Neither Left Behind nor Superstar: Ordinary Winners of Digitalization at the Ballot Box

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The nascent literature on the political consequences of technological change studies either left-behind voters or successful technology entrepreneurs ("superstars"). However, it neglects the large share of skilled workers who benefit from limited but steady economic improvements in the knowledge economy. This article examines how workplace digitalization affects political preferences among the entire active labor force by combining individual-level panel data from the United Kingdom with industry-level data on information and communication technology capital stocks between 1997 and 2017. We first demonstrate that digitalization was economically beneficial for workers with middle and high levels of education. We then show that growth in digitalization increased support for the Conservative Party, increased support for the incumbent party, and voter turnout among beneficiaries of economic change. Our results hold in an instrumental variable analysis and multiple robustness checks. While digitalization undoubtedly produces losers (along with some superstars), ordinary winners of digitalization are an important stabilizing force that is content with the political status quo.

The latest wave of technological change is profoundly reshaping labor markets. The spread of computers, smart software, robots, and, increasingly, artificial intelligence has sparked debates about the future of work and potential repercussions in the political arena. While pessimistic voices emphasize the potential of new technologies to replace human labor and cause political upheaval, technology optimists point to a long history of misguided fears of technological unemployment.[1]

A rich literature in labor economics studies the large but unequally distributed benefits of recent technological innovation. Routine-biased technological change has mostly substituted for workers who do tasks that can be accomplished by following explicit rules, thus reducing the number of routine jobs in the lower middle of the income distribution. At the same time, digital technologies complement many workers concerned with more complex tasks, increase their productivity, and create high-quality jobs (Acemoglu and Restrepo 2019; Autor, Levy, and Murnane 2003). The resulting process of "upskilling" in an increasingly digital world of work is a central feature of the emergence of the knowledge economy (Boix 2019; Hope and Martelli 2019; Iversen and Soskice 2019).

Does this crucial economic transformation affect the political preferences of workers? Despite the evident economic benefits of digitalization, most media accounts as well as the nascent scholarly literature dealing with the political consequences of technological change have primarily been concerned with its downsides and risks and have focused on groups left behind by this process (Anelli, Colantone, and Stanig 2019;

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1. A note on terminology: we use the term "digitalization" to distinguish our concept analytically from the more generic term "technological change."

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Frey, Berger, and Chen 2018; Im et al. 2019; Kurer 2020). Another highly visible group that has received considerable attention is composed of exceptionally successful and politically influential technology entrepreneurs (Broockman, Ferenstein, and Malhotra 2019). Even though both "left behinds" and "superstars" are important constituencies, the majority of workers does not belong to either group.

In this article, we seek to provide a more encompassing understanding of the political consequences of digitalization by studying how increases in information and communication technology (ICT) capital intensity in an industry affect the political preferences of workers. Our empirical analysis uses longitudinal data from the United Kingdom that encompass all individuals who remain active in a changing labor market. The core contribution of this article is to document that digitalization generates a large group of "ordinary winners"—that is, skilled workers who have the cognitive abilities to use new technologies productively at the workplace—and to show that the political preferences of such workers who benefit economically from this development change in a stabilizing prosystem direction.

Our innovative empirical approach improves on two weaknesses of existing work about the political consequences of technological change. A first concern is measurement. The previously mentioned studies rely either on indirect indicators of exposure to digitalization based on the prevalence of routine tasks in an occupation or on a more direct measure of exposure to robotization. Indicators of routine task intensity (RTI) capture the task content of an occupation at a certain point in time rather than variation in technology exposure over time. Hence, RTI has difficulty isolating a "technology effect" from other relevant occupational characteristics. The prevalence of industrial robots, on the other hand, certainly represents a key source of pressure for particular industries (e.g., automotive production). But its consequences are of more limited relevance in the many nonmanufacturing domains of the economy. We measure digitalization differently—namely, as industry-specific capital stocks of ICT. Importantly, ICT capital is a time-varying measure of investment in digital technology that applies to all industries. As such, it is well suited for an analysis of the economic and political implications of digitalization among the entire labor force.

A second limitation of existing work concerns identification. Pioneering publications have relied on cross-sectional or regional data. We merge our indicator of digitalization to rich individual-level panel data from the United Kingdom and fit a series of fixed effects models to provide plausibly causal estimates of the effects of digitalization on political preferences. Panel data substantially reduce concern about omitted variables by focusing on within-individual change, which rules out that the results are driven by selection of individuals to industries or individual- and industry-level time-invariant variables. In addition, we support the causal interpretation of our findings through an instrumental variable approach and a series of robustness checks.

The empirical analysis demonstrates that a large share of the population indeed benefits economically from investment in new technology and that this economic process has political consequences. In contrast to accounts that highlight the disruptive potential of technological change among the "left behind," we show that exposure to digitalization increases wages for a majority of workers, a process that does not come at the cost of substantially higher unemployment. These economic benefits in turn entrench support for the political status quo: digitalization leads to increased (*a*) support for the Conservative party, (*b*) support for the incumbent, and (*c*) voter turnout among ordinary winners of digitalization.

Our finding that digitalization is economically beneficial for a majority of workers and that these workers become more likely to support center-right mainstream and incumbent parties does not preclude that certain subgroups of society suffer in absolute or relative terms and might increasingly support antisystem forces. Indeed, we do find some evidence that unskilled workers, who are most susceptible to the downsides of automation, are increasingly drawn to right-wing populists when their industry digitalizes. Still, our article shows that technological change does not only shape politics by creating a reservoir of dissatisfied losers who find the political remedies offered by populist or antiestablishment parties appealing—it also increases support for the establishment and the democratic status quo among a large group of beneficiaries. Rather than resulting in dissatisfaction across the board, digitalization generates political divergence between a majority of beneficiaries and a minority of nonbeneficiaries and thus presumably contributes to increasing political polarization.

To the best of our knowledge, this is the first essay that produces well-identified, individual-level effects of workplace digitalization on political outcomes using panel data. We contribute to the political economy literature on current political realignments and populist upheaval (Boix 2019; Iversen and Soskice 2019; Rodden 2019). These important accounts point to the "knowledge economy" or the "fourth industrial revolution" as the main economic force underlying changing voting patterns, party realignments, and political geography, but they do not attempt to measure technological change directly and have not examined whether the introduction of digital technology modifies workers' political preferences.

We also contribute to the growing literature about how economic shocks and changes in labor market outcomes alter political preferences and vote choices (see Margalit 2019).

These studies typically focus on intense negative changes in economic standing, such as unemployment experiences or large income drops. The question of whether positive changes in the workplace situation affect political behavior has received less attention. The few well-identified studies focus mostly on large, exogenous shocks such as winning the lottery (e.g., Doherty, Gerber, and Green 2006). We extend this literature by focusing on a particular source of changes in the workplace, digitalization, which produces smaller but more continuous economic effects on workers' economic fortunes than shocks studied previously.

DIGITALIZATION: ECONOMIC OUTCOMES AND POLITICAL RESPONSES

The introduction of new technology at the workplace is a source of continuous change in workers' situation in advanced capitalist democracies. In a nutshell, our argument has three steps. First, digitalization has important distributive consequences and affects wages and unemployment risk. Therefore, digitalization affects voters' attitudes and economic preferences. Second, this, in turn, links digitalization to voting Conservative, voting for the incumbent, or voting for mainstream parties more generally, rather than supporting populists or abstaining. Crucially, all of this is moderated by education; the more highly educated benefit more from digitalization, while the less educated suffer wage reductions and face diminished employment prospects in the digital age. Third, digitalization hence generates political divergence between a majority of beneficiaries and a minority of nonbeneficiaries and contributes to increasing political polarization.

The (many) winners and (fewer) losers of digitalization

Recent theoretical work contends that the effects of technological change on wages and employment depend on the outcome of two countervailing forces (Acemoglu and Restrepo 2019): a displacement effect as machines start to perform tasks previously done by humans, and a productivity effect as they complement workers and free up time spent on dull tasks. The net effect of these two forces on wages and employment is a priori uncertain, but empirical estimates suggest that the productivity effect has dominated in past centuries (Mokyr, Vickers, and Ziebarth 2015). Technology, along with well-designed complementary institutions, are the most important causes of the unrivaled growth in output and living standards since the Industrial Revolution. Positive net effects also hold during the most recent wave of technological innovation, which is characterized by the extension of ICT. Our first expectation is that a majority of workers economically benefit from the introduction of new digital technologies.

A related, less optimistic expectation is that positive net effects go hand in hand with significant heterogeneity. While digitalization has increased the demand for highly educated workers, it has substituted for less skilled work and those in routine occupations (e.g., Autor et al. 2003; Goldin and Katz 2009). At the aggregate level, these countervailing effects have produced a pattern of job polarization (Goos, Manning, and Salomons 2014). How the well-documented reduction in jobs in midpaying occupations translates into individual economic fortunes is less clear and represents one of the questions we set to explore. A decline in semiskilled jobs does not necessarily imply that individual semiskilled workers suffer downgrading over time. The observed aggregate reductions in midpaying jobs might be absorbed by retirement without replacement or by exit to other, potentially higher-paying, jobs (Cortes 2016; Dauth et al. 2017; Kurer and Gallego 2019). In short, we expect that the introduction of new digital technologies in the workplace has positive economic consequences for a majority of workers. However, these benefits are unevenly distributed and mostly accrue to workers who possess the cognitive abilities to use new technologies productively.

Political implications of digitalization

To derive expectations about political ramifications, we draw on theoretical accounts that view individuals' economic self-interest as an important determinant of vote choice. We consider economic channels as a key mechanism linking workplace digitalization to changing political behavior, but do not rule out the existence of noneconomic psychological channels. In contrast to most existing work, we do not narrow our focus on workers left behind by technological change. Because technological change might have positive net effects, we are just as interested in the theoretical implications for ordinary winners of digitalization.

Drawing on the small existing literature on political ramifications of digitalization as well as on the broader literature on the impact of economic changes, we discuss four possible effects. The first possibility is that workers at risk of displacement resulting from automation demand more protection and support for redistribution (Thewissen and Rueda 2017), which should push them to vote for parties that defend economically left-wing policies. The mechanism is consistent with standard models of voting based on preferences for economic platforms, which depict political competition as a conflict about redistributive issues, where individual material circumstances and economic risk are a main driver of policy preferences and, ultimately, party support (e.g., Iversen and Soskice 2006; Margalit 2013; Rehm, Hacker, and Schlesinger 2012). In the case of the United Kingdom, this argument implies that workers who are harmed economically by digitalization may become more supportive of the Labour Party, while workers who benefit become more likely to support to the Conservative Party.[2]

A second possibility is that workers who are economically affected by digitalization respond by voting for or against the incumbent. Frey and colleagues (2018) find that US counties with a higher exposure to industrial robots experienced larger shifts in vote shares in favor of the Republican Party between 2012 and 2016. They interpret this finding as anti-incumbent voting, an interpretation that is congruent with research about the political consequences of other structural transformations such as offshoring and trade with China (Autor et al. 2016; Jensen, Quinn, and Weymouth 2017; Margalit 2011). The basic mechanism in this case is economic voting: negative changes in economic prospects should generate dissatisfaction with the status quo and motivate workers to support parties in the opposition. Conversely, improvements in workers' economic situation as a result of digitalization should increase satisfaction and increase the likelihood of supporting the incumbent.

A third possibility, and the one that has received most attention so far, is that workers who are threatened in their jobs or lose out economically from being in digitalizing work environments become more likely to vote for antisystem, radical, right-wing parties (Anelli et al. 2019; Im et al. 2019; Kurer 2020; Kurer and Palier 2019). The key mechanism in this case is related to changing social hierarchies and the lack of trust, among the disadvantaged, in the political system's potential to improve conditions and provide the left behind with the recognition they seek. This option might have limited applicability in contexts with majoritarian electoral systems, where fringe parties are not electorally viable in many constituencies. Still, we examine this third possibility by studying whether workers who lose out economically from digitalization become more likely to support the UK Independence Party (UKIP), while workers who benefit economically do not.

A fourth conceivable way in which technological change affects electoral outcomes is via turnout—that is, the possibility that digitalization affects the probability to turn out in elections. One possible channel is related to changes in the resources available to participate in politics. In particular, a drop in resources can lead to "political withdrawal" as citizens concentrate on solving more pressing problems (Rosenstone 1982). Alternatively, psychological changes (i.e., the realization that tasks previously performed by humans can be carried out by machines) might undermine feelings of self-efficacy and self-esteem, which are important precursors of political engagement (Marx and Nguyen 2016). The reverse applies to winners of digitalization.

All four possibilities are reasonable ways in which digitalization can affect voting behavior. Previous research in political science about the impact of changes in workers' economic situation provides little guidance about which option is most plausible. In fact, in a recent review of the literature, Margalit (2019, 279) compiles abundant evidence that negative economic shocks, such as becoming unemployed or experiencing income drops, can produce different political effects, including anti-incumbent voting, support for radical parties, support for the left, or a reduction in voter turnout, and concludes that "research to date offers very limited insight on the conditions that lead to one such response over another." For this reason, we examine all possibilities in our empirical analysis and attempt to examine distinct mechanisms, including attitudes about economic issues and overall satisfaction.

Note that the four possibilities apply, even in the absence of public debate about the issue of digitalization, even if workers do not consciously relate changes in their workplace to digitalization (which, as we have argued, may affect them economically and/or psychologically), such changes in digitalization can still affect their party choice.[3] For instance, voters may just rely on loose cues about general satisfaction to evaluate the performance of the incumbent. Our theoretical expectations could vary if parties more actively politicized the issue of digitalization. However, as in other Western European democracies (König and Wenzelburger 2018), digitalization remains a marginal issue in UK party manifestos in spite of the pressure for policy change. An analysis of the most recent manifestos shows particularly little attention to digitalization and new technology in the Labour manifesto. The Conservatives talk somewhat more about this topic and, interestingly, do so in an almost exclusively positive tone, highlighting business opportunities, prosperity, and security (see app. sec. 6.2; appendix is available online). If anything, we would therefore expect that their approach to the issue would be particularly appealing to winners of digitalization.

DATA AND DESCRIPTIVE OVERVIEW

Our empirical analyses focus on the case of the United Kingdom, an established democracy at the frontier of technological

2. Although Labour's absolute position on redistributive issues has varied over time, expert survey data on the two major parties' economic left-right position leave no doubt about the two parties' relative position, even during the Blair era (see fig. 8 in the appendix).

3. One might reach different conclusions when studying more specific and fine-grained policy preferences instead of general preferences in favor of a center-left or center-right parties. For example, Barber, Beramendi, and Wibbels (2013) have demonstrated substantial informational barriers when voters are asked to distinguish between the redistributive and insurance elements of public policy.

innovation for which rich longitudinal microlevel data are available.

Industry-level measure of digitalization

To measure digitalization, we follow Michaels, Natraj, and Van Reenen (2014), who use yearly changes in ICT capital stocks within industries (see also Acemoglu and Restrepo 2020; Graetz and Michaels 2018). This is our main explanatory variable. We use the September 2017 release of the European Union Capital, Labor, Energy, Materials, and Service (EU KLEMS) data set (Jaeger 2016), which contains yearly measures of output, input, and productivity for 40 industries in a wide range of countries, including the United Kingdom, and covers the period 1997–2015. The data are compiled using information from the national statistical offices and then harmonized to ensure comparability. Most important for our purposes, the database provides a breakdown of capital into ICT and non-ICT assets (O'Mahony and Timmer 2009). This allows for the creation of time-varying, industry-specific indicators of digitalization based on ICT stocks. We extend the existing time series until 2017 on the basis of cross-classified Eurostat data on fixed assets by industry and asset (stocks), indexed by 2015 EU KLEMS values.

Our measure of digitalization is constructed as follows:

$$D_{jt} = \frac{(\text{ICT capital stock in thousand GBP}_{jt})}{(\text{Employees}_{jt})},$$

where GBP is the British pound, and where ICT capital stock_{jt} is the sum of the fixed capital stocks in computing equipment, communications equipment, computer software, and databases in industry j in year t, at constant 2010 prices, and is normalized by the number of employees in that industry.[4]

Figure 1 plots the evolution of our indicator of digitalization over time for the industries provided by EU KLEMS.[5] Some industries are disaggregated only at the one-digit level (e.g., agriculture, forestry and fishing), while for other industries EU KLEMS also breaks down the data at the more fine-grained two-digit level (e.g., manufacturing is disaggregated into 11 categories like "food products, beverages and tobacco").

As expected, we see a general increase in the importance of digital technologies over time. The levels of ICT intensity also vary across industries in a sensible way (e.g., they are highest for telecommunications, or finance and insurance, as we would expect), adding to our confidence that the measure is valid. If anything, the trend shown understates the true degree of digitalization as ICT prices fell over time.

An important difference between our measure and the more widely used measure of robotization (Acemoglu and Restrepo 2020; Anelli et al. 2019; Frey et al. 2018; Graetz and Michaels 2018) is that ICT investment has affected all sectors in recent decades, allowing us to study effects of digitalization across the entire labor force. ICT capital reshapes all sectors of the economy and only 40% of total investment takes place in manufacturing industries. By contrast, deployment of robots is more concentrated: according to the International Federation of Robotics, in the United Kingdom in 2017, more than 90% of the operational robots were used in manufacturing, by far the largest chunk in the automotive industry. Hence, while robotization certainly represents a key source of pressure on workers in certain manufacturing industries, our time-varying measure of technological change appears well suited to studying political repercussions in the broader population. ICT capital affects the entire active labor force and thus nicely complements other studies that focus on particularly disruptive but more concentrated technological innovation in specific sectors of the economy.

Individual-level survey data

We combine our measure of digitalization at the industry level with individual-level panel data. The British Household Panel Study (BHPS) is a longitudinal study that has interviewed about 10,000 individuals nested in 5,000 households drawn from a stratified random sample of the British population yearly from 1991 to 2008. In 2009, the BHPS was transformed and expanded into the Understanding Society (UKHLS) survey (see Buck and McFall 2011). Every year, participants are asked detailed questions about their economic situation, and current and past employment, as well as a few political questions.

For each year (date of interview), we assign every worker the value of our measure of digitalization (ICT per worker) in her current industry. Because the latest release of EU KLEMS only covers the period since 1997, we exclude respondents surveyed between 1991 and 1996 from our study. We also exclude respondents aged 65 and older (who should be less

4. Productivity-enhancing and potentially labor-replacing investments can, in principle, affect our measure in two ways. First, they increase the numerator (the ICT capital stock); second, they can reduce the denominator if labor-saving technologies are implemented and reduce the number of employees in the industry. This is a manifestation of the twofold consequences of digitalization: it can be beneficial for workers by increasing productivity or threatening if it reduces labor demand. Our measure hence captures ICT intensity relative to labor in an industry, rather than ICT intensity in an absolute sense.

5. EU KLEMS data are disaggregated by 35 industries based on the industry standard classification system used in the EU (Nomenclature statistique des activités économiques dans la Communauté européenne [NACE] rev1). For three industries, ICT data are missing or have only zero values, which reduces our sample to 32. NACE codes are consistent with UK Standard Industrial Classification codes provided in the BHPS, which allows for a comprehensive merge of the two data sets. The scale of the *Y*-axis is logged to facilitate visualization, but the analyses use the original variable, operationalized as discussed above.

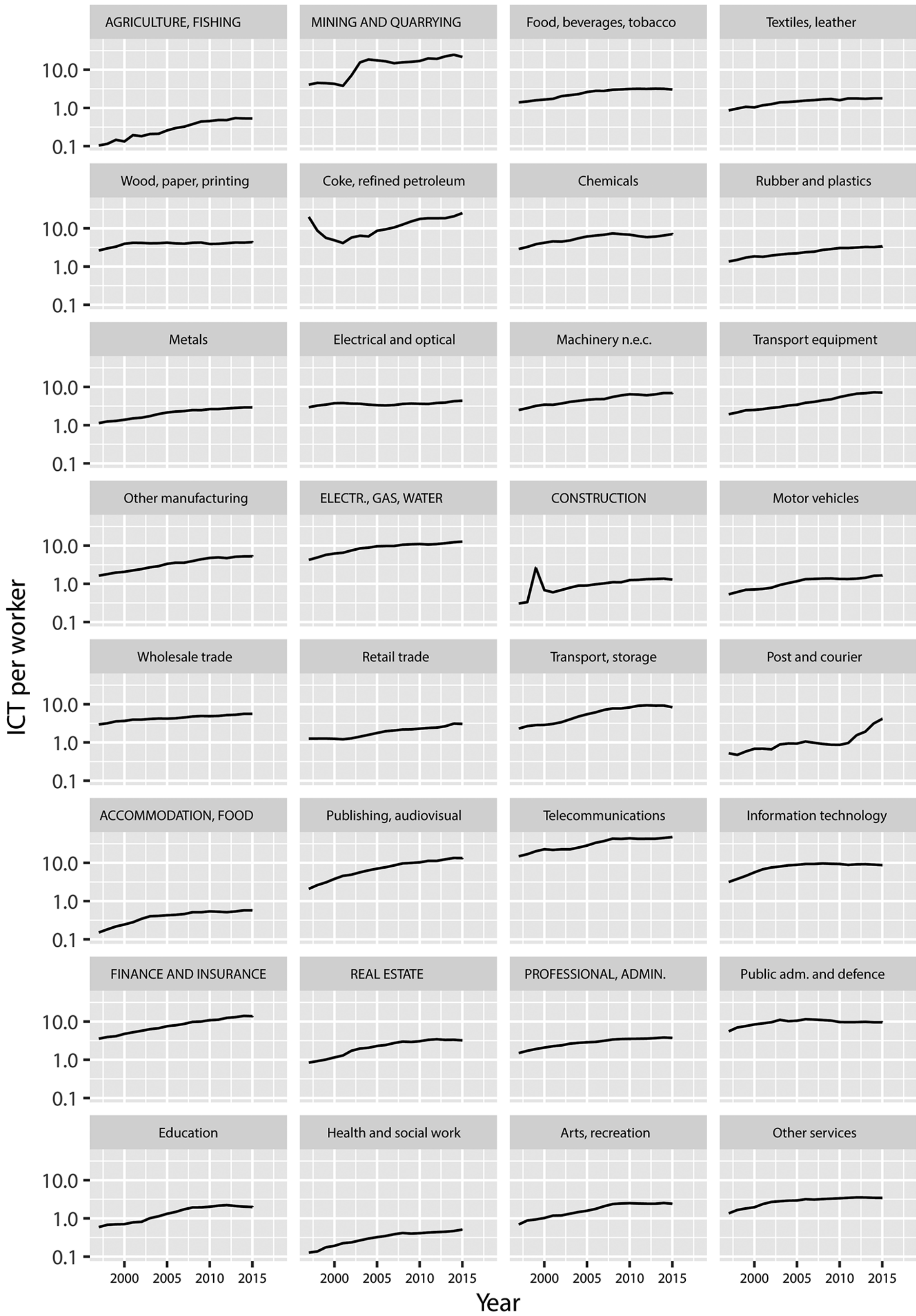

Figure 1. Information and communication technology (ICT) capital stock per employee, by industry. Digitalization measured as yearly ICT capital stock per worker for the industries provided by EU KLEMS. Industries at the one-digit level are written in capital letters, while industries at the two-digit level are lowercase; n.e.c = not elsewhere classified. The *Y*-axis has a logarithmic scale to facilitate visualization.

affected by changes in the labor market) and respondents less than 18 year old. From the remaining sample, 71.3% can be linked to one of 32 industries (NACE rev. 2). We exclude extraterritorial organizations and households as employers as there is only sparse information on ICT capital stocks. Our total final sample contains 287,352 observations for 61,071 unique individuals. People not assigned to an industry are excluded from our sample (including students or the currently unemployed, if no industry is reported), people who never enter the labor force, and people who have exited the labor force. Table 1 in the appendix provides detailed summary statistics of all variables used.

The dependent variables in our analyses are a set of indicators of the personal economic situation and political attitudes asked consistently over time by BHPS/UKHLS. We compute hourly net wages in constant 2010 prices using the variable usual net pay per month, which is derived by BHPS/UKHLS staff using answers to detailed income questions and imputed if this information is missing. This is normalized by hours worked. We exclude observations with less than half-time employment (20 hours per week) from this analysis because we found that they contain considerable measurement error.

The employment status refers to the week when the respondent was interviewed. As a result of the lack of information about unemployment spells between surveys, we can thus only look at the moment of the interview, which most likely provides a lower-bound estimate. Since we are interested in the effect of digitalization on the probability of becoming unemployed, we focus on the effect of current digitalization on a worker's probability of being unemployed at the time of the next interview.

Our measure of voter turnout is self-reported participation in the last general election, which is asked in all waves until 2008 and then in 2010, 2015, and 2017. We construct a party-support variable using a series of questions asked every year on whether respondents consider themselves supporters of a party or (if they are not) whether they feel closer to one political party than to the others.

To measure support for the incumbent, we code respondents as supporters of the incumbent party if they supported the Labour Party before the government change on May 7, 2010, and supported the Conservative Party after it changed. The Liberal Democrats are coded as incumbents during their spell in the coalition government between May 2010 and May 2015.

Our key moderator variable, education, is coded in six categories: university degree (27% on average over the entire period); other higher degree (such as teaching or nursing, 12%); A level and other higher secondary qualifications (24%); General Certificate of Secondary Education (GCSE), O level, and other lower-secondary qualifications (22%); other qualifications (8%); and no formal qualifications (7%).

We concentrate on education rather than on task content (i.e., the distinction between routine vs. nonroutine occupations; Autor et al. 2003), for theoretical and empirical reasons. Education is a generally stable individual characteristic, as relatively few people acquire higher educational credentials after finishing schooling in young adulthood. Intraindividual stability makes education more suited for our longitudinal analysis than routine task intensity (RTI), which is measured on the level of occupations and changes as workers switch between different jobs. RTI is hence a fluid and potentially endogenous characteristic giving rise to varied trajectories. More important, education should be correlated with individuals' unobserved cognitive skills and ability to learn and hence with their potential to adapt to and reap the benefits of the introduction of new digital technologies in the workplace. By contrast, it is unclear whether the current RTI of a worker's job is informative about her ability to adapt to digitalization. In our empirical setting, which interacts an industry-level measure of digitalization with an individual trait capturing the ability to deal with this development, education is more informative about the ability to learn, retrain, and ultimately benefit from digitalization than routine task content of the current job. We support this claim with empirical evidence in the appendix to this article, where we show that education is a stronger moderator than RTI in predicting whether workers are positively or negatively affected by digitalization in their industries.

ESTIMATION AND IDENTIFICATION

Fixed-effects model

We use individual industry-spell fixed-effects models to estimate the effects of digitalization in a worker's industry on labor market and political outcomes. Our modeling strategy controls for all time-invariant individual and industry-level characteristics and only uses over-time variation in the level of digitalization within industries for workers who remain in the same industry for two or more periods to identify the effect of digitalization.

To test the expectation that the effects of digitalization on labor market and political outcomes are heterogeneous depending on workers' education level, we estimate separate slopes for the effect of digitalization in a worker's industry for workers with different education levels. Our baseline specification is:

$$Y_{ijt} = \sum_{s^*=1}^{6} I_{[S_{it}=s^*]}\delta_{s^*} + \theta_0 \times D_{jt} + \sum_{s^*=1}^{6} I_{[S_{it}=s^*]}\theta_{s^*} \times D_{jt} + \eta_{ij} + \mu_t + \gamma' \boldsymbol{C}_{it} + \varepsilon_{ijt}, \quad (1)$$

where Y_{ijt} is the outcome of interest (economic or political) for individual i in industry j at time t. It is a function of six dummy variables $I_{[S_{it}=s^*]}$, which take the value 1 if an individual has the corresponding education level and 0 otherwise. The coefficient vector δ identifies separate intercepts for each education level.[6] We further add the time-varying measure of digitalization (ICT capital stock per worker) at the industry level D_{jt} described above and interact it with the education-level dummy variables $I_{[S_{it}=s^*]}$ to estimate a different slope for the effect of digitalization on economic and political outcomes for each education group. This is important, as we argued that

6. For most individuals, the education level is constant in all waves of the study. In our fixed-effect model, the coefficient vector δ will only be identified by the few who upgrade their education level, as education is otherwise absorbed by the individual fixed effect. Therefore, we do not focus on the direct effect of education when interpreting the results.

a worker's education level is a key moderator for understanding the implications of being exposed to digitalization.

In our baseline specification, we include the term η_{ij}, a vector of individual by industry fixed effects (or industry-spell fixed effects) that captures all time-invariant variables that might affect labor market and political outcomes; self-selection of workers into specific workplaces, such as their gender, personality, or family origin; and time-invariant industry-level characteristics. The industry-spell fixed effects include separate intercepts for the same individual in periods when she has worked in a different industry, which allows us to rule out that switchers are driving the results.[7] However, we also conduct extensive robustness checks to examine whether our conclusions hold using alternative fixed-effects specifications.

Furthermore, we include a year fixed effect μ_t. The fixed effect absorbs the impact of any contextual factors that are common to all individuals, such as the growth of the economy or the performance of a given party. Hence, our analyses rely only on within-individual variation, controlling for circumstances that are common for all individuals. While the fixed effect captures most unobserved heterogeneity, we still add a vector $\mathbf{C}_{it}$ of time-varying individual-level controls. Here, we include age as a nonlinear control because there is a sharp increase in the average values of most variables (such as hourly wages or voter turnout) during people's 20s and 30s, while their values level off later in life. To allow for the correlation of error terms of the same individual over time and when they work in different industries, we cluster the error term ε_{ijt} at the individual level. We report an alternative specification with standard errors clustered at the level of the variation of the treatment, that is on the industry-year level, in the appendix.

Threats to identification

A key concern with our empirical approach is the possible endogeneity of our measure of digitalization. In particular, ICT capital stocks per worker in the United Kingdom could be influenced by governmental policies that also affect workers' economic and political outcomes (e.g., policies adopted to shelter some industries from competition, subsidies to accelerate or slow down the adoption of digital technologies in some industries in response to their political power). In return, workers employed in that industry could have a more favorable view of the party in power.

7. This is important because differences in digitalization across industries are much larger than differences within industries from one year to another. Any changes occurring when workers move to a different industry (which may coincide with many other relevant changes besides digitalization) would dominate the more subtle effects of digitalization at a given workplace we are interested in.

To address this concern, we follow recent work on the Chinese import shock (Autor, Dorn, and Hanson 2013) and instrument our measure of ICT capital stocks per worker in the United Kingdom (D_{jt}) with an analogous measure from the United States (D_{jt}^{USA}):

$$D_{jt}^{\mathrm{USA}} = \frac{(\text{ICT capital stock in the USA in thousand USD}_{jt})}{(\text{Employees in the UK}_{jt})}.$$

In the second stage, $\tilde{D}_{jt}^{\mathrm{USA}}$ represents digitalization in the United Kingdom instrumented with values from the United States:

$$\begin{aligned} Y_{ijt} = {} & \sum_{s^*=1}^{6} I_{[S_{it}=s^*]}\delta_{s^*} + \theta_0 \times \tilde{D}_{jt}^{\mathrm{USA}} + \sum_{s^*=1}^{6} I_{[S_{it}=s^*]}\theta_{s^*} \\ & \times \tilde{D}_{jt}^{\mathrm{USA}} + \gamma \mathbf{C}_{it} + \eta_{ij} + \mu_t + \varepsilon_{ijt}. \end{aligned} \quad (2)$$

The first stage of the instrumental variable (IV) analysis is strong (all F-statistics are larger than 75). This is to be expected, given that the United States is clearly at the technological frontier and competition and profit maximization motivate industries in other countries to adopt these productivity-enhancing technologies once they exist. Digital technologies adopted in an industry in the United States are likely to be adopted in the United Kingdom as well, perhaps with a time lag.

The exclusion restriction of our IV strategy is that changes in ICT capital stocks in the United States do not produce changes in the economic outcomes or political views of workers from the same industry living in the United Kingdom if ICT stocks in the United Kingdom are held constant. Channels other than technology diffusion are likely to affect workers in the United Kingdom too indirectly and too slowly to drive the effects we capture. Furthermore, given the unequal size of the countries, politics and economics in the United Kingdom are unlikely to affect the adoption of technology in the United States.

We address further concerns—including the specificity of ICT investment as opposed to general investment, within-subject switching between industries, displacement effects of technology, regional effects, the impact of trade, and panel attrition, among others—in the robustness section.

RESULTS

This section presents the marginal effect of a one-unit increase in digitalization (a £1,000 [pound sterling, or GBP] increase in the ICT capital stock per worker, which is equal to 1.4 standard deviations of within-industry variation in ICT), for workers of different education levels. The complete regression tables are presented in the appendix.

Digitalization and labor market outcomes

The first part of our analysis tests our expectations about the distributive consequences of digitalization and helps

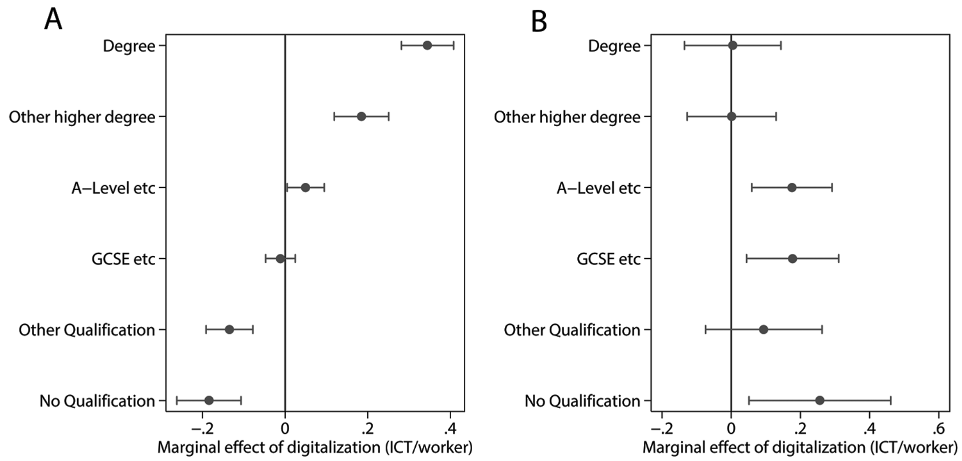

Figure 2. Effect of information and communication technology (ICT) capital stock increases on labor market outcomes. *A*, Marginal effect of a one-unit increase in digitalization (£1,000 in ICT capital/worker) on hourly net wages. *B*, Probability of becoming unemployed, in percentage points. GCSE = General Certificate of Secondary Education.

validate our novel longitudinal approach. Figure 2 presents the marginal effects of digitalization on net hourly wages and the probability of unemployment at the time of the next interview for workers with varying levels of education.

We find a strong positive effect of increases in digitalization in an industry on the hourly net wages of workers with higher education levels, especially university degrees. At the same time, individuals with low levels of education or no qualifications experience a reduction in their hourly wages in periods when their industry digitalizes rapidly.[8] The coefficients can be interpreted as follows: a one-unit increase in digitalization (£1,000 ICT capital stock per worker) increases the average hourly net wage of a university graduate by £0.4, which is equivalent to a yearly net wage increase of £768. By contrast, a one unit increase in digitalization decreases the average hourly wage of workers with no qualifications by £0.16 or £312 per year.

Second, we study the effect of digitalization on employment status. In this case, we use lead models because we are interested in the probability of becoming unemployed in the future. We find some evidence that digitalization increases the likelihood that less educated workers report being unemployed when they are reinterviewed after digitalization occurred. This finding is in line with the task-based literature emphasizing that primarily routine jobs in the middle and low end of the wage and education distribution are susceptible to automation (Autor et al. 2003). However, the effects are substantively small. For example, a one-unit increase in our measure of digitalization (i.e., a £1,000 increase in the ICT capital stock per worker [0.4 standard deviation]) is associated with an increase in the probability to report being unemployed at the next interview of 0.24 percentage points for the no-qualification group. This constitutes a 7% increase in the odds of becoming unemployed, from 1 in 30 to 1 in 28.5. As noted above, a caveat is that we do not observe unemployment spells between interviews. The reported increase thus likely represents a lower-bound estimate.

Our findings are in line with previous studies and suggest that our novel empirical approach is valid. For example, Autor, Dorn, and Hanson (2015) conclude that digitalization has rather limited net employment effects, despite its profound impact on the overall employment structure. For the United Kingdom, Kurer and Gallego (2019) show that most routine workers stay in their jobs, and the decline in the share of routine jobs happens through retirement and lower entry rates, rather than layoffs.

So far, the analysis yields two important takeaways. The impact of faster-than-average digitalization on hourly wages is positive for a majority of workers, but digitalization has unequal effects on highly educated and less educated workers. Those with a higher degree represent 39% of our sample in 2015 and are unambiguous economic winners, as digitalization increases their wages without any adverse employment effects. If we add workers holding A-level certificates (upper-secondary education), whose wage gains come at the cost of slightly increased unemployment risk, this share increases to 61% of the population. Workers with secondary education (GCSE and similar) make for about a fifth of the population and experience neither positive nor negative income effects from digitalization. The unambiguous economic losers of digitalization are concentrated in groups with low formal educational credentials, which account for about 20% of the population. In sum, digitalization first and foremost benefits those

8. We tested whether the differences in the effect of digitalization across education groups are statistically significant. All of them are, except for the difference between "no qualification" and "other qualification."

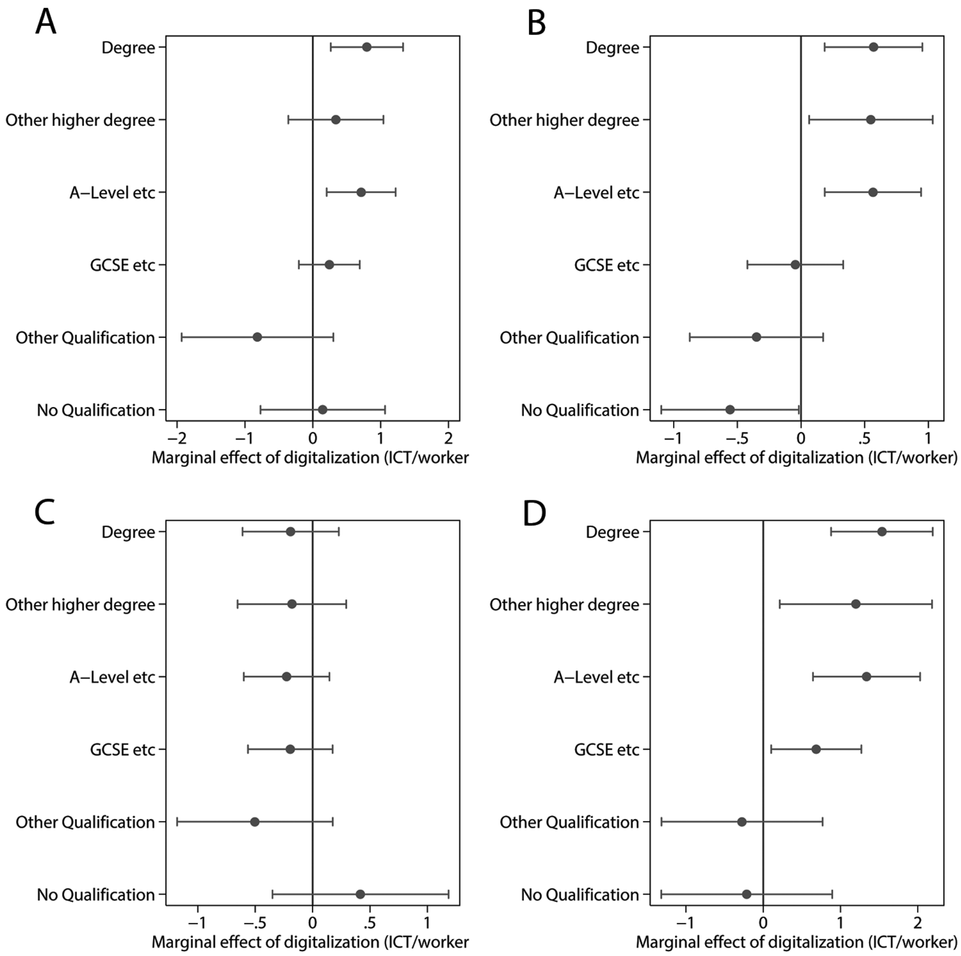

Figure 3. Effect of digitalization on political outcomes, industry-spells fixed-effect specification. *A*, turnout; *B*, Conservatives; *C*, Labour; *D*, incumbent. Results show marginal effect of one-unit increase in digitalization (£1,000 in information and communication technology capital / worker) on the probability of reporting having voted or having supported a given political party. All results are in percentage points. GCSE = General Certificate of Secondary Education.

who have the skills to thrive in a rapidly changing world of work and reinforces patterns of wage polarization.

Digitalization and political outcomes

Our primary interest is in whether and how these distributive effects lead to changes in individual political behavior. Figure 3 presents the main results regarding voter turnout, support for the Conservative Party, support for the Labour Party, and support for the incumbent.

We find evidence of increasingly unequal political participation as a result of technological change. Highly educated workers in industries digitalizing more quickly become more likely to vote. A one-unit increase in digitalization raises turnout among voters with university degrees by 0.64 percentage points. On the other hand, we find no effects or negative effects among less educated workers. Recent work has shown that the gaps in the turnout rates of citizens with high and low socioeconomic status has increased over time in the United Kingdom (Heath 2018). Our results suggest that digitalization contributes to increasing inequalities in voter turnout by (weakly) augmenting existing gaps.

We also examine the relationship between digitalization and support for parties. The results provide clear evidence for increased support for the Conservatives among winners of technological change. For example, a £1,000 increase in the capital stock per worker is associated with an increase in support for the Conservatives of approximately 0.6 percentage points among the highly educated. For less educated workers, digitalization is associated with a reduction in support for the Conservatives.[9]

The results are consistent with our expectation that workers who benefit from digitalization become more likely to support an economically right-wing party, which could be the result of changes in economic preferences about redistribution. In line with other studies on economic shocks

9. The differences in the effects of digitalization for workers with university degrees and workers of the three lower education groups are statistically significant at conventional levels. The same is true for the difference between the top three education groups and the group with no qualifications.

and voting behavior (see Margalit 2019), the effect is limited in magnitude. Still, the reported effects are short-term and can accumulate over time, leading to more significant shifts in party support. Moreover, even modest changes in political behavior can be politically consequential, as elections are often won by small margins.

With respect to support for the Labour Party, we do not find clear results. While the pattern is to some extent a weak mirror image of support for the Conservative Party, the effects are small and imprecisely estimated. This is true even among less qualified workers, which contrasts with previous research suggesting that losers of digitalization ask for more redistribution (Thewissen and Rueda 2017). However, it should be noted that our industry-spell fixed-effect approach may underestimate the effects on the behavior of losers of digitalization, given that our analyses only capture political reactions of workers who remain in the labor market (see app. sec. 4.3 for an approach that includes displaced workers).

We also theorized effects on support for the incumbent that are analytically distinct from voting decisions based on support or opposition to redistribution. The main hypothesis in this case is that through a simple reward-punishment mechanism, winners of digitalization become more likely to support the incumbent, while losers withdraw support. Figure 3*D* reports marginal effects of digitalization on support for the incumbent party. The results provide clear-cut evidence in line with the egotropic economic voting hypothesis: being in a digitalizing environment increases the likelihood of supporting the incumbent, but only for highly educated workers (who benefit more from digitalization).

Incumbency effect: Analysis by period

So far, our analysis finds that digitalization increases support for the Conservative Party and for the incumbent among highly educated workers. In an attempt to distinguish between these two possibilities, we reran our analysis separately before and after the government change in May 2010.[10]

Table 1 shows that our results about political effects are mainly driven by the years after 2010. Column 1 shows that digitalization did not result in significantly increased support for the Labour Party during its period in government (until 2010). Columns 6 and 7, on the other hand, speak in favor of an incumbency effect, because the coefficients for incumbent voting are twice as large than the coefficients for supporting the Conservative Party. Also, the Conservative Party did not benefit from digitalization when they were in opposition (pre-2010, col. 4).

The findings are consistent with the interpretation that digitalization affects support for parties through two distinct mechanisms (spatial voting and economic voting), which can cancel each other out or reinforce each other depending on the ideological profile of the party in power. Although both parties' relative position on the economic left-right axis has varied over time, the Tories have had a clearly more pronounced pro-market stance during the entire time span of our analysis (see fig. 8 in the appendix). Accordingly, when the Tories are in power, both mechanisms push in the same direction for winners of digitalization, resulting in more clear-cut effects. In contrast, when the Labour Party is in power, winners of digitalization face a trade-off: on one hand, the improvements in their economic situation push them to vote for the incumbent. On the other hand, this incumbent has policy positions on the economic left-right dimension that are not in line with their economic interests. Such tension may be smaller when Labour governments are in favor of promoting the advanced sectors of economy than under a more sharply left-wing party.

Do the left behind turn to the populist right?

An important question attached to our primary focus on winners of digitalization is whether the minority of workers who lose out in the same process politically respond by increasing support for populist or antisystem parties. Admittedly, our case and data are not ideal for fully examining this question—in a majoritarian electoral system, protest and populist parties are rarely electorally viable, making their political presence marginal. In the case of the United Kingdom, the UKIP has been a fringe party over most of the period studied and support for UKIP has only been coded since 2013 in BHPS/UKHLS. Hence, the data available to examine this question are limited to the latest period.

Nevertheless, our results, which should be interpreted with caution, support the possibility that the "left behind" might turn to the populist right when their workplace digitalizes. Figure 4 shows marginal effects of digitalization on UKIP support. We find increased support among the small group of unambiguous losers of digitalization (the "no qualification" group has been about 4% of our sample since 2013). This is consistent with previous findings that digitalization makes losers more likely to support antiestablishment parties (Anelli et al. 2019; Im et al. 2019; Kurer 2020). The magnitude of the effect is impressive, but it is very imprecisely estimated.[11] While the

10. Note that results are not driven by differential economic effects of digitalization before and after the Great Recession. Additional analyses presented in the appendix show that the estimates of the effects of digitalization on hourly wages and unemployment are comparable across periods.

11. A possible concern is that a large share of low-skilled workers has a migration background, which in turn mutes right-wing populist support, but table 11 in the appendix shows that the results are substantively unchanged when excluding people born outside of the United Kingdom.

Table 1. Subperiod Analysis: Pre–May 2010 and Post–May 2010

	Vote for Labour			Vote for Conservatives			Incumbent
	Pre–May 2010 (1)	Post–May 2010 (2)	Overall (3)	Pre–May 2010 (4)	Post–May 2010 (5)	Overall (6)	Overall (7)
Degree × ICT	.453	−.710	−.191	.143	.630	.569**	1.536***
	(.246)	(.370)	(.214)	(.197)	(.402)	(.196)	(.336)
Other higher degree × ICT	.152	−.378	−.180	.318	.793	.549*	1.199*
	(.332)	(.447)	(.243)	(.323)	(.447)	(.248)	(.504)
A-level, etc. × ICT	.0222	−.512	−.227	.415	.766*	.564**	1.337***
	(.231)	(.383)	(.190)	(.220)	(.377)	(.193)	(.353)
GCSE, etc. × ICT	.0605	−.397	−.194	−.234	.658	−.0451	.686*
	(.248)	(.412)	(.188)	(.260)	(.412)	(.192)	(.298)
Other qualification × ICT	−.222	−1.336*	−.502	−.386	.703	−.351	−.275
	(.449)	(.644)	(.349)	(.331)	(.607)	(.269)	(.535)
No qualification × ICT	.292	−.439	.417	−.462	−.387	−.558*	−.213
	(.434)	(.861)	(.391)	(.302)	(.741)	(.276)	(.564)
Age	−.667	.644	.0827	.102	.704	.365	−.968*
	(.344)	(.519)	(.272)	(.274)	(.456)	(.224)	(.409)
Age × Age	.00466	−.0102**	−.00413*	−.00198	−.00534	−.00334*	.0000293
	(.00270)	(.00339)	(.00182)	(.00236)	(.00300)	(.00164)	(.00317)
Individual × Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Education level FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	106,362	114,671	221,033	106,362	114,671	221,033	221,033

Note. FE = fixed effect; GCSE = General Certificate of Secondary Education; ICT = information and communication technology. Liberal Democrats are coded as the incumbent party during the 2010–15 coalition government. We present, for each education group, the marginal effect of digitalization (direct effect + interaction effect). This allows readers immediately to infer the effect of digitalization among workers with a given education level: e.g., if a university degree holder working in a digitalizing industry starts earning *X* more than if this industry were not digitalizing. The standard approach proposed by Brambor, Clark, and Golder (2006) involves including the main effect and interaction effects separately, which yields identical results. However, the coefficients would then be relative to the base category, i.e., we would compare affected workers with different education levels. Marginal effects, on the other hand, compare affected and nonaffected workers with the same education level and are better suited in a longitudinal framework because they emphasize within-person changes. All results are in percentage points. Standard errors in parentheses are clustered at the individual level.

* $p < .05$.

** $p < .01$.

*** $p < .001$.

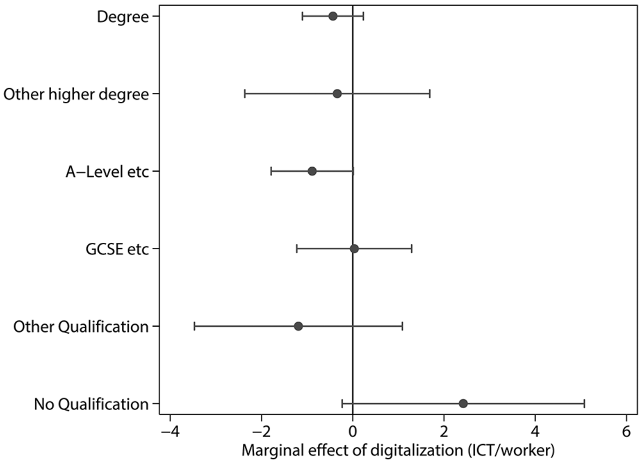

Figure 4. Effect of digitalization on UKIP support, industry-spells fixed-effect specification. GCSE = General Certificate of Secondary Education; ICT = information and communication technology.

negative effect of digitalization on low-skilled workers' wages might rather suggest support for a prowelfare party than for the populist right, the below section on attitudinal mechanisms offers some evidence that welfare chauvinism and competition for social expenditure might be part of the explanation.

INSTRUMENTAL VARIABLES ANALYSIS

Because one might worry about endogeneity of our measure of digitalization (e.g., as a result of governmental policy support for specific sectors), we instrument ICT capital stocks in the UK with analogous data from the United States. Tables 2 and 3 present the results of the instrumental variables analysis next to the baseline results.

All economic and political results remain qualitatively unchanged, although the instrumental variable approach tends to produce larger point estimates. Obtaining larger IV estimates is not unusual and could result from various factors. A small part of the difference between our main specification and the IV can be attributed to differences in the sample used. EU KLEMS does not provide data for two industries in the United States (telecommunications and wholesale, repair of motor vehicles), resulting in a slightly smaller and more homogeneous sample. When we rerun the main analyses excluding these industries, the coefficients become somewhat closer to the IV results. Measurement error may also contribute to explain the larger IV coefficients if ICT capital stocks are better measured in a larger economy like that of the United States.

More substantively, the difference between the coefficients suggests that our measure of digitalization in the United Kingdom is indeed partly endogenous. One possible reason is that policy in the United Kingdom may work to limit the polarizing effects of digitalization on economic and political outcomes. Another reason could be that industrial policy in the United Kingdom might lead to an inefficient allocation of ICT investment across industries. Yet another explanation is related to trade unions' pressure on firms to mitigate the strongest symptoms of digitalization on workers' material and psychological well-being. All three processes would result in attenuation bias in our main specification.

ROBUSTNESS CHECKS

We run a series of robustness checks in order to rule out alternative interpretations and further concerns about endogeneity. Perhaps the most important concern with respect to the main findings relates to the possibility that an increase in ICT capital investment simply reflects the fact that an industry is doing well and thus able to offer higher wages and better working conditions. This could invalidate the interpretation of our results, because they would not capture the specific consequences of digitalization but rather the effect of working in a thriving industry. To assess this possibility, we conduct an additional analysis using non-ICT investments as the main explanatory variable. Non-ICT investments are simply the sum of all assets minus our three ICT categories (capital stocks in computing equipment, communications equipment, and computer software and databases) divided by employees. (we discuss different disaggregations of the residual asset categories in the appendix.) Changes in an industry's non-ICT capital stock per worker do not predict any of the outcomes we are interested in, suggesting that our results specifically capture the consequences of digitalization rather than the thriving of an industry.

Further analyses deal with potential outliers (e.g., rapidly digitalizing industries or regions), additional controls for trade exposure to isolate the impact of technology, and different fixed-effects structures and clustering at the industry instead of the individual level. In addition, we replicated all analyses using lead models to better capture negative effects on workers who lose their job and hence drop out of the labor force. Finally, we have a closer look at attrition. Overall, the result of the robustness checks are reassuring. We can recover our substantive results in all of these additional models. We present a more detailed description of both the empirical concerns and our proposed remedy, including full regression tables, in appendix 4.

MECHANISMS

The causal chain underlying our argument assumes three steps, namely that (1) digitization creates winners and losers through its differential impact on wages and employment along an education gradient. These distributive consequences (2) affect individuals' political preferences and attitudes, which

Table 2. Instrumental Variable Results: Economic Outcomes

	Hourly Net Wage		Probability of Becoming Unemployed	
	Main Specification (1)	Instrumental Variable (2)	Main Specification (3)	Instrumental Variable (4)
Degree × ICT	.345***	.437***	.00423	.206
	(.0323)	(.0805)	(.0711)	(.197)
Other higher degree × ICT	.185***	.306***	.00105	.215
	(.0338)	(.0747)	(.0654)	(.257)
A-level, etc. × ICT	.0497*	.104	.175**	.398
	(.0230)	(.0859)	(.0592)	(.206)
GCSE, etc. × ICT	−.0113	−.0439	.177**	.539
	(.0185)	(.0596)	(.0679)	(.412)
Other qualification × ICT	−.135***	−.222*	.0941	.529
	(.0290)	(.0873)	(.0856)	(.279)
No qualification × ICT	−.185***	−.306***	.256*	.608
	(.0399)	(.0876)	(.104)	(.446)
Age	.356***	.357***	−.367***	−.367***
	(.0272)	(.0279)	(.101)	(.103)
Age × Age	−.00316***	−.00314***	.00158**	.00168**
	(.000213)	(.000221)	(.000603)	(.000623)
Individual × Industry FE	Yes	Yes	Yes	Yes
Education level FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Region FE	Yes	Yes	Yes	Yes
Observations	179,510	151,663	216,227	187,272
First-stage *F*-statistic		104.7		89.34

Note. FE = fixed effects; GCSE = General Certificate of Secondary Education; ICT = information and communication technology. Probability of becoming unemployed is the probability of being unemployed at the time of the next interview (reported in percentage points). Standard errors in parentheses are clustered at the individual level.
* $p < .05$.
** $p < .01$.
*** $p < .001$.

leads beneficiaries of digitalization to (3) voting for conservative parties, voting for the incumbent, and higher turnout rates. We have provided robust evidence for 1 and 3 in the above analysis.

As a final step, we assess some attitudinal mechanisms possibly linking digitalization's implications to electoral behavior. To be clear, our panel data are not ideally suited to trace attitudinal mechanisms. The number of questions on preferences and subjective perceptions of respondents is small, and they are infrequently included, as most attitudes are only inquired about in a few waves. The few questions asked repeatedly are imperfect indicators of the theoretical concepts of interest, introducing measurement error, which attenuates results and is particularly relevant in a longitudinal analysis. This final auxiliary analysis helps us assess the plausibility of attitudinal channels, but it is not powerful enough to refute any of them clearly.

We argued that workplace digitalization can increase support for right-wing parties through a change in preferences for economic policies if winners of digitalization become less likely to support a redistributive welfare state. In addition, we argued that digitalization can increase support for the incumbent party if winners become more satisfied in general and more supportive of whoever is in government. For both processes, we anticipate the opposite reaction for losers. We operationalize preferences about economic policies through a battery about preferences for state intervention that asks about governments' capacity to solve economic problems and its obligation to provide jobs, and we operationalize satisfaction with a question asking respondents about general life satisfaction. The exact wording and results figures are provided in the appendix.

Digitalization is associated with at best small changes in life satisfaction, but we do observe a clear pattern of divergence

Table 3. Instrumental Variable Results: Political Outcomes

	Turnout		Conservatives		Labour		Incumbent	
	Main (1)	IV (2)	Main (3)	IV (4)	Main (5)	IV (6)	Main (7)	IV (8)
Degree × ICT	.797**	1.376*	.569**	2.157**	−.191	.359	1.536***	2.917*
	(.272)	(.620)	(.196)	(.674)	(.214)	(.529)	(.336)	(1.446)
Other higher degree × ICT	.340	2.090*	.549*	1.727*	−.180	.266	1.199*	2.361*
	(.357)	(1.058)	(.248)	(.695)	(.243)	(.662)	(.504)	(1.180)
A-level, etc. × ICT	.713**	2.013*	.564**	1.443*	−.227	−.520	1.337***	2.745**
	(.258)	(1.025)	(.193)	(.586)	(.190)	(.529)	(.353)	(.940)
GCSE, etc. × ICT	.243	1.211	−.0451	.934	−.194	.502	.686*	2.109*
	(.229)	(.986)	(.192)	(.657)	(.188)	(.599)	(.298)	(.950)
Other qualification × ICT	−.815	1.994	−.351	1.431	−.502	.584	−.275	2.750
	(.571)	(1.859)	(.269)	(.994)	(.349)	(.971)	(.535)	(1.756)
No qualification × ICT	.147	2.198	−.558*	.494	.417	.248	−.213	.560
	(.469)	(3.151)	(.276)	(1.072)	(.391)	(1.759)	(.564)	(2.137)
Age	−1.126**	−1.041*	.365	.332	.0827	.174	−.968*	−.930*
	(.392)	(.405)	(.224)	(.230)	(.272)	(.280)	(.409)	(.418)
Age × Age	−.00836**	−.00891**	−.00334*	−.00279	−.00413*	−.00496**	.0000293	.000657
	(.00266)	(.00291)	(.00164)	(.00170)	(.00182)	(.00191)	(.00317)	(.00325)
Individual × Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Education level FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	103,755	81,077	221,033	187,875	221,033	187,875	221,033	187,875
First-stage *F*-statistic		108.5		86.40		86.40		86.40

Note. FE = fixed effect; GCSE = General Certificate of Secondary Education; ICT = information and communication technology; IV = instrumental variable. All outcomes are in percentage points. Standard errors in parentheses are clustered at the individual level.

* $p < .05$.

** $p < .01$.

*** $p < .001$.

between winners and losers. Workers with no formal qualification become significantly less satisfied compared to all workers who hold at least a GCSE when their sector digitalizes ($p < .01$). This divergence mirrors the pattern with respect to incumbency support.

We find support for the claim that digitalization reduces support for state intervention in the economy among university degree holders. This result is consistent with the possibility that very skilled workers, the main economic beneficiaries of digitalization, adjust their economic preferences in a more promarket direction, which makes them increasingly attracted to the Tories' program. However, we also find an unexpected result: the group with the lowest qualifications (i.e., unambiguous losers of digitalization) also seem to become less supportive of state intervention. A plausible explanation in light of this specific group's support for UKIP (see fig. 4) might be related to the particular social policy position of many right-wing populist parties, who strongly differentiate between deserving segments of society (veterans, elderly, "ordinary people") and the rest (Fenger 2018). Indeed, UKIP has been shown to support insurance-based welfare interventions, especially pensions, but in general opposes a more equity-based, universalist expansion of the welfare state (Ennser-Jedenastik 2018). It is possible that concerns about deservingness and competition for increasingly scarce welfare benefits are reflected among the lowest skilled group's critical stance on general state intervention that benefits the broader population.

We also tested a competing mechanism, namely that digitalization may affect political preferences through changes in attitudes about noneconomic issues. It has long been argued that economic modernization and rising living standards increase the importance of nonmaterial goods and help spread social progressiveness on issues such as gender, the environment, or gay rights (Inglehart 1977). This argument is in conflict with our finding of increased support for the Conservative Party and lead us to test the competing hypothesis that increases in digitalization make workers more liberal on social issues. Note that the prediction, if this mechanism holds, would be a shift of winners toward socially progressive parties, such as Labour or the Liberal Democrats, rather than the Conservative Party. The best-suited indicator of socially progressive attitudes available for a sufficiently large number of years in our data is an item battery on support for gender equality. Interestingly, but in line with our main results, we do not find any evidence that changes in digitalization affect progressiveness about gender issues among skilled beneficiaries.

This final result clashes with a common depiction of digitalization winners in the media: the socially progressive celebrity tech entrepreneurs or creators of innovative start-up companies in dynamic urban areas. It is worth reiterating at this point that our analysis is not concerned with such exceptional beneficiaries. We do not study superstars, and we do not primarily cover individuals who self-select into thriving technology industries. Our analysis is concerned with the large but less visible group of regular beneficiaries of new technologies who continue to work in their factories, laboratories, and offices; become more productive when new digital tools are introduced at their workplace; and benefit from limited-but-steady improvements of their material conditions.

Our analysis of wage effects has provided strong support for an economic channel linking digitalization and political behavior. Moreover, in light of our auxiliary results on attitudinal variables, an economic voting mechanism seems plausible. Reflecting the polarization of wages, we find a gradient in life satisfaction between winners and losers of digitalization. Furthermore, winners' relatively stable economic situation makes them less supportive of state intervention, especially compared to semiskilled workers with more ambiguous economic prospects. This aspect may help explain their tendency to lean toward center-right rather than center-left incumbents. We also do not find any evidence of particularly progressive values on the cultural dimension. Taken together, ordinary winners of digitzalization are unspectacular supporters of the status quo. For them, mainstream promarket parties, especially those in government, are a reasonable choice on election day.

DISCUSSION

The digital revolution is accompanied by two fears: that many workers will be displaced from their jobs and that this will lead to political unrest. Public debate and the scarce academic literature on this topic has primarily been concerned with its downsides and focused on the losers of technological progress. While this focus is comprehensible in light of recent political disruptions, we contend that this one-sided attention is at odds with standard economic theories emphasizing productivity gains as well as with historical experience, which has proven many gloomy projections wrong.

We document both economic and political effects of digitalization. Contrary to pessimistic accounts, a majority of workers benefit economically from rapid digitalization in their industries. Yet, these benefits are not equally distributed, and they disproportionately accrue to the highly educated. Our most novel finding is that these diverging economic trajectories are mirrored in diverging political trajectories. First, regarding party choice, the beneficiaries of digitalization become more likely to support the Conservative Party, in particular when they are the incumbent party. Second, with respect to turnout, we observe that digitalization reinforces inequalities along education lines: The highly educated turn out more to vote if their sector digitalizes, whereas we do not find such mobilizing effects among the less educated. The large, but often neglected, pool of voters who benefit from technological innovation thus seems willing to support mainstream parties and uphold the existing social contract.

There are several reasons why our results are more optimistic than previous work. First of all, we look at the effects of a general-purpose technology—that is, ICT—on the workforce. This approach is likely to produce different results than if we had focused on more specific technologies, such as industrial robots, that may have particularly strong displacement effects. Indeed, Acemoglu and Restrepo (2020) show that industrial robots have strong negative effects on employment and wages, whereas the effects of increases in other ICT capital, such as computers per worker or investment in software and computers, are often positive. Clearly, some technologies have stronger labor-displacement effects, and possibly political effects, than others. We see our contribution as an important complement to studies with a focus on technologies that have a more concentrated and more unequivocally negative impact on employment. Our approach allows us to include all sectors rather than mostly manufacturing, a sector that has seen particularly sharp reductions in employment in advanced economies, but is overall rather small (according to the Office for National Statistics, the UK share of people in manufacturing is below 10%). Our coverage of all sectors with a general measure of digitalization possibly facilitates identifying gains of technological change and results in a more optimistic picture.

Another reason that our conclusions may be relatively optimistic is our empirical approach. We study the political implications of digitalization on the active labor force, not on the population as a whole, and we focus on individual effects, which can differ from contextual effects. Using a longitudinal approach, we find little indication of political unrest among regular workers. We do not include in our sample retired people, disabled people, students, or people doing housework, though workplace digitalization may affect them through various channels, including changes in their communities and spillovers in the household. Some segments of this population might react more negatively (e.g., workers who lose their job and cannot find a new one or young citizens with trouble entering the labor market in the first place), although the size of these groups is too small to produce large differences. For these reasons, we do not make inferences based on our findings to population-wide political effects.

To conclude, our findings reveal a complex picture of the political consequences of digitalization. The innovative empirical analysis provides abundant and robust evidence that digitalization is economically beneficial for a majority of the labor force and is politically consequential in two contrasting ways. First, the large group of winners becomes more likely to support incumbent mainstream parties and thus can act as a stabilizing force in democratic systems. Second, while we only find weak evidence of an antiestablishment backlash among unskilled workers as a reaction to digitalization, we demonstrate that the economic polarization associated with digitalization is accompanied by differential political effects on winners and losers of this process. The resulting divergence in political behavior between the two groups might translate quite directly into increasing political polarization.

For good reasons, much of the reporting on recent political disruptions like Brexit has been on the grievances among the disadvantaged and the likely reasons for their support of leaving the EU. The Brexit vote should certainly be attributed to a wide range of causes, but it is plausible that the economic and political polarization between beneficiaries of digitalization and other citizens we document in this article generated political alienation among a subset of the electorate who are exposed to the downsides of economic modernization. While the group of clear-cut losers of digitalization in absolute terms is small, a larger segment of the population in the lower middle class is confronted with relative decline as they observe how others thrive in a digital world while they themselves stagnate.

At the same time, our results remind us that the emergence of antiestablishment forces in most advanced capitalist democracies up to now remains a minority phenomenon. Certainly, how large, exactly, that minority grows is a question of crucial importance; in some cases, most notably Brexit, antiestablishment forces even managed to mobilize a tight majority of the population. Nevertheless, even in exceptionally disruptive events like Brexit, there was a less attention-grabbing but equally sized group of remainers who seemed content with current circumstances and supporting the political status quo. All in all, we thus contend that the implications of digitalization at the workplace are more multifaceted than the narrative of the "revenge of the left behind" suggests.

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