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RESEARCH ARTICLE

Embedding technological transformation: the welfare state and citizen attitudes toward technology

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Abstract
Much scholarly attention has been given to the potentially disruptive distributional implications of new technologies in labor markets. Less explored is the way citizens as socially embedded individuals perceive and respond to technological transformation. This study fills this gap by exploring how welfare state institutions shape and are shaped by citizens' perceptions of technological transformation. My analysis covering over 50 developed and developing countries finds that welfare state generosity is associated with a greater acceptance of technological change. I also provide evidence consistent with the expectation that labor market interventions of the welfare state have the potential to reduce the skill cleavage over technological transformation by mitigating the insecurity faced by the low-skilled. Additionally, citizens embracing technological transformation are more supportive of the welfare state than techno-skeptics are.

Keywords: technological transformation; technology attitudes; economic insecurity; welfare state; welfare attitudes

Introduction

> *It's cheaper to buy a $35,000 robotic arm than it is to hire an employee who's inefficient making $15 an hour bagging French fries – it's nonsense and it's very destructive and it's inflationary and it's going to cause a job loss across this country like you're not going to believe.*
> *(Ed Rensi, Former McDonald's CEO, 2016)*[1]

> *In Sweden, if you ask a union leader, 'Are you afraid of new technology?' they will answer, 'No, I'm afraid of old technology,' . . . The jobs disappear, and then we train people for new jobs. We won't protect jobs. But we will protect workers.*
> *(Ylva Johansson, The Swedish minister for employment and integration, 2017)*[2]

Economic transformation that extends market relations engenders reactions to embed, successfully or not, the transformation into social relations (Polanyi, 1944). A large body of literature has reflected on this wisdom in the context of economic globalization, suggesting that the institutional configurations of *embedded liberalism* (Ruggie, 1982) have been integral to building the legitimacy and social acceptance of an open economic order. Studies across Western democratic societies

[1]Fox Business, May 24, 2016, Fmr. McDonald's USA CEO: $35K Robots Cheaper Than Hiring at $15 Per Hour.
[2]The New York Times, Dec. 27, 2017, The Robots Are Coming, and Sweden Is Fine.

find that citizens who are exposed to the risks and uncertainties of global capitalism demand greater social protection from their government (Burgoon, 2001; Cusack *et al.*, 2006; Walter, 2010; Margalit, 2011). Empirical analyses also reveal that more open economies tend to have larger public spending to compensate for and insure against the vagaries of an open economy (Garrett, 1995; Rodrik, 1997, 1998; Rickard, 2012; Nooruddin and Rudra, 2014).

This study extends the empirical inquiry on the embedding of economic transformation to the context of recent technological advancements or what some refer to as the Fourth Industrial Revolution (Schwab, 2017). In doing so, I pose two inter-related questions. First and at the society level, how would the presence/absence of welfare state institutions shape popular acceptance of new technologies? Second and at the individual level, how does one's perception of technological change shape her welfare attitudes?

The dearth of studies answering these questions is surprising given the substantial amount of work reporting potentially disruptive distributional implications of technological change (Iversen and Cusack, 2000; Jaumotte *et al.*, 2013; Goos *et al.*, 2014; Helpman, 2016). A recent study by the International Monetary Fund (2017) concludes that technological change accounts for about half of the decline in the labor share of income in advanced economies. For the USA alone, it is estimated that 13 million mainly low-skilled jobs could be lost due to automatization, which would 'amount to several times the disruption in local economies caused by the 1950s decline of the car industry in Detroit' (Quintini *et al.*, 2018). The developing world is not an exception to the trend. In a recent press conference, World Bank Group President Jim Yong Kim stated that 'two-thirds of all jobs that currently exist in developing countries will be wiped out by automation.'[3]

Acknowledging the disruptive potential of technology, recent policy papers rightly prescribe a 'more inclusive, open, and deliberative form of technology assessment' (OECD, 2017) and a 'coordinated action on skills development, labor regulation, social protection, and income redistribution' (Asian Development Bank, 2018). A crucial yet missing component needed to gauge the political feasibility of these and other prescriptions is the systematic empirical investigation of how citizens perceive the unfolding technological transformation and develop preferences for government intervention. The present study addresses this issue.

In the next section, I present my hypotheses in light of the current literature. As for the first question on welfare state determinants of the public's attitudes toward technology, I hypothesize that welfare state generosity promotes social acceptance of technological transformation. The guiding notion is that welfare institutions mitigate a broad range of risks associated with the adoption of new technologies including, but not limited to, the risk of job loss. On the second question pertaining to the individual-level nexus between technology acceptance and welfare state attitudes, I explore two competing hypotheses. On the one hand, those with a more optimistic view of technological transformation might exhibit lower support for the welfare state as they might perceive that new technologies allow them to better address various social risks on their own. On the other hand, techno-optimists may not reduce their support for the welfare state. Being more actively on board with new technologies and adapting their behaviors in accordance with them might incentivize techno-optimists to seek insurance against future uncertainties. Techno-optimists may also support the welfare state because compensating for the disaffected losers under the transformation serves their own interests of sustaining technological advancements.

These hypotheses are tested using a multilevel analysis covering over 50 countries. While previous studies have explored the determinants of technology attitudes in the context of advanced economies (e.g., Dekker *et al.*, 2017 on public attitudes toward robots in Europe), this study is the first to incorporate countries with widely different socio-economic settings. Existing empirical research suggests that economic liberalization has accelerated technological changes in developing countries by facilitating technology transfers from high-income countries (Behar, 2013). Because new technologies are more skill intensive in relation to those already in use domestically before

[3]WBG/IMF 2017 Spring Meetings Opening Press Conference, Apr. 20, 2017.

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liberalization, developing countries and in particular, middle-income countries that liberalize, experience skill-biased technological change (SBTC) similar to the trend in developed countries (Meschi and Vivarelli, 2009; Conte and Vivarelli, 2011). As such, studying the social embedding of technological transformation should not be confined to the developed world.

To preview, my empirical analysis finds that welfare state generosity is associated with greater social acceptance of technological advancement. Such a positive association is found to be stronger in developing countries than in developed countries. When it comes to labor market interventions of the welfare state, a protective intervention has a positive association with technology acceptance in developing countries but less so in developed countries. For the latter, I provide some first-cut evidence that interventions that empower and capacitate workers more effectively promote technology acceptance than passive protective interventions. Furthermore, I find that citizens who are more optimistic about technological change are in general *more*, not less, supportive of the welfare state than techno-skeptics. The positive coupling between pro-technology and pro-welfare attitudes is especially pronounced among the low-skilled.

The findings together imply that the social embedding of technological transformation via the welfare state fosters a positive perception of new technologies, which, in turn, can sustain a broader support base for the welfare state as well as technological advancements.

Theoretical expectations

This section develops my theoretical expectations in light of the existing literature. I first discuss the expectations on the welfare state determinants of public technology attitudes. I then move on to discussing the micro-level nexus between welfare and technology attitudes.

Welfare state determinants of technology perception

Studies have long focused on the role the welfare state plays in mitigating risk perceptions and promoting risk-taking attitudes among citizens (Domar and Musgrave, 1944; Bird, 2001; Grant *et al.*, 2010). A generous welfare state that protects its citizens against various social risks is expected to foster positive attitudes toward economic changes that entail both risks and opportunities. Economic globalization is a prime example (Scheve and Slaughter, 2004; Hays *et al.*, 2005; Mayda *et al.*, 2007). In the context of trade liberalization, Schaffer and Spilker (2016) indeed find that a strong social safety net increases the public's 'likelihood of thinking of globalization as something positive'.

Given these studies, I first hypothesize that citizens in more generous welfare states, on average, exhibit more optimistic attitudes toward technological change than citizens in smaller welfare states. The mechanism behind this baseline hypothesis is a broadly conceived risk-mitigating role of the welfare state. Welfare states protect citizens not only against job and income loss but also against various non-work-related risks such as hazardous impacts on human health.

Hypothesis 1: Individuals in a more generous welfare state exhibit more positive attitudes toward technology than individuals in a smaller welfare state.

Given that technological change is an important source of labor market vagaries (Autor, 2015; Quintini *et al.*, 2018), various labor market interventions by the welfare state can influence technology attitudes by attenuating individuals' exposure to and/or perception of job and income insecurity. Three types of interventions are of particular importance as they focus specifically on addressing risks associated with labor market participation and remuneration.

First, measures that compensate the unemployed can mitigate the perception of economic losses among individuals who are at risk of being replaced by new technologies. Anderson and Pontusson (2007), for instance, find that generous unemployment benefits reduce citizens' subjective insecurity.

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Their counter-factual analysis shows that adopting the Swedish-style unemployment compensation alone would substantially reduce the job-loss anxiety of the average American.

Second, wage-setting institutions shape the perception of labor market risks via their effect on employer strategies in hiring, training, and technology adoption. The centralized wage-setting system, in particular, effectively serves to 'force and enable' firms to 'make more efficient use of' production factors including human capital (Streeck, 1989: 90). More specifically, such wage-setting institutions create an additional incentive for firms to increase the productivity of unskilled workers and enable the firms to be 'the residual claimant of the increase in productivity due to technology adoption' (Acemoglu, 2003: 128). Amid technological development, firms are thus incentivized to retain and retrain their workers and selectively adopt new technologies complementary to the existing workforce (Acemoglu, 2003). Such employer strategies, in turn, can reduce labor market insecurity faced by workers.

Third, the 'capacitating' role of the social investment welfare state (Morel and Palier, 2012) is expected to positively influence technology attitudes of citizens facing new labor market risks that are increasingly difficult to predict (Hemerijck, 2018). Governments can proactively equip their citizens with necessary human capital by providing higher education, offering life-long learning, and upskilling active labor market policies. Such active interventions are considered to be distinctive and complementary to protective interventions of the traditional welfare state that are less able to address labor market exclusion (Morel *et al.*, 2012).

Importantly, the effect of the aforementioned labor market institutions may not be uniform among different groups of citizens. Previous empirical studies on trade attitudes find that government policies catering to the economic losers of globalization do mitigate the likely losers' opposition to free trade (Ha *et al.*, 2014) yet might at the same time dampen the likely winners' enthusiasm for free trade (Ehrlich and Hearn, 2014). If so, it is plausible that the salutary effect of welfare state interventions on technology attitudes is observed mainly among the likely losers of technological transformation.

Who are such losers? Generally, the risk of job loss under the current trend of SBTC (Card and DiNardo, 2002) is greater among lower-skilled citizens (Acemoglu, 1998; Goldin and Katz, 1998; Michaels *et al.*, 2014). The lower-skilled, on average, would thus be less sanguine about technological transformation. Yet because they are likely to be the beneficiaries of various welfare state interventions such as unemployment compensation and retraining, the risk-moderating effect of such interventions should be more pronounced in this group.

To summarize, the effect of the welfare state's labor market interventions on technology attitudes would be conditioned by individual skill endowment. The effect is expected to be clearly salutary among the low-skilled, the likely losers of SBTC. The effect would be less positive or might even be negative among the high-skilled. The latter group might exhibit more positive technology attitudes under liberal labor market institutions where firms accelerate SBTC and the skill premium rises faster.

Hypothesis 2: The positive influence of labor market interventions on technology attitudes is more pronounced among the low-skilled than among the high-skilled.

A key macro-level implication of Hypothesis 2 is that the labor market institutions of the welfare state would reduce the otherwise considerable skill cleavage over technological change. In societies with such institutions, the high- and low-skilled would be less divided over the technological transformation.

The technology attitude-welfare attitude nexus

The preceding subsection discussed how existing welfare state institutions shape the public's perception of technological change. This subsection explores how, within a society, citizens'

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perceptions of technological change shape their welfare state attitudes. Investigating this micro-level nexus allows us to predict the coalitions and fault lines over the welfare state forged under technological transformation. I propose two competing hypotheses.

On the one hand, one might expect that citizens who are critical of the new technologies' economic consequences would want more redistributive state intervention that compensates for their losses. Those optimistic about technological transformation might perceive that new technologies allow them to more effectively address various social risks on their own. If so, they would be against the expansion of distributive public programs. This expectation is in line with findings from the literature on trade preference where the likely losers of trade support compensatory public policies whereas the likely winners oppose it (Ehrlich, 2010).

Hypothesis 3.1: Pro-technology attitudes are negatively associated with welfare state support.

On the other hand, one's acceptance of new technologies might foster, not undermine, her support for the welfare state. The expectation of large potential gains from technological advancements involves substantial uncertainties. Compared to those who defy new technologies, individuals more willing to adapt their behaviors in accordance with technological change might have stronger incentives to seek protection against future risks. Their 'insurance motive' for redistribution (Rehm, 2009: 858) is in line with the view that welfare states serve the future-oriented, risk-pooling needs of citizens who do not necessarily face any imminent economic disadvantage (Barr, 2001; Rehm *et al.*, 2012; Busemeyer and Garritzmann, 2017).

Furthermore, pro-technology citizens might support welfare state expansion if distributive policies are seen as essential for sustaining and furthering technological advancements. The expectation is broadly consistent with Rickard (2015) who finds that pro-trade legislators who represent more exporters are actually more likely to vote for expanding Trade Adjustment Assistance programs in order to broaden the pro-trade coalition.

Hypothesis 3.2: Pro-technology attitudes are positively associated with welfare state support.

To summarize, Hypothesis 1 concerns the direct effect of the welfare state on technology attitudes. Hypothesis 2 captures the conditioning effect of the welfare state on the micro-level nexus between technology-induced economic risk and technology attitudes. Lastly, Hypothesis 3 explores the effect of technology attitudes on welfare state attitudes.

Research design

The hypotheses discussed in the previous section were tested using a dataset of over 50,000 individuals from 50 countries. The individual-level data come from the latest (sixth) wave of the World Value Survey (WVS, 2010–2014). Country-level data on the welfare state and other macro-economic characteristics come from the International Labour Organization (ILO), the World Bank, the Database on Institutional Characteristics of Trade Unions, Wage Setting, State Intervention and Social Pacts (ICTWSS), and the Organisation for Economic Co-operation and Development (OECD).

Operationalization of variables

Technology attitudes

Technology attitudes are my dependent variable in Hypothesis 1 and Hypothesis 2 and the independent variable in Hypothesis 3. The WVS includes several questions pertaining to perceptions of science and technology. I created a composite indicator *Pro-Technology Index* (*PTI*) by

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Table 1. Attitudes toward technology and welfare state

WVS ID	Pro-Technology Index
V68	More Emphasis on Technology Development in the Near Future (Good Thing)
V192	Science and Technology Make Lives more Comfortable (Agree)
V193	Science and Technology Bring more Opportunities for Next Generation (Agree)
V197	World is Better/Worse off because of Science and Technology (Agree)
	Pro-Welfare State Index
V98	Government Should Ensure that Everyone is Provided for (Agree)
V131	Government Tax the Rich and Subsidize the Poor (Agree)
V134	People Receive State Aid for Unemployment (Agree)
V137	The State Makes Peoples' Incomes Equal (Essential)

aggregating responses to these questions using factor analysis.[4] More specifically, the index is based on the following ordinal questions: (1) whether putting more emphasis on the development of technology is desirable, (2) whether science and technology make lives easier and more comfortable, (3) whether science and technology are expected to bring more opportunities for the next generation, and (4) whether the world is better off because of science and technology. The list of questions and their WVS question ID number are reported in Table 1. More positive answers to these questions together capture respondents' greater willingness to embrace technological change. The resulting index variable ranges from 0 to 2.7 with a mean of 2.0.[5] For the robustness check, I show in the appendix that my main findings also hold using geometric averaging (with equal weightings) as the aggregation method.

Note that in creating the index I excluded questions that are explicitly about the normative implications of technology such as whether science conflicts with faith or whether science hinders moral judgments. While including these items do not substantially change my key findings, it unnecessarily stretches the index beyond the concept I seek to capture.

Welfare state attitudes

My dependent variable in Hypothesis 3 is welfare state attitudes. Using the WVS, I create a *Pro-Welfare State Index (PWI)*. The index is a composite indicator of the four items in the WVS that capture attitudes toward government redistribution and social protection. The items are listed in Table 1. Note that I only include those items that mention the role of the government; for instance, I exclude the item on inequality perception because an individual unhappy with inequality may not necessarily endorse government interventions to correct it. Similar to the construction of *PTI*, I aggregate the four items using factor analysis. An alternative measure based on geometric mean is also reported as a robustness check. In my sample, *PWI* ranges from 0 to 2.4 with a mean of 1.4.

Welfare state institutions

My independent variables in Hypothesis 1 and Hypothesis 2 are welfare state institutions. As an indicator of overall welfare state generosity (relevant for Hypothesis 1), I employ total public social protection expenditure (as % of the GDP). The data are from the ILO's World Social Protection

[4]Factor analysis allows for the construction of weights representing the information content of individual indicators (Nardo and Saisana 2008). Methodologists are, however, divided on the issue of how factors should be retained without losing too much information: whether the composite indicator values should be based on the first component scores, on a specific number of, or be equal to component scores multiplied by its proportion of variance (Vidoli and Fusco 2018: 13). I use the last approach. The indexes are created using the R package (version 2.0) *Compind* and its *ci_factor* function.

[5]The range starting at zero results from recoding the variable by subtracting the minimum.

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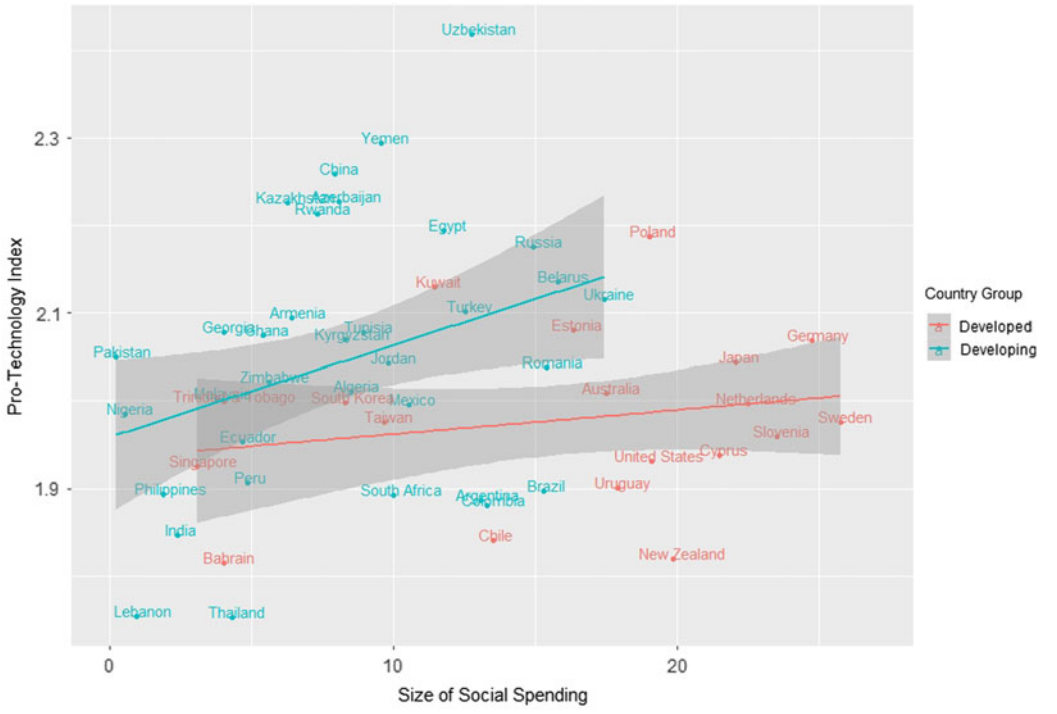

Figure 1. Social spending and Pro-Technology Index.

Report 2014/15 (ILO, 2014).[6] The measure is referred to as *Social Spending* hereafter. It ranges from 0.2 in Pakistan to 26 in Sweden.

As discussed in the previous section, welfare states not only mitigate technology-induced job and income insecurity but can also mitigate other non-labor-market-related concerns such as new technologies' hazardous impact on health and safety. So I expect the *Social Spending* variable to have a positive association with the *PTI*. As shown in Figure 1, the country means of *PTI* and *Social Spending* exhibit a weakly positive correlation in both developing and developed country groups. Of course, more rigorous investigation into the relationship requires controlling for other compounding factors at both country and individual levels, which will be the subject of the next section.

For Hypothesis 2, I employ a series of indicators capturing the labor market interventions of the welfare state. First, I employ *Unemployment Protection*, which measures the effective coverage of unemployment benefits (as % of the unemployed population). The data are from the ILO's World Social Protection Report 2014/15 (ILO, 2014).[7] The variable is highly right-skewed as most developing countries have very low coverage while a few developed countries feature broad-based coverage. I thus employ a log transformation of the variable.[8]

Second, I use an indicator of the coordination in wage setting from the ICTWSS database (Visser, 2016). The measure, *Wage Coordination*, is a 5-category ordinal indicator.[9] It is expected

[6]When the spending information from the survey year is unavailable, the most recent available data are used as long as they are not more than 5 years earlier than the survey year. The data for Argentina are from the Database on Social Investment in Latin America and the Caribbean (https://observatoriosocial.cepal.org/inversion/en).

[7]I use the data from the latest available year, 2013 for the vast majority of countries.

[8]Due to natural zeros (i.e., no government program for unemployment protection in place), a small constant (0.1) was added to all values before the transformation.

[9]'1' indicates fragmented wage bargaining, and '5' indicates centralized bargaining.

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that in countries with more centralized wage-setting institutions the demand for lower-skilled workers does not decrease as much as in other countries with no such institutions (Acemoglu, 2003; Domeij and Ljungqvist, 2013). In line with this expectation, *Wage Coordination* is indeed negatively correlated with the skill premium of high-skilled workers. According to OECD Statistics (2019), in 2015, the relative earnings index[10] of the university educated was 117 in Sweden (the lowest among 38 sample countries) where, according to the ICTWSS database, 'wage norms are based on centralized bargaining by peak associations' (*Wage Coordination* = 4). The index was 174 in the USA with 'fragmented wage bargaining, confined largely to individual firms or plants' (*Wage Coordination* = 1).

Third, I employ spending on active labor market programs (ALMPs % GDP) from the OECD database. While the measure is only available for the OECD member states, it allows for capturing the effect of capacitating interventions. See the Appendix (Table A.2 in Supplementary material) for country-specific data availability.[11]

Exposure to SBTC-induced economic loss (individual skill endowment)

Under SBTC, the likelihood of job and income loss among the low-skilled is greater than that of the high-skilled. The baseline technology attitude would thus be less positive among the low-skilled. Labor-protecting institutions are expected to mitigate such a skill-based gap in the *PTI*. I use the level of *Education* from the WVS as a proxy for skill level. The Education variable has nine ordinal categories where one indicates no formal education and nine indicates completion of university education. The *Education* variable is highly correlated with the respondents' self-positioning of their current occupation on the manual-intellectual spectrum. I prefer an objective measure of education as it can capture one's potential to switch to intellectual tasks in addition to the type of task one is currently performing.

I acknowledge that the association between educational attainment and skill utilization in the labor market varies across time and space. In more advanced economies with a large college-educated population, the association tends to be weaker. Horowitz (2018) indeed finds in his longitudinal study (1970–2010) in the USA that the advantage a college-educated individual has in analytic skill utilization declines as birth cohorts become better-educated. That said, his analysis still concludes that even now 'individuals who earn a college degree still take more skilled jobs than do those with no college experience' (Horowitz, 2018: 790).

While it is also plausible that the higher-educated are more knowledgeable and thus are more capable of objectively assessing the various risks from technology, existing studies present weak and mixed evidence when it comes to whether more technical knowledge leads to lower risk perception and to more favorable attitudes toward science and technology (Slovic, 1987; Bauer *et al.*, 1994; Sturgis and Allum, 2004). Risk perception among lay people is 'a function of many different factors of which the results of technical risk assessments is only one among others' (Renn, 1990: 3). Based on these studies, I assume that the information effect is unlikely to be a strong driver of the positive association between *Education* and *PTI*.

Controls

At the individual level, I control for *Income* (in deciles), *Gender*, and *Age*. Existing studies also emphasize how trust can foster confidence in technology (Siegrist *et al.*, 2005). Empirical studies find that high public concern about a technology-related risk issue (e.g., radiation from nuclear power plants) tends to be 'associated with distrust of the managers responsible for that issue' (Earle *et al.*, 2012: 20). I thus control for *Political Trust*, which is a composite

[10]Earnings of the Upper-Secondary Educated = 100; the OECD average is 155.

[11]The data are from the OECD and available at https://stats.oecd.org/Index.aspx?DataSetCode=LMPEXP. Among various categories of labor market programs, I employed the sum of 'active' measures.

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indicator based on the five WVS questions concerning confidence in political institutions: the courts (V14), the government (V15), political parties (V16), parliament (V17), as well as civil service (V18).[12]

Technology skepticism might stem not only from considerations of rational-material consequences but also from the denial of scientific discoveries that contradict individuals' deeply held beliefs (Kahan *et al.*, 2011). To capture such variation in the *PTI*, I use the *Disbelief* sub-index provided by the WVS which is the inverse of religious beliefs. I expect *Disbelief* to be positively associated with the *PTI*. Existing studies also find that individuals more familiar with new technologies tend to exhibit a more favorable technology perception. I thus control for the arithmetic mean of internet usage and mobile phone usage variables from the WVS as a proxy for individuals' familiarity with information technology (*IT Familiarity)*.

The multilevel nature of the data is handled by estimating random country intercepts. The specification allows for estimating the effect of country-level covariates while capturing unobserved country-specific characteristics with random intercepts. I also control for *GDP per capita* (in thousands constant 2010 USD).[13]National income is often used as a proxy for national-level capital endowment. Higher-income countries are relatively capital abundant and labor scarce whereas lower-income countries are more labor abundant and capital scarce. Provided that firms are not constrained by protective labor market institutions, they would be more likely to adopt (unskilled-) labor-saving technologies in higher-income countries where cost of labor, as a scarce factor, is more expensive than in lower-income countries. If so, *GDP per capita* would be negatively associated with the average worker's pro-technology attitudes.

Given the relatively small number of country-level units (around 50–55 for full sample models), I refrain from adding multiple macro-level control variables. For robustness checks, I explored specifications that include additional national-level indicators. They include indicators of technological advancement such as *Med/High-tech Industry Value Added* (as % of manufacturing value added) and *Patents* (logged number of patent applications filed by residents) as well as the quality of technological infrastructure proxied by *Fixed Broadband Subscriptions per 100 People*.[14] Adding these variables do not substantially change my main results, and the coefficient estimates of these variables lack statistical significance. The results are reported in the Appendix (Table A.3 in Supplementary material).

Measurement validity

Does PTI reflect 'economic' risks from technological change?

Given the general wording of the survey questions employed to construct the *PTI* (see Table 1), the index is subject to the criticism that it may not sufficiently reflect the respondents' assessments about the *economic* consequences of technological change. For instance, one might exhibit a low *PTI* score primarily because she believes new technologies make people more cold-hearted or less religious. If so, *PTI* is not a valid indicator to test my hypotheses, which posit that the welfare state shapes technology attitudes by mitigating technology-induced economic risks.

To address the validity concern, Table 2 presents a set of preliminary models. If *PTI* is indeed a function of expected economic risks and losses from technological change, the indicator of skill endowment (*Education*) should have a positive and significant association with *PTI* because the high-skilled are less exposed to the risks of job and income losses under SBTC. The findings in Model 1 are consistent with the expectation. Importantly, the positive association between

[12]A simple arithmetic mean is used as the aggregation method. Respondents who answered less than four questions are excluded.

[13]The data are from the World Bank Open Data and available at https://data.worldbank.org/indicator/NY.GDP.PCAP.KD. The data for Taiwan are from the Taiwan National Statistical Bureau and available at https://eng.stat.gov.tw/mp.asp?mp=5

[14]The data are from the World Bank Open Data. Indicator codes are IP.PAT.RESD (*Patents*), NV.MNF.TECH.ZS.UN (*Med/High-tech Industry Value Added*), and IT.NET.BBND.P2 (*Fixed Broadband Subscriptions per 100 People*).

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Table 2. Does PTI reflect exposure to technology-induced economic risk?

	DV: Pro-Technology Index		
	(1)	(2)	(3)
Education	0.017***	0.028***	0.017***
	(0.001)	(0.002)	(0.001)
Routine	−0.001	0.010***	−0.001
	(0.001)	(0.002)	(0.001)
Edu: Routine		−0.002***	
		(0.0003)	
Age	0.001***	0.001***	0.001***
	(0.0001)	(0.0001)	(0.0001)
Female	−0.053***	−0.054***	−0.053***
	(0.004)	(0.004)	(0.004)
Income	0.013***	0.013***	0.013***
	(0.001)	(0.001)	(0.001)
(Religious) Disbelief	0.039***	0.039***	0.039***
	(0.008)	(0.008)	(0.008)
IT familiarity	0.013***	0.013***	0.013***
	(0.002)	(0.002)	(0.002)
Political trust	0.073***	0.073***	0.073***
	(0.003)	(0.003)	(0.003)
Edu: GDP per capita			−0.00004
			(0.0001)
GDP per capita	−0.004***	−0.004***	−0.003***
	(0.001)	(0.001)	(0.001)
Constant	1.691***	1.623***	1.688***
	(0.029)	(0.031)	(0.029)
N	58,846	58,846	58,846
Country	55	55	55
Country random effect	✓	✓	✓

*$P < 0.1$; **$P < 0.05$; ***$P < 0.01$.

Education and *PTI* holds, controlling for a set of factors that drive the non-economic variation in *PTI* including (religious) *Disbelief* and social/political *Trust*.

In Model 1, I also include the self-reported task routineness indicator (*Routine*) in addition to *Education*. This consideration addresses findings from the literature that technological change tends to decrease demand for 'middling' occupations performing cognitive but routine tasks relative to occupations with lower routineness (Autor *et al.*, 2003; Goos *et al.*, 2014). Thus, I expect *Routine* to be negatively associated with *PTI*. The variable *Routine* has the expected negative sign in Model 1; that is, individuals performing routine tasks tend to exhibit less positive attitudes toward technological change. The magnitude of the effect, however, is small compared to that of *Education*.

Task routineness is also expected to reduce the positive effect of skill attainment on *PTI*. I thus examine the interaction between *Education* and *Routine* in Model 2. The finding is visualized in Figure 2. I simulate the predicted values of *PTI* for those with vocational secondary education (*Education* = 5, in red) and those with a university degree (*Education* = 9, in blue) over a range of task routineness on the *x*-axis (from 1 = highly creative to 10 = highly routine). All other variables are set at the sample mean values. As expected, the negative slope of the blue line indicates that the positive effect of university education on *PTI* is dampened by task routineness. Due to the low *PTI* of highly educated routine taskers, the skill-based gap over *PTI* (captured by the distance between the two lines) is smaller among routine taskers than among creative workers.[15]

[15]The shaded areas indicate 67% confidence intervals. The figure also reveals that the university educated still exhibits more positive *PTI* than those with secondary vocational education even among the most routine taskers, so I omitted the *Routine* variable in the main analysis in third section for parsimony.

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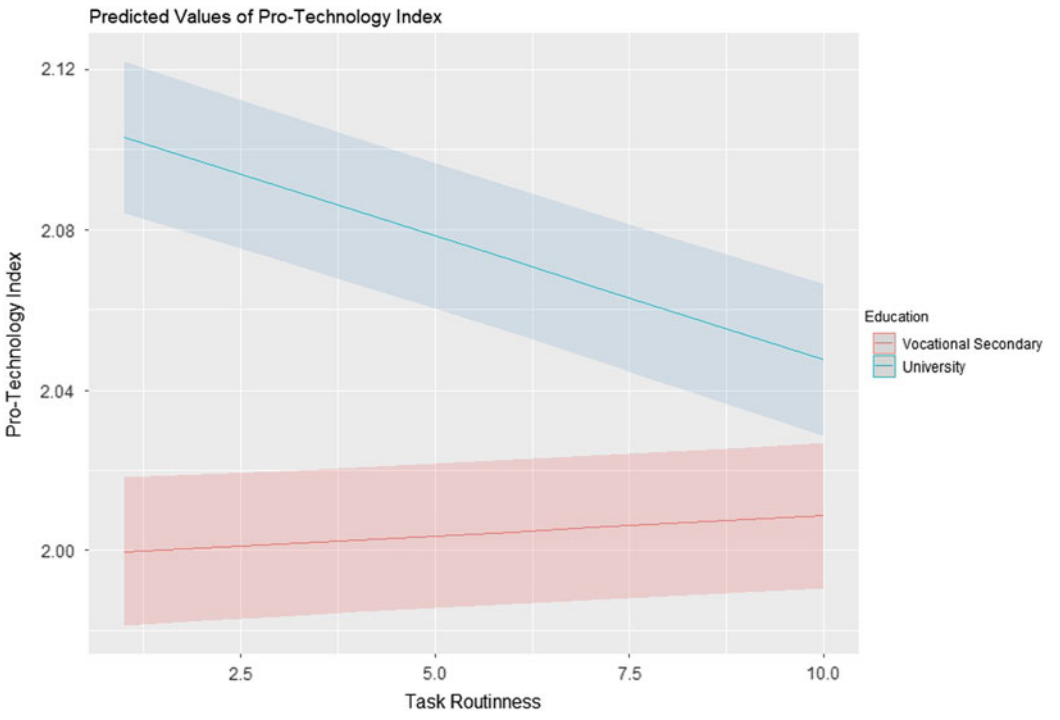

Figure 2. Effects of skill level and task type on technology attitudes.

Because my theoretical expectations for the welfare state's effect on technology attitudes apply to both developing and developed countries, it is also important to show that the cleavage over new technology is not confined to the developed world. Model 3 thus includes the interaction term of *Education* and *GDP per capita*. While the lower-order term *Education* remains significant, the interaction term is not. The *Education* effect (capturing the skill cleavage) is observed at all substantively meaningful values of *GDP per capita*.

The analyses reported in this subsection together suggest that *PTI* reflects individuals' perceptions of economic risks associated with new technologies in developing as well as developed countries. The following section tests my hypotheses concerning the nexus between the welfare state and *PTI*.

Empirical analysis and findings

This section tests the hypotheses I developed in the Theoretical Expectations section. I begin with testing Hypothesis 1, which posits a positive association between overall welfare state generosity (measured by *Social Spending*) and *PTI*. Next, I test Hypothesis 2, which suggests that labor market interventions of the welfare state mitigate the negative technology perceptions among low-skilled workers, and thereby reduce the skill cleavage over technology acceptance. The relevant models include the interaction term of *Education* and the labor market intervention indicator. Lastly, I turn to Hypothesis 3 and explore how technology attitudes (*PTI*) shapes welfare state attitudes (*PWI*).

Tests for Hypothesis 1 and Hypothesis 2: Do welfare state institutions promote technology acceptance?

The models in Table 3 explore the association between welfare state institutions and the dependent variable *PTI*. In Model 4, the key independent variable is *Social Spending*. The coefficient

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Table 3. Effects of welfare state institutions on technology attitudes

	DV: Pro-Technology Index (PTI)							
	(4)	(5) Developing	(6) Developed	(7)	(8) Developing	(9) Developed	(10)	(11)
Education	0.017***	0.018***	0.013***	0.017***	0.018***	0.016***	0.010	0.045**
	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.002)	(0.020)	(0.021)
Social spending	0.009***	0.022***	0.005					
	(0.003)	(0.005)	(0.004)					
Unemp. protection				0.005	0.025***	0.003		
				(0.008)	(0.012)	(0.012)		
Protection: Edu				−0.001**	−0.0005	−0.001*		
				(0.0003)	(0.0005)	(0.001)		
Unemp. generosity							0.054	
							(0.242)	
Generosity: Edu							0.021	−0.021
							(0.034)	(0.035)
Age	0.0002*	−0.001***	0.003***	0.0002*	−0.001***	0.003***	0.008***	0.008***
	(0.0001)	(0.0002)	(0.0002)	(0.0001)	(0.0002)	(0.0002)	(0.001)	(0.001)
Female	−0.048***	−0.037***	−0.074***	−0.048***	−0.036***	−0.073***	−0.211***	−0.203***
	(0.004)	(0.004)	(0.006)	(0.004)	(0.004)	(0.006)	(0.021)	(0.021)
Income	0.012***	0.010***	0.016***	0.012***	0.010***	0.016***	0.044***	0.049***
	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.002)	(0.005)	(0.005)
(Religious) Disbelief	0.031***	0.007	0.071***	0.032***	0.007	0.073***	0.279***	0.285***
	(0.007)	(0.010)	(0.011)	(0.007)	(0.010)	(0.011)	(0.032)	(0.033)
IT familiarity	0.011***	0.004**	0.031***	0.011***	0.004**	0.031***	0.090***	0.081***
	(0.001)	(0.002)	(0.003)	(0.001)	(0.002)	(0.003)	(0.009)	(0.009)
Political trust	0.070***	0.055***	0.111***	0.070***	0.055***	0.111***	0.354***	0.368***
	(0.003)	(0.003)	(0.005)	(0.003)	(0.003)	(0.005)	(0.019)	(0.019)
GDP per capita	−0.006***	−0.038***	−0.003*	−0.004***	−0.038***	−0.002	−0.001	
	(0.001)	(0.007)	(0.002)	(0.001)	(0.008)	(0.002)	(0.002)	
Constant	1.656***	1.825***	1.347***	1.719***	2.003***	1.389***	3.630***	3.540***
	(0.035)	(0.052)	(0.072)	(0.028)	(0.053)	(0.070)	(0.162)	(0.123)
N	68,303	46,707	21,596	68,303	46,707	21,596	12,095	12,095
Country	53	34	19	53	34	19	9	9
Country random effect	✓	✓	✓	✓	✓	✓		
Country fixed effect								✓

*$P < 0.1$; **$P < 0.05$; *** $P < 0.01$.

estimate of *Social Spending* is significant and positive. The finding is consistent with Hypothesis 1, which expects that individuals in a more generous welfare state exhibit more positive attitudes toward technology than individuals in a smaller welfare state.[16]

Does the welfare state-technology attitude nexus vary between developing countries and developed countries? If so, how? Two competing expectations can be considered in this regard. First, the nexus might be weaker in developing countries where many social programs are rather new and less consolidated. Existing studies find that the extent citizens look to the welfare state as a viable means of protection depends on citizens' 'experiences with having lived in settings where state institutions govern social protection to address risks' and that in emerging welfare states, citizens exposed to social risks do not necessarily turn to government protection (Lim and Burgoon, 2018). If so, the effect of social spending on reducing perceived risks under SBTC might be weaker in developing countries than in developed countries with mature welfare state institutions.

Second, the nexus might be stronger in developing countries because the marginal utility of a one-unit income transfer via social spending tends to be greater for developing countries whose average living standard is lower than wealthier countries. Furthermore, it is plausible that citizens in rich and mature welfare states take the traditional measures of the welfare state for granted. Unlike the low-skilled in developing countries occupied with subsistence concerns, those in affluent countries might expect more from their welfare state. If so, the welfare state-technology attitude nexus in developed countries might be sensitive to the type of welfare state measures. Only those measures that directly address 'new' labor market risks under SBTC might have a PTI-increasing effect.

These competing expectations are explored using the subsample analysis reported in Models 5 and 6. In the developing country subsample (Model 5), *Social Spending* has a significant and positive association with *PTI*. *Social Spending* is insignificant in the model with the developed country subsample (Model 6). The finding is in line with the second expectation.

This finding also brings us to the next step in the analysis, which directly employs the indicators of labor market interventions. As discussed in the previous section, I employ three measures of labor market interventions capturing distinct yet complementary functions of the welfare state: unemployment protection, wage coordination, and ALMPs.

First, Models 7–9 employ *Unemployment Protection* measured by the percentage of the population effectively covered by unemployment benefits. As Hypothesis 2 posits that the *PTI*-increasing effect of protective labor market institutions would vary by *Education*, I interact *Unemployment Protection* with *Education*. Model 7 is the full sample model. The interaction term coefficient is negative and significant, but the lower-order term *Unemployment Protection* is insignificant. The findings suggest that unemployment benefits reduce the *PTI* among the higher skilled while having no positive impact on the *PTI* among the lower-skilled.

The finding from the pooled model, however, can be misleading if the same welfare state intervention has distinct effects in developed and developing countries. Models 8 and 9 thus explore developing and developed countries separately. In the developing country subsample (Model 8), the lower-order *Unemployment Protection* term is positive and significant while the interaction term coefficient is not statistically significant. They together capture the positive effect of unemployment benefit coverage on technology acceptance across different skill levels in developing countries. In Model 9, only the interaction term is negative and significant. This suggests that in developed countries, unemployment benefit coverage has no *PTI*-increasing effect among the low-skilled and may even have a small *PTI*-reducing effect among high-skilled citizens. These findings are largely consistent with the findings on the effect of social spending (recall Models 5 and 6).

[16]The finding holds when an alternative measure of PTI based on geometric average is employed. See the Appendix for results.

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Why does *Unemployment Protection* have no positive association with *PTI* in developed countries? One might suspect that the measure based on the population coverage (breadth) has limited variation in the developed world where most industrial employees are covered by unemployment protection. To address this concern, I employ an alternative compensation measure: unemployment insurance replacement rate. Unfortunately, the data are only available for nine developed countries in my sample.[17] Random effect models produce biased estimates for higher-level indicators when the number of higher-level units is small.[18] I thus estimate a pooled ordinary least squares (OLS) model (Model 10) and a country fixed effects model (Model 11) including the interaction term of the country-level moderator and a micro-level independent variable (Möhring, 2012). Nevertheless, I do not find any evidence that the higher replacement rate is associated with more positive technology attitudes among the low-skilled in these developed economies.

As discussed earlier, the divergent findings in developing and developed countries might in part be attributable to the varying public expectations toward the role of the welfare state. Compensation alone would be insufficient to foster technology acceptance where the public is concerned about 'exclusion' (Morel *et al.*, 2012) and 'marginalization' (Gesthuizen *et al.*, 2010) in the labor market. These 'new' social risks are not adequately addressed by unemployment compensation. This explanation is also in line with my earlier finding that the overall size of social spending does not promote public technology acceptance in developed countries. It might be that interventions that are empowering and capacitating are needed to foster their technology acceptance in developed countries.

In Table 4, I thus move on to models utilizing additional indicators of the welfare state's labor market intervention: (1) wage coordination systems incentivizing firms to retain and retrain low-skilled workers and (2) spending on ALMP. See the Appendix (Table A.2 in Supplementary material) for country-specific data availability.[19]

Models 12–14 examine the effect of centralized wage setting. In Model 12, the baseline model without an interaction term, the *Wage Coordination* variable lacks statistical significance while the *Education* term is significant and positive. To test Hypothesis 2, Model 13 adds the interaction term of *Wage Coordination* and *Education*. The positive and significant coefficient estimate of the lower-order *Wage Coordination* variable captures the PTI-increasing effect of a centralized wage coordination system among the lowest skilled. The negative and significant interaction term coefficient points toward skill-varying effects of centralized wage setting that are consistent with Hypothesis 2. The substantive meaning of the interaction effect is visualized in Figure 3a in terms of predicted *PTI*. I vary *Wage Coordination* (on the *x*-axis; from 1 for the most fragmented to 5 for the most centralized) and *Education* while fixing all other covariates at their sample mean values. Again, the distance between the blue and red lines captures the skill-based gap in *PTI*. The gap is larger under a fragmented wage bargaining system (when *Wage Coordination* = 1) than under a coordinated system (when *Wage Coordination* = 5). The findings provide evidence that a strong *Wage Coordination* system might mitigate the skill-based gap in public technology attitudes.

[17]The data are from The Comparative Welfare Entitlements Dataset (CWED) version 2. The replacement rate data are 'calculated for a fictive average production worker in manufacturing sector who is 40 years old, has been working for the 20 years preceding the loss of income or the benefit period' (for more on the measure see Scruggs *et al.*, 2017). I use the data for a single person living alone with no children or other dependents. Using the measure results in the reduction of country sample size from 50 to 9 because only 9 countries were jointly included in both the latest round of WVS and in Scruggs' dataset. The countries included are Australia, USA, Germany, Netherlands, New Zealand, Sweden, Japan, South Korea, and Taiwan.

[18]Stegmueller's (2013) simulations, for instance, point out that when fewer than 15 countries are available, the confidence intervals for the effect estimates of the country-level covariate are 5% to 15% points narrower than their nominal ones.

[19]I still include all countries with data availability in my analysis because I have no theoretical reason to exclude developing countries when examining the role of empowering and capacitating labor market institutions on *PTI*. I control for GDP per capita.

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Table 4. Effects of welfare state institutions on technology attitudes II

	DV: Pro-Technology Index (PTI)					
	(12)	(13)	(14)	(15)	(16)	(17)
Education	0.018***	0.026***	0.025***	0.006***	0.008***	0.013***
	(0.001)	(0.003)	(0.003)	(0.002)	(0.003)	(0.003)
Wage Coord.	0.019	0.040*	0.036*			
	(0.019)	(0.021)	(0.020)			
Coord: Edu		−0.003***	−0.003**			
		(0.001)	(0.001)			
Union member			−0.274***			
			(0.092)			
Coord: Union			0.084**			
			(0.038)			
Edu × Union			0.029**			
			(0.013)			
Coord: Edu : Union			−0.011**			
			(0.005)			
ALMP				0.022	0.064	
				(0.015)	(0.042)	
ALMP : Edu					−0.006	−0.002
					(0.006)	(0.006)
Age	0.002**	0.001***	0.001***	0.002***	0.002***	0.003***
	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0003)
Female	−0.063***	−0.063***	−0.064***	−0.093***	−0.093***	−0.086***
	(0.005)	(0.005)	(0.005)	(0.008)	(0.008)	(0.007)
Income	0.015***	0.015***	0.015***	0.013***	0.013***	0.016***
	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)
(Religious) Disbelief	0.056***	0.055***	0.053***	0.087***	0.087***	0.128***
	(0.010)	(0.010)	(0.010)	(0.011)	(0.011)	(0.012)
IT familiarity	0.011***	0.011***	0.011***	0.024***	0.024***	0.029***
	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)
Political trust	0.101***	0.101***	0.103***	0.124***	0.125***	0.138***
	(0.004)	(0.004)	(0.004)	(0.006)	(0.006)	(0.007)
GDP per capita	−0.003**	−0.003**	−0.003**	−0.003***	−0.003***	
	(0.001)	(0.001)	(0.001)	(0.0003)	(0.0003)	
Constant	1.499***	1.447***	1.456***	1.536***	1.522***	1.254***
	(0.059)	(0.061)	(0.061)	(0.024)	(0.027)	(0.033)
N	32,576	32,576	32,182	16,433	16,433	16,433
Country	22	22	22	13	13	13
Country random effect	✓	✓	✓			
Country fixed effect						✓

* $P < 0.1$; ** $P < 0.05$; *** $P < 0.01$.

Even under a centralized wage bargaining system, some workers have limited access to collective bargaining. The growth of precarious employment in sectors that are difficult to organize has been a problem in many countries, and representation of irregular workers in collective bargaining has been difficult even in countries with strongly institutionalized peak-level tripartism such as the Netherlands (Boonstra *et al.*, 2012). Thus, workers exposed to 'destructive effects of market forces' would feel more shielded when they are unionized and the state intervenes to 'back either collective bargaining or its collective agents (unions and employer associations)' (Traxler, 2003: 144). Furthermore, the experience of taking part in and benefiting from inclusive and centralized wage coordination can have an enlightenment effect on low-skilled union members, which increases their perception of self-efficacy (Markowitz, 1998) under challenging situations such as SBTC. Such experiences might create in workers 'the sense that they can exercise some control over their working lives' (D'Art and Turner, 2007: 108)

As such, Model 14 explores a three-way interaction effect of active union membership (*Union*), *Education*, and *Wage Coordination*. I expect the positive association between *Wage Coordination*

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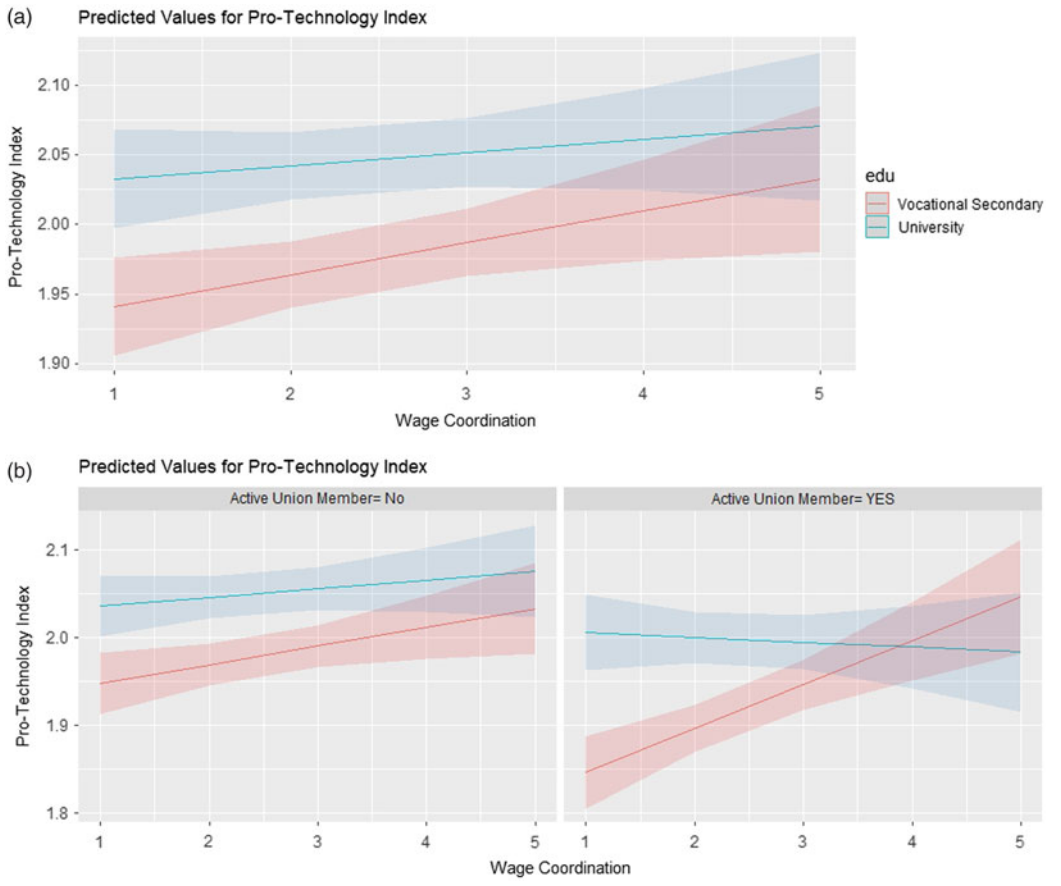

Figure 3. Effects of wage-setting institutions on *PTI*.

and *PTI* among less-skilled workers to be more pronounced when they are union members. The finding is visualized in Figure 3b. The figure on the right(/left) is for those with(/without) active union membership. The difference in the slope of the red lines reveals that the positive association between *Wage Coordination* and the less-skilled workers' *PTI* is stronger among active union members. Meanwhile, the slightly negative slope of the blue line on the right indicates that high-skilled union members are more pro-technology under a fragmented bargaining system allowing for greater wage inequalities and skill premiums. This outcome is consistent with my expectation in Hypothesis 2.

Lastly, I examine how government spending on *ALMP* shapes the skill cleavage over technology acceptance. It should be noted that only 12 countries could be included in the analysis due to limited data availability. I thus turn to pooled OLS (Models 15–16) and a country fixed effects model including the interaction terms of *ALMP* and *Education* (Model 17). I present the finding based on Model 16 in Figure 4. The effect of *ALMP* is broadly in line with the effect of *Wage Coordination*. Spending on active labor market policies seems to promote technological acceptance of the low-skilled (captured by the red upward-sloped line) and reduces the skill-based gap in *PTI*. The magnitude of the effect, however, is very small. Future empirical research should investigate the effect of the social investment welfare state on technology acceptance with more fine-grained data and in a larger sample of countries.

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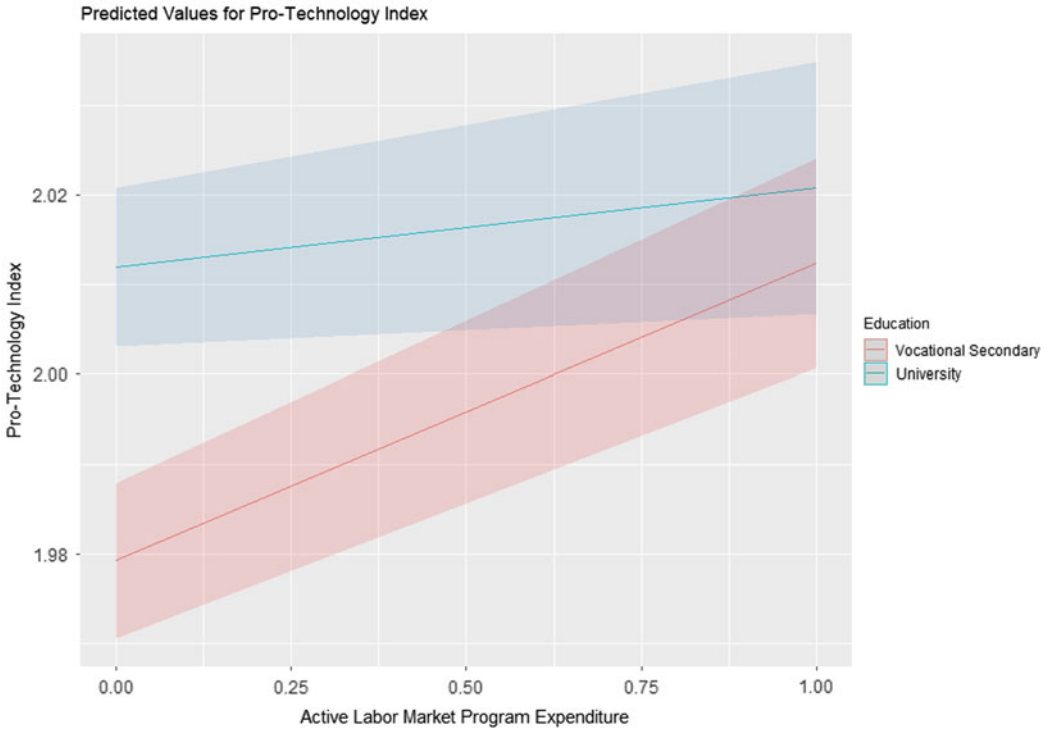

Figure 4. Effects of ALMP spending on welfare attitudes.

Overall, my analyses lend partial support to Hypothesis 2. A protective intervention in the form of unemployment compensation was associated with a broader-based technology acceptance in developing countries. Such measures of protection, however, had no meaningful association with the public's technology acceptance in developed countries. In the latter, I find first-cut evidence that empowering and capacitating workers via institutions for collective bargaining and ALMP might have potential to foster broader-based technology acceptance.

Tests for Hypothesis 3: How does technology perception shape welfare state attitudes?

This section explores the micro-level nexus between technology perception and welfare attitudes within a society (Hypothesis 3.1 and Hypothesis 3.2). Among the citizens with varying *PTI*, who are more likely to turn to the welfare state for the social embedding of technological change?

My dependent variable now is the *PWI*, and the key independent variable is *PTI*. Several macro-level factors such as welfare state generosity, country income, and level of economic openness are important determinants of *PWI* as well as *PTI*. I thus include these macro-variables as controls. Random country intercepts are also included. Table 5 reports the results.

Model 18 is the baseline model including only the macro-level control variables and *PTI*. The *PTI* variable has a positive and significant association with *PWI*. The finding is consistent with Hypothesis 3.2, which posits that pro-tech citizens would be *more* supportive of welfare states than techno-skeptics. Model 19 introduces a set of micro-level control variables. The *PTI* variable itself still has a positive association with the *PWI*. As reported in the Appendix, the finding holds when I employ an alternative measure of *PWI* or use the dominant sub-items from *PWI* (V137) and *PTI* (V192) instead of the composite index.

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Table 5. Determinants of welfare state attitudes

	DV:Pro-Welfare State Index (PWI)					
					(22)	(23)
	(18)	(19)	(20)	(21)	Developing	Developed
Pro-Technology Index (PTI)	0.103***	0.119***		0.175***	0.175***	0.127***
	(0.004)	(0.004)		(0.009)	(0.011)	(0.020)
Tech skeptic			−0.079***			
			(0.004)			
Tech optimist			0.080***			
			(0.005)			
Education		−0.008***	−0.008***	0.011***	0.001	0.016***
		(0.001)	(0.001)	(0.003)	(0.004)	(0.006)
Age		0.0001	0.0001	0.0001	0.0005***	−0.0004*
		(0.0001)	(0.0001)	(0.0001)	(0.0002)	(0.0002)
Female		0.015***	0.014***	0.014***	0.012***	0.018***
		(0.004)	(0.004)	(0.004)	(0.004)	(0.006)
Income		−0.024***	−0.024***	−0.024***	−0.021***	−0.031***
		(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
(Religious) Disbelief		−0.036***	−0.035***	−0.035***	−0.051***	−0.011
		(0.007)	(0.007)	(0.007)	(0.010)	(0.011)
IT familiarity		−0.011***	−0.011***	−0.011***	−0.013***	−0.007***
		(0.001)	(0.001)	(0.001)	(0.002)	(0.003)
Political trust		−0.016***	−0.014***	−0.016***	−0.013***	−0.020***
		(0.003)	(0.003)	(0.003)	(0.003)	(0.006)
GDP per capita	−0.084***	−0.090***	−0.093***	−0.088***	−0.144*	−0.007**
	(0.014)	(0.017)	(0.017)	(0.017)	(0.082)	(0.003)
Econ. globaliz.	0.131***	0.127***	0.131***	0.125***	0.120***	0.006
	(0.004)	(0.004)	(0.004)	(0.004)	(0.006)	(0.004)
Social spending	0.016	0.032	0.033	0.031	0.084	0.010·
	(0.033)	(0.040)	(0.041)	(0.039)	(0.061)	(0.006)
PTI : Edu				−0.010***	−0.004**	−0.013***
				(0.001)	(0.002)	(0.003)
Constant	−5.339***	−4.979***	−4.977***	−4.983***	−4.713***	1.024***
	(0.456)	(0.461)	(0.475)	(0.455)	(0.720)	(0.327)
N	70,723	64,886	64,886	64,886	45,463	19,423
Country	55	51	51	51	33	18
Country random effect	✓	✓	✓	✓	✓	✓

* $P < 0.1$; ** $P < 0.05$; *** $P < 0.01$.

In Model 20, I explore the possibility that technology attitudes have a non-linear effect on welfare state attitudes. It might be that, compared to those with middle-level *PTI*, citizens with low *PTI* and those with high *PTI* both exhibit stronger support for the welfare state; the former wants compensation, and the latter is willing to offer such compensation to prevent any backlash against technological transformation. I thus employ a three-category nominal indicator of technology attitudes: *Techno-Skeptic* (*PTI* < 1st quartile), *Techno-Optimist* (*PTI*> 3rd quartile), and neutral as the reference category. I do not find evidence for non-linear effects. *PWI* is highest among the *Techno-Optimist* and lowest among the *Techno-Skeptic*. The findings together provide consistent support for Hypothesis 3.2.

As discussed earlier, there is more than one reason why pro-technology citizens are more favorable to redistributive welfare state policies than techno-skeptics. First, adapting to new technologies can bring about large potential gains yet, at the same time, involve risks and uncertainties. Being on board with technological transformation thus creates incentives for insurance-seeking via public risk-pooling. Second, individuals with a higher *PTI* might seek to preempt a popular backlash against the trend of technological progress. To the extent that individuals' *PTI* reflects

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their perceived gains from technological change, individuals with a higher *PTI* have a vested interest in maintaining the change by compensating for the losers who might try to block the change.

The two motivations have distinct observable implications. If the insurance-seeking motivation explains the pro-tech population's support for the welfare state, the positive *PTI–PWI* nexus would be stronger among the higher-risk-bearing segment of the pro-tech group (i.e., the low-skilled techno-optimists). If the intention is to preempt a popular backlash and secure their gains, the nexus would be stronger among those who enjoy disproportionate economic gains from technological transformation, that is, the high-skilled techno-optimists. To see whether and how the association between *PTI* and *PWI* varies by skill type, I interact *PTI* and *Education* in Model 21. The lower-order *PTI* coefficient is positive, but the interaction term coefficient is negative. In other words, the positive nexus between pro-technology attitudes and welfare state support is stronger among the lower-skilled.

The findings also hold when we examine developing countries (Model 22) and developed countries (Model 23) separately. I visualize the finding from Model 23 in Figure 5 in terms of predicted values for *PWI*. I vary the level of *Education* and *PTI* while setting all other variables at the sample mean values. The positive slope of the red line suggests *PTI* is positively associated with *PWI* among those with secondary education. The finding is consistent with the explanation emphasizing the pro-tech population's insurance motive. Those facing higher risks under SBTC who nevertheless embrace the opportunities offered by new technologies exhibit the highest *PWI*. These citizens are stronger supporters of the social embedding of the technological transformation than both low-risk tech-enthusiasts (i.e., the university educated with high *PTI* scores) and high-risk techno-skeptics (i.e., the secondary-educated with low *PTI* scores).

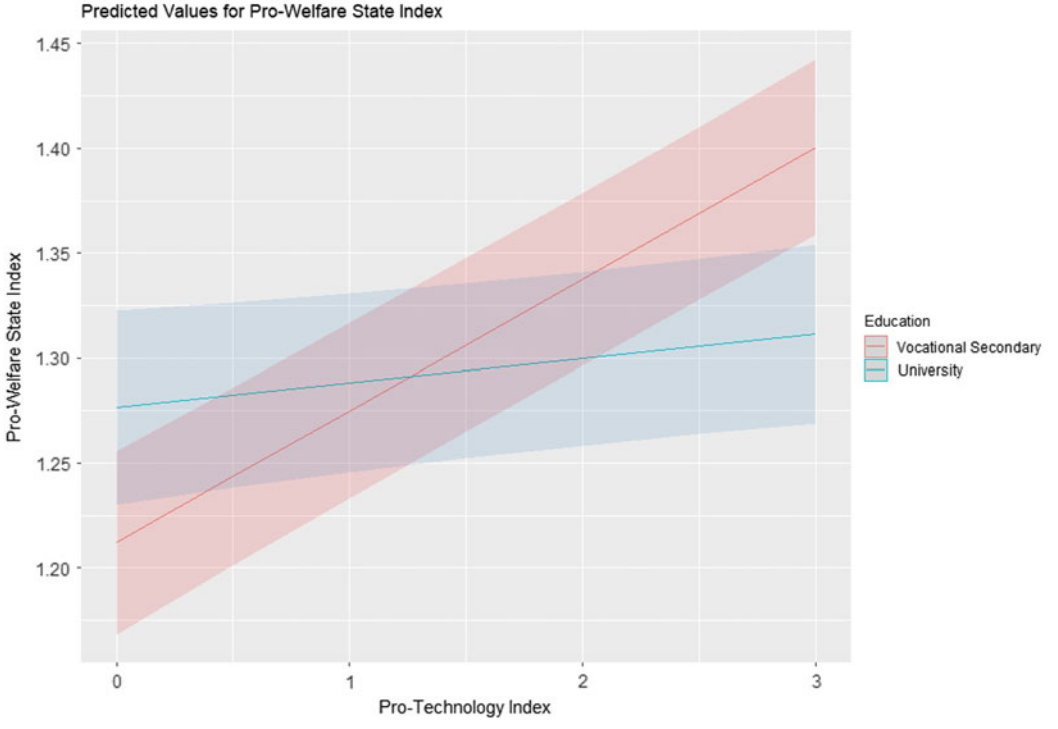

Figure 5. Effects of technology attitudes on welfare attitudes by skill level.

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Conclusion

This paper is timely given the growing and somber interest in the distributional implications of technological change. Many scholarly works and policy documents rightly focus on what governments, corporations, and scientific communities could and should do to make the process more equitable and socially acceptable. Less explored has been the fundamental question of how ordinary citizens within and across societies assess the ongoing technological changes and react to their (perceived) consequences. This study fills in this gap by exploring how citizens' attitude to technological change is affected by and has an influence on the social embedding of the change via the welfare state.

I theorize and find some empirical evidence that citizens in more generous welfare states tend to hold more positive attitudes toward technological change. I also find some evidence consistent with the expectation that labor market interventions of the welfare state can reduce the skill cleavage over technology acceptance by mitigating the perceived economic losses of the low-skilled under SBTC. Yet, importantly, which type of intervention most effectively fosters a broader-based embrace of technological change might vary among countries. This finding, I believe, is an important agenda for future research.

My subsample analyses indicate that, in developing countries, a broader unemployment compensation is associated with broader-based technology acceptance. The same type of intervention, however, seems to have a less meaningful association with technology attitudes in developed countries. In developed countries, I find some preliminary evidence that empowering and capacitating workers via centralized wage setting and ALMP might have potential to mitigate the skill-based gap in technology attitudes.

I also explored whether individuals' technology attitudes are associated with their welfare state preferences. I find that, all else being equal, pro-technology citizens are *more*, not less, supportive of the welfare state than other citizens. I provide some evidence that the insurance-seeking motivation of pro-tech citizens explains their favorable attitudes toward the welfare state. The strongest supporters of the social embedding of technological transformation are those bearing high risks under SBTC who nevertheless embrace the opportunities offered by new technologies.

As I mentioned above, an important avenue for future research would be to examine the effect of technological change on the choice of social policy instruments. For instance, how does SBTC shape citizen preferences between ALMP focusing on human capital development and unconditional cash transfers such as basic income programs? Might the preferred type of welfare state intervention vary among different countries whose populations have distinct experience with and expectations of the welfare state? How should social policy reforms be designed to mitigate an existing divide over technological transformation while avoiding new cleavages?

Understanding the structure as well as the sources of public technology attitudes, which has been the focus of this paper, is the very first step toward answering these questions. Another promising and complementary research agenda on the theme of the technology-welfare state nexus is to further explore political factors such as the party system, government partisanship, and the number of political veto points. As different political institutions empower different actors, countries undergoing similar technological changes might diverge to the extent that changes are embedded into society.

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