Automation, Digitalization, and AI in the workplace: Implications for Political Behavior

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Abstract (150 words)

New technologies are a key driver of labor market change in recent decades. There are renewed concerns that technological developments in areas such as robotics and artificial intelligence will destroy jobs and create political upheaval. This article reviews the vibrant debate about the economic consequences of recent technological change and then discusses research about how digitalization may affect political participation, vote choice, and policy preferences. It is increasingly well established that routine workers have been the main losers of recent technological change and disproportionately support populist parties. Digitalization also creates a large group of economic winners that support the political status quo. The mechanisms connecting technology-related workplace risks to political behavior and policy demands are less well understood. Voters may fail to fully comprehend the relative importance of different causes of structural economic change and misattribute blame to other factors. We conclude with a list of pressing research questions.

Keywords: Technological change, voting behavior, political preferences, automation, AI

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Introduction

Automation, digitalization, and, more recently, artificial intelligence (AI) are fundamentally reshaping the employment structure of post-industrial societies. The introduction of computers, robotics, or the internet changes the way workers perform their jobs, which skills are valuable, and creates new job titles. This profound transformation is raising recurring concerns about the potential of labor markets to create sufficient employment and about the capacity of workers to acquire the skills needed to succeed in tomorrows' world of work. It should not come as a surprise that the strong distributive implications of introducing new technologies in the workplace have sparked a vivid academic debate about the political consequences of such transformation. More pessimistic views point to historical precedents in arguing that digitalization, automation, or AI pose a threat to democratic stability because citizens will revolt if economic modernization does not favor a large enough part of the population and states fail to sufficiently compensate those left behind. Other arguments, in contrast, highlight the role of technology as a unique source of innovation and prosperity, providing economic opportunity for many and thus shoring up support for twenty-first century democracy.

This article attempts to offer an overview of the state-of-the-art in a very dynamic field. The most consistent finding of the literature is that those who lose out to technological innovation turn against the political status quo in general and towards the populist radical right in particular. In that sense, technological change is likely one of the forces contributing to recent political disruptions observed on both sides of the Atlantic. However, the disruptive potential of technological change is only one side of the coin. Technological change also creates a less conspicuous but numerically larger and politically relevant group of technology beneficiaries. The overall effects of these two processes on political outcomes and systems will depend on the magnitude of effects, the relative size of each group, the speed of change, and the potential for inclusion. In any case, the presence of an important but somewhat neglected group of "ordinary winners" leads us to conclude that technological change might result in less electoral backlash than commonly assumed. Yet it may be important force to understand political realignments.

In a next step, we review work about the underlying mechanisms that link structural economic change and individual political behavior and discuss some unique features of

automation and digitalization compared to international trade and immigration. Workers affected by technological change may not correctly attribute their economic decline to this transformation due to a combination of at least three factors: (1) the complexity and lack of visibility of this specific transformation, (2) basic psychological biases which make ingroup-outgroup conflicts a more compelling source of political conflict, and (3) strategic mobilization by political entrepreneurs who downtone technology vis-à-vis other -- politically more worthwhile -- sources of structural change. Affected voters might misattribute their economic difficulties to related but distinct economic transformations, notably international trade and immigration. Recent survey evidence indeed points in this direction. This "misattribution" or "divertion" hypothesis can have important implications if it reduces demand for policies that address the downsides of technological change. If people misperceive the source of an economic problem, they are likely to support inadequate policies, which do not efficiently address the root of the problem. This channel may reinforce other possible channels by which economic decline affects second dimension preferences on issues like immigration.

The brief preview of core arguments already hints at the thematic and conceptual contours of our review article. First, we do not aim at a comprehensive historical perspective but focus on the so-called *Third and Fourth Industrial Revolutions*, which includes the developments in roughly the last 50 years. This stage of technological change was marked first the rise of electronics, personal computers, and information technology, and more recently also by robotics and data-based artificial intelligence. We collectively label both waves as "digitalization". Second, our key outcome of interest is *political behavior* broadly conceived. We mostly review implications on voting behavior and political preferences, and only discuss the discourses of political parties and the policies that could moderate the impact of structural economic change in passing. Third, we review the political consequences of digitalization and automation from a labor market perspective and limit ourselves to the political downstream effects of technological change at the *workplace*.

Inevitably, these scope conditions neglect various closely related topics of similar importance. Perhaps the most important exclusion is that we take technological change as an independent variable and do not cover the large literature about why some countries and actors are more likely to develop and adopt new technologies than others. Taking technology as exogeneous is a wild simplification, and obviates that innovation is directed by both

economic considerations and political struggles. Also, we concentrate on advanced industrial democracies, mostly the US and European countries, and exclude autocracies. We only discuss industrial relations in the passing and do not address the political influence of technological firms nor on the specificities of work performed through the platform economy. Related to this, we do not examine how technological change affects citizens as consumers (as opposed to citizens as workers), for example of services provided by the gig economy or of news.

The remainder of this review is structured as follows. We first summarize the vibrant literature on the economic consequences of technological change and workplace automation from the perspective of attentive outsiders. Our goal is not to provide a detailed summary of this technically complex and rapidly-evolving literature but instead to distill a few key insights about the distributive implications of technological change that in turn inform our discussion of likely political consequences. We then critically discuss the existing evidence on the implications of digitalization for political behavior in advanced industrial democracies, including on support for populism, vote choice, and policy preferences. We conclude our review with a list of important research questions that have not yet been accurately addressed by the existing body of work.

Economic Implications of Technological Change

Technological change periodically raises anxiety and hope. Some voices worry that the introduction of new technologies can displace large numbers of workers, increase inequality, and ultimately lead to political upheavals. Yet many authors, including most economic historians, point out that technology has been the main driver of economic growth in the last three centuries (Mokyr 1998, 2017). The maturation and adoption of a set of computer-based technologies since the 1970s and by robotics and artificial intelligence more recently, have again revived this centuries-old debate (West 2018, Ford 2015, Boix 2019, Frank et al 2019, Iversen and Soskice 2019, Busemeyer 2021).

In this section, we first briefly summarize a few helpful insights from formal models about the labor market impact of new technologies, and later turn to empirical research about the economic impact of digitalization in the Third and Fourth Industrial Revolution.

Is this time different? Theoretical considerations from labor economics

Modern theoretical economic models emphasize that new technology can both complement and substitute labor (Autor, Levy and Murnane 2003, Acemoglu and Autor 2011). The distributive implications of technological change strongly depend on whether a particular technology predominantly substitutes or complements labor and on which type of workers are affected by each effect. In principle, both higher and less skilled workers can be complemented or substituted by technology. For instance, waving machines in the early phases of the industrial revolution and Fordist technologies in the first half of the 20th century complemented low-skilled workers and substituted specialized workers. Hence, the distributive consequences of the introduction of a new technology vary across specific technologies. There is now widespread agreement that the computer-based technologies introduced since the 1970s in the Third Industrial Revolution, including the use of personal computers in the workplace and the introduction of basic algorithms, tended to complement workers with high levels of education, while they mostly substituted workers who performed routine tasks. Because many routine workers were located in the middle of the income distribution, this substitution process has contributed to a "hollowing" of the middle class and increased income inequality.

More recent theoretical models further refine a "task-based" approach that takes tasks performed by workers within occupations as the relevant unit of analysis and combines it with theoretical models of directed technological change in which new technology is endogenous to the cost of labor or other factors (Acemoglu and Restrepo 2018, see also Hémous and Olsen 2021, Caselli and Manning 2019). Acemoglu and Restrepo (2018) distinguish between two types of technological change: *automation* that allows to substitute capital for tasks previously performed by labor; and the *creation of new tasks*. The authors argue that economies are usually in a balanced growth trajectory because there are powerful self-correcting forces when they go off-path. For example, when automation increases too much, the cost of labor decreases, reducing incentives to continue automating while increasing incentives to create new tasks. This explains why massive technological unemployment has not occurred in the past. However, a technological innovation that makes automation easier than the creation of new tasks ("so-so" innovation) can in principle lead to lower employment and labor shares.

Theoretical models can support both optimistic and pessimistic predictions about the effects of technology on labor market outcomes depending on the extent to which the productivity effects of technology offset substitution effects, and on which type of workers are most affected. How computer-based technologies and more recent technologies such as robotics or artificial intelligence reshape labor markets is ultimately an empirical issue. The following sections thus aim at summarizing the most important findings from a rich and rapidly growing empirical literature in labor economics.

Empirical findings: Routine-biased technological change

In a decades-long research effort, the MIT economist David Autor and his co-authors have pushed our understanding of the labor market implications of technological change. Autor, Katz and Krueger (1998) claimed that the diffusion of computers and related technologies made educated workers more productive and increased inequality. Building on the then standard "skill-biased technological change" hypothesis, the article argued that computer-based technologies *complement* educated workers but said little about who was being substituted. In a closer examination of what computers do through a case study of the banking industry, Autor, Levy and Murnane (2002) observed that rule-based or routine tasks (of the type "if X, then Y") can be more easily computerized than other tasks due to the logic of basic programming and show how a new technology, the proof machine, changed the task composition of jobs by automating routine tasks.

This observation set the ground for the seminal Autor-Levy-Murnane model that articulated what became known as the "routine-biased technological change" hypothesis (Autor, Levy and Murnane 2003).[1] Computer-based technologies, in addition to complementing skilled workers (and hence increasing the number of high-paying jobs for educated workers and the low-paying service workers who cater to them), substitute for labor in routine tasks, which were typically performed in industrial, sales, or clerical middle-income occupations, traditionally accessible to non-college educated men. As a result of both upskilling and substitution of routine workers, new technologies lead to a "hollowing" of the middle class and growing income inequality. To assess this hypothesis empirically, the authors created a measure of routine task intensity (RTI), or the share of routine tasks performed by workers in

[1] The term was introduced by Goos, Manning and Salomons 2009.

an industry (later also estimated at the occupation level) based on data from occupational dictionaries in the United States, which is still the standard measure of automation risk. In subsequent studies, Goos, Manning, and Salomons (2009, 2014) find that the routine biased technological change hypothesis applies to other advanced industrial economies outside the US as well.

There is agreement that RBTC is one of the main drivers if not the key driver of job polarization and rising income inequality (e.g. Goos, Manning and Salomons 2009, 2014, Autor and Dorn 2013, Nolan, Valenzuela and Richiardi 2019, Hoffman, Lee and Lemieux 2020). By contrast, there is debate about whether computer-based technologies have increased unemployment (Dorn et al 2015, Gregory et al 2019, but see IMF 2019). This weaker link to unemployment is due to several reasons. Although the number of workers in routine occupation is shrinking, productivity growth can create jobs in the industries undergoing change or in other sectors. It is also increasingly clear that computer-based automation increases non-participation rates (Jaimovich et al 2020). A significant share of routine workers who lose their jobs exit the labor force rather than move to unemployment (Cortes et al 2017, Kurer and Gallego 2019), which points at the difficulties at retraining them. Trade unions seem to be accepting a compromise in which they choose to preserve wages for existing routine workers at the expense of the creation of new jobs. Using data from the US, Parolin (2021) finds that in regions and industries with high unionization rates, occupations with a high RTI did not experience declines in earnings, but employment shares in those occupations fell more.

Yet, automation risk is no longer confined to traditional routine industrial jobs, as popular examples about AI-powered radiologists, driverless cars, or automated legal assistants illustrate (Brynjolfsson and McAfee 2014, Frank et al 2019). This has motivated researchers to find ways to assess occupational risk that are not dependent on the RTI measure. Frey and Osborne (2013, 2017) classify a sample of occupations as highly likely to disappear in the next 20 years based on current opinion about technological feasibility and then applied a machine learning algorithm to predict the risk of automation of 702 occupations. Arntz, Gregory, and Zierahn (2017) and Nedelkoska and Quintini (2018) use OECD's PIACC data, and Feng and Graetz (2020) use data on job-specific training and engineering complexity to propose variants of this basic approach to estimate *how much* of an occupation is at

automation risk (rather than coding jobs as at risk or not). This later thinking about the measurement of automation risk is consistent with the theoretical task-based approach.

Directly measuring technology adoption: ICT and Robotics

A series of empirical studies are combining novel measures of actual technology adoption, rather than potential risk, with causal identification designs.[2] Prior studies used variables such as IT expenditure (Bloom, Sadun and van Reenen 2012), sector-specific investment in information and communication technologies (Michaels et al, 2014), or IT intensity measured as the number of computers (PCs plus laptops) per worker (Bloom, Draca and van Reenen 2016). But the empirical study of the labor market effects of technology has really taken off by studying the case of robots. In a study of 17 countries, Graetz and Michaels (2018) use data about robots sales collected by the International Federation of Robotics in 25 industries which classifies machines as robots if they are "automatically controlled, reprogrammable, multipurpose manipulator, programmable in three or more axes". The authors find that the adoption of robots did not affect overall employment in an industry but reduced the share of low-skilled workers. Carbonero, Ekkehard and Enzo (2020) extend the analyses to 43 countries and show that robots have a small negative effect on employment in developed countries, but a much larger negative effect in emerging economies.

Robot adoption country case studies allow examining who gets displaced, who benefits, and local labor market equilibrium effects. Acemoglu and Restrepo (2020), estimate for the US that exposure to robots in a commuting zone (defined as a shift-share variable that interacts baseline industry shares in a commuting zone to the acquisition of industrial robots in an industry) led to significant reductions in both the number of jobs and real wages. Lerch (2021) complements this study by using microdata and finds that 6 out of 10 displaced workers exit the labour force. While younger displaced workers often go back to education, older workers who do not re-enter the labour force go on disability benefits or retire early. For the case of France, Acemoglu et al (2020) find that firms that purchase robots increase

[2] Note that technical potential to automate may never be realized because of legal, cost-related or other barriers. A more practical type of concern with RTI and other measures of risk, which is particularly relevant for comparativists, is that task performed in jobs are based on US occupational dictionaries which are updated only infrequently. Because the actual task content of a job title varies across contexts and time, this measure does not necessarily travel well. A few countries, like Italy (Cirillo et al 2020), have O*NET-types coding of occupations, but most have not.

employment, value added and productivity but the aggregate effect at the industry level is negative because firms that do not purchase robots contract, offsetting the gains.[3] In a careful study of the German case, Dauth et al (2021) show that robot exposure is associated with a reduction in manufacturing jobs which is fully offset by the creation of new jobs in services. The main beneficiaries are managers and engineers. And while incumbent workers maintain their jobs when robots are adopted (although wages suffer), younger workers are not hired and change their occupational choices. Using firm-level data from Spain, Koch, Manuylov and Smolka (2021) find that better performing firms are more likely to adopt robots and that adoption generates large gains for these firms, a reduction in labour cost share and a net job creation of 10% in 10 years, but that this gain is dominated by job destruction in other firms.[4]

It is important to note that research about the important US case has been held back by the lack of administrative and firm-level data. The US Census Bureau has recently started including questions about robotics, AI, cloud-hosting, and other technologies in firms surveys (see Seamans and Raj 2019, Zolas et al 2020). A second remark is that robotic studies should be read as case studies of the automobile industry, where more than 70% of the robots tracked by the International Federation of Robotics are deployed (see also Krzywdzinski 2020). Given the specificities of this industry (e.g. in many countries it is strongly unionized and geographically concentrated), it is unclear to what extent the findings apply to other industries.

Recent developments: AI, automation, and the pandemic

Artificial intelligence (AI) comes second to robots in terms of attention in empirical research. AI is a general-purpose technology which is analytically distinct from previous digital technologies based on the basic programming logic of "if X, then Y". Computer software which uses AI relies on algorithms to find patterns in data, create models, and make predictions. It is inductive and probabilistic. Examples of applications include natural

[3] Since 2015, China is the country that is buying more industrial robots. To the best of our knowledge, the impact of robot adoption on jobs and wages has not been estimated in China, but Cheng et al (2019) study the correlates of robot adoption and Nicole Wu studies attitudes among workers and managers.

[4] Working papers about the impact of robotization include Humlum (2020) who uses data from Denmark and estimates that industrial robots slightly increase average real wages but produce a concentrate decrease in real wages of production workers in manufacturing (and especially older workers) or Dixon, Hong and Wu (2021) show using firm-level data from Canada that robot adoption leads to increased employee turnover and increased employment within the firm.

language processing and speech recognition, self-driving cars, machine translation, or image recognition (Varian 2018).

As other technologies, AI technologies can in principle both substitute and complement labor (Agrawal, Gans and Goldfarb 2019) and there is much interest in which effect prevails in practice. To investigate this, Acemoglu et al (2020) code online job adverts since 2010 as being in AI-related positions or not and estimate if firms have workers exposed to AI by coding if the tasks described in job adverts can be performed with AI at current capabilities. Relying on three measures of current AI capabilities (Felten, Raj and Seamans, 2019 AI occupational impact measure, Brynjolfsson, Mitchell and Rock, 2018 Suitability for Machine Learning index, and Webb's AI exposure score), they find that exposed firms hired more AI-workers but fewer workers overall, suggesting that AI is being adopted to substitute labor and that displacement effects clearly trump productivity and complementary effects within firms. At the industry or occupation level, by contrast, they do not find consistent effects on employment or wages.

Two further recent investigations that measure the adoption of specific automation technologies are worth mentioning. Bessen et al (2019) measure automation through a survey question asking firms in the Netherlands if they had paid for third-party automation services provided by specialists. Spikes in investment reduced the average worker's wages by 10% in 5 years and increased their probability to separate from firms and to retire early, compared to workers in matched firms that automated later. They also find that workers in firms that automated in some period had *higher* wages than firms that never automated. Perhaps the most clearly optimistic result of the recent set of studies is provided by Mann and Püttmann (2021) who compute a new measure based on classifying all patents between 1976 and 2014 as automation patents or non-automation patents in the US.[5] They estimate that adopting automation technologies had a positive effect on local employment, which is driven by the service sector.

Finally, the covid-19 pandemic may have worked as a catalyst for yet another surge in the adoption of new technologies in the workplace (for an early review see Coombs 2020), raising many highly relevant research questions. Clearly, some sectors will be more affected

[5] Buarque et al (2020) present a dataset of AI patents in Europe.

than others, with automation accelerating more in sectors in which work cannot be conducted online and with abundance of routine tasks (Blit 2020) or in sectors with particularly high uncertainty (Leduc and Liu 2020). Teleworking has also forced companies to adopt new software that allow work to be performed remotely, but it is still unclear what will be the effects on the productivity of workers and the organization of firms.

In our view, Baldwin's (2019) concept of "globotics" will be particularly relevant in the post-pandemic world: as firms have set up the technological and organizational infrastructure that allow working from home, competition between well-paid workers in developed countries and workers in emerging economies that accept lower wages is likely to intensify. The resulting increased competition for skilled jobs, together with the potential of AI applications to automate relatively skilled tasks, suggest that in the 4th industrial revolution, technology-related risks are possibly spreading beyond routine workers to other types of workers, including skilled ones.

Take-aways for studying political implications of technological change

Even if the literature in labor economics is still evolving and some questions are still contested, we can extract three key take-aways that are particularly relevant when thinking about the consequences on political behavior. First, routine-biased technological change has been a main driver behind job polarization and income inequality in the last decades but the effects on employment were positive or neutral. This could change with the further rise of AI, a general-purpose technology that may be producing a net reduction in employment and may be moving risk up the skill ladder.

Second, empirical studies in labor economics suggest that a given technology (such as robots) can have different aggregate and distributive effects, across countries which points at the importance of culture, policies, and labor market institutions at modulating how technology affects labor markets. Political science provides the theoretical toolkit to explain such cross-national variation and to derive relevant policy implications and thus has the potential to effectively contribute to this literature.

Third, the adoption of a new technology has complex ripple effects throughout economies. "Reduced-form" analysis that zoom in on displaced workers or specific firms or industries obtain different results than "equilibrium" analyses that estimate community-wide effects. But even if a technology is beneficial on average, costs tend to be concentrated, and they have been worse for male middle-skilled industrial workers in the last decades and more pronounced in areas where affected industries clustered. Such clustering of adverse effects is relevant when considering political reactions.

Consequences of workplace digitalization for voting behavior

We now turn to the main question of the review: Does labor market disruption due to new digital technologies affect the political behavior of workers? If yes, how?

Historical experience suggests that significant technological change in the workplace, as other deep economic transformations with strong distributive consequences, is likely to create political upheaval. Unless they were appropriately compensated, workers who lost out from the introduction of weaving machines in the first industrial revolution often demanded compensation through non-market mechanisms (Caprettini and Voth 2020). True, pure Luddist movements against the machines have been historically rare, but discontent does not need to manifest politically as an explicit movement against technology. For instance, technological change is widely acknowledged as one of the key structural economic transformations that triggered the political movements that culminated in World War I and II (Boix 2019, Eichengreen 2018).

The recent transformations of labor markets and workplaces due to the use of digital technologies has coincided in time with extensive political unrest. The literature about the rise of populism identifies economic change and insecurity as one of the contributing factors (e.g. Rodrik 2018, 2020, Colantone and Stanig 2019 - although the relative magnitude of the effect of economic factors is hotly debated, see Berman 2021, Margalit 2019). However, this large literature has rarely specifically focused or attempted to measure technological change. Instead, analyses about the economic drivers of the rise of populism have tended to focus on related but distinct economic factors such as international trade and globalization (for reviews see Walter 2021, Naoi 2020), with extensive focus on the questions how growing trade with

China and rising immigration have impacted political behavior. This relative inattention to technology compared to immigration or trade is surprising in light of the general agreement in the economics literature that technological change is a more important source of job polarization compared to offshoring or competition from migrants (e.g. Goos, Solomon and Manning 2014).

Our review first summarizes the empirical work that assesses the question if and how new technologies at the workplace may shape political behavior before we return to the question of the distinctiveness of technological change vis-à-vis other structural economic transformations.

Political implications of digitalization: Economic losers turn against the political status quo

The larger part of the existing literature on the political consequences of technological change has focused on voters at the losing end. As the previous section has made clear, the negative economic consequences of the adoption of computer-based technologies are strongly concentrated among routine workers, who are mostly men in blue- and white-collar jobs in the middle of the income distribution such as industrial workers or clerks. RBTC disproportionately affects a group of voters who used to think about themselves as middle class and who have the means to carry their dissatisfaction into the political arena (Kurer and Palier 2019). There is mounting evidence that this is exactly what they are doing.

A rapidly growing empirical literature finds that losers of technological change are disproportionately represented among those who are turning against the political status quo. Gingrich (2019) uses International Social Survey data and finds that workers in occupations with high RTI are more likely to vote for the populist right and for the mainstream left. Im et al (2019) show in a cross-sectional analysis covering Western Europe that a measure of occupational automation risk is associated with voting for right-wing populist parties among citizens who are "just about managing" financially. This effect is not observed for those who already find it difficult or very difficult to live on their current income. Similarly, a panel-data analysis by Kurer (2020) covering Germany, the UK, and Switzerland shows that routine workers who are strongly exposed to automation but still manage to cling to their threatened jobs are particularly likely to vote for right-wing populist parties. Also using panel data, Mitsch (2020) studies young risk-exposed voters in Germany, i.e. potential automation losers

who are only at the beginning of their occupational career. Drawing on a specific measure that captures the substitution potential of an occupation based on current technological capabilites (see Dengler and Matthes 2018), his analysis provides further evidence for disproportionate support for the radical right among this specific constituency.

Other work that supports the connection between RTI and vote for populist parties includes Milner (2021), who finds in both regional- and individual-level analyses that RTI is positively associated with populist voting, Dal Bo et al (2020) for the case of Sweden, and cross-national studies that do not focus on technology but use RTI as a control variable (Inglehart and Norris 2019, Guiso, Moreno and Solli 2018, Oesch and Rennwald 2018, Gidron and Hall 2017).

This basic finding is also confirmed by analyses about the impact of robotization on voting behavior using International Federation of Robotics data. Based on a regional-level analysis, Frey et al (2018) document that support for Donald Trump in the 2016 U.S. election was significantly higher in local labor markets more exposed to robotization. Caselli, Fracasso and Traverso (2021) document increased vote for the far right in Italian municipalities more exposed to robotization. Finally, Milner (2021) finds in analyses using regional data that robotization increases support for right-wing populist parties.

An innovative recent contribution by Anelli et al (2021) provides further evidence for a link between automation risk and radical right support. They argue that measures of automation risk based on *current* occupation underestimate the true scale of the phenomenon because workers in ostensible low-risk jobs, e.g. in sales or services, might very well be canonical automation losers. This could be either due to *direct* replacement in previous employment or *indirect* replacement in the sense that labor market entrants may be unable from the start to find stable and better paid jobs in a shrunk manufacturing sector. Combining pre-automation probabilities of working in a given occupation with individual automation risk scores from Frey/Osbourne and the pace of regional robotization, they compute a measure of individual exposure to automation that aims at capturing such direct and indirect replacement over and beyond current employment. Measured as such, individual vulnerability to industrial robot adoption increases support for the radical right across 13 Western European countries.

An open question is if digitalization can push displaced workers to voter abstention. Kurer (2020) finds that routine workers who lose their job and actually end up unemployed tend to abstain from politics. Boix (2019) also argues that the ICT revolution has led to increasing voter abstention. However, the question of the conditions under which technological change increases voter abstention rather than support for populism has received little attention in empirical studies. This is also one of the main puzzles in the more general literature about the consequences of economic shocks for political behavior (Margalit 2019).

Can the political backlash of economic losers be prevented through compensatory policies? Gingrich (2019) provides the only careful comparative study that assesses if public policies addressed at palliating labor market risks for workers affected by deindustrialization and automation can help prevent political disillusionment and the turn to the radical right. She finds that workers highly exposed to automation as measured by RTI are not less likely to vote for populist parties in countries with more generous early retirement policies and in-kind spending, nor in countries with more protective labor market regulation. This is a concerning finding, as it suggests that compensating workers is not effective at preventing their turn to protest voting.

So, the first consistent finding of the literature is that the losers of technological change are voting against the political establishment. This finding seems to hold for RTI, robotization, and related measures of substitution risk, can be observed across different political and institutional contexts, and does not appear to be substantially mitigated by compensatory policies. One important qualification to this finding is that it might not apply equally to different subgroups of the population. Recent evidence in particular points to differences between women and men (see Aksoy et al 2021, Gingrich and Kuo 2021, Müller 2021) but similar heterogeneity in susceptibility to automation as well as political reactions could be expected between groups of workers from different races, ethnicities, or generations.

Other implications: Does the political behavior of economic winners also change?

Economic losers of workplace digitalization are a politically relevant group, but we cannot lose sight of the fact that they are a minority of the population. The literature in economics emphasizes that, along with substitution effects that produce losers in routine and manufacturing jobs, new technologies have extensive complementary effects on labor. As a

consequence, technological change creates economic opportunity and produces a large group of beneficiaries with little reason to revolt against the political status quo.

The transformative potential of innovation and technological progress is at the heart of a related literature describing the transition of our society into modern "knowledge economies". Several influential accounts of political change in advanced industrial economies discuss the benign consequences of educational expansion and the fact that a broad upper middle class enjoys economic growth, wealth, and opportunity (Boix 2019, Iversen and Soskice 2019). The loss of mid-skilled routine jobs has been compensated by the creation of new non-routine and service sector jobs, often highly skilled, in a broad upskilling process. Although the inclusiveness of contemporary knowledge economies remains disputed (e.g. Unger 2019) because its gains have been "concentrated at the upper tail of the income distribution" (Iversen and Soskice 2019, p. 21), this transition has undoubtedly fueled economic opportunity for many.

In spite of this influential body of work that paints a considerably optimistic picture of economic modernization, the voting behavior of the economic winners of digitalization has received little attention in the empirical literature. Prospect theory (Kahnemann and Tversky 1979) provides one possible explanation for this inattention, as we may expect that economic gains are less likely to have behavioral consequences, including on political behavior, than economic losses. Still, three recent pieces of work suggest that workplace digitalization also has consequences for the political behavior of economic winners.

First, Broockman et al (2019) study the political preferences of tech entrepreneurs, a group of extraordinarily successful and hence politically influential beneficiaries of technological change. Based on an original survey, they document their complicated relationship to left-right positions in contemporary US politics. On the one hand, tech entrepreneurs have traditional center-right attitudes when it comes to regulation and state intervention. On the other hand, they hold unusually pronounced progressive values on non-economic issues. These cross-pressures result in lukewarm Democratic support and can result in pressure to modify the positions of the party in a broader realignment process.

More directly examining how exposure to technology affects political preferences, we (Gallego, Kurer and Schöll 2021) have combined longitudinal panel data from the United

Kingdom and information about ICT investment at the industry level. In line with the expectations of the knowledge economy literature, we find that "ordinary winners" of technological change are clear-cut supporters of the political status quo in the United Kingdom. We document how the experience of moderate but gradual wage increases as a result of ICT investment in an industry results in increased voting for the incumbent party, especially when the center-right is in power. In addition, a recent working paper finds that governments' investment in higher education, which helps workers reap the benefits of technological change, might represent one important mechanism explaining the pro-government shift in partisan voting (Lastra-Anadon, Scheve and Stasavage 2020).

Finally, Schöll and Kurer (2021) draw on fine-grained local labor market data from Germany to study how technological change affects regional electorates. They do find the expected decline in manufacturing and routine jobs in regions with higher robot adoption or higher investment in information and communication technology (ICT), but show that this decline was more than compensated by employment growth in the service sector and cognitive non-routine occupations. On balance, the net change in the regional composition of the electorate may actually favor parties from the New Left rather than anti-establishment forces because workers in occupations dominating the growing sectors typically hold more progressive political values (Kitschelt and Rehm 2014). To be sure, aggregate welfare gains at the regional level likely mask certain disruptive consequences of automation (see Anelli et al 2021). But in thinking about the political consequences of technological change in general, such equilibrium effects appear as an important corrective to more specific studies on particularly exposed parts of the voting population.

Two views on mechanisms: Effects on political preferences

The results reviewed above suggest that workplace digitalization matters for voting behavior, but *how* this happens is less clear. The question about the exact underlying mechanisms linking technological innovation to electoral competition is related to a second issue lurking in this literature: Is there something "special" about workplace digitalization vis-à-vis other structural changes?

We argue in this section that not all structural economic changes are alike. Different economic transformations can have different political consequences depending on whether and how they are perceived by voters and politicized by political actors. In the case of technological change, the literature in labor economics reviewed above suggests that it is the most important structural driver of rising income inequality in recent years and a direct cause of the relative economic decline of routine workers. Yet, economic losers do not seem to directly and explicitly blame technological change for their (relative) decline in economic well-being. Instead, they at least partly (mis)attribute this decline to related but distinct economic transformations, notably international trade and immigration. At the same time, economic winners do not realize that digital economies disproportionately reward people like them and embrace meritocratic discourses to justify their fate (Sandel 2020).

If confirmed, the *misattribution or divertion* hypothesis[6] is relevant not only as a curiosity for study, but because it is likely to lead to harmful policy responses. If people misperceive the source of an economic problem, they are likely to support inadequate remedies, which do not target the root of the problem. Worse, these policies may be inefficient and damaging.

To build our argument, we first review what we label the "classical political economy" model which expects that changes in material interests directly affects economic preferences and then elaborate on the alternative misattribution or diversion model which recognizes that other factors such as perceptions about the causes of economic decline, the attractiveness of different policies, and positions on second dimensions of political conflict beyond redistribution, are relevant.

Classical political economy: Direct path from economic risk to political preferences

A first view about why digitalization may affect voting behavior builds on the large literature about the relationship between labor market risks and political preferences (e.g. Meltzer and Richard 1981, Moenen and Wallerstein 2001, Iversen and Soskice 2001, Rueda 2005, Rehm

[6] The terms "misattribution" and "diversion" point at two different but possibly compatible processes. Using the term misattribution emphasizes micro-level psychological processes that may motivate people to assign blame for relative economic decline actually caused by technological change to other factors. Using the term "diversion" emphasizes the active role of political entrepreneurs who frame issues according to calculations about their mobilization potential.

2009, Rehm 2011, Emmenegger et al 2012). In standard political economy, potential labor market risks or realized economic decline shape economic interest, which in turn shapes political preferences.

The literature on digitalization and political preferences has examined if automation risk affects preferences for redistribution and other economic attitudes. The evidence so far is mixed (for a thorough review, see Weisstanner 2021). Thewissen and Rueda (2019), regress routine task intensity on attitudes towards redistribution in European Social Survey data and found a positive correlation. Kurer and Häusermann (2021) use a measure of subjective automation risk that asks workers in eight countries how likely it is that their job will be automated by a robot, software, AI or another technology in the next 10 years as well as two measures of objective risk. They find that workers at higher risk support spending more on unemployment benefits, but not on pensions or other policies. Yet, other studies find no link between risk of digitalization and preferences for redistribution. Gallego et al (2021) find no correlation between several objective measures of automation risk and preferences for redistribution in neither correlational nor experimental analyses with data from Spain (though they find associations with other attitudes). Several experimental papers have provided information about automation risk and do not find that it affects preferences about welfare policies, immigration or trade (Zhang 2019), or only increases demand for redistribution if a politicised rhetoric that explicitly presents redistribution as an antidote to increasing inequality is also primed (Jeffrey 2020).

Redistribution and social protection are not the only -- and perhaps not the most adequate -- policy response to technological change. However, the growing evidence about how automation risk affects preferences for more active kinds of social policy produces similarly inconclusive findings. Preferences about labor market policies are particularly relevant, as these that are often advocated as an adequate response to the risks posed by automation. Both Busemeyer and Sahm (2020) and Weisstanner (2021), relying on routine task intensity, and Kurer and Häusermann (2021), relying on a measure of subjective automation risk, find that at-risk workers do not support more spending on active labor market policies or education. At the same time, Im (2020) reports that workers at high risk of automation are more likely to demand active labor market policies using data from the European Social Survey and several measures of risk.

Other work has examined how digitalization risk affects preferences for basic income, an unconditional cash transfer with no conditions for receipt nor time limits, is presented by advocates as a policy that can help reduce risks in a context of rapid technological innovation (e.g. Van Parijs 2004). Sacchi, Guarascio and Vannuttelli (2020) find that RTI is correlated with support for a universal basic income among some subgroups of voters in Italy. However, Dermont and Weisstanner (2020), Weisstaner (2021), and Busemeyer and Sahm (2021), using data from the European Social Survey, do not find that higher risk of automation is correlated with demand for a universal basic income.

This literature sheds mixed results on the question if being exposed to automation-related risks affects the economic preferences of workers. The mixed findings may be due to the fact that different studies use different measures and model specifications, and some agreement on these two aspects is crucial to move forward. They can also be due to genuine differences across contexts, as pointed by Weisstanner (2021), for instance if in some countries workers are more aware about automation risk than in others or if they feel more protected by the state. Another source of variation may be in the political discourse about digitalization, which varies across countries, although in general "[c]entral political actors have used their discursive agency to frame digitalization not as something that should be cushioned by compensatory policies but as something that can and should be actively shaped" (Marenco and Seidl 2021, 13).

To be clear, we do not generally discard preferences on economic policies as a mechanism linking technological change to vote choice, and have claimed in our own work that the economic effects of digitalization may affect preferences about economic policies (Gallego, Kurer and Schöll 2021). But we note that the existing evidence is just not as robust as in the case of the correlation between technological change and voting and possibly points at partial misattribution of determinants as well as at relevant between-country variation.

Alternative channels linking risk and preferences: Misattribution and diversion

An alternative theoretical narrative in this literature starts with the widely agreed fact that routine workers perceive that neither governments on the mainstream right nor on the mainstream left have been able to stop their secular economic decline or represent their views, neither descriptively not substantively. In this period, routine workers have

disappeared from political parties (Dal Bo et al 2018, O'Grady 2019). However, this is not an apathetic or disengaged group and they still participate in politics, but turn against anti-establishment parties. The simplest version of this argument is that economic decline motivates affected workers to support political outsiders as a form of protest. For instance, Frey et al (2018) interpret their findings about how robotization increased support for Trump as a sign of blind retrospection and protest voting.

Still, the specific platforms that digitalization losers end up supporting are puzzling. While migration and trade are central in the types of "economically nationalist" platforms (Colantone and Stanig 2020) offered by the populist parties to which digitalization losers turn, policies more directly related to technological change are not discussed often. As Rodrik notes, "While disentangling the effects of automation and globalization is difficult, most existing studies attribute the bulk of the decline in U.S. manufacturing employment to the former rather than the latter. Yet we do not see populists campaign against technology or automation" (Rodrik 2018, 18). Digitalization generally remains a marginal issue at elections with little visibility in party manifestos, but when it is discussed, most parties propose to speed up technology adoption (König and Wenzelburger 2019). Emerging related issues that may well become politicized more in the future are the gig economy, artificial intelligence and online commerce, although positions on these issues are not (yet) clearly correlated with existing cleavages and how they are constructed varies across countries (Marenco and Seidl 2021, Thelen 2018).

We start with the plausible assumption that workers are unlikely to know the exact contribution of different causes to their relative economic decline and suggest that some causes are more appealing as explanations than others. For reasons further elaborated below, technological change may be a particularly intangible and inaccessible explanation and hence especially prone to misattributions. This does not imply that technological change does not matter for political behavior, but that discontent actually caused by this transformation is likely to manifest in the political arena, at least partially, through debate on *other* issues.

There are several candidate explanations of secular economic change, but three core structural economic possibilities are: a) international trade and globalization; b) competition from immigrants; c) digitalization-related technological change. We have identified three possible explanations as for why technological change may feature less prominently in the

political arena and political discourse than one would expect based on its paramount economic relevance.

First, it may be more *psychologically gratifying* to attribute economic decline to globalization because immigration and trade offer clear out-groups to mobilize against (migrants, China), and there are relatively straight-forward policies to counteract them (such as borders and tariffs). Technological change is different. Seeing one's tasks performed by machines can take particularly large hits on self-esteem. It may be more difficult to mobilize against non-humans than against human outgroups. The policies adequate to meet this challenge, such as intensive and continuous retraining may be costly and unappealing for workers. On the side of winners, mericrotacy offers a psychologically attractive explanation of the good economic fortune of the highly educated in the last decades (Sandel 2020).

Second, and most likely as a consequence of the first reason, political entrepreneurs (especially populist parties) supply discourses against immigration and trade that connect economic grievances to policy solutions (Kurer and Palier 2019, Kitschelt 2018, Kriesi et al 2008), further contributing to voters' misattributions, as parties makes some explanations more cognitively available than others. In other words, voters may develop certain policy opinions because politicians and parties cue or divert them into thinking that the cause of economic transformations that they experience as undesirable is international trade or immigration.

A third consideration is that the *speed and visibility* of each structural change may affect how likely it is to become politicized. Politicization may be more likely when events occur as specific visible shocks because sudden shocks are more noticeable than ongoing processes. Identifiable events have occurred for instance in the case of trade with liberalization of trade with China or in the refugee crisis which made the issue of immigration more salient in some countries. In the case of automation, the threat may be much more gradual.

The most articulated account of the misattribution narrative has been provided by Nicole Wu (2021a, 2021b) who shows that workers at higher risk of automation feel less secure in their jobs and are more likely to oppose free trade and immigration, but they do not have different preferences about spending on technology. Similarly, Kaihovaara and Im (2021) find that European workers in high RTI occupations are more likely to support trade protectionism and

restrictions on immigration. Further supporting this claim, Rodrik and di Tella (2020) show that citizens are more supportive of protectionism when they hear in an experimental setting about workers who have lost their job due to technological change.

Ideas about misattribution and diversion are compatible with current debates about the intertwined economic and cultural origins of populism, which emphasize the interaction between relative economic decline, nationalist attitudes, and identity politics (Gidron and Hall 2020, Noury and Roland 2020, Berman 2021). Recent work claims that the discontent among historically dominant groups in economic decline manifests politically in forms that reach beyond the political left-right dimension typically at the center of traditional political economy models. If the workplace is no longer a reliable source of social status, voters who suffer from relative status decline may seek redress by adopting other identities. One important mechanism is that members of historically dominant groups develop authoritarian attitudes as a protection from social regression and identity loss stemming from long-run economic change, and turn against groups perceived as inferior in order to preserve status (Gidron and Hall 2017, Ballard-Rosa et al 2021). A second general mechanism is that when individuals experience a relative economic decline, their occupation-related identities become less valuable and they become more likely to choose identities that can provide higher prestige and self-esteem, such as national identities (Shayo 2009).

The relative importance of the different channels through which structural economic change can affect political preferences (misattribution or divertion; authoritarian aggression; and social identity) remain unknown. Yet, the three channels point at the possibility that fundamentally economic processes like a changing employment structure can result in changes on noneconomic—or not purely economic—political preferences and identities if economic anxiety and concerns about a shifting status hierarchy is channeled into in-group identification and opposition against a tangible out-group rather than into arguments against abstract structural change related to technological innovation (Gidron and Hall 2017, Rodrik 2018, Kurer 2020).

More research is needed, but overall this stream of work suggests reasons why automation is unique relative to other sources of economic decline: the difficulties at organizing politically around this issue and at connecting problems to solutions. At the individual level, it is not easy for voters to correctly establish what is the contribution of technological change *vis a vis*

other causes of structural change and to discern which policies are more likely to be helpful. At the meso level, political intermediaries such as parties and trade unions may find it difficult to mobilize voters around complex discourses about how technology affects the employment structure and to connect this structural change to specific policies. They may turn to simpler explanations revolving around out-groups instead. These difficulties have important implications -- as wrong diagnoses will likely lead to misguided policy responses.

Taking Stock: What we know and what we need to understand better

It is now reasonably well established that digitalization creates economic losers who are more likely to vote against the political status quo, particularly from the populist right, but it also creates winners with distinct preferences who support the status quo and can even take over some existing political parties. Both processes are likely driving forces of the current political realignments observed across countries, in which right-wing parties are adopting more economically nationalistic policies while left-wing parties are emphasizing tolerance-related issues (Rodden 2019, Colantone and Stanig 2019, Iversen and Soskice 2019). But our reading of the literature is that technological change is not bound to create a large political backlash. Whether this occurs depends on the magnitude of effects, which are still not well understood, and the size of directly affected economic losers, which until now have been a relatively small group numerically, although this may change with the widespread introduction of automation and AI in the aftermath of the covid-19 pandemic.

It is unclear whether citizens at high risk of substitution demand the types of government intervention advocated by economists and policy expers to face this challenge. Citizens' may have difficulties at differentiating between different structural sources of change accurately or they may not like policy solutions which are individually costly for them, such as retraining. In spite of the dominant role of technological change in reshaping labor markets, blame attribution for potential material hardship seems more strongly concerned with international trade or immigration. By implication, political responses to technological change manifest itself indirectly and not so much as a conscious and deliberate reaction to an either benign or detrimental exposure of new technology.

Based on these key insights of the existing literature, we wish to conclude this review by highlighting seven areas in need of deeper attention to arrive at a more encompassing understanding of the politics of workplace automation.

Research Focus 1: Measurement and research design. The existing body of work in political behavior has mostly researched the implications of routineness and robotization, two concepts for which we have available empirical measures, and has relied heavily on cross-sectional surveys and regional data. However, technological change encompasses different and potentially more important aspects, such as artificial intelligence. The field needs innovative approaches to measure the impact of the introduction of specific technologies. The field also does not have a widespread agreement on basic specification issues such as the use of occupational controls. Moreover, economy-wide technological shock-like "treatments" comparable to the China shock for the case of trade are rare or non-existent. Case studies that trace shocks in specific occupations or industries may be useful.

Research Focus 2: Gender, race, generations. Female occupational trajectories in increasingly automated and digitalized labor markets differ systematically from male trajectories but have hardly been studied so far. Little attention has been paid to the experiences of workers from different ethnicities and races. We also suspect that an intergenerational perspective is relevant. The implications of technological change are very different for workers approaching retirement than for new job entrants. Many jobs disappear over generations and workers do not necessarily experience a technology shock within their work career, but the consequences might be felt strongly among the next generation. What happens to middle class children who suddenly see the occupational trajectory of their parents in mid-pay, well-protected routine jobs blocked and either have to succeed in higher education or end up in low-pay and low-prestige jobs in the service sector?

Research Focus 3: Winners of technological change. The field would benefit from a more balanced view at both winners and losers of automation. Initial work has provided evidence that winners in the U.S. and the UK support mainstream parties, but in the UK some winners seem to have shifted to the Conservatives (at least before the Brexit realignment) while in the US they are increasingly a core constituency of the Democrats. The behavior of winners in different political and institutional contexts deserves more attention. Further, differentiation

between the few individuals who have been the disproportionate winners of digitalization, such as successful tech entrepreneurs, from the large number of ordinary winners is relevant.

Research Focus 4: The role of political parties. In spite of all the public attention to the distributive implications of the third and fourth industrial revolutions, political parties have been surprisingly silent on this topic. When party manifestos or political speeches do address automation and digitalization, they tend to focus on abstract labor market opportunities in the future or, much more often, on more tangible issues like digital infrastructure, data protection, or the modernization of administrative processes rather than the potentially disruptive transformation of labor markets. So far, there are no discernible trends as to which party family is willing to claim competence in this important domain. Given the salience of the topic and the considerable size of the socio-structural groups of technology winners and losers – if we can define them as a group in the sociological sense – we cannot rule out that a more active politicization of the distributive implications of technological change might occur at some point and it will be interesting for researchers to systematically study how and by whom this initiative is taken.

Research Focus 5: Perceptions and mechanisms. Much more work on individual perceptions of the upsides and downsides of technological change at the workplace is needed. The mechanisms linking structural change and individual political response are not well-understood. Some initial evidence points at a largely indirect relationship. Voters might experience material change brought about by technology but attribute this experience to other structural factors like international trade or immigration. What are the implications of such misattribution? Does it constitute a barrier to an efficient policy response? And to what extent do political actors systematically (mis)represent this attribution discourse to their benefit?

Research Focus 6: Comparative work. The strong reliance on U.S. labor economics literature might mask important variation and hide potentially powerful political remedies already in place in some countries. There is a need for more explicitly comparative work and comparative theorizing, taking into account underlying variation in the labor market implications of structural change as well as in the institutional setting that may cushion its adverse effects. Differences in education and, particularly, VET regimes should have a more prominent role in this research agenda. In theorizing political responses to technological

change, the findings of the important studies examining distributive implications in the U.S. labor market cannot be blindly applied to other countries and world regions.

Research Focus 7: Policy responses. The debate on efficient and feasible policy responses to accelerating technology-induced labor market transformation is still in its infancy. Existing policy-prescriptive work is very much tied to the classic toolbox of policy responses (minimum wages, unemployment benefits on the passive side, investment in education on the active side). The field would benefit from a more visionary policy typology that does justice to the magnitude of change and reaches beyond the existing set of standard responses. The ideal response to tech change is far from agreed upon. Transformative change needs transformative ideas for the welfare state, including pre-distribution, new types of taxation, and concrete ideas for the practical implementation of "life-long learning".

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