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RESEARCH ARTICLE

Technological vulnerability among the higher-educated: implications for party preferences

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Abstract

The higher-educated were long supposed to be winners of technological change, but recent evidence indicates that they feel (and are) increasingly exposed to the risk of technological redundancy. Based on what is known about how lower- to medium-skilled workers respond to technological exposure, this new sense of vulnerability among the higher-educated could have significant political effects – specifically increased support for right-wing populist parties – but empirical evidence on this is still lacking. I address this gap and investigate the effects of technological vulnerability on the party preferences of the higher-educated using survey data from the 2022 *Risks that Matter* survey. I find that feeling technologically vulnerable does indeed increase support for populist right-wing parties and reduce support for left parties among the higher-educated. I also conduct mediation analyses to explore the mechanisms behind these patterns and find evidence for a significant but substantively small mediation effect of social policy preferences.

Keywords: Technological change; party preferences; mediation

Introduction

Technological change and automation have long been changing labor markets and thereby workers' career trajectories. In part, this has involved the creation of new types of jobs and employment opportunities for many, but technological changes also exposed many workers to the risk (or reality) of technological redundancy and thus job and/or income loss (e.g., Autor, 2015; Kurer and Gallego, 2019). A growing literature demonstrates that this has significant political effects: Workers who are exposed to the negative effects of technological change become more strongly supportive of public social protection and redistribution (Thewissen and Rueda, 2019), and there is also considerable evidence that technologically exposed workers become more supportive of populist and radical right-wing parties (PRRPs) and their political agendas (Anelli *et al.,* 2021; Frey *et al.,* 2018; Im *et al.,* 2019; Kurer, 2020; Kurer and Palier, 2019).

So far, this story about technological change and its negative effects has centered on lower- to medium-skilled workers who were traditionally the most exposed to technological redundancy and, accordingly, the most likely to exhibit the political effects of this exposure (Im *et al.,* 2019; Kurer, 2020). In contrast, the higher-educated were seen as net beneficiaries of technological change and the new job opportunities it brings (Autor, 2015), and they were correspondingly found to support policies that promote further technological advances as well as mainstream parties, in particular on the conservative side (e.g., Gallego *et al.,* 2022).

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The status of the higher-educated as "automation winners" seems to be eroding, however. Recent survey data show that the higher-educated are now feeling almost as concerned about losing their jobs to technology as workers without higher education (Busemeyer *et al.,* 2023; Kurer and Häusermann, 2022). These concerns seem to be in part (but not exclusively; see e.g., Knotz *et al.,* 2024) driven by the advancement of machine learning and algorithmic decision-making ("AI") technology, which has become more widespread at many workplaces since the 2010s, and to which higher-educated white-collar workers are particularly strongly exposed to (e.g., Acemoglu *et al.,* 2022; Felten *et al.,* 2021). Some first negative effects of AI-related technological change have indeed already been documented (e.g., Grennan and Michaely, 2020; Lane *et al.,* 2023). Finally, the increased sentiment of technological vulnerability among the higher-educated has already been shown to have political effects in the form of greater support for social protection policies that compensate for economic hardship (e.g., unemployment insurance) and lower support for investment-oriented policies like training or education (Busemeyer *et al.,* 2023).

Given that many of the higher-educated are now feeling vulnerable to technological change and given that this already has meaningful effects on their policy preferences, there may also be corresponding effects on their party preferences and voting behavior – specifically, and mirroring patterns among lower- or medium-educated workers, in the form of increased support for PRRPs and reduced support for mainstream parties. Obviously, this would have significant wider political implications in that it would add to an already ongoing "authoritarian turn" in the Western democracies (Inglehart and Norris, 2017). Evidence on whether and how technological vulnerability affects the party preferences of the higher-educated is still lacking, however.

I address this gap using comparative survey data from the 2022 OECD *Risks that Matter* (RTM) survey (OECD 2023), which provides data on people's perceived technological vulnerability, their party and social policy preferences, and a range of socio-demographic controls for 27 countries in Europe, South and North America, and Asia. This combination of data allows me to study not only whether perceived technological vulnerability is linked to party preferences among the higher-educated and others, but also to explore some of the potential mechanisms connecting technological vulnerability to party preferences (Imai *et al.,* 2011). I will focus here on social policy preferences, which are known to be affected by risk exposure (Thewissen and Rueda, 2019) and which, in turn, affect party preferences (Häusermann and Kriesi, 2015).

I find that perceived technological vulnerability does indeed have effects on the party preferences of the higher-educated by lowering support for left parties and raising support for PRRPs. I also find that social policy preferences do mediate a significant but substantively small part of the overall effect of perceived vulnerability on party preferences. This suggests that other mechanisms (unobserved in this analysis) dominate, and in particular authoritarian responses to economic threats might be the most relevant (Feldman and Stenner, 1997; Kurer, 2020; Osborne *et al.,* 2023).

These findings contribute, firstly, to current research on the political effects of technological change by qualifying the image of the higher-educated as winners of technological change and by showing how perceived technological vulnerability affects their party preferences. More generally, this study adds further evidence that technological change has tangible and significant effects on support for right-wing populist parties, which is directly relevant to research on electoral behavior, party politics, and right-wing populism more broadly (e.g., Inglehart and Norris, 2017). Finally, while previous research on the political effects of technological change has already considered changing policy attitudes as potential mechanisms that bring about changing party preferences (Anelli *et al.,* 2021; Gallego *et al.,* 2022; Kurer, 2020), conducting a dedicated mediation analysis that assesses the mechanism from perceived risk exposure over policy preferences to party preferences is a new endeavor.

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The remainder of this article proceeds as follows: The next section reviews the existing research on technological change and its political effects and thus sets the stage for the third section, which develops hypotheses about the potential effects of technological vulnerability on the party preferences of the higher-educated. The fourth section presents the data and methods used in the analysis. The fifth section presents the results, and a final section concludes.

State-of-the-art: technological change and its political effects

Technological advances that enable machines to perform tasks that were previously done exclusively by human workers tend to have tangible negative effects including layoffs and unemployment, but more commonly reduced job opportunities and stagnating or declining incomes (e.g., Autor, 2015; Kurer, 2020). Unsurprisingly, exposure to this type of economic risk is linked to significant changes in people's political attitudes and preferences, including firstly, preferences toward social protection and redistribution. Thewissen and Rueda (2019) showed that technological vulnerability is associated with increased demand for redistribution, notably over and above a large range of other risk factors and demographic variables. Subsequent research refined this finding further and showed that technological vulnerability affects social policy preferences in a more nuanced way, increasing on the one side, support for compensating or protective social policies such as unemployment insurance or "robot taxes" while lowering, on the other side, support for social investment policies like education and training (Busemeyer *et al.,* 2023; Busemeyer and Sahm, 2021). As Busemeyer et al. (2023, p. 597) argue, this pro-compensation/anti-investment shift occurs because workers who feel vulnerable to technology prioritize policies that deliver tangible and direct help (such as unemployment benefits or "robot taxes") over investment-type policies such as training, which have less certain effects and work even in the best case only in the long-run.

A closely related and growing literature shows that technological vulnerability also leads to changes in party preferences and voting behavior, notably by pushing technologically vulnerable workers toward right-wing populist parties and away from mainstream parties (Gallego *et al.,* 2022; Im *et al.,* 2019; Kurer, 2020). For example, Anelli *et al.* (2021) and Frey et al. (2018) showed that increased exposure to industrial robots at the worker or county level is linked to greater support for PRRPs in both Europe and the United States, respectively. The dominant account of the causal mechanism linking technological vulnerability to increased PRRP support centers on right-wing authoritarian sentiment and its relation to threat exposure (Anelli *et al.,* 2021; Kurer, 2020), building on findings from psychological research that exposure to threats in general can trigger increased authoritarian sentiment (e.g., Osborne *et al.,* 2023) which in turn is a known driver of PRRP support (e.g., MacWilliams, 2016).

This being said, it is also well-established that party preferences are strongly driven by policy preferences, and in particular by preferences toward social protection and redistribution (e.g., Häusermann and Kriesi, 2015). In the specific case here, the pro-compensation/anti-investment stance among technologically vulnerable workers happens to correspond well with social policy platforms of PRRPs (e.g., Busemeyer *et al.,* 2022; Enggist and Pinggera, 2022).

As mentioned above, technological vulnerability and the resulting political effects were, so far, concentrated among the lower- to medium-educated, and in particular those who specialize in routine-intensive tasks (e.g., Autor, 2015). The higher-educated, in contrast, were generally seen as net beneficiaries of technological advances and that this status leads them to support policies that advance and accommodate further technological change, but also to act as a stabilizing force in politics, in part by supporting mainstream (and especially mainstream conservative) parties (Gallego *et al.,* 2022).

However, as also mentioned above, there is increasing evidence that at least some of the higher-educated are now more exposed to the risk of technological redundancy (e.g., Lane *et al.,* 2023).

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This, in turn, is already reflected in survey data, which show that the higher-educated now show on average almost the same level of worry about being vulnerable to technology-related job loss as those without higher education (Busemeyer *et al.*, 2023; Kurer and Häusermann, 2022). This new perceived technological vulnerability has also already been found to change their social policy preferences, turning them more in favor of compensating policies (which they typically support less) and against investment-oriented policies that they otherwise favor (Busemeyer *et al.*, 2023). In effect, this pro-compensation/anti-investment shift largely aligns the policy preferences of the technologically vulnerable higher-educated with those of the technologically vulnerable lower- and medium-educated workers.

Technological risk and the party preferences of the higher-educated

If the higher-educated are now facing increased technological vulnerability, and if this already has meaningful effects on their social policy preferences, then it is likely that there are also effects on their party preferences – and that these effects are similar to those that were previously observed among lower- to medium-skilled workers. This section develops a set of hypotheses about these effects.

The higher-educated are generally supporters of established mainstream parties, both parties on the mainstream (conservative/liberal) right and those on the mainstream left and green side (e.g., Gallego *et al.*, 2022; Häusermann and Kriesi, 2015). Where exactly the higher-educated fall here – whether they support mainstream right or left parties – is strongly determined by socio-economic variables: Parties on the mainstream right are mainly supported by higher-educated workers in more economically advantaged positions, while left or green parties tend to find support from higher-educated workers who are in more precarious positions or those who work in the public sector (e.g., Gingrich, 2017; Oesch, 2008). These differences in support for mainstream parties notwithstanding, higher-educated voters generally exhibit low support for PRRPs, a pattern that reflects in part the more culturally liberal values that go along with higher educational attainment (e.g., Middentorp and Meloen, 1990) and which obviously conflict with PRRPs' more socially conservative agendas.

These preferences can be expected to change in response to technological vulnerability. First, the fact that technological vulnerability raises demands for compensating social protection and reduces support for investment-type policies should directly work against mainstream conservative and liberal parties. These parties are generally skeptical toward policies that interfere with market relations, and in particular toward redistributive or compensating social policies like unemployment benefits or "robot taxes." Thus, the increased support for these types of policies among the technologically vulnerable higher-educated (Busemeyer *et al.*, 2023; Thewissen and Rueda, 2019) should push them away from conservative or liberal parties. The simultaneous decline in support for investment-type policies should further reinforce this effect, given that conservative and liberal parties have recently come to endorse these policies to at least some extent (Bonoli, 2013; Morgan, 2013).

To the extent that technological vulnerability also goes along with increased authoritarian sentiment and culturally conservative attitudes, one could in principle expect at least mainstream conservative parties to benefit since they traditionally appeal to such attitudes. However, as Kurer and Palier (2019, p. 4) have argued, there are reasons to expect that this effect may be limited: For one, PRRPs with their even more conservative positions may simply render mainstream conservatives less attractive in comparison. Secondly, mainstream conservatives have moderated their traditional positions in many cases, notably in the area of family policies (see above) but also when it comes to issues like immigration and multiculturalism (e.g., Rensmann, 2014). *Overall, it can therefore be expected that technological vulnerability lowers support for mainstream conservative and liberal parties* (*H1*).

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Matters are similar when it comes to left parties. On the one hand, the increased support for compensation and redistribution that follows technological vulnerability should push the higher-educated toward left parties as the traditional advocates of precisely those policies. However, this should be counteracted by the simultaneous drop in support for investment-type policies, which left parties are also major proponents of (Bonoli, 2013). In addition, findings indicate that the pro-compensation shift in response to technological vulnerability is actually stronger in magnitude than the turn away from investment-type policies (e.g., Busemeyer *et al.,* 2023, pp. 608 & 611). On balance, this shift in social policy attitudes should then work in favor of left parties. Weighing strongly against this, however, is the potential increase in authoritarian sentiment, which should work directly against left parties as these are generally strong proponents of culturally liberal and cosmopolitan values. *This leads to the expectation that, overall, technological vulnerability decreases support for left parties* (*H2*).

This negative effect should be even stronger for green parties. For one, when it comes to social protection policies, green parties tend to put more emphasis on investment-type policies while being more ambivalent about compensation-type policies or also taxes as means to redistribution (Röth and Schwander, 2020). This means that what green parties offer – strongly pro-investment but more lukewarm toward compensation – does not fit well with the pro-compensation/anti-investment stance of technologically vulnerable higher-educated workers, which should obviously work against green parties. Added to this is the fact that green parties are also major advocates of culturally liberal and cosmopolitan values, which would also go directly counter to any potential increased authoritarian sentiment among the technologically vulnerable. *This suggests that technological vulnerability lowers support for green parties* (*H3*).

The effects on support for PRRPs, finally, are straightforward. For one, PRRPs have in recent years adopted a more pro-welfare state stance in general, but with a clear preference for compensation-oriented policies and an equally clear aversion toward investment-type policies (Enggist and Pinggera, 2022) – which directly corresponds to the pro-compensation/anti-investment shift in policy preferences among higher-educated voters who feel technologically vulnerable. Added to this is that any potential increase in authoritarian sentiment and culturally conservative attitudes in response to technological vulnerability will work directly in favor of PRRPs as major and outspoken champions of such attitudes. *Thus, it can be expected that technological vulnerability increases support for PRRPs* (*H4*).

Data & methods

Data

To test my hypotheses about the effects of technological vulnerability on the party preferences of the higher-educated, I use data from the 2022 round of the OECD's *Risks that Matter* (RTM) survey (OECD, 2023). The RTM survey is a relatively new source of comparative survey data on people's perceived exposure to different social risks, including technology risk, and their political preferences, and is conducted biannually in a large number of OECD member countries. The 2022 round was conducted in 27 OECD countries in Europe, North and South America, and Asia with respondents (~1000 per country) that were recruited from incentivized online respondent pools based on quotas for gender, age, educational attainment, income, and labor market status.[1] I restrict the sample to only those respondents who were (or intended to be) economically active,

[1]Austria, Belgium, Canada, Switzerland, Chile, Germany, Denmark, Spain, Estonia, Finland, France, the United Kingdom, Greece, Ireland, Israel, Italy, South Korea, Lithuania, Latvia, Mexico, the Netherlands, Norway, Poland, Portugal, Slovenia, Türkiye, and the United States. See Table S-1 in the online Supplement for the number of respondents per country. See Figure S-2 for the sample demographics.

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reducing the overall sample size from 27'469 to 23'420.[2] It is also relevant to mention that the survey was fielded between October and November 2022, which means that the data collection concluded just prior to the public release of *ChatGPT*.[3] It is therefore very unlikely that any responses were affected by this event.

Perceived technological vulnerability: A major advantage of the RTM survey is that it includes dedicated items on people's perceptions of technological change, where one item is specifically related to their perceived vulnerability to technological change:

> *"How likely do you think it is that the following will happen to your job (or your job opportunities) over the next five years? – My job will be replaced by a robot, computer software, an algorithm, or artificial intelligence."*

The original response scale was an ordinal four-point scale (1 = "Very unlikely", 2 = "Unlikely", 3 = "Likely", 4 = "Very likely", 5 = "Can't choose"), but I collapse the responses to this item into a binary variable ("Very likely/likely" vs. "Unlikely/very unlikely") that measures whether respondents feel or do not feel vulnerable to technological change.[4]

Higher education: Since my main interest is in the higher-educated and their responses to feeling technologically vulnerable, I use as my measurement of respondents' education a dummy variable that measures whether respondents have or have not completed tertiary education.

Party preferences: Unlike previous rounds, the 2022 RTM round included an item on vote intention, which allows me to measure respondents' (stated) party preferences. Respondents were given country-specific lists of political parties and were asked for which out of the named parties they would vote if a national election were held tomorrow. Respondents could also indicate an intention to vote for an "other left-wing party" or "other right wing party" if their preferred party was not listed, and they could indicate that they would not participate at all.[5] I recode the responses to these items into four binomial variables that measure respondents' intentions to vote for (a) a left party (but see also below), (b) a populist or radical right party, (c) a conservative or liberal party, or (d) a green party.

In grouping parties into broad families, I follow the example of Häusermann and Kriesi, who use this approach to be able to perform cross-country comparisons in the presence of differences in the compositions of countries' party systems (Häusermann and Kriesi, 2015, p. 219). In assigning parties to party families, I follow where possible the categorization by Armingeon *et al.* (2022) and rely on other available sources (e.g., Ivaldi and Zankina, 2023, p. 24) otherwise. The online Supplement provides tabulations for each country showing the different parties respondents could choose from, how they were coded into party families, and the number of observations per party (see Tables S-19 to S-45).

Left parties include both mainstream social democratic (e.g., the German *SPD*) and socialist or populist left parties (e.g., *Podemos* in Spain, *SYRIZA* in Greece), but not communist or other far-left parties (e.g., the Greek *KKE*) or left parties that target specific regional or ethnic groups (e.g., *Esquerra Republicana de Catalunya* or *Candidatura d'Unitat Popular* in Spain).[6] This

[2]I use an item that asked respondents to indicate whether they are in general economically active (in paid work; not in paid work but actively seeking; not in paid work and not actively seeking; temporarily away from their job due to health reasons or caring and other responsibilities; other) and exclude all respondents who indicated that they were not working and not looking for work, keeping those respondents who are either economically active or only temporarily inactive. Around 80% of all retained respondents are in employment or self-employed, a further eight percent are unemployed, and the remainder is distributed over the other categories (see Figure S-3 in the Supplement).

[3]See also Figure S-1 in the Supplement.

[4]This greatly simplifies the estimation and the interpretation of the results. A visual inspection of the distribution of the original variable across educational groups (see Figure S-4 in the Supplement) also shows that there are no obvious finer-grained differences in response patterns that would be lost by dichotomizing the variable.

[5]Respondents could also indicate that they were not eligible to vote, "other", "can't choose", or did not want to answer, which were re-coded as missing.

[6]The French and Portuguese socialist parties (*Parti Socialiste*, *Partido Socialista*) were for some reason not provided as available options to respondents, which is arguably reflected in the high numbers of respondents that indicated a preference

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categorization of left parties is admittedly broad, but a more fine-grained differentiation between mainstream and radical or populist left-wing parties proved impractical given the variety of countries and party systems covered by the RTM survey. The typical distinction between mainstream and populist/socialist left parties is straightforward to apply to Western European countries like Germany or Denmark but less so in countries that have a relatively fragmented spectrum of left parties (e.g., Chile), countries where the numerical mainstream left party is ideologically populist (e.g., Greece), or countries where radical or populist left parties are essentially absent (notably the US or Canada). Applying a coding framework that is particularly suited to Western Europe would run the risk of confounding the categorization with a particular geographic region, which is why I chose a broader categorization for the main analysis. However, I do apply a finer categorization, differentiating between mainstream and populist left parties, to the subset of Western European countries that are covered in the RTM survey and conduct analyses based on this categorization as robustness checks below.

PRRPs include populist and radical right-wing parties (e.g., the German *AfD* or the French *Rassemblement National*), but not extremist or militant far-right parties (e.g., the Polish *Ruch Narodowy* or the Turkish *Milliyetçi Hareket Partisi*). Two parties, the US *Republican Party (GOP*) and the British *Conservative Party*, were admittedly difficult to classify. On the one hand, both parties have had undeniable populist tendencies in recent years, most obviously under the Trump administration in the US and the Johnson government in the UK. On the other hand, however, both parties are historically speaking mainstream right parties and differ in that regard clearly from, say, the *Rassemblement National*. In addition, there are still elements within the *GOP* and the *Conservatives* that do not endorse populist politics (e.g., Strawbridge and Lau, 2022). The final decision was to code the *Conservatives* as a mainstream right party and the *GOP* as a PRRP, which reflects the more moderate stance of the *Conservatives* after the end of Boris Johnson's term as Prime Minister in September 2022 (before the survey fieldwork), and the fact that a similar shift had been absent in the *GOP*. However, I show in my robustness checks further below that the results are essentially unaffected when either case is excluded from the analysis, or when I categorize the two parties differently.

Policy preferences: The survey included an item battery to measure respondents' views on how governments could help workers and industries cope with technological change. Building on Busemeyer *et al.* (2023), who used the same items from the previous round of the RTM survey, I use these to measure respondents' social policy preferences, which allows me to analyze to what extent these preferences act as mediating variables between technological vulnerability and party preferences.

Respondents were asked how much they support or oppose the following measures (presented in random order and using common five-point Likert scales from "strongly oppose" to "strongly support" and including "Can't choose" as an extra option):

(1) Investing more in university education and vocational training opportunities for young people
(2) Investing more in re-training opportunities for working-age people
(3) Investing more in digital infrastructure, such as the broadband network
(4) Introducing (or increasing) a tax on robots and/or technology companies
(5) Introducing (or lowering) a limit on working hours

for "another left-wing party" in these countries (see the corresponding tables in Section 5 of the Supplement). To account for this, a preference for "another left-wing party" was counted as a left-wing preference in France and Portugal. I code the US *Democrats* as a left party, in contrast to Armingeon *et al.* (2022), who count them as centrist. This is to account for the fact that the US *Democrats* have moved to the left as part of the broader polarization of US politics, including on issues of social security (e.g., Bateman *et al.,* 2017).

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(6) Making public benefits and services, such as unemployment benefits, more generous to provide a better safety net for workers facing possible job loss.
(7) Introducing a universal basic income that covers essential living costs for everyone, regardless of their financial situation.
(8) Providing subsidies to firms in industries that are hardest hit by technological change, so as to reduce job losses
(9) Promoting the migration of skilled workers to your country

As Busemeyer *et al.* (2023, pp. 601–2), I use all items except for the one on skilled migration and conduct a factor analysis to see if the items can be aggregated. The results point (admittedly weakly) to a two-factor solution (see also Figure S-6 in the Supplement) and the pattern in which the items load on the two factors resembles that found by Busemeyer *et al.* (*ibid.*). I therefore aggregate the items into two factors, one capturing support for compensation-oriented policies and the other support for investment-oriented policies, and use the two factors in the mediation analysis.

Capturing increased authoritarianism as a second potential mechanism is unfortunately not possible here since this would require dedicated instruments (Feldman, 2003), which are not available in the RTM data. For this reason (and also given limited space), I focus here on the role of social policy preferences as mediators.

Pandemic: The survey fieldwork overlapped with the tail end of the COVID-19 pandemic and the associated economic and social disruption. To account for this, I add a control that measures if respondents were directly or indirectly affected by the pandemic or the associated lockdowns, etc. To do so, I use two item batteries that capture respondents' exposure to the pandemic and construct a dummy that takes the value 1 if a respondent (or, where applicable, their partner) was in some way affected by the pandemic, and 0 otherwise.[7]

Industry: There are known and enduring differences in party preferences between occupational groups (e.g., Oesch, 2008), which translate at least in part also to the industry level (especially when it comes to the public vs. private sector divide). Technological risk exposure equally differs between occupations and, at least in the case of AI technology, also between industries (e.g., Acemoglu *et al.,* 2022; Felten *et al.,* 2021). Thus, any differences in party preferences between more or less technologically vulnerable persons may at least partly reflect enduring political differences between occupations and industries. Ideally, one would therefore control for respondents' occupation or occupational class (Oesch, 2008). Unfortunately, the RTM survey measures occupation only at the most general (ISCO-08 Major Group) level, which is too general to link it to commonly available indicators of class (or indicators of technological exposure). In addition, the ISCO-08 Major Group level indirectly captures levels of education (professionals or associate professionals tend to have higher levels of education than workers in elementary occupations), making it problematic to include it in a model while also controlling for education.

I instead control for the respondents' industry of employment (measured at the ISIC rev. 4 Section level) and, separately, the industry-level AI exposure (AIIE) indicator by Felten *et al.* (2021; see also Figure S-5 in the Supplement for descriptive statistics) as a relevant predictor of technological exposure among especially the higher-educated. The industry-dummies are more demanding in terms of degrees of freedom, but also more flexible, which is why I use them as my primary control and the Felten *et al.* AIIE indicator for robustness checks.

Other socio-demographics: I control for several other socio-demographic variables, including gender, age group, relative disposable net household income in deciles (as provided in the RTM data), locality (big city; suburbs/outskirts of a big city; town or small city; country village; countryside or rural area), and labor market status (respondents' main activity: employed or self-employed, both part- and full-time; apprentice/intern and student; retired; ill or disabled;

[7]See the Supplement, p. 11 for the detailed item formulations.

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military/community service; carer; unemployed but actively seeking work; other).[8] I also control for being member of an ethnic or other minority via a dummy that takes the value of 1 when respondents consider themselves as part of a minority based on either their ethnicity or skin color, language, religion or belief, or migrant status.

Empirical model

Following previous studies (Häusermann and Kriesi, 2015; Kurer, 2020), the dependent variables in my estimations are binomial dummies indicating support for a given party family, and I estimate separate binomial logistic regression models for each party family. To account for the multilevel structure of the data, I include country-fixed effects (a recommended approach when, as in this case, the main interest is in micro-level variables; see Bryan and Jenkins 2016: 6). To ensure that my results are not affected by the inclusion of controls, I run the main analyses once with and without controls (Lenz and Sahn, 2021).

My main model specification is interactive and regresses party support on the higher education dummy, the perceived technology risk dummy, an interaction between the two, and the controls. The interaction term captures the main pattern of interest: How are the party preferences of the higher-educated affected by perceived technological vulnerability?

Mediation effects

In addition to testing, if technological vulnerability affects the party preferences of the higher-educated, I also explore the role of social policy preferences as one potential mediating variable that carries the effect of technological vulnerability on party preferences. In this analysis, I rely on the estimator by Imai et al. (2010, 2011; see also Tingley *et al.,* 2014). The Imai et al. approach is particularly useful here because it is more general than previous approaches and can accommodate non-linear models in parts of the causal chain. More importantly, it allows for interactions between mediation effects and other variables (so-called 'moderated mediation'; see Tingley *et al.* 2014, section 3.2), which makes it possible to see if any mediation effects differ between the higher-educated and others. It is important to point out that the Imai et al. mediation estimator relies on strong assumptions about, simply put, the absence of confounders along the entire causal chain that is being analyzed. As they themselves point out (Imai *et al.,* 2011, p. 770), these assumptions are not even automatically satisfied in randomized controlled experiments – let alone in observational data.[9] I therefore use the mediation analysis as an exploratory tool, and the results should be interpreted accordingly.

Results

Descriptive statistics

To familiarize readers with the data, I start by providing some descriptive statistics for my main variables. The right-hand graph in Figure 1 presents the distribution of perceived technology risk among the higher-educated and those without higher education, and shows that around a third of respondents in both groups perceive themselves to be vulnerable to technological change. The numbers here are overall lower than those found in slightly older data (cf. Busemeyer *et al.,* 2023, p. 604), but they nevertheless confirm that perceived technological vulnerability has clearly spread to the higher-educated (as also found by Kurer and Häusermann, 2022).

[8]I group two categories ("Military or community service" and "Other") into a single "Other" category for the analysis. Figure S-3 in the Supplement shows all categories ungrouped.

[9]Sensitivity analyses also indicate that – if the assumptions were violated – the mediation effect estimates would indeed be different (see Figure S-24 in the Supplement).

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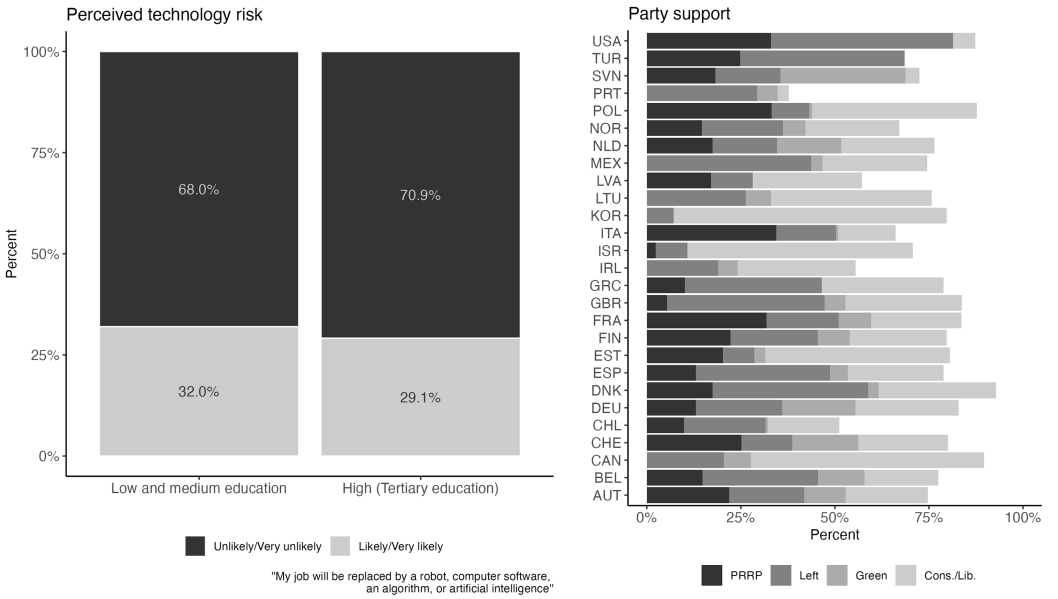


Figure 1. Perceived technology risk and party preferences.

The graph on the left in Figure 1 presents the overall distribution of the dependent variables, support for different party families across countries. Important to keep in mind here is that party families may include multiple individual parties in some countries (e.g., South Korea, where there are two large conservative and liberal parties), and that some parties or party families are not captured by the coding scheme (e.g., regional or communist parties, as mentioned above). The latter is why some of the bars do not sum up to 100%. Otherwise, a cursory comparison to relevant official statistics lends plausibility to the data. Support for PRRPs in Italy (∼34%), for example, is about the same as the combined vote share of *Fratelli d'Italia* and *Lega* in the 2022 parliamentary elections. Similarly, support for PRRPs in Germany (∼13%) is somewhat higher than the *AfD*'s vote share in the 2021 federal elections – but corresponds to poll numbers from late 2022, which placed the *AfD* at around 14%. This is similar when it comes to the German *Greens*, which are placed at 19% in the data here and at around 21–22% in polling data from the fall of 2022 (cf. Forschungsgruppe Wahlen, 2024).

The relationship between perceived technological vulnerability and party support

Moving to the main analysis, I start by looking at the main relationships of interest here, the effect of perceived technological vulnerability on party support among the higher-educated. Table 1 presents the results of the main estimations including all controls and the interaction between higher education and perceived technological vulnerability.[10] Starting with the model of left party support, the result here indicates that support for these parties among the higher-educated is not significantly affected by perceived technological vulnerability (counter to *H2*). The interaction between higher education and technological vulnerability is negative, which indicates reduced support among technologically vulnerable higher-educated workers, but fails to reach statistical significance (but see also below). The two main effects are also not significant, which is the same in a non-interactive specification (see Table S-2 in the Supplement). The insignificant main effect of

[10]Tables S-2 to S-5 in the Supplement show also the effects of the country-specific intercepts and additional model specifications, including estimations without control variables.

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Table 1 Higher education, technology risk, and party support (logistic regressions)

	Left	PRRP	Cons./Lib.	Green
Intercept	−1.32 (0.21)*	−1.13 (0.23)*	−1.63 (0.20)*	−2.80 (0.40)*
Higher ed.	**0.01 (0.05)**	**−0.47 (0.06)***	**0.37 (0.05)***	**0.30 (0.09)***
Vuln. to techn. change	**0.02 (0.06)**	**−0.05 (0.07)**	**0.02 (0.06)**	**0.09 (0.12)**
Higher ed. X vuln. to techn. change	**−0.13 (0.09)**	**0.25 (0.11)***	**−0.08 (0.09)**	**0.04 (0.16)**
Female	0.11 (0.04)*	−0.21 (0.05)*	−0.15 (0.04)*	0.20 (0.08)*
Age				
25–34	−0.02 (0.08)	0.10 (0.10)	−0.09 (0.08)	0.10 (0.13)
35–44	0.03 (0.08)	0.11 (0.10)	0.04 (0.08)	−0.24 (0.14)
55–64	−0.07 (0.08)	0.21 (0.10)*	0.20 (0.08)*	−0.26 (0.14)
Rel. HH income	−0.01 (0.01)	−0.01 (0.01)	0.05 (0.01)*	0.00 (0.01)
Affected by COVID	0.12 (0.07)	−0.06 (0.08)	0.04 (0.06)	0.18 (0.11)
Minority member	0.04 (0.05)	−0.12 (0.07)	−0.18 (0.05)*	−0.10 (0.09)
Sector				
Mining and quarrying	−0.52 (0.32)	−0.09 (0.31)	0.13 (0.27)	0.37 (0.59)
Manufacturing	−0.04 (0.16)	0.07 (0.18)	0.00 (0.16)	0.52 (0.36)
Electricity, gas, steam	−0.20 (0.22)	−0.02 (0.23)	0.01 (0.20)	0.67 (0.42)
Water supply, sewerage, etc.	0.20 (0.23)	−0.13 (0.26)	−0.43 (0.24)	0.73 (0.43)
Construction	−0.11 (0.17)	0.04 (0.18)	−0.01 (0.16)	0.46 (0.37)
Wholesale and retail trade	−0.01 (0.17)	−0.15 (0.18)	0.15 (0.16)	0.62 (0.36)
Transportation and storage	−0.03 (0.18)	−0.01 (0.20)	0.07 (0.17)	0.19 (0.39)
Accommodation and food service activities	0.02 (0.20)	0.11 (0.22)	−0.06 (0.19)	0.54 (0.40)
Information and communication	0.13 (0.17)	−0.39 (0.20)*	−0.05 (0.17)	0.98 (0.36)*
Financial and insurance activities	−0.21 (0.18)	−0.30 (0.21)	0.42 (0.17)*	0.55 (0.38)
Real estate	−0.46 (0.25)	0.36 (0.24)	0.15 (0.22)	−0.30 (0.54)
Professional, scientific and techn. activities	−0.03 (0.17)	−0.30 (0.20)	0.07 (0.17)	0.82 (0.36)*
Administrative and support service activities	0.09 (0.18)	−0.17 (0.21)	−0.03 (0.18)	0.65 (0.38)
Public administration and defense	0.03 (0.17)	−0.07 (0.19)	−0.01 (0.16)	0.81 (0.36)*
Education	0.37 (0.17)*	−0.37 (0.19)	−0.29 (0.16)	0.71 (0.36)*
Arts, entertainment and recreation	0.26 (0.20)	−0.72 (0.26)*	0.05 (0.19)	0.36 (0.43)
Other service activities	−0.00 (0.16)	−0.11 (0.18)	0.01 (0.16)	0.57 (0.35)
Labor market status				
Apprentice, student, etc.	−0.02 (0.12)	−0.39 (0.16)*	0.19 (0.13)	0.43 (0.18)*
Full-time self-emp.	−0.13 (0.08)	−0.04 (0.10)	0.01 (0.08)	−0.04 (0.15)
Other (early ret., carer, ill, etc.)	−0.02 (0.12)	0.21 (0.13)	−0.11 (0.12)	0.35 (0.18)
Part-time empl.	0.02 (0.07)	−0.12 (0.09)	0.03 (0.07)	0.08 (0.12)
Unemployed	0.13 (0.27)	0.12 (0.32)	−0.47 (0.32)	−0.51 (0.76)
Part-time self-empl.	0.10 (0.13)	−0.13 (0.18)	0.09 (0.13)	0.08 (0.24)
Locality				
Suburbs or outskirts of a big city	−0.16 (0.06)*	0.18 (0.08)*	0.16 (0.06)*	−0.23 (0.11)*
Town or small city	−0.15 (0.05)*	0.30 (0.06)*	0.01 (0.05)	−0.32 (0.09)*
Country village	−0.36 (0.08)*	0.37 (0.09)*	0.04 (0.07)	−0.20 (0.11)
Countryside or rural area	−0.39 (0.11)*	0.40 (0.11)*	−0.03 (0.09)	−0.32 (0.18)
Country FE	Yes	Yes	Yes	Yes
Log Likelihood	−7392.40	−5153.05	−7559.75	−2893.04
Num. obs.	14468	11386	14031	11421

Standard errors in parentheses. *$p < 0.05$.

higher education arguably reflects the fact that the electorates of left parties are increasingly made up of a combination of "traditional" blue-collar working class, lower-skilled service workers, and the higher-educated new middle classes (Gingrich, 2017), while the insignificant main effect of technological vulnerability mirrors similar findings in previous studies (Im *et al.*, 2019). The effects of the controls are mostly insignificant but those that are significant point in the usual directions: Left party support is positively associated with being female and with working in education but decreases with living in a more rural area compared to living in a big city (the omitted baseline category of the *Locality* variable).

The results are stronger when it comes to PRRP support. Here, the significant and positive interaction term indicates that feeling technologically vulnerable significantly increases support

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for PRRPs among the higher-educated (supporting *H4*). The main effect of higher education is significantly negative, which is the same in non-interactive specifications (see Table S-3 in the Supplement) and which reflects the fact that the higher-educated are overall less likely to support PRRPs. There is, on the other hand, no effect of the main term for feeling technologically vulnerable on PRRP support. As in the model of left party support, the controls behave generally as expected: All else equal, women, people working in art and entertainment and the IT and communication sections, those living in more urban settings, and students are less likely to support PRRPs, while support for PRRPs increases with advanced age.

Finally, support for green parties and for conservative and liberal parties among the higher-educated is never significantly affected by technological vulnerability, as indicated by the consistently insignificant interaction effects (counter to *H1* & *H3*). In the non-interactive specifications (see Tables S-4 and S-5 in the Supplement), higher education is by itself significantly and positively associated with green and conservative/liberal party support, which is in line with established findings (see above). Technological vulnerability, on the other hand, has by itself no robust main effect.

Figure 2 presents these results in the form of more meaningful marginal predicted probabilities of supporting a given party family by educational attainment and perceived technological vulnerability.[11]

The graph on the upper left of Figure 2 shows how left party support varies by perceived technological vulnerability among both the higher-educated and others. Support for left parties among the higher-educated drops by around two percentage points when they feel vulnerable to technological change, but it barely affects support among those without higher education. However, the difference in predicted support among the higher-educated (i.e., the average marginal effect) is not statistically significant here ($p = 0.11$; but see also below).

The results are again clearer when it comes to PRRPs. While the higher-educated are usually less likely to support PRRPs compared to those without higher education, their support increases significantly (by around 3pp.) when they feel vulnerable to technological change ($p = 0.021$).[12] It is worth adding that these effect magnitudes – amounting to around two to three percentage points – are perhaps not drastic but still comparable to those found in previous research on the effect of technological vulnerability on support for PRRPs and other parties (cf. Gallego *et al.,* 2022; Im *et al.,* 2019). Interestingly, among those without higher education, feeling technologically vulnerable is linked to slightly *lower* support for PRRPs. This effect is not significant, but nevertheless noteworthy. I return to this further below.

Moving finally to the results for green and conservative and liberal parties (shown in the two graphs at the bottom of Figure 2), the predicted probabilities reveal only minimal effects. Support for conservative or liberal parties is slightly lower among the higher-educated who feel technologically vulnerable compared to those who do not (which is in principle in line with *H1*), and the opposite is the case for support for green parties (in direct contradiction to *H3*). However, neither difference is statistically significant.

Overall, the results so far indicate that feeling technologically vulnerable significantly raises support for PRRPs among the higher-educated, net of a range of controls, while it has no similar effects on the extent to which the higher-educated support other types of parties.

Robustness checks & additional analyses

A first important robustness check is to show that the main results hold whether or not control variables are included in the regression models (Lenz and Sahn, 2021). That is indeed the case (see Tables S-2 to S-5 and Figures S-8 and S-9 in the Supplement), the only difference being that there

[11]The corresponding average marginal effects estimates are shown in Figure S-7 in the Supplement).

[12]See also Figure S-7 in the Supplement.

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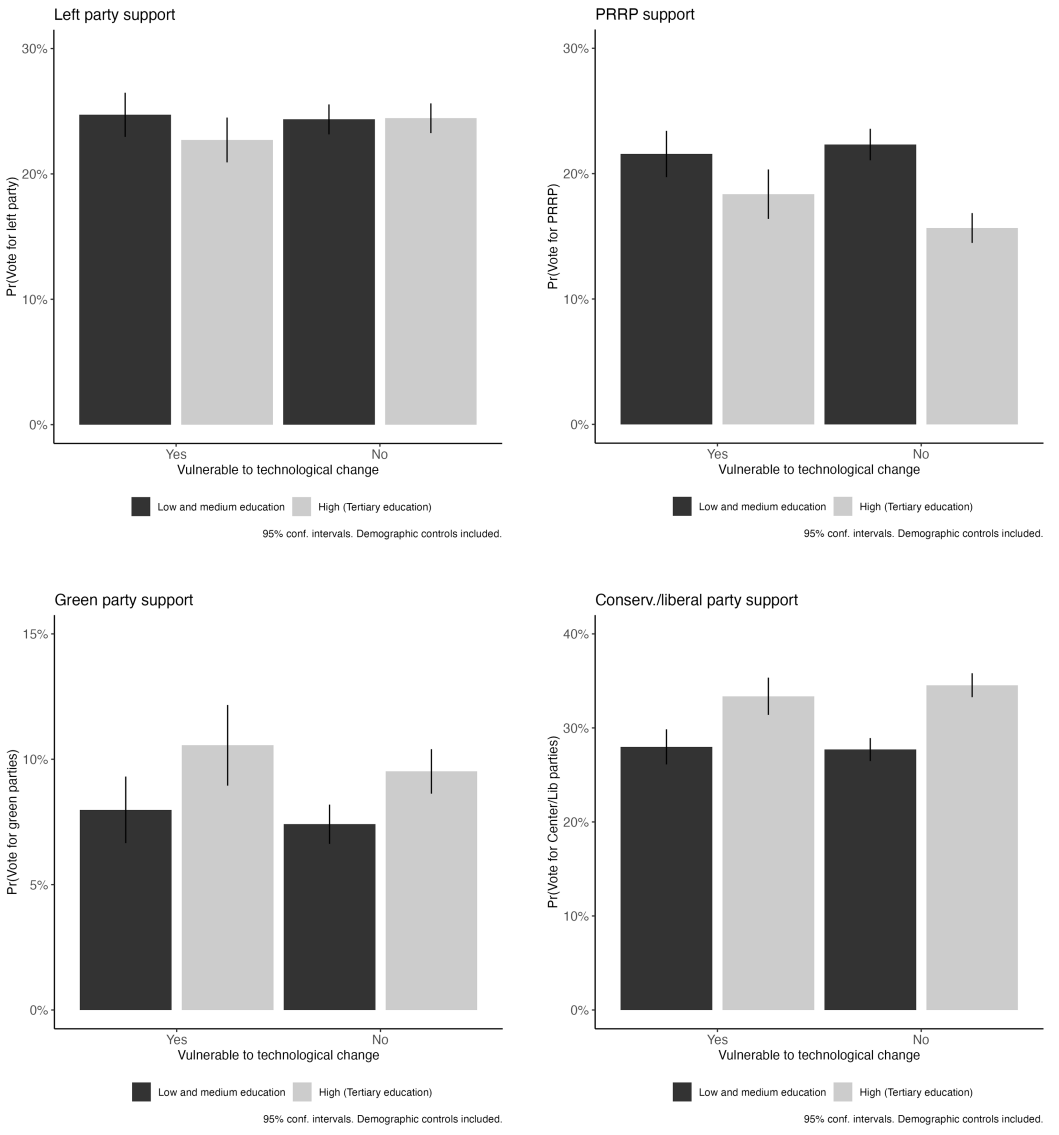


Figure 2. The effect of perceived technological vulnerability on party support.

is now a statistically significant negative interaction effect between technological vulnerability and higher education in the model of left-party support. As a second check, I test if the results stay robust when I use the Felten *et al.* AIIE indicator instead of the industry dummies as controls. This is again the case, and there is now again a significant negative effect of technological vulnerability on left-party support among the higher-educated.[13] The fact that the effect on left-party support turns significant in these two models, which both include fewer covariates than the main specification, indicates that the lack of a significant interaction effect on left-party support in the main model may actually reflect a lack of precision due to a large number of covariates (esp. the industry-dummies) rather than the absence of a substantive effect.

[13]The coefficient estimate on the interaction term is still not significant here, but the average marginal effect – which is the more relevant quantity – is (see Figure S-10 in the Supplement).

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Third, I run four additional models to test if the decision to code the UK *Conservatives* as a non-PRRP and the US *GOP* as a PRRP may have affected the results: One model excluding the UK, one excluding the US, one with neither party coded as a PRRP, and one with both coded as PRRPs. The results remain essentially unchanged (see Table S-7 and Figures S-16 and S-17 in the Supplement).

Fourth, I test if differentiating between mainstream and radical or populist left parties produces stronger effects of technological vulnerability on party preferences. As mentioned above, I limit this analysis to Western European countries.[14] Both the model of mainstream and the model of radical left support yield negative but again insignificant interaction effects between higher education and technological vulnerability, resembling the results of the main model (see Figures S-14 and S-15 and Table S-6 in the Supplement).

Finally, I address one finding in the main analysis that may seem puzzling in light of previous research: the fact that among those without higher education, perceived technological vulnerability has a small and insignificant but nevertheless *negative* effect on PRRP support (see also Figure 2 above). To be clear, this is not the first case of an insignificant effect of technological vulnerability on PRRP support among those without higher education – Gallego *et al.* (2022, p. 430) report similar results – but it still does run counter to some other findings (e.g., Im *et al.,* 2019; Kurer, 2020).

One possible explanation could be that combining the lower and medium educated into one group may hide variation between these groups (as found by e.g., Gallego *et al.,* 2022). In addition, it is possible that the effect of vulnerability to technological change among those with low levels of education is conditional on their economic situation – i.e., only present when they have something to lose (cf. Im *et al.,* 2019). A simple descriptive analysis using a more disaggregated measure of education indicates, indeed, that technological vulnerability has a small positive effect on PRRP support among those with less than upper secondary education and the opposite effect on those with post-secondary education (see Figure S-18 in the Supplement). To also see if this depends on their material situation, I regress PRRP support on a triple interaction between the disaggregated education measure, the perceived technological vulnerability measure, and relative household income (plus country dummies). The results (see again Figure S-18) indicate that support for PRRPs indeed increases significantly with household income among those who have less than upper secondary education and who feel vulnerable to technological change – and here the effect is substantial, with PRRP support reaching around 30% among lower educated workers in the higher income deciles. This latter finding resembles, despite the different operationalizations, the patterns found elsewhere (in particular Im *et al.,* 2019).

Mediation analysis

Having found that perceived technological vulnerability increases support for PRRPs and (although less robustly) weakens support for left parties among the higher-educated, I conduct a mediation analysis to assess one potential mechanism, changing preferences for compensating or investment-type policies, behind these patterns. The presentation of the results here focuses on the higher-educated, and I comment only briefly on the results for the medium- and lower-educated as well as overall mediation effects.[15]

In the first step, I estimate models of the individual links in the causal chain separately, meaning I estimate (a) the effect of technological vulnerability on social policy preferences and then (b) the effect of social policy preferences on party support. These estimations (which include all controls used above) basically replicate earlier findings or well-established patterns, and

[14]Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, the Netherlands, Norway, Portugal, and Spain.

[15]These are shown in the Supplement (see Figures S-22 and S-23).

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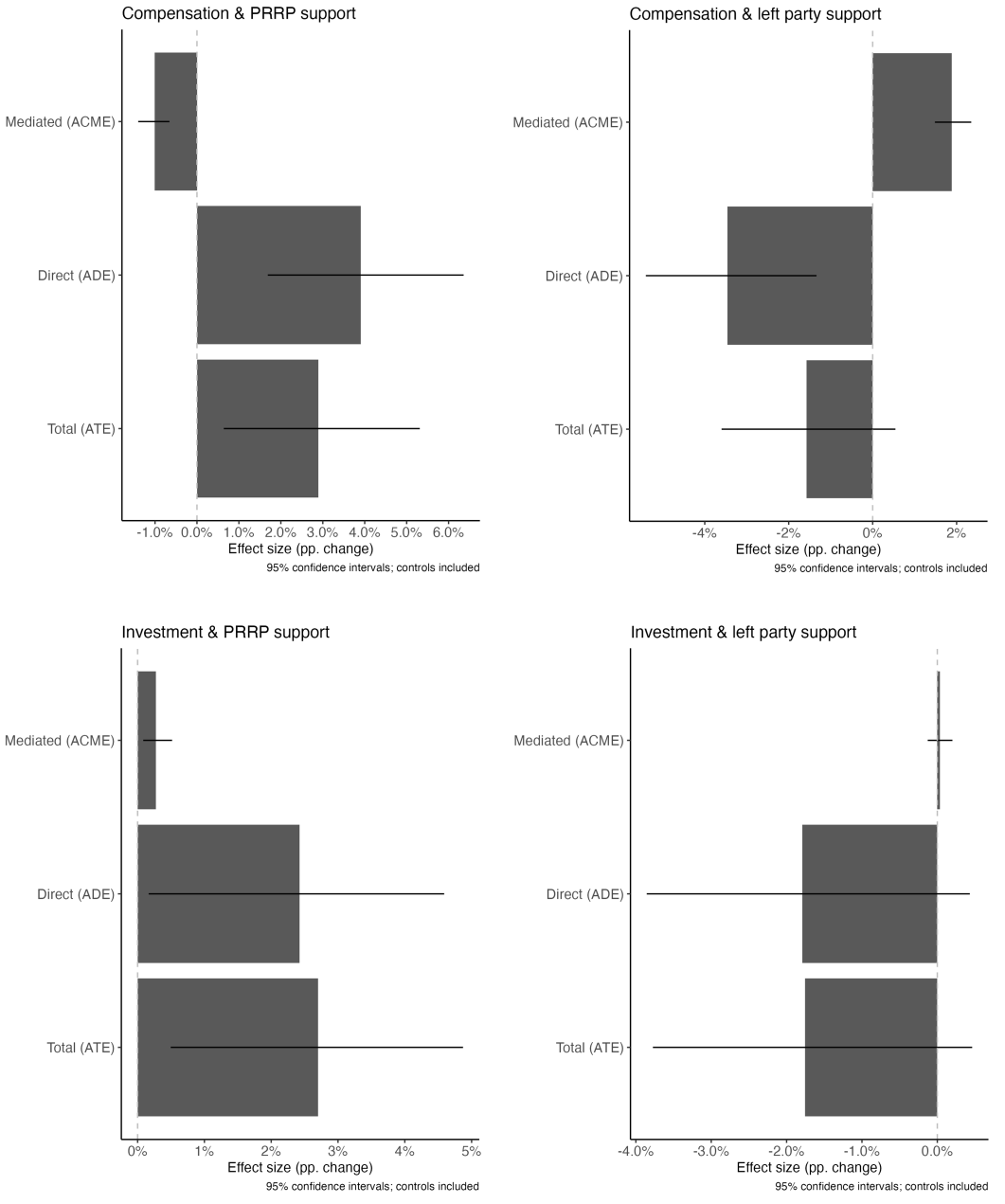


Figure 3. Mediation effects among the higher-educated.

I therefore report the results in the Supplement (see Figures S-19 and S-20 and Tables S-9 to S-12 in the Supplement). First, I find that technological vulnerability significantly increases support for compensating social policies and significantly reduces support for investment-type policies among the higher-educated (as Busemeyer *et al.*, 2023 also found in other data). Second, policy preferences unsurprisingly affect party support (Häusermann and Kriesi, 2015). Specifically, I find that greater support for compensating and investment-type policies both reduce support for

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PRRPs, while support for left parties increases significantly with support for compensation policies but is unrelated to support for investment policies.

With this as a background, I move to the results of the mediation analysis, which are shown in Figure 3.[16] The graph on the upper right shows how attitudes toward compensation-oriented policies mediate the relationship between technological vulnerability and PRRP support among the higher-educated. There is, firstly, a significant average causal mediation effect (ACME), which needs to be interpreted in light of the findings above: Technological vulnerability first *increases* support for compensation policies and, because support for these policies is by itself *negatively* linked to PRRP support, this generates the *negative* mediation effect shown here. This effect is, however, clearly outweighed by a strong positive and significant direct effect (ADE). The total effect (ATE) is the net sum of the ACME and the ADE and corresponds in magnitude roughly to the 3pp. increase in PRRP support found in the main analysis above. In a nutshell, these results indicate that the positive effect of technological vulnerability on PRRP support among the higher-educated would be even stronger if it were not partly counteracted by the simultaneous increase in support for compensation policies.

When it comes to investment-type policies and PRRPs (shown in the upper-right graph in Figure 3), the analysis reveals a positive mediation effect. This reflects the fact that technological vulnerability reduces support for investment-type policies, which then pulls people closer to PRRPs (because support for investment-type policies and support for PRRPs are negatively related). Combined with a still positive direct effect, this again generates the same positive and significant total effect amounting to a ca. 3pp. increase in PRRP support.

In the case of left parties and compensation policies, the mediation analysis indicates that hidden underneath the insignificant overall effect of technological vulnerability on left party support among the higher-educated in the main analysis above, there is a "tug-of-war" between two countervailing effects.[17] On the one side, the positive mediation effect reflects the fact that technological vulnerability first increases support for compensation policies, which in turn pushes people closer to left parties and thus increases support. However, this positive mediation effect is counterbalanced by a negative and significant direct effect. Ultimately, both effects cancel each other out, creating an insignificant total effect. Put differently, these findings suggest that technological vulnerability would actually push the higher-educated away from left parties – were it not for the countervailing effect of increased demand for compensation policies.

The final set of results shown in the lower-right graph in Figure 3 show, in essence, that the reduction in support for investment-type policies in response to technological vulnerability does not have any further effects on left-party support. This arguably reflects the fact that support for investment-type policies is unrelated to left-party support (see above) – therefore, whatever changes in policy preferences do happen in response to technological vulnerability, these do not have meaningful effects on left-party support. Reflecting the absence of a mediated effect, the ADE is identical to the total effect.

To briefly comment on the results for the medium- and lower-educated and the overall mediation effects: In the former case, there is also evidence for essentially identical mediation effects of social policy preferences, but the overall and direct effects on party support are considerably weaker (as in the main analysis above). Correspondingly, the overall mediation analysis reveals effects that lie in terms of strength and significance between those for the higher-educated and those for the medium- and lower-educated.

[16]These are estimated via a moderated mediation model, where simply put, all mediation effects are interacted with the higher-education dummy and effect estimates are then computed separately for the higher-educated and others (see Tingley *et al.* 2014, Section 3.2).

[17]This combination of insignificant total effect and significant ACME is a possible result, as is the combination of a negative ACME and positive ADE (Imai *et al.* 2010: 312).

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Overall, the mediation analysis indicates that social policy preferences do indeed play a small but significant role as "transmitters" of the effect of technological vulnerability on party support. However, partly contrary to what was expected, the fact that technological vulnerability increases support for compensating social policies turns out to work *against* PRRPs but in favor of left parties. In the former case, however, this negative mediated effect is clearly outweighed by a strong positive direct (or otherwise mediated) effect of technological vulnerability on PRRP support.

Conclusion

The status of the higher-educated as net winners of technological change is increasingly in question (e.g., Grennan and Michaely, 2020), and, as this paper has also showed, many higher-educated are clearly *feeling* vulnerable to the negative effects of technological change. Extending previous studies on this (Busemeyer *et al.,* 2023), this analysis showed that this perception of vulnerability among the higher-educated is linked to increased support for populist and radical right-wing parties and (albeit less robustly) reduced support for left parties. The results of the mediation analysis suggest that changes in social policy preferences transmit a significant but substantively small part of the overall effect of technological vulnerability on changing party preferences – and also that some mediation effects actually counteract the overall effects. For example, the results suggest that there would be an even stronger increase in PRRP support in response to technological vulnerability if it were not for the negative mediation effect of support for compensating social policies.

These findings confirm, on the one hand, a range of previous studies that show a positive link between technological vulnerability and PRRP support (e.g., Anelli *et al.,* 2021; Kurer, 2020) – but, in contrast to these earlier studies that were focused on the lower- to medium-educated, the results here indicate that this pattern has now spread to the higher-educated. While it is unclear if the effects of perceived vulnerability among the higher-educated (3pp. differences in PRRP support) are large enough to trigger large-scale changes in electoral results, they still contribute to already existing authoritarian tendencies in the advanced democracies (Inglehart and Norris, 2017). More generally, the results found here suggest that these tendencies might be increasingly driven by a cross-class coalition between parts of the lower- to medium-educated and parts of the higher-educated.

Obviously, the analysis presented here has weaknesses and limitations, and a major one is that I was unable to test a second – and likely more influential – mechanism linking technological vulnerability to party support: increased authoritarian sentiment (e.g., Osborne *et al.,* 2023). This variable may likely be behind the strong positive direct effect of perceived technological vulnerability on PRRP support. Thus, future research should investigate the role of authoritarianism as a mediator between technological risk and party preferences, both among the higher-educated but also among others.

Supplementary material. The supplementary material for this article can be found at https://doi.org/10.1017/S1755773925000013.

Data availability statement. Replication data and code are available on OSF.io (https://doi.org/10.17605/OSF.IO/EJP3X).

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