-lift truck drivers	-1.495965
8223	Agricultural machinery drivers	-1.495965
8229	Mobile machine drivers and operatives N.E.C.	-1.495965
9121	Laborers in building and woodworking trades	0.4486654
9132	Industrial cleaning process occupations	0.027381
9133	Printing machine minders and assistants	0.4486654

9134	Packers, bottlers, canners, fillers	0.4486654
9139	Laborers in process and plant operations N.E.C.	0.4486654
9149	Other goods handling and storage occupations N.E.C.	0.4486654
9211	Postal workers, mail sorters, messengers, couriers	0.027381
9221	Elementary office occupations N.E.C.	0.027381
9222	Hotel porters	0.027381
9223	Kitchen and catering assistants	0.027381
9224	Waiters, waitresses	-0.5976907
9225	Bar staff	-0.5976907
9226	Leisure and theme park attendants	0.027381
9229	Elementary personal services occupations N.E.C.	0.027381
9231	Window cleaners	0.027381
9233	Cleaners, domestics	0.027381
9234	Launderers, dry cleaners, pressers	0.027381
9235	Refuse and salvage occupations	0.027381
9241	Security guards and related occupations	0.027381
9244	School mid-day assistants	-0.5976907
9251	Shelf fillers	0.0534066
9259	Elementary sales occupations N.E.C.	0.027381

Source: Authors' compilation. See http://www-2009.timeuse.org/information/studies/

Table B2. RTI and offshoring measures by occupation in the UK

	(1)	(2)	(3)	(4)
	ISCO 88 2-digit code	**Number of workers**	**RTI measure**	**BK index**
Managers of small enterprises	13	312	-1.52	-0.63
Drivers and mobile plant operators	83	190	-1.50	-1.00
Life science and health professionals	22	71	-1.00	-0.76
Physical, mathematical and engineering	21	204	-0.82	1.05
Corporate manager	12	429	-0.75	-0.32
Other professionals	24	296	-0.73	0.21
Personal and protective service workers	51	269	-0.60	-0.94
Other associate professionals	34	254	-0.44	0.10
Physical, mathematical and engineering	31	102	-0.40	-0.12
Life science and health associate professionals	32	75	-0.33	-0.75
Extraction and building trades workers	71	327	-0.19	-0.93
Sales and service elementary occupation	91	153	0.03	-0.81
Models, salespersons and demonstrators	52	112	0.05	-0.89
Stationary plant and related operators	81	33	0.32	1.59
Laborers in mining, construction, manufacturing	93	105	0.45	-0.66
Metal, machinery, and related trade work	72	191	0.46	-0.45
Machine operators and assemblers	82	141	0.49	2.35
Customer service clerks	42	122	1.24	-0.25
Other craft and related trade workers	74	36	1.24	1.15
Precision, handicraft, craft printing a	73	34	1.59	1.66
Office clerks	41	361	2.24	0.40
Number of diaries		4,926		
Number of workers		3,817		

Notes: Data come from the 1983, 2000 and 2015 UK time diary surveys. The sample are full-time workers aged 21-65, and in working days defined as those with at least 60 minutes to market work activities, excluding commuting. The RTI index in column (3) is based on the five original DOT task measures in Autor, Levy and Murnane (2003). See footnotes 10 and 11 for a description of how the index is constructed using the UK TUS occupation classification. The offshoring index in column (4) is taken from Blinder and Krueger (2013) and is based on professional coders' assessment of the ease with which an occupation could potentially be offshored. Both indices are rescaled to mean 0 and standard deviation 1. A higher value means an occupation is more routine-intense (column (3)) or more offshorable (column (4)). Occupations are ranked from the lowest to the highest value of the RTI.

Table B3. Changes in the share of employment by occupation category in the UK

	(1)	**(2)**	**(3)**	**(4)**	**(5)**
	Share of employment			*Change*	
	1983	*2000*	*2015*	*2000-1983*	*2015-2000*
High-paying occupations	34.95%	44.71%	49.08%	14.13%	4.37%
Middle-paying occupations	51.61%	39.59%	31.71%	-19.91%	-7.88%
Low-paying occupations	13.44%	15.70%	19.22%	5.77%	3.51%
Number of diaries	540	2,865	1,521		

Notes: Data come from the 1983, 2000 and 2015 UK time diary surveys. The sample are full-time workers aged 21-65. We select working days in which there are at least 60 minutes of market work activities, excluding commuting. Classification of occupations follows Table 1 in Goos, Manning and Salomons (2014). *High-paying occupations* include occupations with ISCO88 codes 12, 13, 21, 22, 24, 31, 32 and 34. *Middle-paying occupations* include occupations with ISCO88 codes 41, 42, 71, 72, 73, 74, 81, 82 and 83. *Low-paying occupations* include occupations with ISCO88 codes 51, 52, 91 and 93. See footnotes 6 and 7 in Section 4 for a description of how the RTI index is computed using the UK TUS occupation classification.