

# Shrinking and shouting: the political revolt of the declining middle in times of employment polarization

Research and Politics  
January-March 2019: 1–6  
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sagepub.com/journals-permissions  
DOI: 10.1177/2053168019831164  
journals.sagepub.com/home/rap



Thomas Kurer<sup>1</sup> and Bruno Palier<sup>2</sup>

## Abstract

Automation, digitalization and smart software fundamentally reshape the employment structure of post-industrial societies. The share of routine jobs is constantly shrinking while non-routine jobs at both ends of the skill distribution tend to grow. We contend that the existing political science literature has not sufficiently connected the distributive implications of technological change with contemporary political disruptions. The fact that disadvantages are strongly concentrated among blue- and white-collar routine workers in the lower middle class is of crucial importance. Routine workers are a large and electorally relevant group with all the necessary means for political participation. Increasingly bleak prospects in the labor markets of tomorrow create a demand for social, cultural, and economic protectionism. Socially conservative parties in general and right-wing populist parties in particular have recognized the electoral potential of disaffected routine workers and skillfully address and acknowledge their anxieties. We conclude that a lower middle class no longer protected from the vagaries of economic modernization is a potential electoral game changer.

## Keywords

Technological change, employment polarization, middle class, routine work, radical right, populism, digitalization

Technological change profoundly transforms the world of work and creates substantial uncertainty about workers' fortunes in the labor markets of tomorrow. This paper argues that the very particular distributive consequences of technological change have considerable political implications. In contrast to other structural economic developments like deindustrialization or globalization that have been shown to primarily hit the lowest skilled workers, the adverse effects of new technologies first and foremost affect routine workers in the middle of the earnings- and skill distribution. Employment polarization puts unprecedented strain on a politically relevant part of society that has long benefited from economic stability and the prospect of upward mobility: the lower middle class. In this paper, as well as in the whole special issue, we contend that this "shrinking and shouting" middle is a core driver behind the political turmoil observed in many post-industrial societies.

## A lack of analysis of the political consequences of technological change

The current debate about the future of work features quite distinct perspectives on the labor market of tomorrow. While

tech optimists point to a long history of misdirected fears of "the end of work" and technological unemployment, pessimists argue that historical evidence is of limited value because the pace of innovation is unprecedented with advances in technology affecting jobs more brutally than ever before. We take as a point of departure what might be the smallest common denominator between both perspectives: at least temporarily, automation and digitalization create a period of major adjustment and displacement on labor markets. New jobs emerge and old jobs disappear, what separates optimists from pessimists is their perception of how well, how smoothly and how quickly societies get over this period of transition (Kessler, 2017). Yet, we contend that such a period of profound economic adjustment creates

<sup>1</sup>Weatherhead Center for International Affairs, Harvard University, Cambridge, USA

<sup>2</sup>Centre d'études européennes et de politique comparée, Laboratory for interdisciplinary Evaluation of Public Policy, CNRS, Sciences Po, Paris, France

### Corresponding author:

Thomas Kurer, Weatherhead Center for International Affairs, Harvard University, 1737 Cambridge St, Cambridge MA, USA.  
Email: tkurer@wcfia.harvard.edu



politically relevant grievances no matter whether the optimistic or pessimistic tale will prevail in the long-term.

Rapid advances in automation and computerization push us into a new era where many existing skills and competencies become increasingly redundant. Evidence shows that technology is the most important driving force behind current changing employment structure and tends to outperform international trade as an explanation of the rise in inequality and job polarization observed in recent years (Autor, 2015; Goos et al., 2014). However, while a broad literature examines political implications of other recent economic transformations such as globalization and international trade (Autor et al., 2016; Colantone and Stanig, 2018; Margalit, 2011), empirical evidence on the political consequences of technological change is relatively scarce (notable exceptions are Thewissen and Rueda, 2017; Frey et al., 2018).

There are comprehensible reasons for a lack of an explicit discussion of the political consequences of technological change among politicians and political scientists alike. For politicians and governments, discussing workplace automation is an unrewarding task because the remedies against its adverse effects are not obvious. In contrast to immigration or trade, for which walls and tariffs provide intuitive or at least media-effective answers, the political response to technological progress is tricky. Technological change only gradually alters the employment structure. Jobs are eliminated over a long period of time, usually without highly visible events like a plant closing that lend themselves for a headline or tweet (Davenport, 2017). Furthermore, straightforward policy reactions seem in direct conflict with governments' economic goals of growth and rising productivity. For example, the recently debated tax on robots is associated with a fairly hostile attitude toward innovation and business. This makes government parties rather unlikely advocates of such policies. As Davenport (2017) writes: "[A]utomation usually comes with corporate investment rather than cutbacks. [...] Who wants to criticize that?" Without the capacity to offer comprehensive solutions, political actors might prefer not to confront the issue all too actively.

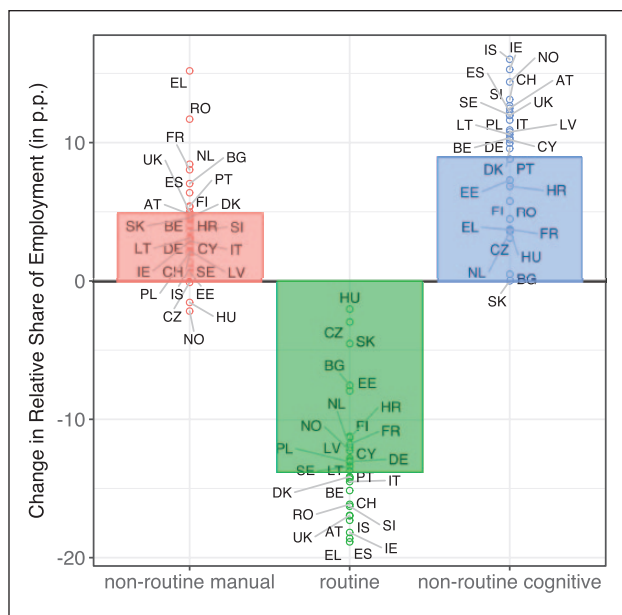
The gradual nature of technology-induced occupational change and the complexity of its underlying distributive processes also hamper scientific analyses of political repercussions. Employment polarization happens slowly over cohorts or even generations (Cortes, 2016; Kurer and Gallego, 2019). This implies that a systematic analysis of the political consequences of technological change needs to very carefully examine the actual occupational transitions that underlie the aggregate pattern of employment polarization. While "import shocks" from international trade have attractive properties for the empirical identification of economic (Autor et al., 2013) and political outcomes (Colantone and Stanig, 2018), the slow but momentous impact of technological change is more difficult to capture.

If jobs are gradually eliminated over time and a significant proportion of affected workers manages to "survive" in an occupational environment of structural decline, the usual measures of economic hardship might not suffice to capture grievances among the disadvantaged (Kurer, 2017). The study of the political consequences of technological change thus demands innovation and precision on both the conceptual and the empirical front, which might explain the scarcity of existing work on the subject.

## Distributional implications of job polarization

We argue that political scientists should have a keen interest in the under-explored relationship between technological change and the political turmoil that has recently disrupted many post-industrial democracies. We do *not* believe that Brexit, Trump, or the alarming success of radical right parties in almost all European countries should be interpreted as mere "electoral accidents." Instead, we suggest that the current destructuring of political systems is connected to the profound transformation of labor markets in times of automation. Our core argument is that the specific distributive effects of current technological innovations are key to understanding their political implications: while other structural transformations, first of all globalization, primarily hit low-skilled workers, the adverse consequences of technological change strike right in the middle of society.

The literature on the distributional implications of globalization emphasizes that in advanced economies, exporting capital-intensive goods, low-skilled workers are "unambiguously worse off" as a result of trade liberalization (Rodrik, 2018; see also, e.g., Conconi et al., 2018). In contrast, studying the distributive implications of technological innovation, Autor et al. (2003) established that computers are particularly powerful in replacing routine jobs characterized by tasks that follow explicit, clearly defined rules. At the same time, non-routine jobs, even those with limited skill requirements, are complemented rather than substituted by new technology. The disadvantages of new technologies at the workplace are thus strongly concentrated among middle-skilled routine workers (both in the manufacturing and service sectors) who prove susceptible to automation. In its pure form, this pattern of routine-biased technological change results in employment polarization, characterized by a strong decline in routine jobs and growing opportunities in non-routine jobs at both ends of the skill- and earnings distribution. Figure 1 shows relative changes in employment since the 1990s. For country-specific patterns, see Figure 1 in the Supplemental Material. Distinct institutional set-ups obviously create different shapes of the employment structure, leading to more or less pronounced patterns of polarization (Fernandez-Macias,



**Figure 1.** Relative changes in the employment structure across Europe.

Note: Country-specific changes are share of labor force in 2017 minus share in first available year (varying, most countries between 1992 and 1998, BG = 2000, HR = 2002). Task groups are classified based on ISCO-1d codes. Non-routine manual = Service and Sales Workers; Elementary Occupations. Routine = Clerical Support Workers; Skilled Agricultural, Forestry and Fishery Workers; Craft and Related Trade Workers; Plant and Machine Operators and Assemblers. Non-Routine Cognitive = Managers; Professionals; Technicians and Associate Professionals. Bars are population-weighted average changes across countries. Data source: Eurostat.

2012; Peugny, 2019). However, the “hollowing of the middle” is strikingly consistent all across Europe. Therefore, even if we do not observe perfectly balanced growth in both kinds of non-routine work, we think that polarization is an appropriate term to describe recent trends in post-industrial labor markets.

### Job polarization as driver of economic, social and political change

From a political science perspective, this disproportionate strain on routine workers is of crucial importance. Technology-induced employment polarization does not only affect mid-skilled blue-collar routine jobs in production, e.g., machine operators, but also seriously threatens many routine jobs in back offices and administration, e.g., secretaries or bank tellers (Peugny, 2019). Such white-collar occupations have faced much less pressure from international trade and offshoring. A large part of routine jobs are occupations “at the fringes of the lower-middle class” that require certain skills and training, used to secure middle-range wages and thus provided for a relatively comfortable standard of living (Oesch, 2015). But in the face of rapid technological change, the experience of “collective

ascend” (Mau, 2015) for the lower middle class increasingly appears as a thing of the past.

Automation and digitalization jeopardize upward mobility for moderately skilled routine workers. Peugny (2019) shows that expanding occupations in the lower skilled (service) sector, evident alternatives in the face of shrinking opportunities in routine work, are on average not only low-pay jobs but also low-quality jobs: precarious working conditions are widespread in non-routine manual or interpersonal work. Furthermore, technological change tends to complicate trade union organization (Meyer and Biegert, 2019). Increasingly bleak prospects in mid-skilled routine jobs in combination with even less attractive alternatives highlight the delicate situation of the lower middle class in times of automation.

That said, while *fears* of falling down the social scale are certainly well-founded, many routine workers actually manage to avoid the *experience* of economic hardship. Routine work often disappears through “natural turnover,” that is lower entry and higher exit rates, and only a minority effectively ends up unemployed (Cortes, 2016). Although “survivors” in routine work face economic stagnation compared with highly skilled and highly specialized non-routine workers who benefit from technological complementaries (Kurer and Gallego, 2019), they have and keep the traits of (former) labor market insiders with salaries above the lowest ones and with permanent job contracts. This aspect makes political repercussions highly likely. Routine workers are a large and electorally relevant group with the capacity to actively voice dissatisfaction in the political arena. A lower middle class no longer protected from the vagaries of economic modernization and in fear of losing its acquired position in society is a potential electoral game changer.

We contend that the existing political science literature has not sufficiently and systematically connected the distributive implications of technological change with contemporary changes in the political landscapes of many advanced capitalist democracies. Standard approaches to examine political reactions to structural economic transformations are likely to fall short of providing encompassing answers given the unusual position of the losers in the (lower) middle. Although threatened by work automation, the large majority of routine workers is doing relatively well in absolute terms and does not suffer from poverty or acute economic hardship. A focus on the usual indicators of economic disadvantage, e.g., low income, unemployment, or precarious working conditions, will not fully capture routine workers’ grievances. For example, the most influential strand of research on political reactions to economic risk in recent years, the dualization literature (Emmenegger et al., 2012; Rueda, 2005), is not well-suited to analyze the fate of routine workers since it emphasizes the problems of labor market outsiders without analyzing the fears of the lower middle class (i.e., the fear of *becoming* an outsider).

In order to detect political reactions to technological change, we need more fine-grained measures of economic insecurity among precisely defined groups.

### Mechanisms linking job polarization and political behavior

The relative economic decline of historically dominant core groups is a likely source of discontent and insecurity and a nascent literature has linked these perceptions to an increased demand for social conservatism in the political arena. Two recent studies focusing on the economic roots of authoritarian and socially conservative preferences, respectively, provide an explicit theoretical discussion of the underlying mechanisms based either on a negative change in social identity or a sense of a loss of control (Ballard-Rosa et al., 2018; De Vries et al., 2018). In a similar vein, a relatively novel literature on demand-side factors of right-wing populist parties emphasizes the role of societal pessimism and nostalgia among losers of economic modernization (Gest et al., 2017; Steenvoorden and Harteveld, 2018). What both types of argument have in common is the emphasis on a gradual shift in relative societal position that creates a specific perception of insecurity and loss of control, which can even emerge in the absence of absolute material hardship. As a consequence, we might not observe the strongest political reaction among the hardest-hit but rather among those who are most concerned about their economic well-being and future prospects in the labor market (Im et al., 2019; Kurer, 2017). The recent rise of the “*gilet jaune*” movement in France is an apt illustration of our argument since most protesters do have jobs but are increasingly concerned about making ends meet.

The emphasis on relatively subtle mechanisms in routine workers’ perceived position in the social hierarchy has two important implications. First, the observed political disruptions are hardly a sudden and conscious revolt against automation. Rather, the demand for socially conservative parties is a consequence of a gradual change in preferences and later electoral decision-making. Second, and directly related, such a more subtle process implies that the political outcomes we are interested in are not uniquely caused by technological change. Such a mono-causal explanation is certainly at odds with the multifaceted drivers of voters’ economic fortune and perceptions thereof. However, while perhaps not the *only* driver, we contend that technological change is a *main* driver behind economic and social polarization and the demise of the lower middle class, which itself is feeding political turmoil.

The most recent literature has become increasingly skeptical toward an overly simple narrative emphasizing direct effects of material disadvantage and economic hardship (e.g., Antonucci et al., 2017; Gidron and Hall, 2017; Mutz, 2018). For example, Antonucci et al. show on the basis of the British Election Study that the typical Leave

voter does not fit the image of an angry, unskilled and perhaps even unemployed outsider. Rather, voting Leave is associated with intermediate classes who suffer from a perceived decline in their economic position.

This description very much resembles our understanding of routine occupations: moderately skilled but increasingly less valued work with rather bleak prospects in labor markets due to susceptibility to automation. Based on comparative survey data, Im et al. (2019) confirm the conjecture that the endangered prospect of social upward mobility among routine workers is a powerful driver of political behavior, and they provide empirical evidence for one of the guiding hypotheses of this special issue: the risk of automation is positively related to support for social conservatism. Given that structural transformations in the economy create uncertainty, which in turn increases the demand for socially conservative policies, the mainstream right as well as the (populist) radical right might appeal to losers of automation. However, we expect that right-wing populist parties are more successful in this endeavor. According to expert surveys, in most cases their actual position on social conservatism is more pronounced than the one of mainstream right parties. In addition, they very often have the benefit of the newcomer who has not been part of the machine, which after all is (made) responsible for the state of the matters. By implication, we would expect mainstream right parties’ attempts to mobilize said constituency to remain relatively unsuccessful in the presence of a more radical competitor on the right. This reasoning is indeed confirmed by existing empirical work, including one of the contributions to the special issue (Burgoon et al., 2018; Im et al., 2019; Kurer, 2017).

Political actors promoting socially conservative platforms have identified the still significantly large group of routine workers as electorally relevant and actively seek to gain their support at the ballot box. Anecdotal evidence is abundant. Donald Trump carried Rust Belt states on the promise of reviving industries and ending job loss and population stagnation. Theresa May rallied so-called Jams (“just about managing”), i.e., hardworking but financially struggling families just not poor enough to profit from welfare state benefits. In addition, Nicolas Sarkozy in 2007 called upon the French population “who gets up early” in order to work more and earn more.<sup>1</sup> What these calls have in common is the explicit reference to “honest work.” They are not about increasing welfare benefits to cushion economic vulnerability but about appreciating the value of ordinary work (Lamont, 2000). We believe that this appeal to personal dignity is key to winning routine workers’ support. Perhaps even more than social protection, they demand economic and cultural protection. They feel attracted by promises to re-establish the values of a bygone era of a more homogenous demography, more rigid hierarchies and an economic system that protects domestic workers (Gest et al., 2017). An exclusive understanding of the

nation state and citizenship, which often figures prominently on the right-wing populist agenda, certainly adds decisively to their success.

An important implication of the central role of dignity and social status in routine workers' election calculus is that political contestation tends to be skewed in favor of political challengers or newcomers. It is far from obvious which concrete policy response could mitigate the perceived decay of traditional values and the declining esteem of ordinary work. If routine workers' grievances are not primarily about material concerns, expanding social security will be an ineffective remedy and mainstream parties will have a hard time satisfying routine workers' demands. Indeed, Gingrich (2019) provides sobering evidence on mainstream parties' limited leeway to compensate the losers of economic modernization. As expected, welfare retrenchment is electorally harmful and benefits right-wing populist mobilization. However, the reverse mechanism (more spending, less populism) is not borne out by the data – despite demonstrably positive effects on individual welfare. This finding highlights the strategic disadvantage of responsible mainstream parties in competition with challenger parties that thrive on a less policy-based, less programmatic appearance, which makes it much easier to appeal to the subtle, perhaps slightly diffuse fears and demands of those fearing the negative consequences of technological change.

## Conclusion

The political disruptions we currently observe around the world are a likely expression of fears revolving around workplace automation and economic modernization. In contrast to what could be expected in the first place, the pendulum has not swung back to the left. Instead, right-wing populist parties' promises to turn back the clock seem to strike a chord with routine workers' fears of social regression. More than the mainstream left and in fact more than any other party, political actors rooted in far-right challenger parties (or movements) have recognized the political relevance of a disaffected lower middle class. They explicitly acknowledge and address the widespread anxieties among the shrinking middle and thereby gain their support – despite the virtual absence of concrete policy remedies.

As a final note, we wish to emphasize that a sole focus on the (shrinking) group of losers would certainly not paint an encompassing picture of the political consequences of technological change. While it is important and normatively imperative to study the more concerning aspects of a changing employment structure, we do not want to gloss over the substantial part of the population that benefits from new technologies and the rise of knowledge economies (Gallego et al., 2018; Iversen and Soskice, 2019). On the one hand, we have discussed the structural roots of

electorally consequential anxieties, suggesting that the demand for socially conservative policies and support for right-wing populist parties is likely to become a constant feature of post-industrial democracies. On the other hand, significant other parts of society do not share these gloomy prospects and have good reasons to continuously support the existing mainstream parties and democratic institutions. In that sense, the prospects for post-industrial societies in the medium term might rather be characterized by increased political polarization than by a steady deterioration of political norms.

## Acknowledgements

We are grateful to the participants of two workshops at Sciences Po, the anonymous reviewers and the editors of *Research & Politics* for helpful comments and feedback.

## Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

## Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This work has been supported by a public grant overseen by the French National Research Agency (ANR) as part of the “Investissements d’Avenir” program LIEPP (ANR-11-LABX-0091, ANR-11-IDEX-0005-02).

## Note

1. According to the above logic, however, we would expect the latter two attempts of mainstream right parties to attract working class voters to be electorally unsuccessful due to the presence of an arguably more credible competitor from the far right.

## ORCID iD

Thomas Kurer  <https://orcid.org/0000-0003-2339-6282>

## Supplemental materials

The supplemental files are available at <http://journals.sagepub.com/doi/suppl/10.1177/2053168019831164>

The replication files are available at <https://dataverse.harvard.edu/dataset.xhtml?persistentId=doi:10.7910/DVN/QDHGCI>

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# The decline in middle-skilled employment in 12 European countries: New evidence for job polarisation

Research and Politics  
January-March 2019: 1–7  
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[sagepub.com/journals-permissions](http://sagepub.com/journals-permissions)  
DOI: 10.1177/2053168018823131  
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Camille Peugny

## Abstract

Is the middle class shrinking? This article contributes to the debate on job polarisation in Europe. Based on data from the European Union Labour Force Survey (EU-LFS) and looking at 12 European countries, it shows that there is an evident trend towards job polarisation. While this polarisation takes various forms, it is clearly the highest- and lowest-skilled jobs that have increased most rapidly among the active population over the past 20 years, to the detriment of middle-skilled jobs. The article then goes on to demonstrate that polarisation also exists when it comes to working conditions insofar as the lowest-skilled jobs are also where the most precarious employment conditions are found. Conversely, the remaining middle-skilled jobs are relatively shielded from this decline in working conditions.

## Keywords

Social stratification, polarisation, inequalities, working conditions, middle classes

Since the early 2000s, a substantial body of literature has focused on the issue of the polarisation of social structures in western countries. While the proportion of highest-skilled jobs has risen considerably over the last few decades, several empirical investigations have shown that this is not the only pattern in play and that the proportion of the lowest-skilled jobs also seems to have risen. This result was first shown in the USA (Autor et al., 2003, 2008; Wright and Dwyer, 2003) and the UK, before being extended to the rest of continental Europe (Goos et al., 2009). Insofar as these studies also highlight a decline in jobs in the middle of the skills structure, they conclude that employment structure in the western world is becoming increasingly polarised, essentially in connection with the effects of technological change (Goos et al., 2014).

However, this conclusion has not met with overall consensus. With the same data, Fernandez-Macias obtains very different results by using more detailed job classifications. He distinguishes between three patterns of change in employment structure in Europe (Fernandez-Macias, 2012). The main issue that has sparked controversy and led to different conclusions has been the changes affecting middle-skilled employment: to what extent has its proportion declined? Put differently, is the core of the middle class being eroded? This question of the shrinking middle class has been subject to much debate since the mid-2000s

(Alderson et al., 2005; Atkinson and Brandolini, 2013; Pressman, 2007).

This article aims to contribute to this debate by analysing the evolution of job structure in 12 European countries over the last 20 years and asking two questions. First, to what extent are we witnessing a significant decline in the proportion of middle-skilled jobs and a rise in low-skilled jobs? Second, beyond quantitative changes in the proportion of workers in different categories of employment, what changes can we see in job quality among the fast-spreading jobs in the lower fractions of the social structure? In other words, are we also witnessing a general polarisation of working conditions? This question is important insofar as it sheds light on the trajectory of the lower fractions of the middle classes, destabilised by the erosion of middle-skilled employment, and raises the question as to whether they are doomed to being downgraded to precarious and badly paid jobs.

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Printemps Research Group, University of Versailles Saint-Quentin-en-Yvelines, Versailles, France

## Corresponding author:

Camille Peugny, University of Versailles Saint-Quentin-en-Yvelines, 47 Boulevard Vauban, Guyancourt 78280, France.  
Email: [camille.peugny@uvsq.fr](mailto:camille.peugny@uvsq.fr)



Analysing the polarisation of job structure by taking employment conditions into account breaks with prevailing methodological choices in this field. Irrespective of their results, the studies cited above analysing changes in employment structure all take an approach that measures job quality solely by wage.

Wage is an important indicator of the quality of a job and its ranking in the social structure. However, two criticisms can still be levied against these studies. First, they are based on a questionable methodological choice insofar as they take into account hourly wage, which fails to account for the expansion of the most unskilled and precarious employment. In such jobs, insufficient working hours can be a central feature of employees' working conditions. Consequently, hourly wage fails to account for the reality of changes in social structure: due to the fragmentation of labour, many employees in the most unskilled jobs are poor workers. It is therefore essential to take into account working hours as a parameter.

Furthermore, in order properly to describe job quality, factors other than wage must also be taken into consideration. In countries that have set a minimum wage, this salary can apply to a large range of jobs that nevertheless belong to very different sectors and, once again, involve very different working conditions.

In order to address these two criticisms levied against studies taking hourly wage as sole indicator of job quality, I suggest introducing two new factors. First, an approach in terms of socio-professional categories aimed at showing changes in the proportion of jobs in different employment categories. Socio-professional classifications are imperfect tools, but they do afford a finer-grained approach to job quality than one solely based on salary. The European Socio-economic Groups Classification (ESeG) distinguishes between jobs according to level of skill and sector of activity, thereby making it possible to better describe the types of job that are in expansion. Second, in order to take into account insufficient working hours in certain jobs, I also use the proportion of involuntary part-time employment to better describe job quality in the lower fractions of the social structure.

After outlining the data and methodology, I will show three forms of job polarisation in Europe that go hand-in-hand with a fairly evident decline in middle-skilled employment. I will then, however, show that the remaining middle-skilled jobs are relatively protected from the instability and fragmentation of employment that particularly affects the least-skilled fractions of the service sector.

## Data and methodology

The present study draws on data from the European Union Labour Force Survey (EU-LFS). This data set makes it possible to describe the main changes that have affected job structure in around 12 countries between 1993 and 2013.

Several arguments suggest that there has been a certain homogenisation of social structures among western countries over recent decades (global trade and the concomitant alignment of economic policies, technological change). However, we also know that these overall trends should not prevent us from observing potential national specificities linked, in particular, to the welfare regime in place (Esping-Andersen, 1990). The latter influences the rate of growth in the service sector but also employment structure and the ethno-racial and gendered division of labour. Where the service sector is concerned, recent figures provided by Oesch show that expansion of the lowest-skilled jobs in the service sector is connected to the type of welfare regime in place (Oesch, 2015).

In this study, I recreate the groups of the ESeG classification based on the labels of professions coded in the International Standard Classification of Occupations (ISCO).<sup>1</sup> This classification is the result of two decades of debate at a European level (Filhon et al., 2013). At its most aggregated level, the ESeG project posits seven groups for the actively employed: managers, professionals, technicians and associated professional employees, clerks and skilled service employees, industrial skilled employees, and less-skilled employees (in agriculture, industry, or the service sector). In this study, I use a more detailed level of the ESeG classification that distinguishes between clerks and skilled service employees (Amar et al., 2014).

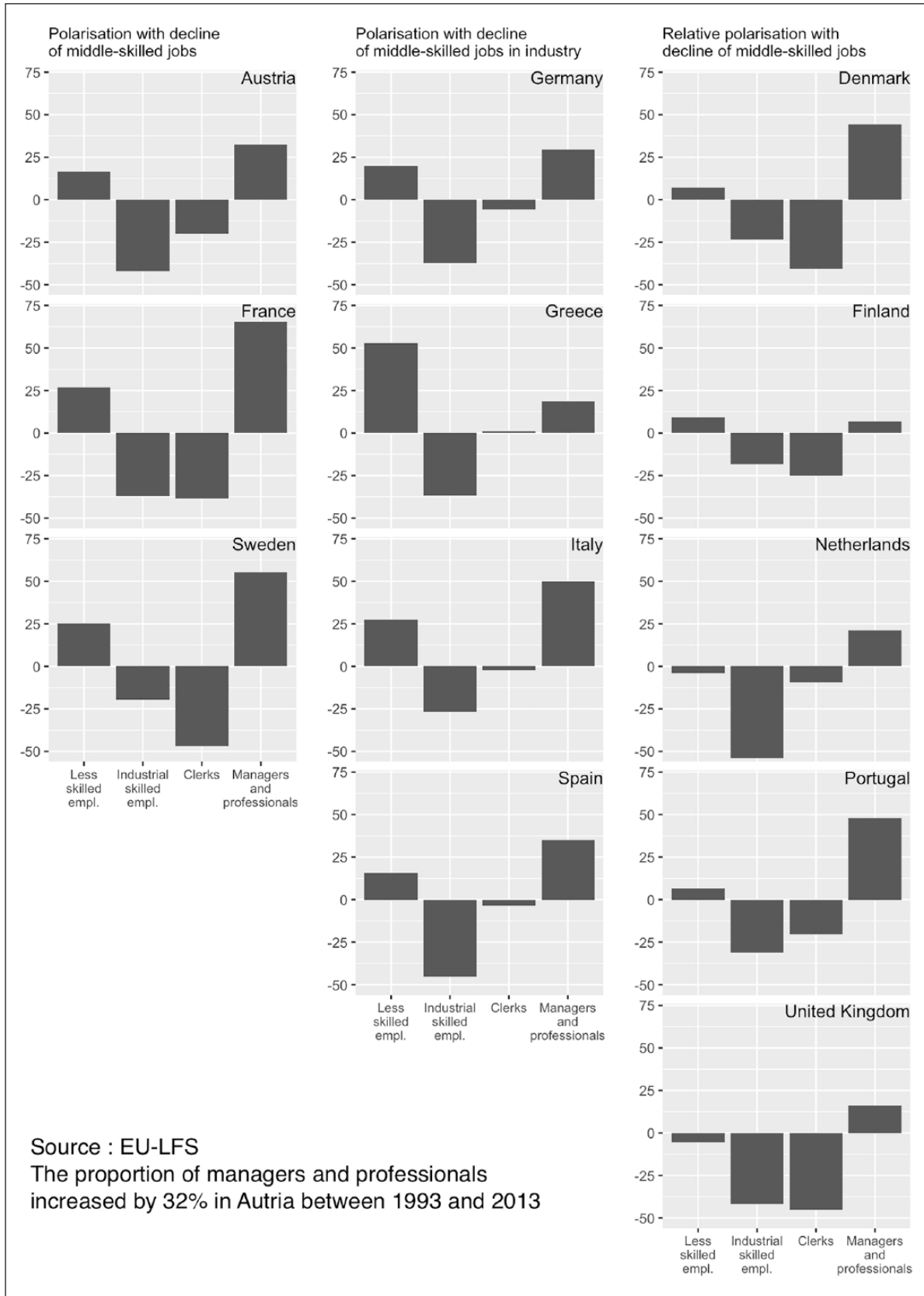
In the second section of this article, I use the proportion of workers in involuntary part-time jobs as an indicator to describe working conditions at the bottom of the social structure. The EU-LFS data set provides information about working time as well as the reasons for part-time work (person still undergoing training, for personal health reasons, need/choice to look after children or incapacitated adult, person could not find a full-time job, other personal reasons). It is therefore possible to calculate the proportion of part-time workers in each group of occupations who state they were unable to find a full-time job or contract.

## The erosion of middle-skilled employment: Patterns of change in European social structures

Here I present changes in share of the workforce for four groups of the ESeG classification:<sup>2</sup> the high-skilled jobs of managers and professionals, the less-skilled jobs, and two middle-skilled categories, namely less-skilled industrial employees and clerical workers in administration and the service sector (Figure 1).

The results allow three groups of countries to be distinguished. In France, Sweden and Austria, polarisation is particularly strong. Four trends can be seen in these countries: (a) an increase in the proportion of highest-skilled jobs (managers and professionals); (b) an increase in the proportion of less-skilled employees; (c) a decline in the





**Figure I.** Three patterns of change in European social structures.

proportion of industrial skilled employees; and (d) a decline in middle-skilled clerks' jobs. In these three countries, polarisation is not just about the concomitant rise in the proportion of the highest- and lowest-skilled jobs, it has also resulted in a significant decline in the proportion of middle-skilled jobs over the past two decades.

A second group of countries comprising Spain, Italy, Greece and Germany has also seen a form of polarisation insofar as there has been an increase in the proportion of the highest- and lowest-skilled jobs. However, while these countries have also seen the fraction of industrial skilled employees decrease, the same is not true of clerks. In other words, in absolute terms, there has been no significant erosion of the share of middle-skilled jobs across all sectors of activity. In relative terms, however, the latter is indisputable.

Finland, Denmark, Portugal, the UK and the Netherlands form a third group of countries in which polarisation takes a less obvious form, insofar as the proportion of less-skilled employees seems relatively stable. However, these countries are facing a decline in the proportion of middle-skilled jobs. For these countries, it all therefore depends on how one chooses to define polarisation: the fact that middle-skilled jobs in industry and administration are in decline, whereas the proportion of less-skilled employees remains stable, could be seen as indicating a more moderate form of polarisation or, put differently, 'relative polarisation'.

What conclusions can be drawn from this quick overview? Seven of the 12 countries in question are facing a very clear trend toward polarisation of social structure and particularly an increase in the proportion of the lowest-skilled and most precarious jobs, largely in the service sector. Moreover, my results show a fairly clear trend towards a decline in middle-skilled employment. In industry, this has decreased sharply in all countries. In administration and bureaucracies, it has declined in eight countries. These results are congruent with those obtained recently by Cirillo. Based on different data but taking an approach through socio-professional categories, she demonstrates a fairly clear trend towards job polarisation while also emphasising the need to take into account sector of activity (Cirillo, 2018).

Is this enough to allow us to talk about a shrinking middle class, more generally? These middle-skilled jobs in industry or the service sector in fact correspond to the lower fractions of the middle class. Conversely, technicians and associated professional employees – who constitute the core, or perhaps even the higher fractions, of the middle classes, with higher levels of income and qualifications – are increasing in proportion across all countries. With the decline in jobs at the interface of the upper working classes and lower middle classes, the middle classes are being undermined from the bottom up. Nevertheless, there are variations between national contexts. Some countries are not experiencing any clear decrease in administrative jobs

and others, where the latter are in decline, have not experienced any real polarisation insofar as there has been no significant increase in the least-skilled jobs.

In order to account for changes in social structures and look beyond common trends (i.e. the decreased proportion of industrial workers and increased proportion of highest-skilled employees), several factors must be taken into consideration, and first and foremost public policies that shape the effects of technological change. The unequal decline in the proportion of administrative employees is partly linked to differences in structure according to sector of activity: in Germany, 25% of administrative workers are employed in industry as opposed to 14% in France, according to the EU-LFS data set. Differing rates in the penetration of new technologies is probably also a factor. However, where public administration is concerned, it is important to also look to the effects of differences in the time frames of administrative reform. Similarly, differences in the increase rate for the proportion of 'lowest-skilled' occupations can be linked to a certain number of public policies that affect job expansion in certain types of services, for example, in the sector of interpersonal services, where states can either encourage the creation of these jobs or not, particularly on a fiscal level (Carbonnier and Morel, 2015; Morel, 2015).

Approaching this issue through broad occupational categories makes it possible to describe an initial form of polarisation, highlighting an increase in the proportion of less-skilled employees in seven countries and a consistent decline in middle-skilled job across most countries. It is nevertheless necessary to go beyond simply describing general changes in different job categories. To complete this study of the dynamics of employment structure in Europe, it is important to focus on the issue of working conditions. Are we witnessing a general trend towards the polarisation of working conditions? Above and beyond the erosion of a large number of middle-skilled jobs, is there also a trend towards more precarious conditions for workers who manage to retain these kinds of jobs?

### **The polarisation of working conditions: Are the remaining middle classes being spared?**

By using a more detailed level of the ESeG classification, it is possible to take involuntary part-time employment as an indicator of job quality (Table 1).

First, in 2013, in all countries, the highest proportion of involuntary part-time work is found among the less-skilled employees, ranging from 11% in Austria to 40% in Italy. Second, and in comparison, the proportion of involuntary part-time work is much lower among clerks (ranging from 3% in Portugal to 13% in Sweden) and among skilled industrial employees (ranging from 1% in Austria, Denmark and Portugal to 6% in Greece). This result underscores the fact that the middle-skilled jobs that do remain

**Table 1.** Proportion of involuntary part-time jobs in 2013.

	Clerks	Sales workers	Skilled service employees	Less- skilled service employees	Skilled industrial employees	Labourers	Agricultural labourers	All employees	Technicians and associated professional employees	Managers and professionals
<b>Austria</b>	3.5	6.9	6.3	11.3	1.4	3.6	5.1	3.8	2.4	2.4
<b>Germany</b>	4	12.6	10	19.7	2.9	9.1	10.1	5.5	3.0	1.9
<b>Denmark</b>	7.2	6.6	15	12.6	1.8	4.9	4.4	6.1	3.5	4.2
<b>Spain</b>	6.9	16.5	15.5	35.9	3.7	12.9	8.2	11.8	4.8	5
<b>Finland</b>	5	16.7	8.6	13.8	3.3	8.5	7.5	4.5	2.5	2
<b>France</b>	8	17.3	12.6	30.7	3.5	7.2	11	9	4.7	3.5
<b>Greece</b>	4.4	11.3	5.2	22.3	5.9	7.7	11.8	7.3	3.2	3.9
<b>Italy</b>	10.8	27.1	20.4	40	4.8	7.2	14.4	12.6	5.1	4.9
<b>Netherlands</b>	6.5	8.8	10.6	12.7	5.5	8.5	4.9	6	5.6	3.8
<b>Portugal</b>	3	9.4	2.5	17.7	1.7	6.9	10.7	5.7	1.7	3.1
<b>Sweden</b>	13.5	28	22.2	23.8	3.8	12.8	9.5	10.4	5.4	5.1
<b>United Kingdom</b>	5.3	15.3	7.3	17.5	3	7.7	5	5.3	2.8	1.8

are relatively well protected when it comes to working conditions and are fairly comparable, in this regard, to professionals and managers, as well as technicians and associated professional employees. It is clear that the deterioration of working conditions first and foremost affects the least-skilled employees in the service sector.

In this regard, the second observation is that there is a division in most countries between the more-skilled employees in the service sector and their less-skilled counterparts,<sup>3</sup> as the proportion of involuntary part-time work is significantly higher among the latter. Two Scandinavian countries present a notable exception: in Denmark and in Sweden, the two proportions are comparable. In the Netherlands, the discrepancy between the two is not considerable and the same is true, to a lesser extent, of Finland. Conversely, it should be noted that this divide is particularly significant in France and countries in southern Europe where the discrepancy between skilled and unskilled work in the service sector is particularly pronounced.

The third observation is that the proportion of involuntary part-time employment is at its highest among the lowest-skilled service employees in Italy, Spain and France: 40%, 36% and 31% respectively. The proportion of service sector employees within the active population is particularly high in Spain and France and increased sharply in Spain between 1993 and 2013 (Bernardi and Garrido, 2007).

Fourth observation, it would seem that the proportion of involuntary part-time jobs is higher in southern European countries and lower in northern European countries. However, this link is not automatic, as Sweden has a high proportion (24%) and Portugal a relatively low proportion (18%). Within these results, France clearly falls among the southern European countries, whereas Germany (20%) and

the UK (18%) are in an intermediate position. These results should be considered in light of public employment policy. In France, the 2005 Borloo law relating to the interpersonal service sector aimed to double the number of employees through a policy reducing employer costs and making employment conditions more flexible. Conversely, in Finland the sector has historically been run by local authorities: most workers are state-employed workers covered by collective agreements that afford them much greater protection (Kröger, 2011).

Finally, while the proportion of involuntary part-time employment in the service sector differs quite considerably according to country, these employees' working conditions are far more similar than those of managers or experts. Whatever the country, the proportion of managers or experts facing involuntary part-time work is lower than 5%. This means that the polarisation of working conditions is particularly stark in countries where the proportion of involuntary part-time work is high among low-skilled service employees. In Spain and France, for example, the greatest rise in employment share has been, on the one hand, in managerial and professional jobs and, on the other, among low-skilled service sector employees – in other words, the jobs that are the most protected from labour fragmentation and the jobs that have been most affected by this.

## Conclusions

By describing three patterns of change in employment structure in Europe, my results underline the decline in the proportion of middle-skilled jobs in most of the countries. The proportion of skilled industrial workers has decreased in all countries, whereas the proportion of administrative employees has seen considerable erosion

in eight of the 12 countries. These changes are a sign of the undermining of the lower fractions of the middle classes. However, the remaining jobs in these sectors are relatively protected from the deteriorating working conditions and increasingly precarious employment affecting the least-skilled jobs in the service sector. The jobs that remain in this area of middle-skilled employment continue to offer relatively good employment market participation. One question does remain, however, that would require individual and longitudinal data to answer: what has happened to the millions of employees in Europe who have lost their jobs as skilled labourers or clerical staff? Have they increased the competition for less-skilled and less-stable jobs, therefore fuelling a massive flow of occupational downgrading with potentially major social and political consequences?

These results also make progress in analysing the factors that explain European employment patterns. The fact that change has not followed one single pattern shows that technological change is far from the only factor to take into account when it comes to explaining the evolution of social structures; institutions and public policy should also be taken into account (Fernandez-Macias and Hurley, 2017). In each country, patterns of change in employment sectors and working conditions are also the result of political choices and power relations between social actors.

This also means that type of welfare regime should be taken into account, even though traditional classifications do not provide a perfectly adjusted interpretative grid for this. The differences observed between northern and southern European countries are particularly enlightening in this respect. With the exception of Sweden, countries in the North seem to have contrived to contain the expansion of the lowest-skilled jobs and to avoid the decline in working conditions of people in such employment. This is not the case for countries in the South, where the increase in the proportion of the lowest-skilled jobs has gone hand-in-hand with the fragmentation of labour and ever more precarious working conditions.

### Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

### Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

### Supplemental materials

The supplemental files are available at <http://journals.sagepub.com/doi/suppl/10.1177/2053168018823131>.

The replication files are available at <https://dataverse.harvard.edu/dataset.xhtml?persistentId=doi:10.7910/DVN/DI6NY2>

### Notes

1. The language referring to 'skills', which is strongly present in the analysis that follows, requires some explanation. The ISCO classification, which provides the building blocks for the ESeG groups, divides professions according to the level and type of 'knowledge' upon which they draw. 'Elementary professions' therefore correspond to jobs that purportedly only require skills relating to primary school knowledge. It should also be noted that beneath this language surrounding skill level lies a hierarchy of both salary and job stability which should not be forgotten when considering the polarisation of social structure.
2. At its aggregated level, the ESeG classification comprises seven categories. The following categories are not taken into account here: (a) self-employed workers in craft and related trades, sales, and agriculture; (b) technicians and associated professional employees, in lower managerial positions. The latter will, however, be taken into account in the next section analysing working conditions. More generally, taking into account the ESeG's seven categories does not alter this overall configuration. In particular, if technicians and associated professionals were to be incorporated into the analysis, they would have to be included alongside professionals. Analysis of the working conditions of these associated professionals at the level of the EU-27 (proportion of unskilled workers, of involuntary part-time work, risk of unemployment) shows them to be closer to the world of professionals than to that of skilled service employees. And in terms of salary, two-thirds of associated professionals earn more than the median salary in their country. Table 2, in the Online Appendix, shows how the proportion of the different ESeG categories in the 12 countries changed between 1993 and 2013.
3. In this table, the following professions are included among 'skilled service employees': 'Travel attendants, conductors and guides (ISCO 511)', 'Cooks (ISCO 512)', 'Hairdressers, beauticians and related workers (ISCO 514)', 'Personal care workers (ISCO 532)', 'Protective services workers (ISCO 541)'. The 'less-skilled service employees' include: 'Waiters and bartenders (ISCO 513)', 'Building and housekeeping supervisors (ISCO 515)', 'Other personal services workers (ISCO 516)' as well as all the service professions categorised 'elementary occupations (ISCO>900)'.

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# Distributional consequences of technological change: Worker-level evidence

Research and Politics  
January-March 2019: 1–9  
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sagepub.com/journals-permissions  
DOI: 10.1177/2053168018822142  
journals.sagepub.com/home/rap



Thomas Kurer<sup>1</sup> and Aina Gallego<sup>2</sup>

## Abstract

This paper explores the employment trajectories of workers exposed to technological change. Based on individual-level panel data from the UK, we first confirm that the share of middle-skilled routine workers has declined, while non-routine jobs in both high- and low-skilled occupations have increased, consistent with country-level patterns of job polarization. Next, we zoom in on the actual transition patterns of threatened routine workers. Despite the aggregate decline in routine work, most affected workers manage to remain in the labor market during the time they are in the study: about 64% “survive” in routine work, 24% switch to other (better or worse paying) jobs, almost 10% exit routine work via retirement and only a small minority end up unemployed. Based on this finding, the final part of our analysis studies the economic implications of remaining in a digitalizing occupational environment. We rely on an original approach that specifically captures the impact of information and communication technology at the industry level on labor market outcomes and find evidence for a digital Matthew effect: while outcomes are, on average, positive, it is first and foremost non-routine workers in cognitively demanding jobs that benefit from the penetration of new technologies in the workplace. In the conclusions, we discuss if labor market polarization is a likely source of intensified political conflict.

## Keywords

Job polarization, panel data, routinization

## Introduction

Automation, digitalization and, increasingly, artificial intelligence are profoundly transforming the world of work. Changing job skill demands create substantial uncertainty about workers’ fortunes in the labor markets of the future. In this article, we study the effects of technological change on individual labor market trajectories with worker-level data. From a political science perspective, examining individual trajectories is crucial because they can reveal which groups become better or worse off due to technological change. Whether digitalization is a likely source of political disruption depends on the distributive consequences of structural change and not just on the overall effects on economic growth. Even if workplace automation does not result in net job loss, political backlash is possible if disadvantages are concentrated in some groups. At the same time, an examination of trajectories is crucial to assess if the progressive nature of technological change allows

affected individuals enough time to adapt. Workers in occupations susceptible to automation might manage to switch jobs, while those unable to adapt may have the opportunity to exit the labor force non-traumatically through (early) retirement. Such a scenario would protect them from the experience of job displacement and, hence, attenuate the political repercussions of economic transformation. In other words, understanding individual-level labor market trajectories is a fundamental prerequisite to assess whether digitalization is a likely source of the political disruptions we currently observe.

<sup>1</sup>Harvard University, Cambridge, USA

<sup>2</sup>Institut Barcelona d’Estudis Internacionals, Barcelona, Spain

### Corresponding author:

Thomas Kurer, Weatherhead Center for International Affairs, Harvard University, 1737 Cambridge Street, Cambridge, MA 02138, USA.

Email: tkurer@wcfia.harvard.edu



We add to the literature on the social and political consequences of technological change by studying (a) which share of workers susceptible to digitalization are actually forced out of their jobs and (b) where they end up. Furthermore, we ask (c) how digitalization affects objective (income) and subjective (job satisfaction) labor market outcomes and (d) whether adverse economic effects are particularly pronounced among so-called routine workers. An influential study in labor economics (Autor et al., 2003) has suggested that *routineness* is the primary characteristic that renders jobs susceptible to automation. Routine occupations are mostly middle-skill and middle-wage jobs in both blue-collar (e.g. manufacturing) and white-collar (e.g. administration) sectors.

Our approach goes beyond compositional changes in the employment structure and studies the actual frequency of distinct trajectories out of threatened routine jobs among the active labor force. We report three empirical results. First, the population included in the UK study has undergone clear-cut employment polarization, characterized by a decline in the share of routine jobs relative to non-routine jobs. Second, the aggregate decline of routine jobs does not result in massively increased unemployment rates among (former) routine workers. During the time covered by our study, a majority manage to cling to their jobs until retirement, about a quarter switch into better or worse paying jobs in less threatened non-routine occupations and only a small share actually end up unemployed. In all likelihood, the aggregate decline in routine jobs is driven by fewer new entrants to routine jobs rather than abrupt exit. The relatively large share of “survivors” motivates the third part of our analysis, which focuses on the economic implications of staying in a digitalizing industry. We rely on an original approach building on industry-level data specifically capturing the investment in information and communication technology (ICT). We show that increases in the penetration of ICT at work are, on average, economically beneficial for workers, presumably because technology creates productivity gains. Our main indicator of “economic benefits” is labor income, perhaps the most typical indicator of objective economic well-being, but we also look at subjective measures; that is, individual job satisfaction.

There is an important qualification to the positive economic impact in the overall sample: effects are not constant across the entire population. Middle-skilled routine workers, who are particularly susceptible to automation, benefit less than non-routine cognitive workers. Wage growth is lower and subjective job satisfaction does not increase at all with rising computerization and digitalization. “Survival” in routine jobs thus comes at the cost of economic stagnation. Low-skilled non-routine manual workers fare similarly badly. The results thus highlight strong distributive implications of technological change and provide evidence for a digital Matthew effect that

itches highly skilled and specialized workers in cognitively demanding jobs against the rest. Although technology tends to improve labor market outcomes, on average, the main beneficiaries are workers in non-routine cognitive jobs.

The substantive implications of our results are open to interpretation. On the one hand, we find that digitalization in an industry *increases* wages across occupations. Workers who stay in non-routine manual jobs and routine jobs become better off in absolute terms (even if not in relative terms) as their industry digitalizes. On the other hand, digitalization has heterogeneous consequences for different types of tasks and, hence, exacerbates existing inequalities in pay and job satisfaction. Given these unequal gains and losses, the positive net effects of technological innovation may not prevent political push-back. Recent research suggests that individuals are very sensitive to *relative* changes in economic well-being, even if absolute indicators would not necessarily give rise to concern (see Burgoon et al., 2018; Im et al., 2018; Kurer, 2017).

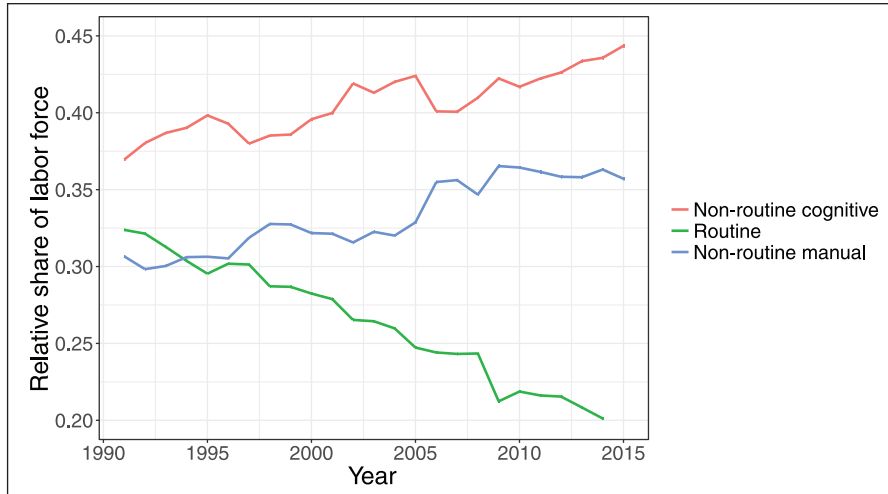
Our contribution to this special issue, using worker-level evidence, attempts to bridge the link between studies of aggregate economic trends and the nascent literature on the political consequences of technological change. Taken together, our results suggest more nuance than a broad-brush story based on previous findings would suggest. Given that we do not find evidence of negative effects (in absolute terms) on individual economic well-being, the question becomes whether the growth in inequality due to technological change is sufficiently significant to motivate political discontent or whether other groups left out of our analysis (such as future labor market entrants or the long-term unemployed) are significant enough to create a political backlash.

## Data and operationalization

### *Individual-level data on occupational transitions and labor market outcomes*

We rely on longitudinal data from the British Household Panel Study (BHPS) and the Understanding Society (UKHLS) survey in order to assess individual occupational trajectories, as well as the individual labor market outcomes (wages and job satisfaction) of workers exposed to varying levels of digitalization.

The BHPS is a longitudinal study that has interviewed approximately 10,000 individuals nested in 5000 households drawn from a stratified random sample of the British population yearly from 1991 to 2008. In 2009 the BHPS was transformed into the UKHLS survey, leading to a substantial increase in sample size (for details on survey design, see Buck and McFall, 2011).



**Figure 1.** Aggregate trends in the employment structure.

### Industry-level data on digitalization

We study the impact of new technologies on objective and subjective labor market outcomes based on a novel approach that combines individual-level panel data with data about the prevalence of ICT at the industry level. The main advantage of this approach is that it facilitates the creation of a longitudinal data set, which includes both time-varying indicators of the increasing importance of technology at the workplace as well as time-varying information on individual labor market outcomes.

We use European Union (EU) KLEMS data (Jäger, 2016) to create our measure of digitalization (see also Graetz and Michaels, 2015; Michaels et al., 2014). The EU KLEMS database contains yearly measures of output, input and productivity for 40 industries in a wide range of countries, including the UK. We use the September 2017 release, which covers the period 1997 through 2017. The data are compiled using information from national statistical offices and then harmonized to ensure comparability. Most importantly for our purposes, the EU KLEMS database provides a breakdown of capital into ICT and non-ICT assets (O'Mahony and Timmer, 2009).

### Sample

For the descriptive first part of our analysis, we exploit the full potential of the combined BHPS/UKHLS data and include all respondents between 1991 and 2015 with non-missing information on occupation (International Standard Classification of Occupations (ISCO) codes). This sample contains 320,080 observations from 66,267 different individuals. On average, respondents are observed in 4.8 waves. For the second part of the analysis, we excluded respondents surveyed between 1991 and 1996, as the 2017 EU KLEMS release only includes data from 1997 onward. We

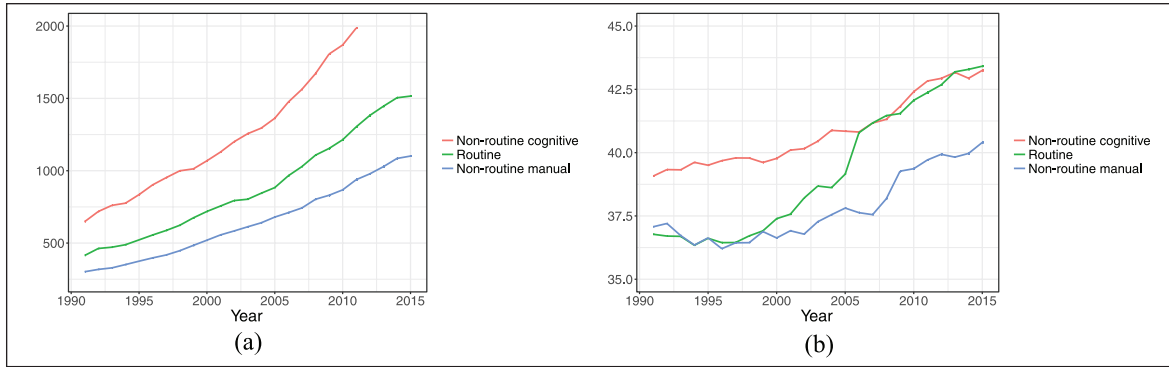
also lose people who drop out of the labor force because they are no longer associated with an industry. This second sample contains 268,120 observations from 59,793 different individuals (on average, 4.5 waves per individual) with non-missing data on occupation and industry codes.

### Employment structure and occupational transitions

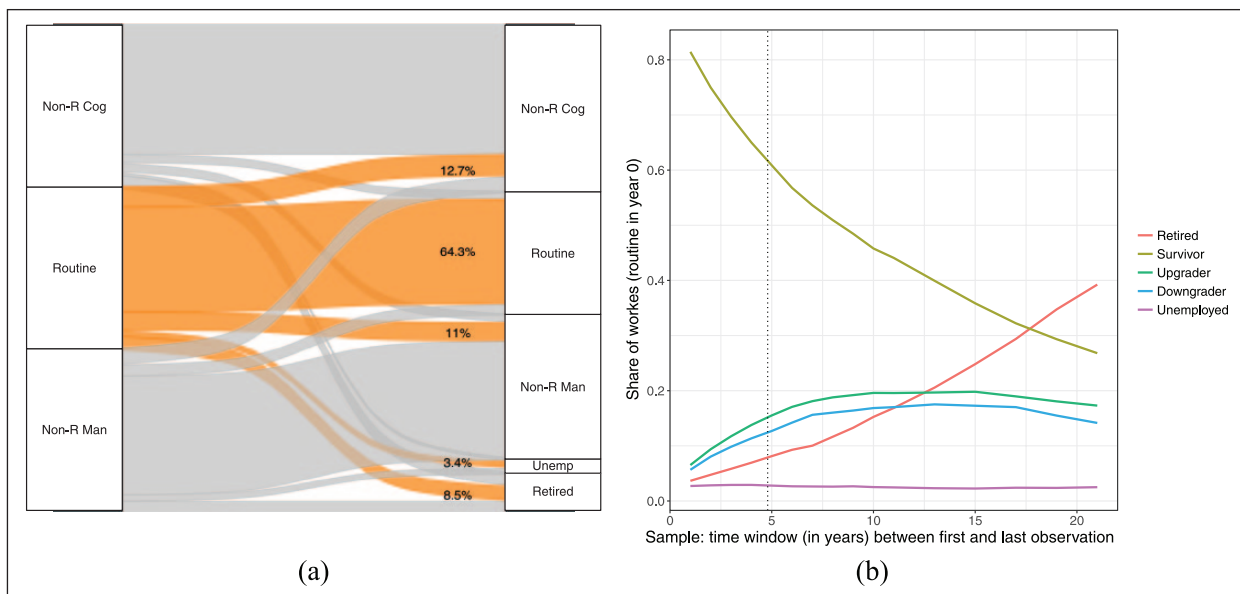
To begin, Figure 1 shows the relative shares of routine work and non-routine work over time. In line with previous examinations of aggregate trends in the employment structure in the UK (Goos and Manning, 2007; Goos et al., 2014), we see a clear trend of job polarization. The share of middle-skilled routine jobs steadily declines whereas the share of both kinds of non-routine work, high- and low-skilled, grows over time.<sup>1</sup>

Figure 2 provides additional descriptive information with respect to routine workers, non-routine cognitive workers, and non-routine manual workers. Figure 2(a) displays average monthly income and confirms the characterization of routine workers as being in the middle of the earnings distribution. The rank order of the three task groups regarding income does not change substantially over time, although the wage premium of high-skilled work in cognitively demanding jobs continues to increase over time, which can be read from the growing distance to the two other task groups. The age structure displayed in Figure 2(b) reveals an interesting pattern: the average age among routine workers distinctly increases over time relative to both non-routine groups. This is consistent with lower rates of entry by young labor market entrants into routine jobs (Cortes, 2016) and confirms the relationship between changes in the size of an occupation and shifts in the age distribution of its workforce, which has been documented for the USA (Autor and Dorn,





**Figure 2.** Average income and age structure of occupational groups: (a) monthly income (CPI-corrected, 2010 GBP); (b) age (in years).



**Figure 3.** Occupational transition patterns: (a) occupational transitions (first to last observation); (b) occupational transitions by time span between observations.

2009). An implication of this pattern is that the relative share of routine workers remains fairly stable among older respondents while less and less younger respondents enter routine jobs. Put differently, the “decline of the middle” is driven by declining entry rates of younger cohorts to routine occupations (see Supplemental Figure 1).

Aggregate trends provide a valuable starting point, but researchers studying the political consequences of technological change should have a keen interest in the specific occupational transitions underlying the decline in routine employment. Polarization can be driven by various forces, most importantly increased unemployment rates, increased rates of occupational switching or higher exit rates – for example, into retirement or disability (Cortes, 2016). Such distinct trajectories out of routine work most likely trigger different political reactions. Technology-induced job displacement presumably creates political push-back only if

workers cannot find better alternative employment (Caprettini and Voth, 2017) and are not compensated or sheltered by a system of social protection (see also Gingrich, 2018). We would not expect workers who are able to upgrade to better jobs or who exit the labor force through retirement to accumulate strong grievances that result in disruptive political behavior.

Figure 3 makes full use of the longitudinal data and visualizes actual transition patterns between the three occupational groups as well as alternative exit options – that is, unemployment and retirement. The alluvial plot on the left (Figure 3(a)) shows transitions between the first occupation that has been recorded for each respondent and the same respondent’s job situation in the last completed BHPS/UKHLS wave. The plot in Figure 3(b) shows the transition probabilities for sub-samples with varying duration between the first and last observation since the likelihood of transitions obviously increases

**Table 1.** Transition matrix.

	NRC	R	NRM	Unemployed	Retired
NRC	0.802	0.048	0.051	0.017	0.083
R	0.127	0.643	0.110	0.034	0.085
NRM	0.100	0.067	0.733	0.037	0.062

NRC: Non-routine cognitive; R: Routine; NRM: Non-routine manual.

with the observed time span. By design, the alluvial chart on the left is a weighted average of the varying transition probabilities over time, plotted on the right. The key point here is that occupational transitions happen less often than the aggregate numbers in Figure 1 might suggest. Based on an average time span of 4.8 years, a clear majority (64%) of routine workers “survive” in their routine jobs. About every fourth routine worker switches into non-routine jobs that are less exposed to digitalization, where upgrading into high-skilled cognitive work is slightly more frequent (13%) than downgrading into low-skilled manual jobs (11%). Only 3.4% ended up unemployed. The plot in Figure 3(b) adds interesting nuance to this snapshot. As expected, surviving in routine work becomes less frequent with increasing time spans – that is, with increasing duration between the first and last observation in BHPS/UKHLS – but the lion’s share of this decline is due to “natural” transitions into retirement. All other transition probabilities remain stable after about seven years of observation. It should be noted that the underlying sample sizes decline rapidly with increasing time windows.

This pattern of individual-level transitions suggests that the main mechanism behind job polarization is not layoff, displacement or general upgrading but a gradual transformation of the employment structure over time. Rather than being immediately and massively replaced, an interpretation sometimes conveyed in the media, routine work slowly goes extinct. (There are also some transitions into routine work but these are less frequent than into any of the non-routine task groups, see Table 1 for the full transition matrix.)

## Digitalization and labor market outcomes

In line with the our analysis of individual occupational transitions, overall employment numbers have not decreased in recent years despite the demonstrable impact of new technologies on productivity (Oliner and Sichel, 2000). While automation substitutes for some tasks, it complements others and can thereby increase output, earnings and demand for labor (Acemoglu and Restrepo, 2016; Autor, 2015; Autor and Salomons, 2018). A comprehensive assessment of the political consequences of technological change should, thus, not exclusively focus on the most obvious losers – that is, displaced workers – but rather on those who remain in the labor market. In electoral terms, they represent a more relevant part of the population.

Importantly, a neutral or even positive impact on overall employment should not hide the fact that shrinking job opportunities in the middle present a challenge for many; for example, workers with difficulties adapting to a changing demand for skills or mid-skilled labor market entrants who traditionally entered routine jobs. Digitalization has very specific effects on skill demand (Autor et al., 2003) and, accordingly, might produce politically relevant grievances, even among workers who manage to cling to their jobs. Thus, the last part of our analysis studies heterogeneous labor market outcomes among the active labor force. We ask how digitalization affects wages and job satisfaction and whether these effects vary between different task groups. In line with the literature on skill demand, we would expect non-routine workers, in particular high-skilled ones, to reap a disproportionate share of the economic benefits from digitalization.

## Estimation

The breakdown of EU KLEMS data into ICT and non-ICT assets allows for the construction of the following indicator of digitalization

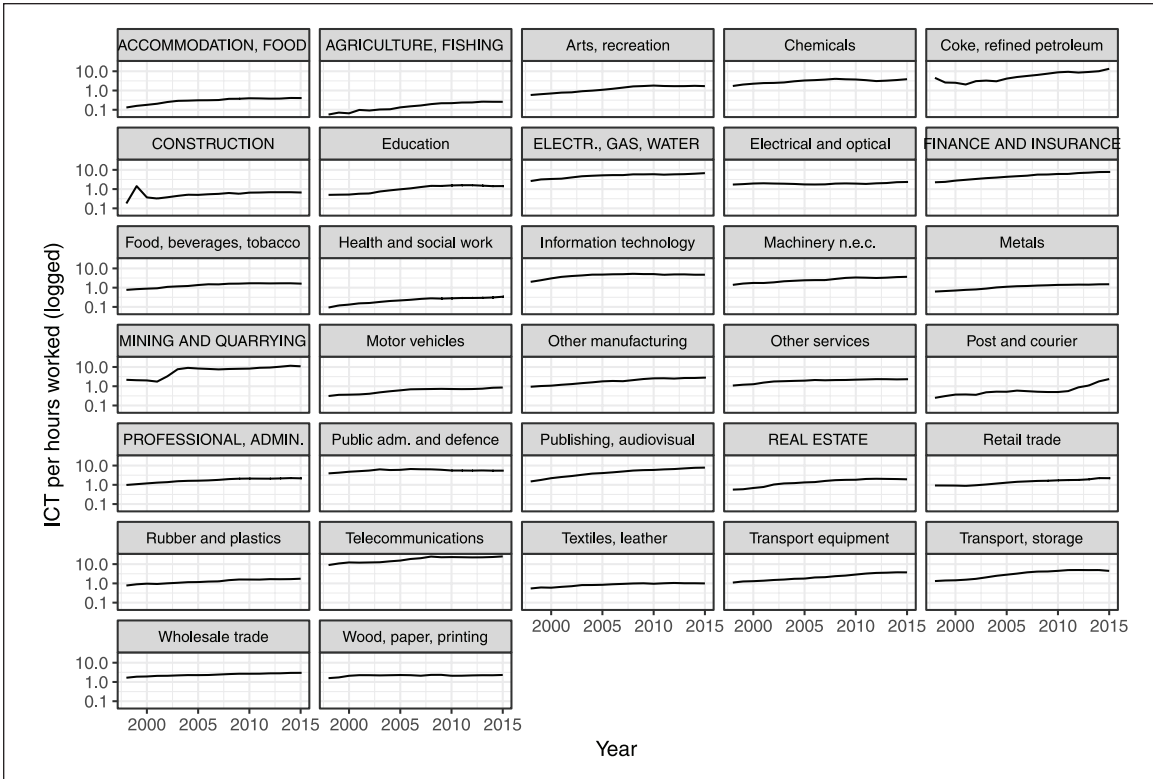
$$D_{jt} = \frac{(\text{ICT capital}_{j,t})}{(\text{hours worked}_{j,t})}$$

where ICT capital is real fixed capital stock in computing equipment, communications equipment, computer software and databases in industry  $j$  and year  $t$ , in million GBP at constant 2010 prices, estimated using the perpetual inventory method based on past investment and applying a geometric depreciation rate. We divide ICT capital stock by hours worked (also in millions) to adjust for the size of the industry. As expected, the resulting indicator of ICT capital stock in GBP per hour worked (mean = 2.1; standard deviation = 2.4) increases over time. Descriptive information by year as well as a breakdown of ICT capital stock per industry is provided in Supplemental Table 1 and Figure 4.

We use fixed-effects regressions to estimate the effects of digitalization at the industry level on income and subjective job satisfaction. The general model is as follows

$$Y_{ijt} = \beta D_{jt} + \theta S_{ijt} + \delta S_{ijt} \times D_{jt} + \gamma C_{ijt} + \eta_{ij} + \mu_t + \epsilon_{ijt}$$

where  $Y_{ijt}$  is the outcome of interest for individual  $i$  in industry  $j$  at time  $t$ . We look at monthly wages and subjective job satisfaction to measure the economic benefits from digitalization. Here  $Y_{ijt}$  is a function of the time-varying indicator of digitalization at the industry level ( $D_{jt}$ ). To test for heterogeneous effects between routine and non-routine workers, we introduce an interaction term between digitalization  $D_{jt}$  and individual’s occupational task group (non-routine cognitive, routine, non-routine manual)  $S_{ijt}$ ;  $C_{ijt}$  is



**Figure 4.** ICT capital stock 1997–2015; breakdown by industry.

a vector of individual-level controls. Due to the potential post-treatment bias that we may introduce by controlling for time-varying covariates (which may themselves be affected by changes in a workers' industry) we only include age and age squared as controls.

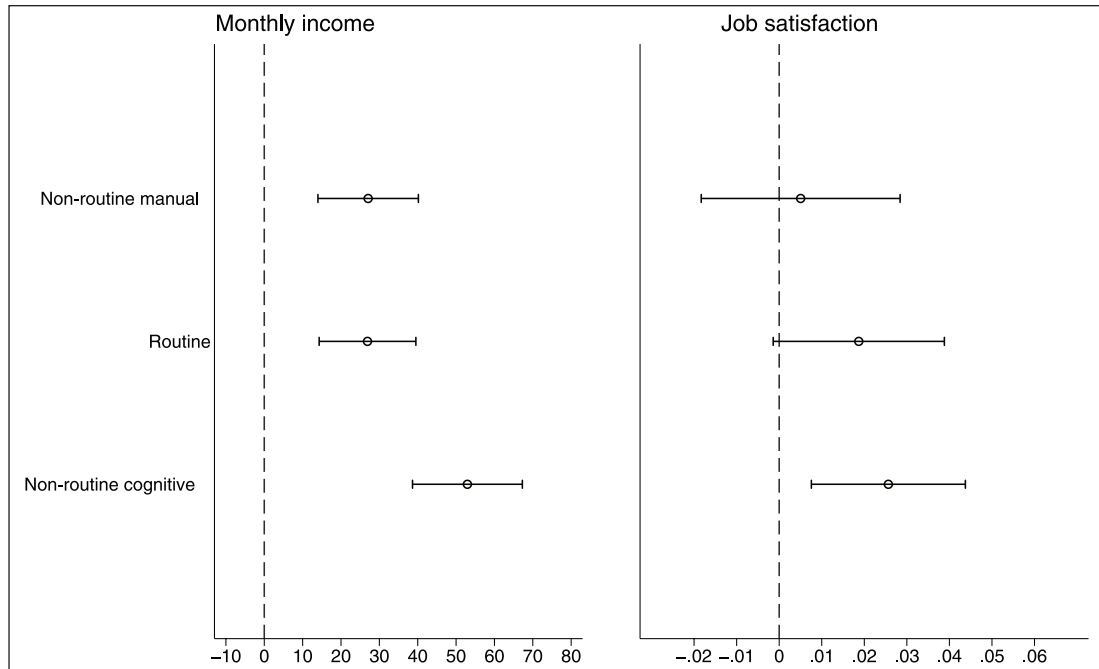
The term  $\eta_{ij}$  is a vector of individual by industry fixed effects, which captures all time-invariant variables that might affect the self-selection of workers into specific workplaces such as their gender, personality or family origin, as well as time-invariant industry-level characteristics. The individual by industry fixed effects includes separate intercepts for the same individual in periods when he or she has worked in a different industry. Finally, we include year-fixed effects  $\mu_t$  to account for common shocks. This specification is quite demanding and only exploits over time variation in the level of digitalization within industries for workers who remain in the same industry (but not necessarily occupation) for two or more periods.

## Results

Our analysis provides clear evidence of unequally distributed benefits. The left panel in Figure 5 displays the results with respect to labor market income.<sup>2</sup> While the earnings of every task group grow with increasing digitalization, thus confirming the textbook expectation of positive overall effects, the main winners clearly are workers in cognitively

demanding non-routine jobs. Here, the wage increases due to digitalization are nearly double the size of both routine and low-skilled non-routine jobs. This finding nicely ties in with previous work studying distributive implications of the service-sector transition and rise of the knowledge economy (e.g. Wren, 2013). The size of the effect is substantial: an increase in ICT capital stock of £1 per hour worked ( $=0.41$  standard deviations) is related to a wage increase of almost £60 per month for a high-skilled non-routine worker, which is about 2.5% of the 2017 median gross wage in the UK.<sup>3</sup> Note that the *difference* between non-routine cognitive workers and the two other task groups is statistically significant (see full regression results in Supplemental Table 2).<sup>4</sup>

The right panel in Figure 5 confirms that the unequal distribution of benefits is reflected in subjective perceptions. Only high-skilled non-routine workers, who benefit most from the complementary effects of new technology, are more satisfied with their jobs in the face of increasing digitalization of their industry. By contrast, objectively positive—even if weaker—effects on wages do not translate into higher satisfaction at the workplaces of routine and non-routine manual workers. However, it should be noted that the impact on subjective economic well-being is weaker than the effects on earnings. The magnitude is substantively small and the differences between groups are much less pronounced (see Supplemental Table 2).



**Figure 5.** Marginal effects of digitalization on labor market outcomes, conditional on task group.

## Discussion

This special issue explores the political consequences of technological change and employment polarization. Our contribution focuses on the distributive implications of changes in the labor market. Distributive conflicts are very common causes of political contestation and we demonstrate that the benefits of digitalization, indeed, are not equally shared.

Who are the winners, who are the losers? Our analysis reveals relatively complex distributional implications, which are not always spelled out explicitly in existing work. The tension arises from the fact that the task-based literature in labor economics emphasizes routine workers' disadvantages even vis-a-vis lower-skilled non-routine manual workers (Autor et al., 2003). This is not entirely in line with the main thrust of our paper, which is that non-routine cognitive workers benefit compared to everybody else; that is, compared to both routine *as well as* non-routine manual workers. We can reconcile these somewhat contradictory expectations by more explicit reference to the particular outcome of interest. When looking at wages and job satisfaction, the main finding is polarization between high-skilled workers and the rest. By contrast, when looking at employment shares, both non-routine groups are doing better than routine workers. However, our analysis shows that this decline in the aggregate does not necessarily have negative material implications for individual workers. Many routine workers remain in their jobs until retirement. The decreasing share of routine jobs is primarily driven by lower entry rates, not by massive involuntary exit. We would expect this pattern to generalize beyond our

single case because, if anything, the flexible labor market of the UK allows for more rather than less job switching and more rather than less frequent unemployment spells.

An important take-away from the relatively large share of survivors in routine work is that a comprehensive analysis of the political consequences of technological change should not exclusively focus on those forced out of the labor market as a result of increasing automation. A significant part of the electorate is confronted with increasing prevalence of new technologies in their current work environment. A relevant question to ask is, thus, how the experience of digitalizing work environment affects the labor market outcomes of those who keep their jobs. If a majority keep their job and everyone who stays benefits to a similar extent from the introduction of digital technology at the workplace, we would not expect strong adverse repercussions in the political arena.

Interestingly, we find that all occupational groups experience income gains as a consequence of digitalization. Yet, the actual magnitude of these material benefits varies strongly between groups. The main beneficiaries are high-skilled workers in cognitively demanding jobs, who are well-equipped to make use of the benefits offered by new technology. The large residual group of middle-skilled routine and low-skilled non-routine workers (about 60% of the labor force in our sample) also experience some wage increases, but these are not substantial enough to be reflected in more positive subjective evaluations of job satisfaction. Hence, the promise of new technology primarily serves those who are already in a privileged labor market position.

Our results are open to interpretation. Automation and digitalization provide opportunities for many and, in general,

improve individual labor market outcomes. As a consequence, technological change might not look like a plausible source behind recent political disruptions. However, not all voters have an equal share in this economic boost. Employment polarization clearly results in income polarization with disproportionate wage growth for highly skilled and specialized winners of digitalization. This digital Matthew effect could create grievances notwithstanding positive overall effects of technology in economic terms. The combination of generally increasing well-being and the parallel economic stagnation of politically powerful groups might present a toxic political cocktail. Recent research has shown that a positive economic environment can even reinforce political dissatisfaction among those who do not get their piece of the growing cake: when everybody else is thriving, individual stagnation produces even stronger political reactions (see Aytac et al., 2018; Rooduijn and Burgoon, 2017). Another contribution to this special issue (Im et al., 2018) provides further evidence in this direction. Indeed, relative deprivation theory (Runciman, 1966) has long established that economic stagnation and unfulfilled expectations are especially frustrating when other parts of society are doing exceptionally well.

### Acknowledgements

We thank Niko Schöll, Bruno Palier, Jane Gingrich, Stefan Thewissen, Ruben Enikolopov, seminar participants at Universitat Pompeu Fabra and Sciences Po, and two anonymous reviewers for their helpful comments and suggestions.

### Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

### Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This work was supported by the Spanish Ministry of the Economy and Competitiveness (MINECO) under the CSO2016-79569-P, from the BBVA Foundation through the project “Digital technology, ideological polarization and intolerance,” and from the Swiss National Science Foundation (Grant Number 146104).

### Supplemental materials

The supplemental files are available at <http://journals.sagepub.com/doi/suppl/10.1177/2053168018822142>.

The replication files are available at <https://dataverse.harvard.edu/dataset.xhtml?persistentId=doi:10.7910/DVN/BONQSQ>

### Notes

1. The coding of task groups is based on ISCO codes and largely follows Oesch (2013: 156).
2. Our model specification, with a focus on those who remain in the labor force, is not particularly suited to study the effects of digitalization on unemployment. That said, some tentative analyses

point to very weak employment effects. Digitalization does not seem to result in higher unemployment rates, which is in line with our more descriptive analysis of individual transition patterns. A more likely consequence than unemployment is occupational switching into other jobs within the active labor force.

3. According to the Office for National Statistics, the median gross weekly earnings for full-time employees were £550 in April 2017 (<https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/earningsandworkinghours/bulletins/annualsurveyofhoursandearnings/2017provisionaland2016revisedresults>).
4. While non-overlapping individual confidence intervals mean that the difference is statistically significant, the reverse is not necessarily true.

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# The “losers of automation”: A reservoir of votes for the radical right?

Research and Politics  
January-March 2019: 1–7  
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sagepub.com/journals-permissions  
DOI: 10.1177/2053168018822395  
journals.sagepub.com/home/rap



Zhen Jie Im<sup>1</sup>, Nonna Mayer<sup>2</sup>, Bruno Palier<sup>3</sup> and Jan Rovny<sup>3</sup>

## Abstract

This paper studies the association between the risk of automation and vote choice in 11 West European countries. We extend upon labour economics literature on the effects of automation on the labour market by focusing on the political consequences of automation. We also build on existing work relating labour market risks to support for radical right parties. We argue that automation threat is most likely to increase support for radical right parties. We demonstrate that those more inclined to vote for the radical right rather than the average voters are those who are both threatened by automation and are still “just about managing” economically. They are more receptive to the narrative of the radical right, which simultaneously highlights the risk, and proposes protection. Using cross-sectional individual level data drawn from the European Social Survey (rounds 6, 7 and 8), we find that individuals who perceive themselves as “coping on present income” are significantly more likely to vote for radical right parties as risk of automation increases. They are also less likely to vote for major right parties.

## Keywords

Automation, labour markets, electoral behaviour, radical right

## Introduction

In 1921, a theatre play “RUR” by Karel Čapek decried the dehumanizing nature of labour routinization, painting a dystopian world in which humans are replaced by machines. He underlined the perils of modernization devoid of compassion and humility, a peril that he would later associate with the rise of authoritarianism. While the play has largely receded from memory, one word it coined has permeated most world languages – the robot. Derived from the Czech noun “robot”, designating “forced labour” or *corvée*, the robot replaces humans in all but their empathy, tenderness, mercy and love.

Recent years have witnessed an increased focus on the role of labour automation, whereby robots, computers or machines replace human workers. While there is an ongoing debate about the extent to which the rise of automation will displace human jobs (Arntz et al., 2016; Arntz et al., 2017; Autor and Dorn, 2013; Frey and Osborne, 2017; Goos and Manning, 2007), the understanding that diverse occupations are at varying levels of risk of automation is pervasive in academic, as well as popular discourse. However, the question that remains unaddressed is how such risk translates into political behaviour.

This paper consequently proposes to address the electoral impact of automation in the economy. Our guiding hypothesis

is that individuals threatened by automation are a potential reservoir of voters for European populist radical right parties (Camus and Lebourg, 2017; Mudde, 2007). These parties have been taking the side of workers threatened by globalization and unfettered capitalism; they have also started to play on the threat of automation (Mullet, 2017). The potential “losers of automation” could turn to them, as the “losers of globalization” did before (Kriesi et al., 2008).

## Electoral impact of automation

Our argument builds on earlier work that distinguishes between subjective and objective labour market threats (see, e.g., Kurer, 2018; Mayer, 2013, 2015; Rovny and

<sup>1</sup>University of Helsinki, Faculty of Social Sciences, Helsinki, Finland

<sup>2</sup>Sciences Po, Centre d'Études Européennes et de politique comparée, Paris, France

<sup>3</sup>Sciences Po, Centre d'Études Européennes et de politique comparée and Laboratory for Interdisciplinary Evaluation of Public Policy (LIEPP), Paris, France

### Corresponding author:

Jan Rovny, Science Po, 27, rue Saint-Guillaume, Paris, 75337, France.  
Email: jan.rovny@sciencespo.fr



Rovny, 2017). These works demonstrate that it is not those objectively worse-off who lend the highest levels of support to the radical right. Rather, it is those who are above the threshold of precariousness or poverty, but perceive the risk of falling down into it.

In France, for instance, since the 1990s, blue-collar workers are the most inclined to vote for the Front National (Gougou and Mayer, 2012): 29% voted for Marine Le Pen in the 2012 presidential election, 10 points above her average score (Mayer, 2015). However, the proportion was higher among socially secure workers than among socially insecure ones: 35% compared to 20%.<sup>1</sup> These workers who turned proportionately more to the radical right were on the “lower-middle” income and status scales or “little middle” (Cartier et al., 2016). Most importantly, they were also those who had something to lose and feared downward mobility (Mayer, 2015).

A similar result was found by Kriesi and Bornschieer (2012). Using the post-industrial class schema of Oesch (2006, 2008), the authors found that the economically worse-off do not support the radical right more than average; instead, they abstain more than average. The typical radical right voter has “an intermediate level of education, belongs to the manual working class and is not disinterested in politics and her/his reasons are cultural” (Kriesi and Bornschieer, 2012: 26). Immigration is perceived as a threat to their identity. Using panel data on Germany, Switzerland and the UK, which runs from the 1990s to 2014, Kurer (2018) shows that it is fear of social decline by job loss, rather than actual experience of it, which drives support for right-wing populist parties.

Our expectation is that labour automation represents another form of labour market risk. It, however, expands beyond the manual working class and affects “middling” white-collar jobs as well (Autor et al., 2003; Goos and Manning, 2007; Frey and Osborne, 2017). Individuals are likely to perceive the general risk of unemployment that they are exposed to. This risk is made up of a number of components, of which automation is one. One’s employment may be threatened by various mechanisms, such as: globalization (jobs going abroad), migration (replacement by cheaper workers), consumer preference change (demand disappearance), “rationalization” (reduction of workers to increase profit), automation (replacement of workers with machines), etc. In short, the threat of automation is but one particular component of general unemployment risk.<sup>2</sup> We isolate this risk and assess its impact on political behaviour.

Why should those threatened by automation turn to the radical right? The radical right is well placed to respond to this form of risk due to its programmatic focus on the displacement of native jobs by exogenous changes to the labour market, which include globalization, migration and automation. Radical right parties are currently not only the most electorally dynamic in Europe, but also the only

non-mainstream parties to have put forward the issue of automation risk.<sup>3</sup> Furthermore, and contrary to the radical left, which has often defended progress, including technological progress, radical right parties propose a narrative that is resolutely nostalgic of a mythic past (Gest et al., 2017; Steenvoorden and Harteveld, 2018).

We propose a dual mechanism. First, on the demand side, individuals carrying out routine job tasks that lend themselves to automation are more likely to sense the threat of potential downward mobility and thus respond by supporting the radical right.

*Hypothesis 1 (H1): Individuals more threatened by automation are more likely to vote for the radical right.*

Second, we expect this sense of threat to be moderated by individuals’ current perceived economic situation. Threat is a more potent political driver when the danger is unknown. It is in this situation when individuals are still managing economically, but fear a loss of economic status, that they become more receptive to the radical right, whose appeals play heavily on the notion of threats and the “protection” against such threats. Building on the literature on social threats discussed above, as well as social mobility (Jackman and Volpert, 1996; Peugny, 2006), we expect individuals who are just economically coping to be most likely to respond to the threat of automation; they are most likely to fear a loss of status, which triggers greater likelihood of supporting the radical right (Rovny and Rovny, 2017). This is confirmed by a recent study by Frey et al. (2017), showing that “automation anxiety” led to the support of Donald Trump in the 2016 presidential election, and by Dal Bó et al. (2018) on the appeal of the Swedish Democrats to “vulnerable insiders”. By contrast, individuals who perceive themselves as already in economic difficulty are less likely to respond to the threat of automation by supporting the radical right.

*Hypothesis 2 (H2): Automation threat increases the propensity to vote for the radical right among those individuals who perceive their economic situation as middling.*

We thus expect individuals who perceive themselves as standing just at the edge of the economic precipice to react most strongly to the threat of automation. They are thus significantly more likely to turn to the radical right. The response of these in the lower-middle positions is to turn against modernization presented by automation, and in the words of the Communist Manifesto, to “try to roll back the wheel of history” (Marx and Engels 2001: 23), which is offered by some radical right’s recent programmatic calls for a hark back to the “good old times” (Mondon, 2016: 29).



## Data operationalization

To test our expectations, we use data from rounds 6, 7 and 8 of the European Social Survey (ESS). ESS rounds 1 to 5 were excluded from this study because a different occupational classification category is used in these rounds. As we do not have the ability to assess individual perception of automation risk, we rely on an “objective” measure of this risk provided by Arntz et al. (2016), which we assume is diffusely sensed by individuals. We then seek to assess the electoral impact of the narrower component of unemployment risk caused by the threat of automation.

Our dependent variable is voting behaviour in the previous national election. This variable measures five different voting behaviours: (a) vote for radical right; (b) vote for radical left; (c) vote for major left; (d) vote for major right parties; and (e) abstain. The variables are recoded from the variable “*party voted for in last election*”. This classification broadly follows Rovny and Rovny’s (2017) approach (see Table 10 in the online appendix). To construct the category “did not vote”, we used a variable asking whether respondents had voted in the previous national election.

Our key independent variable is the Arntz et al. (2016) index, which measures the risk of automation at the occupational level. It is a continuous variable ranging from 0 to 1, with higher values denoting greater risk. The index is based on the two-digit level of the International Standard Classification of Occupations (ISCO) 2008 system. While ESS rounds 6, 7 and 8 used ISCO-08, rounds 1 to 5 use the older ISCO-88 system, which is why we exclude the latter. We prefer this index to the Frey and Osborne (2017) measure, since the latter is based only on US data, and assumes that all jobs in the same occupation group face the same risk of automation, whereas the Arntz et al. (2016) data concern European countries, and differentiate between risk of automation within occupations and across countries (for a discussion of the differences between the two measures, see online Appendix A11). Like the alternative Frey and Osborne (2017) index, both measure the likelihood of automation at the task level. This follows the recent task-based approach in labour economics literature, which defines tasks as “a unit of work activity that produces output” (Autor, 2013). A job is thus a composite of the different types of tasks a worker does (Owen and Johnston, 2017), and occupations are an aggregate of different jobs with potentially different task structures.

Arntz et al. (2016) use individual-level survey data from the Programme for the International Assessment of Adult Competencies (PIAAC), which measures a comprehensive list of self-reported tasks that people actually perform in their workplace (Arntz et al. 2016: 12), comparable across countries. Individuals are first assigned an automatability value primarily according to the set of tasks they perform, and secondarily according to gender, education, competences, income, firm-size and sector. Since PIAAC contains

individual occupational categories at the ISCO two-digit level, the overall risk of automation for each occupational category reflects its share of workers with a high automation potential. Since this method measures risk of automation at the individual level, differences in task structures across countries are accounted for. They show that similar occupational categories in different countries face different risks of automation.

The ESS data does not, however, allow us to go beyond the level of occupational groups and account for variations of risks of automation within similar occupational groups due to differences in individual job task structures. This may be a limitation of this study since both Autor and Handel (2013) and Arntz et al. (2016) have noted the possibility of variations in risks of automation within similar occupational groups.

The moderating variable proposed by H2 measures respondent feeling of economic security based on their present household income (*hincfel*). Respondents place themselves into one of four categories: (a) living comfortably on present income; (b) coping on present income; (c) difficult on present income; and (d) very difficult on present income.

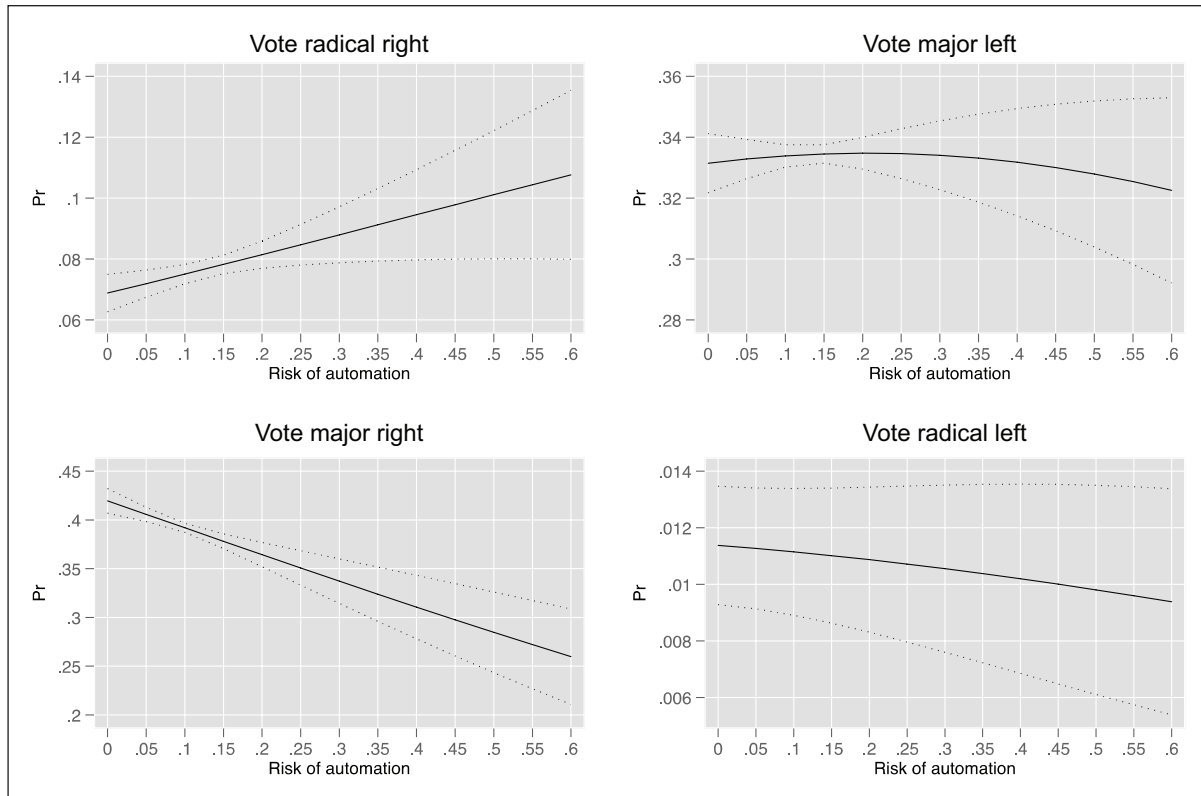
To further strengthen our claims and eliminate the possibility that our results could be driven by confounding factors, our statistical analyses control for age, gender, level of education, religiosity, union membership, if one belongs to an ethnic minority group and income. We also use country and year fixed effects in our model to account for country and time idiosyncrasies.

Our sample includes the following West European countries: Austria, Belgium, Denmark, Finland, France, Germany, Italy, the Netherlands, Norway, Sweden and the UK. We chose countries according to two criteria: (a) these countries are included in the Arntz et al. (2016) risk of automation index; and (b) these countries have radical right parties with significant electoral success.

We employ multinomial logit regression models to test for the effects of the risk of automation on voting behaviour. Note that the voting for radical right parties is the specified base outcome in the regression model. To test if the effects of risk of automation on voting behaviour differ across levels of economic security, we include an interaction term comprising risk of automation and feeling of economic security based on present income. The models use design weights supplied by ESS and standard errors are clustered by countries.

## Results and discussion

Turning to test H1, positing an effect of automation risk on the vote for the radical right, Figure 1 presents the relationship between vote probability and risk of automation. A rise in risk of automation is positively associated with an increase in likelihood of voting for radical right parties. As



**Figure 1.** Predicted probabilities of vote choice as automation changes with 95% confidence intervals.

Note: linear relationship between automation and vote choice. Based on Table 1 in the online appendix.

the risk of automation rises from 0 to 0.6, there is a 3.92 percentage points associated increase in probability of voting for radical right parties. By contrast, an equal increase in risk of automation is associated with a 16 percentage points decrease in likelihood of voting for major right parties. There is no significant effect on the vote for major and radical left parties.

H2 expects the risk of automation to impact support for radical right parties differently across levels of income security. Figure 2 shows that rise in risk of automation is significantly associated with an increase in the probability of voting for radical right parties for respondents who are living comfortably on present income, and particularly for those who are coping. Furthermore, all income groups demonstrate a reduced support for the major right as automation risk increases. Finally, those in very difficult income conditions are significantly less likely to vote for the major left, as the risk of automation increases. There is no effect on vote for the radical left.

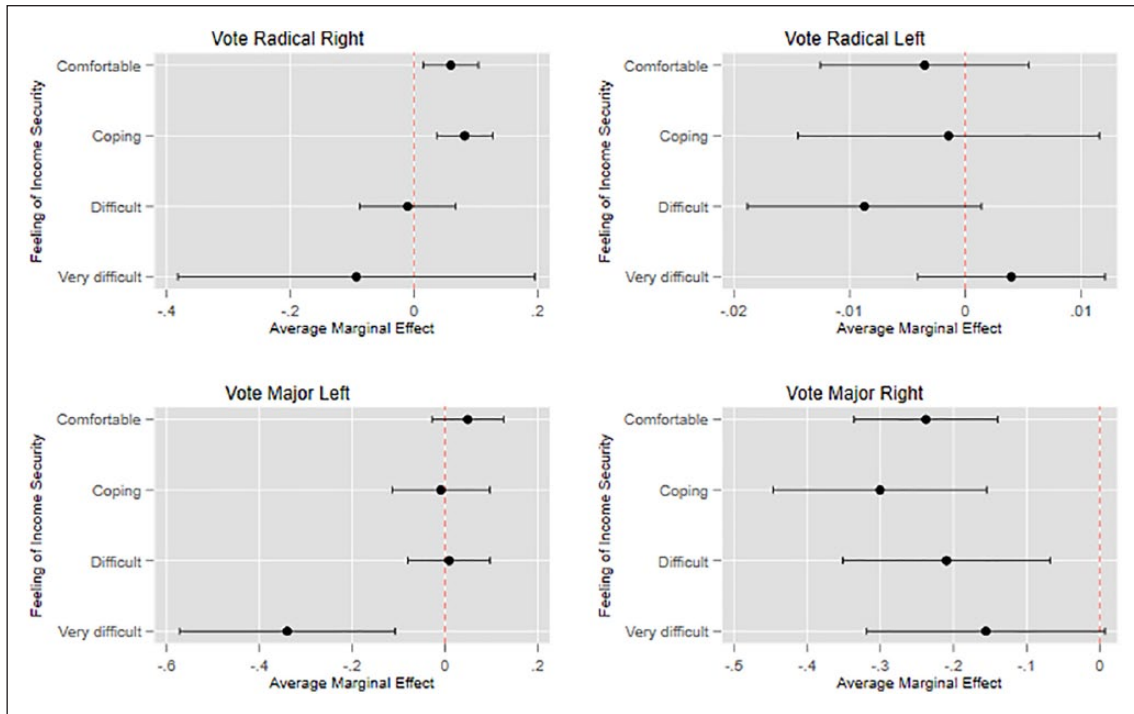
Figure 3 further illustrates the vote probabilities over automation risk and across feeling of income security. It shows that respondents who are coping and living comfortably on present income are more likely to vote for radical right parties as risk of automation increases. This positive relationship is, however, slightly stronger for those who are coping on present income. By contrast, rising levels of risk

of automation are associated with a fall in likelihood of supporting radical right parties among those who find it difficult and very difficult on present income, though these effects are not statistically significant.

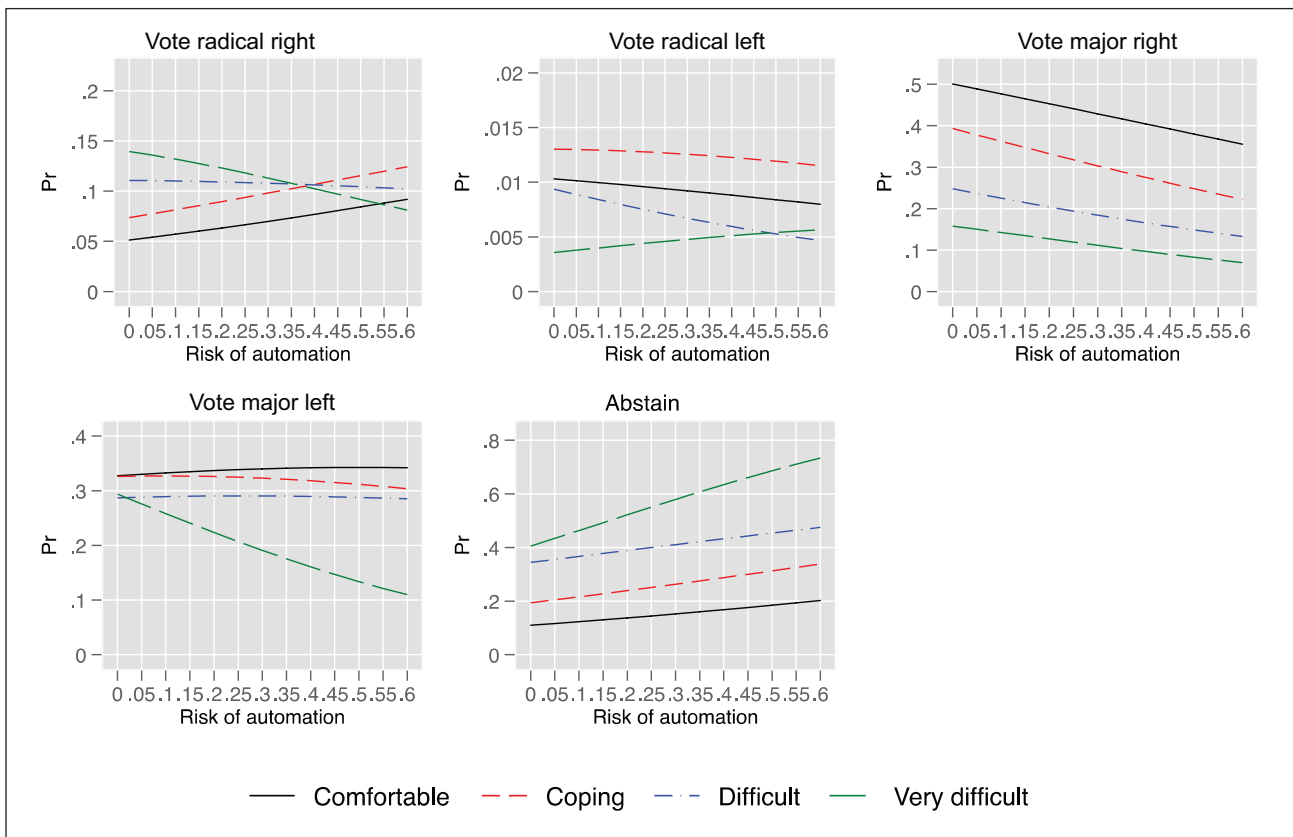
Figure 3 also shows that there is a negative relationship between risk of automation and support for major right parties for all levels of income security. Importantly, the risk of automation dramatically decreases the support for major left parties among those who find it very difficult to cope on their current income. These individuals are then most likely to abstain, or (a small portion of them) turn to the radical left, although the effect on radical left vote is not significant.

The results suggest two important findings. Automation interacts with individual economic situation and compounds the effect on electoral behaviour. Those individuals coping on current income are generally significantly affected by increasing threat of automation, which drives them towards the radical right. This effect is, however, not observed for those who already find it difficult or very difficult to live on their current income – as automation risk increases, they are not significantly more likely to vote for the radical right.

These results are consistent with previous findings that individuals who are facing worse economic difficulties *do not* tend to support radical right parties more than



**Figure 2.** Average marginal effects of risk of automation on vote choice by feeling of income security.



**Figure 3.** Predicted probabilities of vote choice over risk of automation by feeling of income security. Note: Confidence intervals were suppressed for readability.

average (Mayer, 2015; Mayer et al., 2015; Rovny and Rovny, 2017). It is primarily those individuals who are doing just about fine, but who face threats – such as the threat of losing their work to machines or robots – who are more likely to turn to the radical right. Thus, while actual economic hardship leads voters to turn away from the polls, the fear of slipping into economic difficulty leads voters into the arms of the radical right.

## Conclusion

This study examines the political consequences of automation risk. As automation is increasingly able to replace a greater number of human tasks, some workers face a greater risk of redundancy than others. We thus asked whether those facing high risk of automation are a potential reservoir of votes for radical right parties. Our findings suggest that risk of automation alone cannot fully explain support for radical right parties. Rather, it is the risk of automation among those who are just economically coping, but likely to be fearful of falling and losing what they have, which may motivate the vote for radical right parties (Rouban, 2016a, 2016b).

One major limitation of this research pertains to differences in risk of automation within similar occupational groups. Due to limitations in the ESS data, we are only able to estimate individuals' risk of automation at the level of occupational categories: individuals in the same occupational categories were assigned similar risks of automation. Since individuals in similar occupations may take on different jobs comprising different task structures, future studies could estimate the risk of automation at the individual level and relate individual-level risk to voting behaviour.

This comparative study ultimately suggests that automation creates socio-structural conditions that may inform individual political orientations, and become a basis for new social grouping and political organization. Indeed, some political entrepreneurs – particularly from radical right parties – are starting to advance the issue. This is echoed in recent comments by Marine Le Pen, the leader of the French radical right, in an interview in 2017 that “the robotization of work engenders many legitimate fears, as it could replace many unqualified workers” (Mulot, 2017). The threat of robots, conjured up almost a century ago by a humanist writer, may have the potential of becoming strategic electoral fodder for Europe's radical right.

## Acknowledgements

We would like to thank Melanie Arntz, Terry Gregory and Ulrich Zierahn for generously sharing their data on risk of automation.

## Authors' note

Submission for the special issue “Political Consequences of Technological Change”, guest-edited by Thomas Kurer and Bruno Palier.

## Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

## Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This work was supported by a public grant overseen by the French National Research Agency (ANR) as part of the “Investissements d’Avenir” program LIEPP (ANR-11-LABX-0091, ANR-11-IDEX-0005-02). This paper also benefited from the support of the NRF of Korea (grant number NRF-2017S1A3A2066657).

## ORCID iD

Zhen Jie Im  <https://orcid.org/0000-0001-7854-1382>

## Supplemental materials

The supplemental files are available at <http://journals.sagepub.com/doi/suppl/10.1177/2053168018822395>. The replication files are available at <https://dataverse.harvard.edu/dataset.xhtml?persistentId=doi:10.7910/DVN/KVRVLB>.

## Notes

1. According to scores on an indicator of social precariousness mixing social isolation and economic situation items, the “EPICES” score (see Mayer, 2014).
2. Indeed, if we compare our measure of automation risk with a measure of unemployment risk (Rehm, 2016), we conclude that these two measures correlate at  $r = 0.599$ , and automation risk explains 36% of the variance of unemployment risk.
3. See recent declarations by the leaders of the Freedom Party in the Netherlands (Champion and Van Der Schoot, 2017) and the Rassemblement National in France (Mulot, 2017).

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# The conditional effect of technological change on collective bargaining coverage

Research and Politics  
January-March 2019: 1–9  
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DOI: 10.1177/2053168018823957  
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Brett Meyer<sup>1</sup> and Thomas Biegert<sup>2</sup>

## Abstract

Recent work in labor economics has shown that technological change has induced labor market polarization, an increase in demand for both high and low skill jobs, but declining demand for middle skill routine task jobs. We argue that labor market polarization should affect firms' participation in collective agreements, but only in countries where laws automatically extending collective agreements to nonparticipating firms are weak. We develop an argument in which labor market polarization increases the distance between different skill groups of workers in both preferences for unionization and leverage to realize those preferences. Because of this, an increase in labor market polarization should be associated with a decline in collective bargaining coverage. We test our hypothesis about collective agreement extension and collective bargaining coverage in a cross-national sample of 21 Organisation for Economic Co-operation and Development countries from 1970 to 2010 and our hypothesis about labor market polarization in German firm-level and industry-level data from 1993–2007. We find a negative relationship in the Organisation for Economic Co-operation and Development sample between technological change and collective bargaining coverage only in countries that make little or no use of extension procedures. We find that higher workforce skill polarization is associated with lower collective agreement participation in both German firm-level and industry-level samples.

## Keywords

Technological change, labor market polarization, trade unions, Germany

## Introduction

Technological change has continually shaped the labor market for centuries and the past few decades have been no exception. Labor economists have shown that during this period, increases in computing power allowed for the automation of conceptually simple and repetitive “routine tasks” (Autor, Levy and Murnane, 2003). As technology has dramatically affected employment, we might expect it to also have an important effect on labor market institutions, notably trade unions. Many routine task jobs, such as assembly line work, were in heavily unionized plants. With technological change, however, industrial employment declined. Factories had fewer workers and workers moved into service sector occupations, which did not have histories of unionization (Hirsch, 2008). Furthermore, the skill composition of the workforce became more polarized, with increased demand for high-skill workers, but also for low-skill workers (Goos, Manning and Salomons, 2014).

There is some recent evidence that technological change has been in part responsible for the decline in union density,

both in the USA and across the Organisation for Economic Co-operation and Development (OECD) (Dinlersoz and Greenwood, 2016; Meyer, forthcoming). But there has also been divergence in several countries between the percentage of workers who are union members, which has declined almost everywhere, and the percentage of workers who are covered by collective agreements (Figure 1). One important reason for this is that in several European countries, such as France, Spain, and Italy, the government typically extends collective agreements to firms that do not sign them, regardless of union membership rates (Blainpain, 2005). And collective agreement coverage is very important; as we can see in Figure 2, there is a negative cross-country correlation

<sup>1</sup>Tony Blair Institute for Global Change, UK

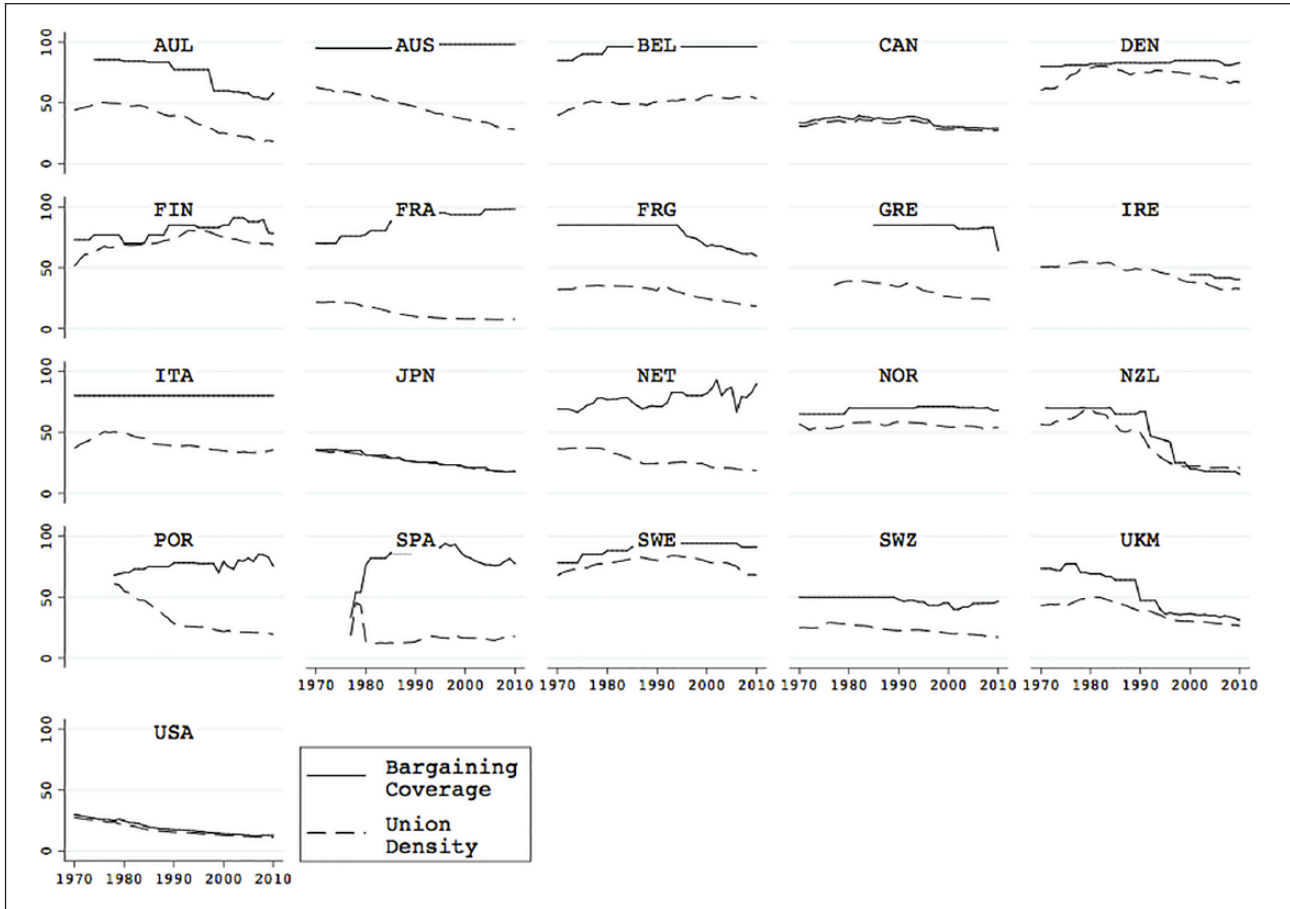
<sup>2</sup>London School of Economics, UK

### Corresponding author:

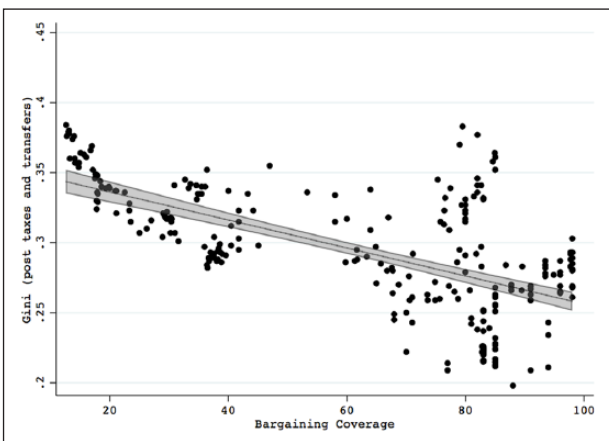
Brett Meyer, Tony Blair Institute for Global Change, 50 Broadway, London SW1H 0BL, UK.

Email: [brettem@gmail.com](mailto:brettem@gmail.com)





**Figure 1.** Bargaining coverage and union density over time. AUL: Australia; AUS: Austria; BEL: Belgium; CAN: Canada; DEN: Denmark; FIN: Finland; FRA: France; FRG: Germany; GRE: Greece; IRE: Ireland; ITA: Italy; JPN: Japan; NET: Netherlands; NOR: Norway; NZL: New Zealand; POR: Portugal; SPA: Spain; SWE: Sweden; SWZ: Switzerland; UKM: United Kingdom; USA: United States of America. Source: Visser (2014).



**Figure 2.** Bargaining coverage and income inequality. Sources: Organisation for Economic Co-operation and Development (OECD) and Visser (2014).

between collective agreement coverage and inequality. In the Scandinavian countries, collective agreements are in large part responsible for setting high minimum wages (Meyer,

2016). Despite this, most cross-national studies of union strength analyze union density rather than collective bargaining coverage.

In this paper, we address whether technological change also affects collective agreement coverage. First, we analyze collective bargaining coverage for a sample of 21 OECD countries from 1970 to 2010. We find that the effect of technological change is conditional on whether the government extends collective agreements to firms that do not sign them. Where there are minimal or no provisions to extend collective agreements, such as in the USA, the United Kingdom, and the Scandinavian countries, technological change is associated with a decline in collective bargaining coverage. Where collective agreements are commonly extended, as in France and Spain, there is little relationship between technological change and collective bargaining coverage.

Based on this finding, we further probe the relationship between technological change and collective agreement coverage in contexts where the government has minimal involvement in collective agreement application. We develop an argument for how technological change would

cause the decline of collective agreement coverage in such an environment by increasing labor market polarization. In previous generations, industrial production required large amounts of semiskilled workers performing routine tasks. Technological change has eliminated many of these jobs, resulting in increased demand for both high- and low-skill workers. Therefore, at least in part, the effect of technological change on collective agreement coverage should be due to the between-skill group polarization that it creates.

We test this argument on a sample of linked employer-employee firm and industry-level data from Germany from 1993 to 2007. While there are legal provisions to extend collective agreements in Germany, the legal hurdles to triggering them are high and they are much less commonly used than in other continental countries. We develop a measure of the heterogeneity of workers' skill profiles based on education levels. We include both this and a measure of routine task employment and find evidence for the skill heterogeneity effect in both the firm- and industry-level analyses. When skill heterogeneity is high, firms are less likely to participate in collective agreements and industry-level rates of participation are lower. This corroborates the mechanism underlying our theory—that the effect of technological change on collective agreement coverage occurs (at least in part) through its polarizing effect.

### Collective agreement coverage: Cross-national analysis

The standard argument for how technological change causes trade union decline is that the most heavily unionized workers worked in manufacturing and industry and that these occupations were most susceptible to labor-saving technologies (Hirsch, 2008). The effect came largely through attrition; unionized jobs in industry were lost and replaced by nonunionized jobs in service sectors. In this section, we examine whether this relationship holds for collective bargaining coverage in a cross-national sample.

In addition to examining different outcome variables, previous work on technological change and union decline has not accounted for how institutions might mediate this relationship. Governments play an important role in the scope of collective bargaining coverage across much of Europe. In France and Spain, the government typically declares collective agreements to be universally binding within a sector, even if a relatively low percentage of workers work in firms that sign these. In these countries, collective bargaining coverage has remained high even though union density is often very low. In English-speaking countries, where extension procedures are almost nonexistent, rates of collective agreement coverage track union density much more closely.

For these reasons, we expect the relationship between technological change and collective agreement coverage to be conditional on the degree to which governments extend

collective agreements. Specifically, we expect technological change to be associated with lower collective bargaining coverage *only* when the government does not extend collective agreements.

To test this, we examine a dataset of 21 OECD countries from 1970 to 2010. Data on collective bargaining coverage, the percentage of the workforce covered by a collective agreement, come from Visser (2015).<sup>1</sup> To capture technological change, we generate a measure of routine task employment (RTE) using data on occupational distributions from European Union Labor Force Surveys for the period 1992–2010 and from the International Labor Organization pre-1992.<sup>2</sup> We generate our measure of RTE by computing the percentage of employment for each occupation within each country year, multiply each of these by the respective measures of occupational routine task intensity (we obtain the occupation-specific indicator for routine-task intensity from Goos et al., 2014), and then sum these scores within country-year. Our measure indicates the degree of employment in routine task occupations in each country-year. If technological change is associated with declining collective bargaining coverage, we would expect a *positive* coefficient on RTE; that is, bargaining coverage is higher when RTE is higher.

Our measure of extension procedures EXT comes from Visser (2014) and consists of four categories indicating increasing presence of extension. We expect a positive relationship between EXT and bargaining coverage. We also expect it to mediate the relationship between RTE and coverage. When EXT is high, we would expect the effect of RTE on coverage to be lower than when EXT is low. Because of this, we expect a negative coefficient on the interaction RTE × EXT.

We analyze our data using a Generalized Error Correction Model because panel unit root tests demonstrate nonstationarity in our dependent variable, and cointegration tests demonstrate cointegration between RTE and bargaining coverage (DeBoef and Keele, 2008).

$$\begin{aligned} \Delta Y_t = & \alpha_0 + \tau_1 Y_{t-1} + \beta_0 \Delta X_t + \beta_1 X_{t-1} + \beta_2 \Delta Z_t + \beta_3 Z_{t-1} \\ & + \left( \beta_4 \Delta X_t * \Delta Z_t + \beta_5 \Delta X_t * Z_{t-1} \right) \\ & + \left( \beta_6 X_{t-1} * \Delta Z_t + \beta_7 X_{t-1} * Z_{t-1} \right) \\ & + \beta_k \Delta W_{k,t} + \beta_k W_{k,t-1} + \lambda_j + \gamma_t + \varepsilon \end{aligned}$$

where  $\Delta Y_t$  represents current changes in bargaining coverage (the first-differenced dependent variable addresses nonstationarity). Here  $\Delta X_t$  and  $X_{t-1}$  and  $\Delta Z_t$  and  $Z_{t-1}$ , respectively, are vectors of the current changes and lagged levels of our two main independent variables and  $Y_{t-1}$  is a vector of the lagged level of the dependent variable L.Coverage. The variables  $\tau_1$  and  $\beta_0$  through  $\beta_3$  are their respective coefficients. In parentheses are all possible interaction terms between the current changes and lagged levels of our two main independent variables with  $\beta_4$  through  $\beta_7$  serving as



**Table 1.** Regressions of bargaining coverage on technological change and extension procedures (error correction models).

	(1) Random effects	(2) Random effects	(3) Random effects	(4) Random effects	(5) Fixed effects	(6) Fixed effects
L.Coverage	-0.009 (0.012)	0.001 (0.006)	-0.029 <sup>+</sup> (0.017)	-0.024 (0.016)	-0.179*** (0.032)	-0.169*** (0.033)
D.RTE	0.495 (0.393)	0.192 (0.391)	0.122 (0.509)	-0.357 (0.522)	0.140 (0.502)	-0.167 (0.515)
L.RTE	0.305 (0.242)	0.248 (0.189)	0.219 (0.253)	0.324 (0.266)	0.361 (0.433)	0.472 (0.417)
D.EXT	6.037** (2.002)	1.038 (0.703)	6.230** (1.933)	0.849 (1.133)	5.530* (2.037)	1.017 (1.468)
L.EXT	0.326 (0.260)	0.205 (0.213)	0.552* (0.278)	0.490 <sup>+</sup> (0.275)	1.424 (0.897)	1.425 (0.842)
D.RTE*D.EXT		-12.908*** (0.506)		-13.842*** (1.093)		-12.029*** (1.817)
D.RTE*L.EXT		0.410 (0.262)		-0.000 (0.299)		-0.229 (0.317)
L.RTE*D.EXT		2.512* (0.992)		2.593* (1.146)		2.207 <sup>+</sup> (1.254)
L.RTE*L.EXT		0.254 (0.206)		0.230 <sup>+</sup> (0.124)		0.187 (0.216)
Controls	No	No	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Constant	0.376 (0.845)	-0.099 (0.605)	0.836 (1.171)	0.667 (1.129)	6.522 <sup>+</sup> (3.482)	6.510 <sup>+</sup> (3.259)
Observations	607	607	607	607	607	607
Number of countries	21	21	21	21	21	21

Standardized coefficients, with country clustered SEs in parentheses. Controls include log gross domestic product, percentage of industrial employment, unemployment, cabinet composition, federalism, trade openness, capital account openness, female employment, union density (all from Brady, Huber and Stephens, 2014), works council rights, union organizational and strike rights, collective agreements extension procedures (from Visser, 2015), and “offshorability” (based on Goos, Manning and Salomons, 2014), migration Lee (2005), UN (1977, 1985).

\*\*\* $p < 0.001$ , \*\* $p < 0.01$ , \* $p < 0.05$ , + $p < 0.1$ .

Note: L.XXX refers to one-year lagged levels of a variable while D.XXX refers to first differences.

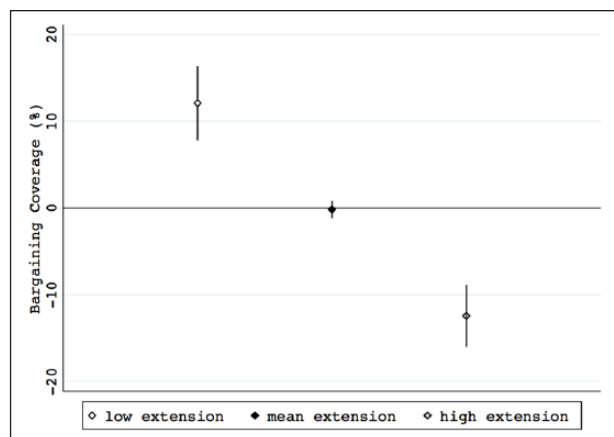
their coefficients (Warner, 2016). Current changes and lagged levels of our control variables are represented by  $\Delta W_{k,t}$  and  $W_{k,t-1}$  with their coefficients in  $\beta_k$ . Finally,  $\lambda_i$  represents country dummies (included in the fixed effects models),  $\gamma_t$  represents year dummies,  $\alpha_0$  is the constant, and  $\varepsilon$  is the error term. We standardize the coefficients so that they can be interpreted as the change in bargaining coverage percentage associated with a 1 SD increase in the respective coefficient.

We first run the models without the country fixed effects and without controls to assess potential overspecification issues or problems arising from restricted variance within countries (Models 1 and 2). Then we successively introduce the covariates (Models 3 and 4) and the country fixed effects (Models 5 and 6). Models 1, 3, and 5 of Table 1 regress bargaining coverage on differences and levels of RTE and EXT in random effects models without and with controls and fixed effects models with controls. Models 2, 4, and 6 present the same models but add the interaction terms between RTE and EXT. The results indicate that there

is no strong main effect of RTE on coverage. A 1 SD increase in EXT, however, is associated with approximately six percentage points higher bargaining coverage, consistent with our expectation.<sup>3</sup>

Looking at the interaction terms, we find some confirmation for our expectations. A short-term increase in RTE has a weaker association with bargaining coverage as EXT increases. Figure 3 (based on Model 6) displays the moderated marginal effect for three levels of EXT (the mean and 1 SD below and above the mean). As we would have expected, when extension provisions are low, higher RTE is strongly positively associated with bargaining coverage. Notice also that when we include the interaction between RTE and EXT, the coefficient on short-run EXT becomes insignificant, further demonstrating the importance of accounting for the conditional relationship between them, as a short-run change in EXT is not associated with a change in coverage when RTE is at the mean (the 0 of the standardized variable).

While these models lend some credence to our theoretical considerations, cautious interpretation is advised. Most



**Figure 3.** Marginal effect of RTE (short-run) on bargaining coverage by levels of extension provisions.

Note: Marginal effects calculated from Model 6 in Table 1 (based on all three coefficients that include D.RTE).

importantly, changes in EXT are very rare and thus the major interaction effect between the first differences of RTE and EXT relies on relatively few observations. This might also explain the large coefficient (e.g., an increase of approximately 13 percentage points in bargaining coverage being associated with a 1 SD increase in RTE in a low EXT context).<sup>4</sup> This issue is exacerbated in the fixed effects models that rely only on within-country variation. Nevertheless, the coefficient on the short-run interaction term is of consistent size across the specifications, which increases our confidence in the robustness of the result.

### Labor market polarization and collective agreements

While we have provided evidence that the relationship between technological change and collective agreement coverage is conditional on extension procedures, many countries either do not have or make minimal use of these procedures. Therefore, it is worthwhile to develop further theory about how technological change should affect collective agreement coverage in an environment without extension.

We build off a limited, but inciteful literature. Acemoglu et al. (2001) developed a model in which technological change causes union decline by shifting the demand for labor in favor of skilled over unskilled workers. This work builds on the concept of skill-biased technological change—that there has been a linearly increasing relationship between skill levels and demand for those skills (Goldin and Katz, 2008). Because unions compress wages between these groups, skilled workers defect from unions.

Dinlisor and Greenwood (2016)<sup>5</sup> argue that skilled workers are more heterogeneous than unskilled workers and will be less likely to form unions due to their interest

heterogeneity. They find an association between skill-biased technological change and union density decline in the USA. While remaining relatively agnostic about the mechanisms, Meyer (forthcoming) finds a similar relationship between technological change and union density decline for a sample of OECD countries.

But while these previous explanations develop their arguments based on skill heterogeneity, the mechanisms that they posit are somewhat different from those suggested by recent work on technological change and employment. In contrast to the skill-biased technological change hypothesis, this recent work has shown that technological change has a polarizing effect on employment, increasing employment at the high and low ends of the wage spectrum while decreasing that in the middle (Autor and Dorn, 2013; Goos et al., 2014).

In line with this new understanding of labor market change, we argue that technological change-induced labor market polarization creates a new economic cleavage between high- and low-skill workers over support for unions that impacts both trade union density and the coverage of collective agreements. Our theory follows recent work in political science on institutional development, which has shown that greater between-group heterogeneity decreases the probability of developing encompassing institutions (Ahlquist, 2010; Lupu and Pontusson, 2011). The polarization of employment into high- and low-wage occupations and “hollowing out” of the middle part of the wage distribution may affect both individual preferences for unionization and the distribution of preferences for unionization across the skill spectrum. High- and low-skill groups should have different preferences for unions, which equalize wages both across and within skill groups, and between firms in multi-firm agreements (Freeman and Medoff, 1984). New technology increases the demand for both programmers and engineers, who create and maintain new technology, as well as for personnel and business managers to manage what are often more complicated production networks. This gives these workers a great deal of individual wage bargaining power and less desire to be represented by unions.

As the distance between skill groups in their ability to make wage demands increases, these different groups should be less likely to agree on whether they should be covered by collective agreements, which redistribute between groups by aiming for parity in wage increases. Low-skill workers want wage redistribution, but high-skill workers do not and have high individual bargaining power in a nonunionized workplace. Furthermore, as demand for high-skill workers increases due to their importance for developing and operating new technology, their wages increase and the wage gap between high-skill and low-skill workers increases. If redistribution raises the median wage toward the mean, the amount that is redistributed from them to low-skill workers increases with the wage gap.

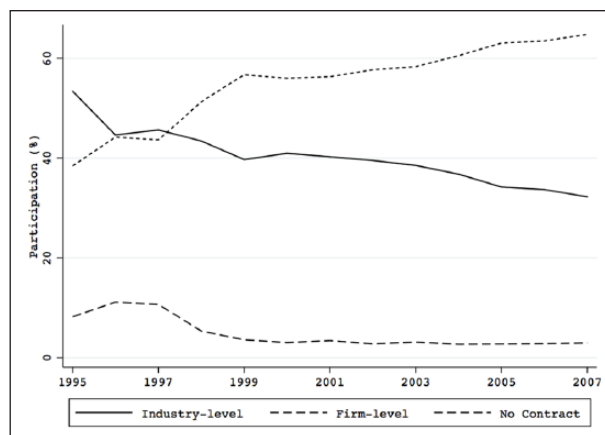
Redistribution has greater “bite” for high-skill workers and they should be more averse to a redistributive institution, such as unions.

### Polarization and collective agreement participation: Evidence from Germany

To test this argument, we use two linked employer-employee data from Germany: the firm-level Linked employer-employee data of the *Institut für Arbeitsmarkt- und Berufsforschung* (LIAB) longitudinal model version 2 and the LIAB Cross-Section Model 2.<sup>6</sup> Both of these datasets consist of the Institute for Employment Research Establishment Panel (*Betriebspanel*), a yearly survey of between 4500 and 16,000 firms with questions on firm performance, employment, training, etc., and social security records drawn for each of the firm's employees each year on June 30, containing information on sex, level of school completion, and occupation. Firms are selected in a stratified random sample according to industry, federal state, and size.<sup>7</sup> The Longitudinal Model includes firms in most or all years of the Establishment Panel while the Cross-Section Model consists of the full yearly sample of firms. We aggregate the latter at the industry-level to examine whether differences in skill profiles between firms are also associated with lower participation in collective agreements.

In Germany, firms make the decision to participate in collective agreements primarily by being members of an employers' association, which concludes an industry-wide agreement with a major union, typically at federal state level (Silvia and Schroeder, 2007).<sup>8</sup> Collective agreement extension exists in Germany, but it has a high threshold for enactment: 50% of firms within a sector nationwide must participate in the collective agreement and the must petition the federal government to extend it to noncovered firms. Although the employer makes the decision to participate in a collective agreement, this will be, in part, a function of employer and worker preferences and power resources, as developed in our theory. While the German case is not generalizable to countries where collective agreement extension is common, it is somewhat analogous to the USA, UK, and Canada, which have, but do not always require, workplace union recognition votes.<sup>9</sup> As we see in Figure 3, although the percentage of firms covered by collective agreements in Germany has been declining, it remains relatively high.

We focus here (see Figure 4) on industry-level agreements, the predominant form of collective agreement. We perform two sets of analyses: (a) a firm-level analysis using the Longitudinal Model; and (b) an industry-level analysis using the (weighted) Cross-Section Model aggregated at the industry-level for each year. The dependent variable in the firm-level analysis is an indicator of whether the firm participates in an industry-level collective agreement. For



**Figure 4.** German firms collective agreement participation. Source: LIAB Cross-Section, Version 2 (weighted data).

the industry-level analysis, it is the percentage of firms participating in an industry-level agreement. We believe that the industry-level analysis is important because workers may sort into firms based on skill level and recent work has shown that German wage inequality is increasingly being driven by differences between firms (Card, Heining and Kline, 2013).

In addition to our RTE variable, which we generate here in the same way as in the cross-national analysis, we generate two measures of worker polarization. In the firm-level data, we generate the SD of worker's education levels for each workplace-year (H.SKILL) from a six-category education variable. At the industry-level, we take the SD of mean firm-level education profiles (from the same six category variable) for all firms in that sector. We hypothesize that firms with higher levels of H.SKILL will be more likely to withdraw from collective agreements and that industries with higher levels of H.SKILL will have a lower percentage of firms participating in collective agreements. We also generate a variable for the workplace's mean education profile (M.SKILL), which we might think, following Thelen (2014), would be associated with a higher probability of collective agreement persistence. High-skill work forces should be more likely to retain collective agreements if they are homogeneous because workers are more difficult to replace.

For the firm-level analysis, we use a Cox Proportional Hazards Model, modeling the number of years until a firm withdraws from a collective agreement as a function of our covariates, plus industry, federal state (*Bundesland*), and industry  $\times$  federal state fixed effects.<sup>10</sup> Because there are several instances in the data where a firm reenters a collective agreement after dropping out in some previous year, we set the data as single-record data where a firm drops out of the dataset after not participating in a collective agreement but reenters the next time it participates in a collective agreement. The clock restarts when the firm reenters a collective

**Table 2.** Firm-level regressions of participation in industry or firm-level collective agreements (hazard ratios in parentheses).

	(1)	(2)	(3)	(4)
H.SKILL	1.04 (4.39)**	1.04 (4.24)***	-0.07 (-2.13)*	-0.06 (-1.74) <sup>+</sup>
RTE	0.99 (-1.62)	0.99 (-0.78)	0.07 (2.32)*	0.10 (2.43)*
M.SKILL	0.97 (-3.31)***	0.97 (-3.22)***	0.06 (1.50)	0.05 (1.17)
Level of analysis	Firm	Firm	Industry	Industry
Controls	No	Yes	No	Yes
Industry fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Industry × year fixed effects	Yes	Yes	—	—
Observations	53,942	22,529	510	510

SEs are clustered at the firm-level in the firm-level analyses and by industry in the industry-level analyses. Firm-level controls in Model 2 include number of workers, percentage of goods exported, percentage of female workers, firm profitability, works council presence, mean workforce age, and a dummy for whether the firm was founded after 1990. Models 1 and 2 contain fixed effects for federal state, industry, and federal state × industry. Coefficients in Models 1 and 2 are hazard ratios. Controls in Model 4 include for mean industrial employment and mean export percentage. Models 3 and 4 include industry and year fixed effects. Coefficients in Models 3 and 4 are percentages.

\*\*\* $p < 0.001$ , \*\* $p < 0.01$ , \* $p < 0.05$ , + $p < 0.1$ .

agreement.<sup>11</sup> For the industry-level analysis, we use Ordinary Least Squares with fixed effects for industry and year.

Table 2, columns 1 and 2, present the firm level results without and with controls respectively, whereas columns 3 and 4 present these for the industry-level data. The regression coefficients in columns 1 and 2 are hazard ratios and give the odds of collective agreement withdrawal with a one-unit increase of the independent variable. Higher values are associated with a higher probability of withdrawal—a hazard ratio of 2 would indicate that with a one-unit increase in the independent variable, twice as many firms withdraw in a given period, whereas a hazard ratio of 0.95 would mean 95% as many firms withdraw. Coefficients in the industry-level regressions in columns 3 and 4 are interpretable as the percentage increase/decrease in collective agreement participation with a one-unit increase in the independent variable.

As we can see, higher skill heterogeneity is associated with a higher percentage of withdrawal from collective agreements both at the firm and industry-level. With an increase in one unit of H.SKILL, firms are four percentage points more likely to withdraw from a collective agreement in a given period in both Models 1 and 2. The opposite is true for firms' mean skill levels; with a one-unit increase in M.SKILL, firms are between three and seven percentage points less likely to withdraw. While higher levels of RTE are associated with lower probability of withdrawal, these

results are not statistically significant. This suggests that the effect is driven by polarization between workers rather than occupational change itself.

The results for skill heterogeneity in the industry-level data are similar. Here, 1 SD of skill difference between firms is associated with seven and six percentage points lower participation in collective agreements respectively. We also find a relationship with RTE; industries with higher RTE also have higher participation in collective agreements. Unlike the firm-level regressions, we do not find strong evidence that industries employing higher-skill workers are more likely to participate in collective agreements.

## Conclusion

We find that the effect of technological change on collective agreement coverage is conditional on collective agreement extension and that in Germany, where this is minimally used, the effect is primarily driven by between-worker and between-firm skill heterogeneity. We examine a sample of 21 OECD countries (1970–2010) and find that where governments regularly extend collective agreements, there is little effect of technological change on collective agreement coverage. But where this is uncommon, decline of RTE is associated with reduced collective bargaining coverage. To further probe the mechanism underlying the latter result, we develop theory about how technological change increases polarization between skill groups in union preferences and test this in firm- and industry-level data from Germany. We find that skill heterogeneity is associated with lower participation in collective agreements at both the firm- and industry-level.

Our results underscore the importance of institutional factors for union strength. Although this general point is hardly original, recent work on how technological change impacts unions has not accounted for the potentially conditional relationship between technological change and institutions. Our results suggest that even if technological change further threatens, politicians can reduce this effect on union outcomes by creating legal conditions more favorable for collective agreement coverage.

## Acknowledgements

We thank Matthew Dimick, John Huber, Isabela Mares, Vicky Murillo, and Josh Whitford as well as participants of the 2014 Midwest Political Science Association annual meetings, the 2014 Columbia University Technology, Economy, Democracy (CUTED) workshop, and seminar participants at Columbia University for helpful comments on earlier drafts of this article.

## Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

## Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: Brett Meyer was funded in part by a Deutscher Akademischer Austauschdienst (DAAD) short-term research grant (A/12/72761) and a Berlin Program for Advanced German and European Studies fellowship.

## Supplemental materials

The supplemental files are available at <http://journals.sagepub.com/doi/suppl/10.1177/2053168018823957>. The replication files are available at <https://dataverse.harvard.edu/dataset.xhtml?persistentId=doi:10.7910/DVN/FJ9UZU>.

## Notes

1. Bargaining coverage data for several countries is spotty. We use linear interpolation to fill these holes, although we do not interpolate before the first year or after the last year of data.
2. We do not include employment in agriculture or in the armed forces.
3. We do not further interpret the lagged coefficients, but to arrive at the long-run multiplier, the displayed first differenced and lagged coefficient would have to be added and divided by 1 minus the lagged dependent variable (DeBoef and Keele, 2008).
4. The same applies to the interaction effect between lagged RTE and the first differenced EXT, which is not our central focus here.
5. Wallerstein (1990) develops a similar model showing how complementarity between different skill groups enables centralized wage bargaining.
6. Data access was provided via on-site use at the Research Data Centre (*Forschungsdatenzentrum*) of the German Federal Employment Agency (*Bundesministerium für Arbeit*) at the Institute for Employment Research in both Ann Arbor, Michigan, USA and Berlin, Germany.
7. It is compulsory for employers to report the individual data, allowing creation of full firm-year profiles of each firm's workforce characteristics.
8. German establishments have historically signed only one collective agreement, which covers all of their workers. However, this has begun to change, following a 2010 Supreme Court ruling, which held that establishments could be covered by multiple agreements. The current grand coalition government has considered a law that would mandate no more than one collective agreement per workplace (that of the largest union), in part in response to persistent strikes by minority railway and pilot unions in 2015.
9. Unlike Germany, each of these countries has a formal balloting procedure through which workers in individual workplaces decide whether to be represented by a union. These votes are not necessary in Canada or the USA, however, if the employer voluntarily agrees to recognize a union through a "card check" procedure, under which a substantial percentage of workers (30–50% in Canada; >50% in the USA) vote for union recognition. Union recognition in the UK was historically voluntary on the part of employers, as it currently is in Germany, with

the statutory recognition process having been introduced in the 1999 Employment Relations Act.

10. Industry  $\times$  federal state fixed effects are especially important because collective agreements are typically concluded at the federal state level.
11. We perform three additional firm-level analyses in the Online Appendix, where we vary the method of accounting for multiple collective agreement withdrawals. The results are substantively very similar.

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# Did State Responses to Automation Matter for Voters?

Jane Gingrich

Research and Politics  
January-March 2019: 1–9  
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sagepub.com/journals-permissions  
DOI: 10.1177/2053168019832745  
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## Abstract

This paper asks whether early responses to de-industrialization and automation shaped how those affected negatively by technological change responded politically. It begins by examining patterns of compensation, outlining cross-national differences in the use of passive early retirement benefits, the expansion of public services, and regulation of the labor market. It then pools 20 waves of the International Social Survey Programme, and examines party choices across groups of workers. It finds that those exposed to technological change are both more likely to vote for the mainstream left and right populists. Differences in compensation have a limited direct or indirect effect. Where spending and labor market regulation does matter, it heightens both left and right-populist voting among affected groups.

## Keywords

Technology, welfare state, compensation

## Introduction

In 2017, the *New Yorker* magazine featured a cover image portraying a group of marching robots, one turning to toss a coin to a bedraggled, left-behind human.<sup>1</sup> This image advances a provocative claim: technological change, far from making all better off, will cause many to lose out. As robots replace old jobs faster than new jobs are created, those who benefit from automation – owners of capital, highly-skilled workers – and those who lose from it – displaced workers – are increasingly expressing different preferences, not just over tax policy or trade, but over the fundamental features of liberal democracy.<sup>2</sup> In response, many advocate for social policies that redistribute income, or more radically, establish a basic income, to limit these divides (e.g., van Parijs and Vanderborght, 2017). But does economic compensation actually shore up support for mainstream parties among the “losers” of automation?

To answer this question, this paper turns to the experience of automation over the past three decades. Oesch and Rodriguez Menes (2010) find that the employment share of “routine jobs” – those using skills replaceable by technology – declined by 30–40% from the early 1990s to late 2000s in the European countries they examine. While these declines occurred everywhere, social welfare programs and labor regulation have modified their pace and distributional implications, creating substantial cross-country variation in experiences.

Drawing on an analysis of 20 waves of the International Social Survey Programme (ISSP), this paper examines whether these varying compensatory policies are associated with differences in party preferences among those negatively exposed to technological change. It finds that, overall, those in the occupations most negatively exposed to automation are more likely to support both mainstream left parties and populist right parties. The impact of compensatory policies on shaping this support is mixed. Where there is more compensation, voters heavily exposed to automation are relatively more likely to support center-left parties than those less exposed. However, automation is associated with populist right voting among exposed workers in both the presence and absence of compensation. While compensation for automation may help left-wing parties retain vote share among the exposed, it does not forestall the rise of the populist right. The paper first reviews compensatory responses and then turns to the ISSP analysis.

Department of Politics and International Relations, University of Oxford  
Oxford, UK

### Corresponding author:

Jane Gingrich, Department of Politics and International Relations,  
University of Oxford, Magdalen College, High Street, OX1 4AU,  
UK.

Email: jane.gingrich@politics.ox.ac.uk



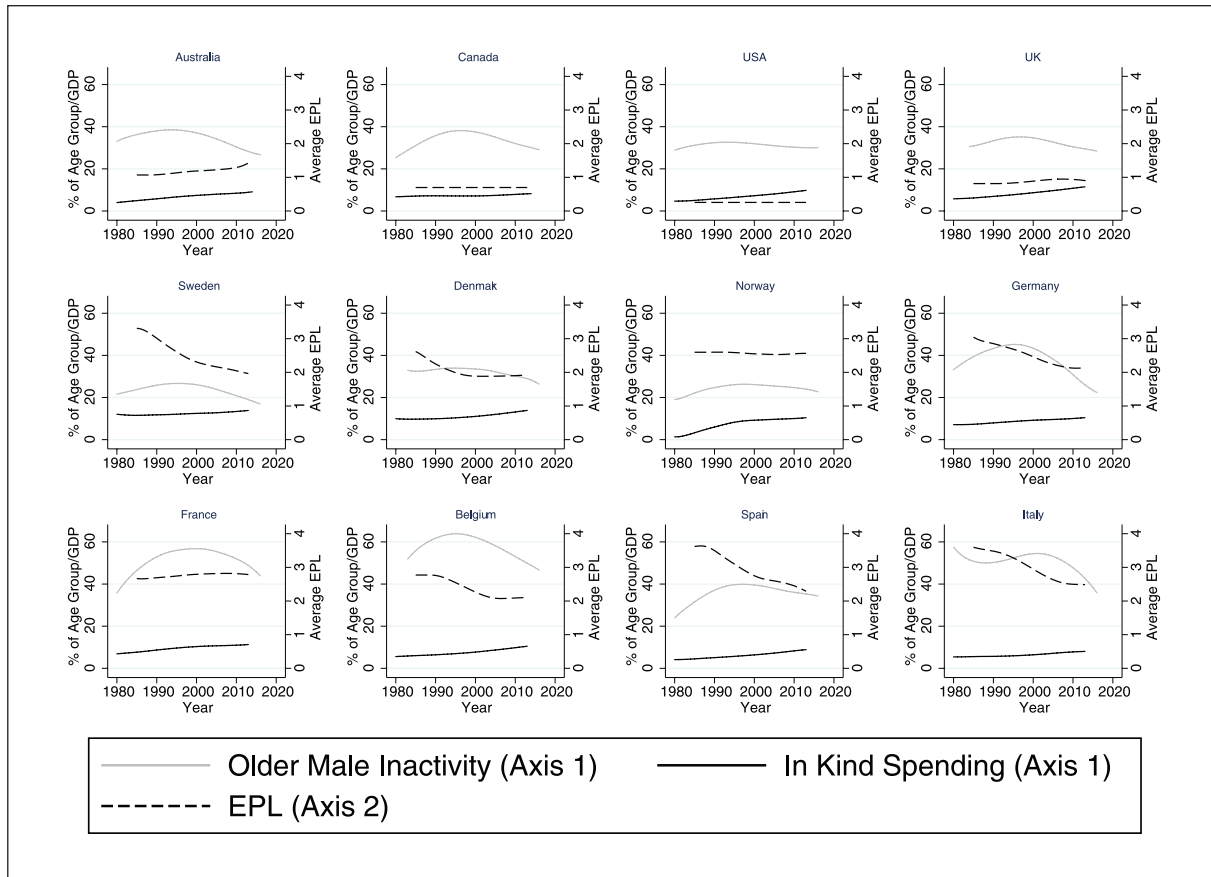


Figure 1. Policy Differences Across Countries.

## Policies targeting the post-industrial transition

From the late 1970s, trade, technology and other social changes increasingly put pressure on traditional industrial jobs. In the face of de-industrialization in the 1980s and 1990s, policymakers pursued a range of strategies that aimed to both compensate older cohorts of industrial workers for these changes and integrate new cohorts of workers into a changing labor force. The direct pressures of automation were often quite distinct to de-industrialization – indeed, some of the occupations hard hit by automation in this period, such as office clerks, were largely non-industrial. However, the policies used to address the transition to a post-industrial economic structure had important implications for those affected by automation.

What were these policies? On aggregate, nearly all countries initially expanded the state as an employer and source of transfers; partly through purposive actions, partly through the “automatic stabilizer” of the welfare state. The character of this expansion, however, varied in three major areas: the use of early retirement benefits, labor market regulation, and the expansion of public services (Iversen and Wren, 1998).

Figure 1 outlines this policy variation. For an illustrative group of countries it shows the percentage of men between 55 and 64 who are economically inactive, a measure of access to early retirement benefits. Although measuring an outcome, not a policy, this indicator is preferable to cross-national spending data, which do not consistently define early retirement policies. On the same axis, it shows in-kind spending as a percentage of GDP – a measure of public service spending. Finally, the second y-axis shows a combined measure of employment protection legislation (hereafter referred to as EPL), with higher numbers demonstrating stricter rules regarding tenure and dismissal of individuals in permanent jobs and more restrictions on hiring temporary workers.<sup>3</sup>

Iversen and Wren’s (1998) early analysis of these differences maps onto Figure 1. They argue that Anglo-countries tended to pursue a market approach to employment regulation (lower EPL) with less extensive support for either early retirement or public services. Continental policymakers maintained regulated labor markets but limited public service expansion (relative to the Nordic countries), cementing a safety net built around transfers, especially early retirement (Ebbinghaus, 2006). Finally, the Nordic countries expanded public sector jobs alongside a more regulated private labor market and less early retirement.



While no strategy prevented dramatic changes in the nature of work, these early differences did shape a) the risks faced by incumbent workers and b) the experiences of new labor market entrants (see Kurer and Gallego, 2019). For older workers threatened by automation, the Scandinavian and Continental paths offered substantially more protection, both reducing the likelihood of job loss and cushioning against its income effects. For younger workers, the anemic job creation in the European Continent contributed to new cleavages between those “inside” and “outside” the labor market (Rueda, 2007). Over time, these differences have blurred. The UK, for instance, substantially increased public service spending through the 2000s, whereas Germany limited both early retirement and cut parts of EPL. Thus, there are substantial cross-place and cross-time differences in the *type* and *degree* of compensating approaches.

### Does compensation matter for voters?

In order to theorize whether compensating approaches altered not just the economic, but the political, consequences of automation, we first need to theorize how “uncompensated” voters respond to automation. A number of recent studies point to two distinct – and potentially contradictory – mechanisms through which automation may affect party choice.

Recent work by Thewissen and Rueda (2019) shows that exposure to automation creates more economic insecurity among exposed workers, encouraging pro-redistributive attitudes. Those who are economically insecure, either because of threats to their own jobs, or changing demand for their skills, are more likely to support some form of redistributive policies. Such policies are traditionally associated with the mainstream left.

A second strand of literature, however, argues that those exposed to automation experience a particular form of insecurity that has non-material effects. Automation has contributed to a decline in the overall demand for mid-skilled work (Goos and Manning, 2014). Existing mid-skilled workers thus face the risk of occupational downgrading (as upgrading through the career cycle is limited) while for new cohorts of workers mid-level skills no longer provide a secure route to a middle-class status. “Status anxiety,” particularly among men, is a strong predictor of populist voting (Gidron and Hall, 2017; Kurer, 2018). Right-populist parties often directly appeal to status concerns, while mainstream left parties, dependent on a middle-class base (Gingrich and Hausermann, 2015), have reduced explicit class-based appeals (e.g., Evans and Tilley, 2017). Im et al. (2018) show that those in occupations hard hit by technological change are more likely to support right populists. Automation then, simultaneously threatens the material well-being *and* social status of exposed workers, the former mechanism pushing voters to

the mainstream left parties, while the latter pushes them to the populist right.

A large literature on compensation suggests that it *should* matter which of these mechanisms dominate.<sup>4</sup> Those studying economic integration have long argued that policies that directly reduce the negative effects of economic volatility on workers’ material well-being can underpin workers’ support for both open markets and mainstream left politics. In an early study of populist voting, Swank and Betz (2003) investigate this logic of “embedded liberalism,” finding that social welfare programs moderate the effect of global integration on support for the far-right. More recently, Halikiopoulou and Vlandas (2016) make a similar claim with regard to economic shocks, arguing that generous welfare states, in securing individual income, reduce the effect of unemployment on populist voting.

While compensatory policies vary in their distributional character, all three of the compensatory approaches outlined above cushion existing workers to some extent from economic change, with labor market regulation limiting the threat of job loss, early retirement programs limiting occupational downgrading, and public services offering both new benefits and opportunities. When the above logic is extended to automation, it suggests that these compensatory approaches, in reducing economic insecurity, should reduce the appeal of populist parties among exposed workers and maintain their support for parties on the left.

H<sub>1</sub>: All else equal, greater spending on public services, more access to early retirement benefits, and higher EPL – in cushioning the material effects of automation – should increase support for center-left parties among those negatively exposed to automation.

H<sub>2</sub>: All else equal, these same compensatory mechanisms should reduce support for populist parties among those negatively exposed to automation.

### Empirical approach

Based on the above hypotheses, we would expect a) those in highly exposed occupations to have systematically different party preferences to those in less exposed occupations and b) the compensatory context should limit these differences.

Since compensation varies over both time and place (Figure 1), testing these differences requires a multi-level cross-time design. To accomplish this task, I combine all waves of the ISSP from 1995 to 2015. I restrict my analysis to long-standing democracies with post-industrial labor markets, where both technological change and compensation have had time to develop.<sup>5</sup>

The ISSP asks about party choice in each wave; unfortunately, the measures vary. Earlier waves asked respondents about their prospective vote choice or party affiliation, whereas more recent waves ask for retrospective vote

choices. These differences limit the surveys' utility in studying questions sensitive to timing, but allow for an evaluation of broad party choices.

I group parties into families: the non-social democratic left (Green, Left, and Communist parties), mainstream left (Social Democrats), mainstream right parties (Liberal, Christian Democrat, and Conservative), right-populist parties, and non-voters (Online Appendix 2). I exclude very small parties (with under 15 respondents over the time period), and regional parties.<sup>6</sup> Those who refused to list a party choice or did not answer are coded as missing.<sup>7</sup>

In order to measure exposure to automation at the individual level, I categorize respondents based on their occupation. I convert varying occupational measures into a 2-digit ISCO-88 code,<sup>8</sup> and link it to an aggregated "routine task intensity" (RTI) index (Goos and Manning, 2014). Autor and Dorn (2013) developed the RTI index to categorize occupations based on the skills most exposed to pressures of automation through the 1980s and 1990s.<sup>9</sup> While other papers in this issue (Im et al., 2018, Kurer and Gallego, 2019) use alternative measures of exposure to automation, the RTI index captures the process of automation during the period under analysis. Because I am interested in broad categories of exposure, I aggregate the RTI measure into five quintiles, rescaled 0–1, ranging from least to most exposed.<sup>10</sup> I restrict my analysis to those in the labor market between the ages of 20 and 65, excluding students, non-working spouses, and the retired. The exclusion of retirees is necessary due to inconsistencies across countries in reporting previous occupations.

First, to investigate cross-sectional differences, I conduct a multinomial logistic regression, regressing party family choice on individual exposure to automation (RTI) and the interaction between the RTI and the *level* of compensation averaged across a five-year cycle. These models allow me to assess whether there is a systematic association between compensation and party choice among exposed workers.

Because the country coverage is unbalanced across years, I pool observations in five-year cycles from 1995–2015. I restrict this analysis to countries that appear at least once per cycle, thus all countries are represented in each cycle.<sup>11</sup> In the multinomial analysis, I first pool all the cycles and include cycle dummies (supplementary figures A3 and A4 show each cycle).

In each model, I include individual controls for age, sex, having a college degree, having no upper secondary education, and being unemployed. Including income reduces the sample size (due to missing data), thus I exclude it, but its inclusion does not dramatically change the results. Due to the small number of countries, I only include a dummy for the electoral system in these models (coded as 1 for proportional, and zero for plurality or the modified system of Australia, France, Italy and Japan) and a measure of the unemployment rate (Armingeon et al., 2015). I further re-estimate each model including only those where any

respondents select a right-populist party in the cycle, which drops Canada, Ireland, Japan, Spain, Portugal, the US and the UK (supplementary Table A2).

Second, to investigate differences within a country over time, I turn to country fixed effects models. To ease interpretation, I dichotomize mainstream left and right-populist party choice, and run a linear probability model, regressing party choice on RTI, and the cross-level interaction between exposure and the core compensation variables. Because fixed effects models net out the overall country effects, the compensation variables in these analyses can be interpreted as differences relative to the within-country sample mean. In these models, I use the full time period and sample (restricting it to the same sample as above does not substantially change the results, nor does using a multinomial logit with fixed effects), including the same individual variables as outlined above and year dummies. At the country level, I further include a control for the unemployment rate.

For both the multinomial logit and the fixed effects models, I cluster standard errors by country year/cycle.<sup>12</sup> I further re-run the above specifications with country random effects (supplementary Table A3). Collectively, these specifications assess whether it is plausible that compensation generally, specific forms of compensation, or within-countries changes in compensation, shape how individual exposure to automation matters for party choice.

## Results

Table 1 outlines the first multinomial logit model, regressing party choice on exposure to automation (RTI), and the cross-level interaction between the compensation variables and RTI. The baseline category is selecting the mainstream right. We see that for the sample as a whole, RTI is associated with increased probability of choosing the mainstream left (column 1) as well as right populists (column 5). The results for other left parties and non-voting are in the supplementary material.

Examining mainstream left support first, Table 1 shows that none of the compensation variables have a direct effect on support (when RTI equals zero). The cross-level interactions between exposure to RTI and inactivity (early retirement), in-kind spending (public services) and EPL (labor market regulation) are all positive and significant (columns 2, 3, and 4). This outcome implies that there is a greater difference in support for the mainstream left among those with higher and lower levels of exposure in all three compensatory contexts.

Drawing on the regression results in Table 1, Figure 2a shows these outcomes graphically. It illustrates the predicted marginal effect of moving from the least to the most exposed occupations on choosing the mainstream left, in both contexts with low values (10<sup>th</sup> percentile of the sample) of public spending, early retirement, and EPL, and in

**Table 1.** Multinomial Logit.

Variables	Mainstream Left				Right Populist			
	1	2	3	4	5	6	7	8
Baseline=Main-Right								
Sex	0.13** (0.03)	0.12** (0.03)	0.13** (0.03)	0.13** (0.03)	-0.41** (0.04)	-0.41** (0.04)	-0.41** (0.04)	-0.41** (0.04)
Age	-0.00 (0.00)	-0.00 (0.00)	-0.00 (0.00)	-0.00 (0.00)	-0.01** (0.00)	-0.01** (0.00)	-0.01** (0.00)	-0.01** (0.00)
No Secondary	0.36** (0.05)	0.36** (0.05)	0.37** (0.05)	0.31** (0.05)	0.14 (0.09)	0.14 (0.10)	0.15 (0.10)	0.10 (0.09)
Degree	-0.15** (0.03)	-0.15** (0.03)	-0.15** (0.03)	-0.16** (0.03)	-0.87** (0.11)	-0.84** (0.10)	-0.88** (0.11)	-0.88** (0.11)
Unemployed	0.42** (0.05)	0.42** (0.05)	0.42** (0.05)	0.43** (0.05)	0.38** (0.09)	0.37** (0.09)	0.38** (0.09)	0.38** (0.09)
Exposure (RTI)	0.43** (0.05)	0.06 (0.17)	-0.24 (0.21)	0.12 (0.09)	0.65** (0.09)	0.58** (0.24)	-0.60** (0.26)	0.76** (0.22)
Policy: Inactivity		0.03 (0.39)				2.59** (1.17)		
RTI*Inactivity		1.09** (0.44)				0.01 (0.60)		
Policy: In-Kind Spending			-2.61 (2.41)				-6.80 (6.21)	
RTI*In Kind			7.45** (2.32)				13.59** (2.73)	
Policy: EPL				0.07 (0.09)				0.20 (0.22)
RTI*EPL				0.17** (0.05)				-0.04 (0.12)
Unem. Rate	-0.00 (0.01)	-0.01 (0.01)	-0.00 (0.01)	-0.01 (0.01)	-0.26** (0.06)	-0.32** (0.05)	-0.27** (0.07)	-0.26** (0.06)
PR system	-0.10 (0.12)	-0.12 (0.12)	-0.10 (0.12)	-0.29** (0.13)	3.28** (0.45)	3.20** (0.44)	3.32** (0.46)	3.07** (0.50)
Constant	-0.53** (0.19)	-0.52** (0.21)	-0.29 (0.29)	-0.49** (0.23)	-2.62** (0.66)	-3.29** (0.73)	-1.97** (0.74)	-2.82** (0.67)
Observations	170,859	170,859	170,859	170,859	170,859	170,859	170,859	170,859
Cycle Dummies	y	y	y	y	y	y	y	y
Question Dummies	y	y	y	y	y	y	y	y

RTI: Routine task intensity groups; EPL: Employment protection legislation; PR electoral system: Proportional representation.

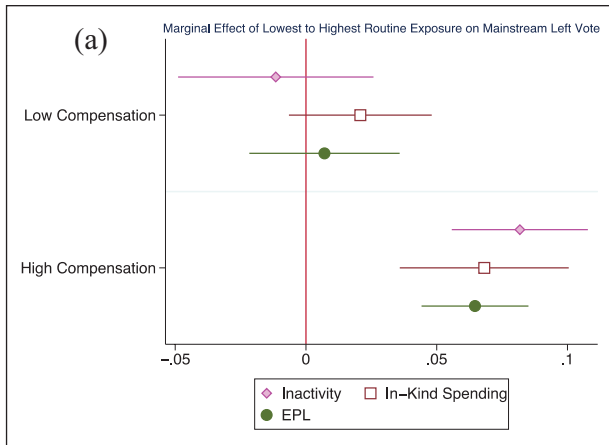
\*\* $p < 0.05$ ; \* $p < 0.1$ .

contexts with high values (90<sup>th</sup> percentile of the sample). At low levels of inactivity, spending, and EPL, an increase in RTI is not a significant predictor of mainstream left vote choices, whereas at high levels, it is. However, this outcome is only a partial confirmation of  $H_1$ . More compensation is associated with greater relative support for the left among the exposed. This outcome, however, is driven in part by lower support among those with low exposure (supplementary Figure A1). Compensation may shore up support for the left among one group, but reduce it among another.

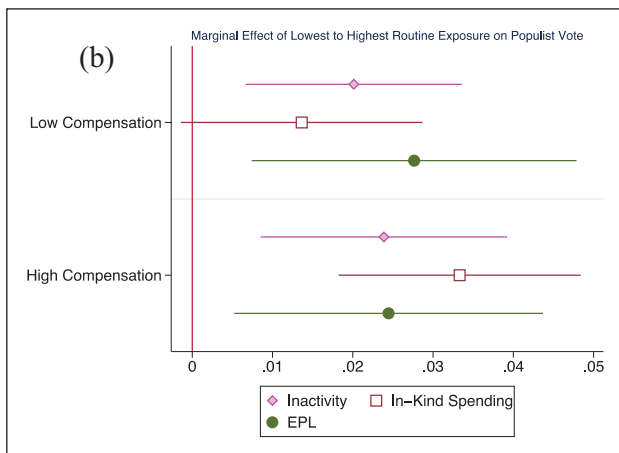
When we turn to right-populist choices, we see little evidence for  $H_2$ . Higher levels of inactivity (when RTI is at zero) is associated with *increased* populist choice, with no additional effect on the exposed (column 6). In-kind

spending has a negative coefficient, but it is not significant. When we restrict the analysis to places with a right populist present (supplementary Table A2), there is a significant negative effect of spending on populist support among those with no exposure (RTI equal to zero), but it has no reducing effect among the highly exposed. Finally, EPL is positively signed but not significant (column 8). These results suggest, if anything, compensation is associated with more populist voting.

Figure 2b, drawing on a model that excludes observations with no right populists shows these effects. While the sample size is low, limiting our inferences, we see that the marginal effect of RTI on the probability of selecting a populist party is consistently around 1–2% – a non-trivial effect given that an average of 6% of respondents selected



**Figure 2a.** Marginal Effect of Lowest to Highest Routine Exposure on Mainstream Left Vote.



**Figure 2b.** Marginal Effect of Lowest to Highest Routine Exposure on Populist Vote.

populists. However, these effects are similar, or even enhanced, in high-compensation contexts.

Table 2 focuses on the fixed effects model. As these models use annual data, and not all the compensation variables are available for 2015, the sample sizes vary. The specifications examining support for right-populists are restricted to country-years with a right-populist contender. Turning to columns 1–4, we can investigate the effects of differences in compensation *within* countries on mainstream left party choice. Here we see a positive direct effect of inactivity on mainstream left choice, but no interactive effect with exposure (RTI) (column 2). As with the multinomial logit models, there is no direct effect of either in-kind spending or EPL on support for the mainstream left, but both, in relative terms, enhance support the mainstream left among exposed workers (columns 3 and 4). The results of the fixed effects models, for the mainstream left, are substantively similar to those outlined above.

Columns 5–8 show the results for right-populist parties. Here, inactivity has a relatively strong negative effect on populist support, and it reduces the effect of exposure. This finding suggests that downward *changes* within countries in levels of inactivity – cut backs – are associated with both increases in overall populist support and increases among those most negatively exposed to automation. The results for in-kind spending are similar to the multinomial logit models discussed above, exposed workers are more supportive in contexts with high in-kind spending. EPL again has little effect.

Both specifications come from a small number of countries and draw on observational data, meaning that they must be interpreted with caution. Collectively, however, they do not provide consistent evidence that compensation has the political effects hypothesized above. In line with  $H_1$ , there is a positive association between compensation and relative mainstream left support among the highly exposed group across place and time. These results, though, come partly from lower overall support in these contexts from workers with low negative exposure to automation.

Across places, there is little evidence that compensation reduces populism, and may in fact enhance it. The fixed effects models hint that cutbacks in early retirement are associated with more support for populism, but not cuts in either spending or EPL. This evidence then, is unsupportive of the claim that more extensive compensation in the face of past automation substantially moderated populism among exposed workers.<sup>14</sup>

## Conclusions

In the observational evidence presented here, we see that the compensatory approaches that deeply modified the structures of advanced labor markets appear to have weak or inconsistent effects on how voters responded to new economic pressures – in some cases shoring up support for both the mainstream left and right populists. Do these results suggest that compensation does not matter?

Not necessarily. Social programs very likely have prevented much radicalization among voters in the face of economic shocks (Halikiopoulou and Vlandas, 2016), and pronounced fiscal austerity and direct cuts to social programs may stimulate a backlash. However, it is possible that compensatory policies are less important for how structural economic pressures play out politically in the face of automation than past forms of compensation were in the face of globalization, as affected workers face the risk of losing both income and status.

If voters react to such structural pressures similarly, regardless of the range of compensatory approaches that address their dislocation, then it may point to the limits of such policies alone in reducing dislocation. Instead, we may need to examine the way in which economic pressures matter, and

**Table 2.** Fixed effects, full sample.

Variables	Mainstream left = 1, All other = 0				Populist right = 1, All other = 0			
	1	2	3	4	5	6	7	8
Sex	0.01** (0.00)	0.01** (0.00)	0.01** (0.00)	0.01** (0.00)	-0.03** (0.00)	-0.03** (0.00)	-0.03** (0.00)	-0.03** (0.00)
Age	0.00** (0.00)	0.00** (0.00)	0.00** (0.00)	0.00** (0.00)	-0.00** (0.00)	-0.00** (0.00)	-0.00** (0.00)	-0.00** (0.00)
No secondary	0.03** (0.01)	0.03** (0.01)	0.04** (0.01)	0.03** (0.01)	0.02** (0.00)	0.02** (0.00)	0.02** (0.00)	0.02** (0.00)
Degree	-0.00 (0.00)	-0.00 (0.00)	-0.01** (0.00)	-0.01** (0.00)	-0.04** (0.00)	-0.04** (0.00)	-0.05** (0.00)	-0.05** (0.00)
Unemployed	0.02** (0.01)	0.02** (0.01)	0.02** (0.01)	0.02** (0.01)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Exposure (RTI)	0.04** (0.00)	0.02 (0.02)	-0.06** (0.02)	0.01 (0.01)	0.02** (0.00)	0.04** (0.01)	-0.03** (0.01)	0.00 (0.01)
Policy: Inactivity		0.22* (0.12)				-0.31** (0.10)		
RTI*Inactivity		0.05 (0.04)				-0.06** (0.03)		
Policy: In-kind spending			-0.49 (0.83)				1.03 (0.67)	
RTI*In kind			1.19** (0.23)				0.52** (0.16)	
Policy: EPL				0.01 (0.03)				0.01 (0.02)
RTI*EPL				0.02** (0.01)				0.01 (0.01)
Unem. rate	0.00 (0.00)	0.00* (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	-0.00 (0.00)	-0.00 (0.00)
PR system	-0.01** (0.00)	-0.01** (0.00)	-0.01** (0.00)	-0.01** (0.00)	0.00* (0.00)	0.01** (0.00)	0.01** (0.00)	0.01** (0.00)
Constant	0.26** (0.03)	0.17** (0.05)	0.31** (0.07)	0.23** (0.06)	0.08** (0.03)	0.18** (0.05)	-0.00 (0.06)	0.05 (0.06)
Observations	186,066	186,066	168,191	167,518	125,558	125,558	110,362	109,689
R-squared	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.06
Country dummies	y	y	y	y	y	y	y	y
Cycle dummies	y	y	y	y	y	y	y	y
Question dummies	y	y	y	y	y	y	y	y

\*\* $p < 0.05$ ; \* $p < 0.1$ .

how they are mobilized, looking less at experienced insecurity, and more at how labor markets structure opportunities and choices for voters. Returning to the questions raised in the introduction, this latter interpretation suggests that compensating the “losers” of change may not be enough to prevent the far-reaching political consequences of automation, instead we need to consider policies that make more people “winners” in the new economic environment.

### Acknowledgements

The author would like to thank Ben Ansell, Bruno Palier, Thomas Kurer and the participants in the Pocotech workshops for feedback on earlier drafts.

### Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

### Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

### Supplemental materials

The supplemental files are available at <http://journals.sagepub.com/doi/suppl/10.1177/2053168019832745>

The replication files are available at <https://dataverse.harvard.edu/dataset.xhtml?persistentId=doi:10.7910/DVN/MR1QW3>

## Notes

1. <https://www.newyorker.com/culture/cover-story/cover-story-2017-10-23>
2. On the “losers” of change, see Im et al. (2018), Kurer (2018), Kurer and Gallego (2018), Frey, Berger and Chen (2017); on the “winners,” on new voting cleavages, e.g., Gingrich and Hausermann (2015).
3. The data on inactivity comes from the OECD Annual Labor Force Statistics. The in-kind spending comes from the OECD SOCX database. The EPL data are from version 1 of the OECD Employment Protection Database.
4. The compensating responses discussed here were introduced/cut slowly, thus conceptualizing compensation in terms of rewards/sanctioning of incumbents is less directly applicable (Margalit, 2011).
5. See the Online Appendix for countries by wave.
6. I follow the ISSP coding of Spanish regional parties as left or (mainstream) right parties. I include the Belgian N-VA as a populist party. The analysis excludes the Bloc Quebecois (Canada), the Swedish People’s Party (Finland), Scottish National Party and Plaid Cymru (UK), and Sinn Fein (Ireland).
7. There are few systematic differences across occupational groups in terms of response rates. The problems are more severe across countries. To compensate for missing data, I included a dummy for question type, and ran the models with different sample restrictions (see supplementary material).
8. In earlier waves, some countries use the ISCO-68 classification or nationally specific codes, and more recent waves use the ISCO-08 methodology. I converted these to a two-digit ISCO 88 classification, following Iversen and Soskice (2001) for the older codes and the ILO crosswalk for the 2008 codes, matching to the largest group in the category.
9. Goos and Manning (2014) provide an ISCO-2 digit measure of Autor and Dorn’s RTI indicator, which is weighted by labor force share. This measure is missing for three major occupational groups (ISCO 23, 33, and 61). In the supplementary material, I show that the results are robust to the inclusion of occupational dummies for these excluded groups.
10. From least to most exposed: 0 (ISCO 12, 13, 21, 22, 24, 83); .25 (ISCO 31, 34, 51); 0.5 (ISCO 32, 52, 71, 91); .75 (ISCO 72, 81, 82 93); 1 (ISCO 41, 42, 73, 74).
11. This exclusion drops Italy and Belgium. The year 2015 is included with the 2010–2014 cycle. I begin in 1995 because the 1990–1994 period contains fewer countries.
12. Cameron and Miller (2015) demonstrate that clustering is necessary even with fixed effects models. Given the unbalanced nature of these data, and differences in question wording across years, I clustered the standard errors by country-cycle/year. When clustered at the country level, the standard errors are larger.
13. Results are substantively similar if the Democratic Party of Japan (DPJ) is coded as a mainstream right party.
14. It is possible that the primary effects of compensation vary across cohorts of workers. For older workers, who are unlikely to retrain and join the public sector workforce, early retirement benefits and high EPL are particularly important. For younger workers, entering the labor force in an era of automation support for greater job opportunities (rather than compensation) is more crucial. Here, both expanded public employment and, more controversially, lower EPL, may create more job opportunities. In the supplementary material I look at differences

across three age groups (20–34, 35–54, and 54–65 years). Here, I found little differential effect of early retirement on party choices, but social democratic voting was higher among older age groups in high spending and high EPL regimes. There was no effect on populism (see supplementary A4).

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