Innovation and Income Inequality: Creating a More Inclusive Economy in Germany

Second Year Policy Analysis

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Executive Summary

- **Income inequality in Germany has increased over the last three decades.** While the progressivity of the tax and transfer system has largely remained constant, market incomes have diverged due to weak income growth at the bottom of the distribution.
- **Technological change is a primary driver of increasing market income inequality.** Reductions in the cost of automation have led to declining labor demand, and thus wages and employment in middle-skilled jobs. Advances in artificial intelligence and robotics are set to continue this trend.
- **Current policy proposals by progressive parties in Germany largely focus on redistribution**. They rest on the notion of compensating the "losers" of structural economic changes. The focus on redistribution appears to stem from an overly deterministic view of technological change.
- **Technological change can be steered into a more employment-friendly direction.** Technology development and adoption respond to economic incentives and social norms. Stronger involvement of workers in firm-level technology decisions, research funding directed to labor-intensive technologies, and increased capital taxation could make technological change more inclusive without adverse effects on productivity.
- **A randomized survey experiment conducted for this report** shows that German workers at high risk of automation (i) generally underestimate their occupations' exposure to automating technologies, (ii) strongly prefer earning their incomes self-sufficiently to relying on social transfers, and (iii) support giving work councils a larger role in firm-level technology adoption.
- Based on these findings, **this report recommends that progressive parties and policymakers make directly improving market incomes a central topic in the debate on the future of work**. Further, to steer technological change in a more employment-friendly direction, **they should advocate for:**
    - **Procedural codetermination for work councils**, giving them the right to propose and partially enforce firm-level participatory processes on innovation questions.
    - **Scaling up the 'innovation space' program**, a subsidized scheme in which managers and workers can jointly explore, develop, and test different technology options.

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Introduction

Germany, like many other advanced economies, has experienced an increase in income inequality in recent decades. While economic growth was generally strong pre-Covid-19, it was mostly the rich who benefitted, with real incomes in the bottom half of the income distribution growing only modestly and for some parts of the population, even decreasing. One of the most important factors of diverging market income inequality is technological change, which is set to further accelerate with advancements in artificial intelligence and robotics. As Germany prepares for the post-Covid-19 economic recovery, it is therefore critical to find ways to make the economy and technological transformations work for those currently left behind.

For the purpose of the Second Year Policy Analysis (SYPA) of the MPA/ID program at the Harvard Kennedy School, this analysis of different policies has been prepared for a *hypothetical* client, the Social Democratic Party (SPD). The SPD is a center-left party in Germany which considers the economically disadvantaged their core constituency, and was therefore a suitable hypothetical client for a research project at the nexus of technological change, inequality, and policy preferences in Germany. Note, however, that *there was no direct contact between the author of this report and representatives of the SPD*. Further, many of the recommendations generalize to progressive parties and policymakers concerned with inclusive growth in other advanced economies.

Diagnosing the Problem – Inequality and Technological Change

An Anatomy of Inequality in Germany

Inequality in disposable (i.e., post-tax and transfer) income increased in Germany over the last three decades. Since 1991, richer households generally experienced larger income growth than poorer households (figure 1). The disposable household income of the top decile increased by more than 30% in that period, while it even decreased in real terms among the bottom decile (Grabka & Goebel, 2018). From the 1970s to 2010, the Gini coefficient for disposable household incomes increased from roughly 0.23 to 0.29 (Peichl et al., 2018).

The increase in disposable income inequality stems from a large increase in market income inequality rather than declining progressivity of the tax and transfer system. In the 1960s, the top 10%, the middle 40%, and the bottom 50% each roughly received the same share of the national market income. Today, the upper 10% receive more than 40% of national income, while the share of the bottom 50% dropped to 20% (Bartels, 2020, figure 2). Over the same time, the progressivity of the tax and transfer system stayed roughly constant and therefore did not fully compensate for the growing inequality in market incomes (Bosch & Kalina, 2016; Peichl et al., 2018). According to the latest available data, market income inequality, as measured by the Gini coefficient, is among the highest in the OECD countries, on a level comparable to the US (OECD, 2021b).

Figure 1. Development of Disposable Household Incomes by Income Deciles. Source: Grabka & Goebel (2018).

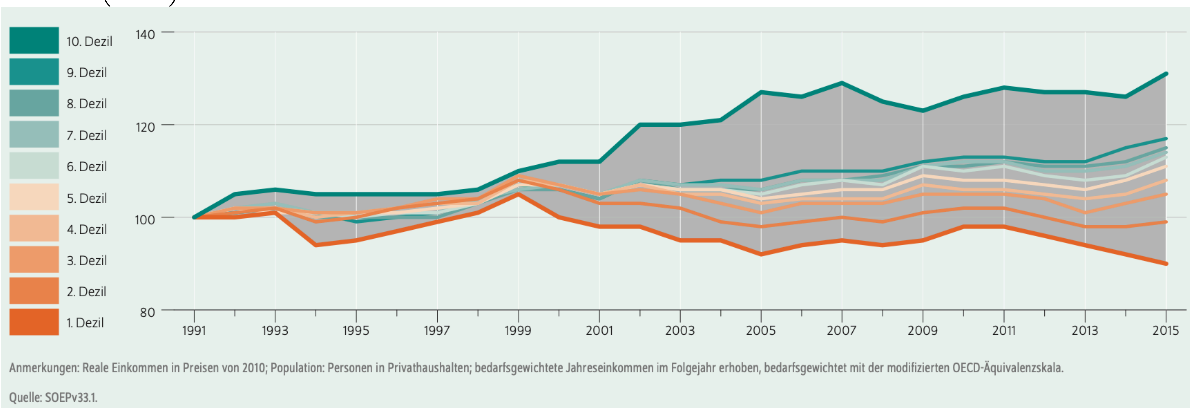
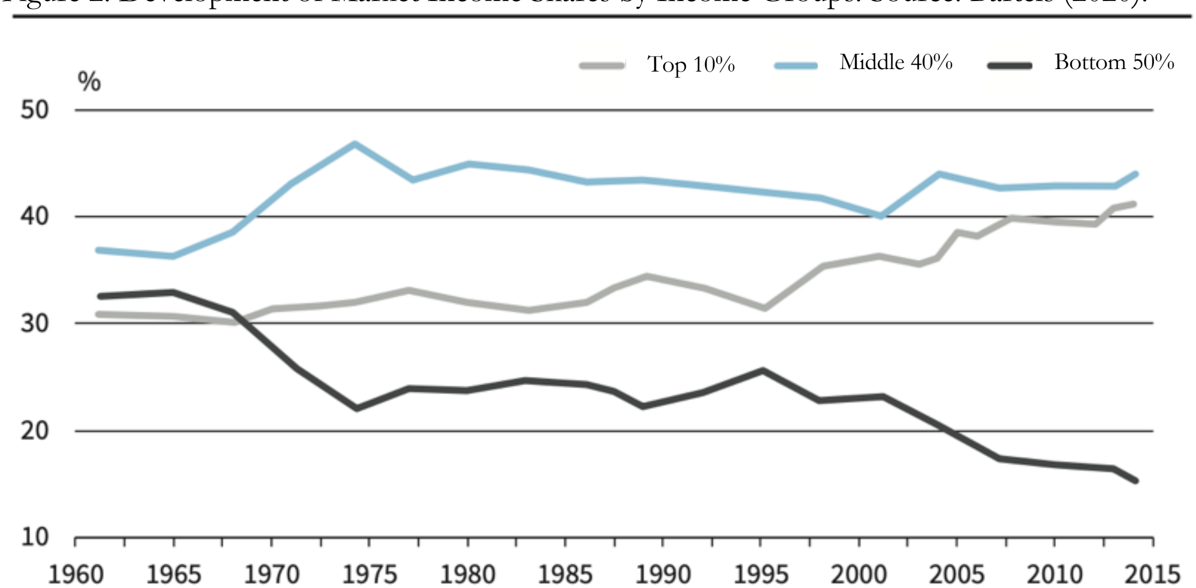


Figure 2. Development of Market Income Shares by Income Groups. Source: Bartels (2020).



Capital income has become more important, increasing the relative income share of the top 1% in recent years. Market incomes can be decomposed into labor market incomes and capital market income (i.e., business incomes, dividends, interest income, and rents). In the four years before the Covid-19 pandemic, the labor share of national income increased from 69.6% to 74.0% due to a general strong economy with historically low unemployment rates (DGB, 2021a). However, in the long run, the labor share has declined: since 1950, capital incomes have increased by a factor of 12.5, while labor income increased only by a factor of 7 (Bartels, 2019).

Yet, the diverging market incomes are primarily driven by incomes from labor rather than capital. Wealth inequality is particularly large in Germany. The OECD estimates that in 2017, the top 10% of the population held around 60% of the net wealth, compared to the OECD average of 52% (BMF, 2019). However, precisely because wealth inequality is so large, capital incomes represent a significant income share only for the top 1% (Bartels, 2019). While rising capital incomes have thus contributed to overall inequality, they have had little effect on the income distribution of the bottom 90%.

Real labor market incomes among the bottom 50% have stagnated and decreased while they increased for the top 50% (Grabka & Schröder, 2019; Fitzenberger & Seidlitz, 2020; figure 15 in the appendix). As a consequence, the share of the middle class, defined as the households between 60% and 200% of the median market income, fell by eight percentage points between 1992 and 2013, from 56.4% to 48% (Bosch & Kalina, 2016). Increases in employment initiated through Hartz IV reforms in 2005 came at the cost of expanding low-wage employment sector: The share of workers receiving less than two-thirds of the median gross wage increased from 16% in 1995 to 23% in 2017 (Grabka & Schröder, 2019), making Germany one of the countries with the largest low-wage sector in the OECD (low wages are defined as being below two-thirds of the median gross wage).

Low market incomes are characterized by low social mobility and part-time work. Rising wage inequality, as well as income inequality more generally, may be considered less problematic if paired with high social mobility. However, both in East and West Germany, wage mobility has declined, and relative wage positions have become more persistent (Riphahn & Schnitzlein, 2016). This trend mirrors low educational mobility, where Germany ranks poorly relative to other OECD countries (OECD 2018a). Further, households with low market incomes tend to not only have lower wages, but also have fewer earners and fewer working hours (Bosch & Kalina, 2016; Bossler et al., 2020).

Technological Change: A Primary Driver of Income Inequality

Technological change is considered a central reason for rising income inequality in Germany. While there is significant controversy around the importance of other factors, most researchers agree that technological change is a key contributor (e.g., Bossler et al., 2020; Antonczyk et al., 2018).

Observed polarization in employment and increases in educational wage premia are consistent with the theory of routine-biased technological change.

- Theory: The task-based theory of technological change predicts that new technologies change the relative demand for different tasks performed by workers. More precisely, it argues that recent technological change has reduced the cost of automating *routine* task. Therefore, it has increased demand for complementary cognitive and manual *non-routine* tasks, predominantly found in the high- and low-skill occupation, but reduced demand for substitutable *routine* tasks, dominant in middle-skilled jobs (Acemoglu & Autor, 2011).

- Employment: Consistent with this hypothesis, Germany experienced polarization in employment over the last three decades, with decreasing employment in middle-skilled jobs and increasing employment in low-skilled and high-skilled jobs (Dustmann, 2009; Goos et al., 2014; Antonczyk et al., 2018; OECD, 2018b). The fact that this development was shared by all economies in the OECD, with different labor market institutions and shocks but arguably all at or close to the technological frontier further provides suggestive evidence that technology is the common underlying factor (OECD, 2018b; see figure 16 in appendix).

- Wages: Germany also experienced an increase in education wage premia, especially between highly and medium skilled workers (Antonczyk et al., 2018). This education premium increased despite increases in the supply of educated workers, resulting from educational upgrading and population aging (Biewen & Seckler, 2020). Put differently, the wage premium persists even when controlling for differences in the composition of cohorts (Antonczyk et al., 2018). This evidence, again, is consistent with the theory of routine task-biased technological change, where the declining cost of automation complements high-skilled workers. The unconditional education wage premium between middle- and low-skilled workers in Germany also increased but stayed constant when controlling for cohort effects. Antonczyk et al. (2018) suggest that the polarizing effect technological changes on the lower end of the wage distribution observed may have been muted in Germany due to a large increase in the supply of low-skilled workers through migration, especially after the collapse of the Soviet Union and reunification. More direct evidence of the polarizing wage effects by automation technologies is provided by Dauth et al. (2021). Studying the adoption of robots in manufacturing in Germany between 1994 and

2014, they find that it had a negative impact on the wages of medium-skilled workers in machine-operating occupations but a positive impact on high-skilled managers.

Advances in artificial intelligence are set to further decrease the cost of automating routine tasks, and thus increase inequality. New developments in artificial intelligence (e.g., speech and image recognition) vastly extend the scope of routine tasks that can be profitably automated (e.g., McAfee & Brynjolfsson, 2017). Comparing the task content of jobs with the expected capabilities of machines, the OECD predicts that Germany has the fifth-largest share of jobs in the OECD that are of high risk of automation or at least, may face significant change due to technological innovations in the next two decades (OECD, 2018b). As in the past, many of these jobs at risk are in the middle-skilled category.

At the same time, the Covid-19 pandemic increases the incentive to substitute labor with capital. The Covid-19 pandemic likely increased the cost of non-automation, especially in manufacturing, as workers are required to stay at home and firms need to take extra measures to protect employees in dense work environments. While it is still unclear how long these social distancing policies need to be in place, decreasing automation costs through technical innovations paired with higher opportunity costs of non-automation may result in a particularly strong push in the adoption of automation technologies over the next few years.

Employment adjustment to automation may occur primarily through new entries and exits into the labor force and may therefore have especially adverse effects on wage inequality. Germany is a coordinated market economy (Hall & Sostice, 2001) and relies on strong cooperation between employers and public institutions in workforce training. Consequently, workers often receive training which is highly firm-, if not job-specific. Germany's dual study programs are a case in point (Graf, 2014). Therefore, retraining costs for German workers might be particularly high, and the German workforce may primarily adjust through cross-generation changes in skills rather than within-generation reallocation of workers. This pattern of adjustment is predicted to be especially slow, and therefore unequal in the transition period (Adão et al., 2020). Consistent with this argument, Dauth et al. (2021) find that robot exposure in manufacturing did not increase the displacement risk of incumbent workers but did lead to fewer manufacturing and more service sector jobs for young labor market entrants.

Other Drivers of Inequality and Their Relationship with Technological Change

Apart from technological change, existing research has identified two other important factors for increasing labor market income inequality: weaker collective bargaining and increasing firm heterogeneity (e.g., Bossler et al., 2020). These two trends also have important interactions with technological change. International trade and offshoring appear to have rather small effects on the overall wage distribution in Germany (Biewen & Seckler, 2019; Goos et al., 2014). The introduction of the minimum wage in 2015 is associated with an increase in real wages among the bottom decile but did not reduce the overall size of the low-wage sector (Dustmann et al., 2020).

Collective Bargaining

A large decline in the coverage of collective bargaining and increase in the relative importance of firm-level negotiations contributed to wage inequality. From 1998 to 2019, the share of employees covered by collective bargaining declined from 70% to 46% in the West and 56% to 34% in the East (Ellguth & Kohaut, 2020). One reason for this massive decline is that the contract negotiated between trade unions and employer associations only covers workers in firms recognizing the contract – and the decision to do so is at the discretion of the firm (Dustmann et al., 2014).[1] As wage inequality is generally higher in the uncovered sector, the decline in the coverage of collective bargaining is considered to have increased the overall wage inequality (Dustmann et al., 2014). Biewen & Seckler (2019) find that this de-unionization is the most important factor for the rise in German wage inequality. Interestingly, however, at least between 1995 and 2008, wage inequality increased faster among workers covered by collective bargaining than workers who were not covered by it. Dustmann et al. (2014) argue that this is due to devolution of collective bargaining from the industry-level to the firm-level. So-called "opening clauses" allow firms to deviate from industry-level collective agreements and negotiate wages directly with work councils. While they were initially intended for temporary "hardship" situations, most collective agreements now include these opening clauses.

The absence of strong unions may increase the adverse effects of technological change. Or conversely, strong unions seem to attenuate the effects of automation. Dauth et al. (2021) find that in regions with large fractions of workers in trade unions, workers were more likely to stay with their original plant and retrained when their firms introduced robots. If retrained, these workers shifted to

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[1] If the firm recognizes the union contract, however, it covers all workers at the firm – regardless of whether they are union members or not.

jobs with a larger share of abstract tasks and experienced an increase in earnings. On the other hand, workers which had to switch plants, industries, or sector experienced significant decreases in earnings. Against this background, the continued decline in the number of union members, from 11.8 million in 1991 to 6.0 million in 2018 (DGB, 2019), is concerning with regards to the effects of technological change.

Wage Inequality across Firms

Increasing firm heterogeneity and assortative matching between workers and firms is another likely source of wage inequality. Card et al. (2013) find evidence of increase inequality of wages between firms for workers with similar education and work experiences as well as evidence of increased matching of workers with high earnings potential to high-productivity firms in Germany from 1985 to 2009. Relatedly, outsourcing of low-wage services (security, catering, logistics, etc.) from larger companies reduced the wages received for these jobs (Goldschmidt & Schmieder, 2017).

Firm heterogeneity may itself be driven by technological change. Across countries in the OECD, the market share of the most productive firms within each industry and year has significantly increased between 1997 and 2014 (Andrews et al. 2016). Explanations for the rise of these "superstar" firms vary, but technology is a central one: If new technologies are primarily available to the most productive firms and new technologies increase productivity, the superstar firms will increase their market shares, profits, and be able to pay higher wages. Stiebele et al. (2020) document these effects for six European countries, including Germany, from 2004 to 2013: The firms that benefits most from robots are the ones that were already the most productive. Similarly, Acemoglu, LeLarge & Restrepo (2020) find that in France, robot adoption is concentrated on few firms and robot-adopting firms tend to expand their market shares.

Progressive Parties in Germany: Unable to Translate Economic Inequities into Political Support

The German population perceives rising inequality as a problem. While there is evidence that people slightly underestimate the extent of economic inequality (Engelhardt & Wagener, 2014), surveys show that the discontent with the distribution of incomes is increasing. According to data from the European Social Survey (2020), the share of German respondents who either 'agree' or 'strongly agree' with the statement 'The government should reduce differences in income levels' increased from 52% in 2002 to 71% in 2016. In an OECD survey from 2018, 58% of German parents rank the risk that their children will not achieve the level of status that they have among their three biggest long-term concerns (OECD, 2018a).

Progressive parties have experienced declining support in federal elections over the last 20 years. The Social Democratic Party (SPD) was last leading the German government from 1998 to 2005, and since then has served as a junior coalition partner for the Christian Democratic Union (CDU) under the leadership of Angela Merkel for 12 years. With a strong and moderate CDU to its right, and a Green Party benefitting from increasing environmental concerns, the SPD has found itself in a shrinking electoral space. Its vote share halved from 40,9% in 1998 to 20,5 % in the last federal election in 2017 (Bundeswahlleiter, 2021). Initiating labor market deregulations during its last time in the chancellery, it also lost trust among its core constituency.

Recent election platforms build on the idea of redistribution. The party has moved noticeably to the left since 2005, as is also evidenced by a text analysis of political manifestos (Manifesto Project, 2020). Many of the party's recent economic policy proposals rest on the notion of compensating the "losers" of economic transformations. They aim to reduce disposable income inequality through transfers rather than through directly curbing inequalities where they emerge, in the market.[2] For example, in a recent interview, SPD's candidate for the chancellery Olaf Scholz mentioned a more generous unemployment insurance as well as a 'right to retrain' as potential key economic proposal for the upcoming campaign (Göbel & Schäfers, 2020). In 2019, the party adopted the introduction of a wealth tax of 1% as its official position (SPD, 2019b).

However, policies that directly improve low-wage and middle-wage workers' market incomes may have more political appeal than policies that improve disposable income through redistribution. In other words, workers may have a preference to earn their income position self-sufficiently rather than through (unpredictable) social transfers. If true, then the progressive parties' current focus on disposable income inequality and redistribution may be misguided. In addition, the level of redistribution, i.e., the difference between market and disposable income inequality, is already very high in international comparison (BMF, 2019). This may foster the perception that the scope for further redistribution has been exhausted.

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[2] This distinction between redistribution and market-level policies is inspired by the classification matrix developed by Rodrik & Stantcheva (2021).

The lack of attention to market-level policies may stem from an overly optimistic perception of technological change. Both party leadership and voters might underestimate the extent to which technological change is a driver of income inequality. Evidence from other countries suggests that workers generally underestimate the extent to which their jobs are threatened by automation (e.g., Zhang, 2019). Technological innovations are often primarily viewed from a productivity and geopolitical angle – representing necessary investments for Germany to maintain its (relative) welfare level in the world despite an aging and declining workforce. In that context, it is sometimes overlooked that potential positive aggregate effects of technological change can go hand in hand with significant negative impact on some workers. Policymakers thus risk repeating a mistake from international trade where a narrow focus on aggregate effects obscured substantial individual-level adjustment costs and distributional consequences (Autor et al., 2016).

Crucially, the neglect of market-level policies may also stem from an overly deterministic and partly ideological view of technological change. In public debate, technological change is often presented as an exogenous process on which policy has little influence. Consequently, it is viewed as something to which workers need to adjust (or if they cannot adjust, be compensated for) rather than something that can be steered in directions beneficial to them (Rodrik, 2020). Further, the German ordoliberal concept of a "social market economy" going back at least to Ludwig Erhard, Germany's first Minister of Economy, still has many supporters in German economic policymaking circles today. In this paradigm, the government's role consists of setting boundaries to markets through pre- and redistribution but it ought not to interfere in markets themselves (unless to break up monopolies and promote competition) (BMWi, 2021b). While this view has always been partly illusionary – the German government always engaged in industrial policy in some form – it still nurtures the view that the government should similarly not seek to steer technological change in one direction or another even if it could. This view is embodied in terms such as "technology openness", the position that government should not favor one technology over another in the transition to a greener economy (Dauke, 2014).

The prevailing narrative of technological matters for policy preferences and election outcomes. Voters' political preferences are not set in stone. They are shaped by their beliefs about the world, how it works, and consequently, what policies are feasible and effective (Rodrik, 2014). Changing the public narrative around technological change could thus open up the door to a new set of policy instruments to curb inequality. The conceptual framework and empirical evidence that could underpin a new narrative, as well as new policy ideas that could be derived from it are explored next.

Technological Change as Progressive Policy Area

Towards a New Narrative of Technological Change

The direction of technological change responds to economic incentives. Acemoglu et al. (2012) developed a framework at the example of green technologies that makes the underlying mechanisms explicit: Researchers choose to develop technologies that maximize they profits through monopoly rents on patented new technologies. This decision is determined by the size and output prices of the pre-existing green and dirty technology markets. Acemoglu et al. (2012) show that in the presence of negative externalities in the dirty sector, the laissez-faire equilibrium would lead to environmental degradation. However, carbon taxes or research subsidies, could redirect technological change and bring innovation in the clean sector to its socially optimal level (Acemoglu et al., 2012). The same framework can be applied to employment-friendly automation technologies, which may be argued to pose "good jobs" externalities (Rodrik & Stantcheva, 2020). The direction of technological change can be steered via taxes and subsidies, but in the absence of these corrective measures, might get locked-in on a paradigm harmful to workers.

The German government already plays an integral role in innovation processes. Governments use a wide range of tools to promote innovation activities, such as direct R&D grants, tax credits, and higher education funding (Bloom et al., 2019). Mazzucato (2011) documents that government funding was crucial to the market creation for many key innovations such as GPS, the internet, and artificial intelligence. In 2018, gross domestic spending on R&D in Germany was 129 billion US dollars (3.1% of its GDP) (OECD, 2021a). Federal and state government funding accounted for 29,3 billion Euros (BMBF, 2020a). The German government runs a multitude of programs offering support for business R&D, many of which focus on small- and mid-size enterprises, and funds large research institutes, such as the Fraunhofer Society. In 2020, it introduced a tax incentive for R&D and now companies can deduct 25% of R&D related expenses from their tax payments (up to maximum of 1 million Euro). Despite claims of "technology openness", it also selectively invests in technologies which it considers of strategic importance, such as hydrogen (BMBF, 2020b). All these activities affect incentives and have an impact on what technologies are developed and adopted across German firms.

Social norms influence what type of technologies are valued. Innovators may not only maximize profit through patented monopolies as described above but also social recognition by peers and society at large. For example, anecdotal evidence suggests that due to increased environmental awareness, energy companies focused on fossil fuels have a harder time recruiting talent than those invested in renewable energies (McDonnel, 2020). A similar mindset that favors employment-friendly technologies does not yet exist. On the contrary, it seems that norms that prevail in innovation hubs, such as the Silicon Valley in the US or the startup scene in Berlin, may put a disproportionate value on using new technologies such as artificial intelligence to replace rather than complement existing human skills (Acemoglu & Restrepo, 2020).

Importantly, technologies can have similar productivity effects but different employment effects. For instance, as Acemoglu & Restrepo (2020) point out, artificial intelligence is a platform technology that cannot only be deployed to automate tasks performed by humans but also to create new, labor-intensive tasks. They cite education and health care as examples, where AI-driven analytics could enable the personalization of services performed by humans (e.g., individualized teaching based on data collected on students). Similarly, robots come with different degrees of interaction, and thus complementarity with humans. Traditionally, robot adoption was focused on "dull, dirty, and dangerous" (Marr, 2017) tasks and consequently robots mostly worked in isolation from humans, not least out of safety concerns. On the other end of the spectrum, so-called 'cobots' (collaborative robots) are designed to operate in conjunction with humans and extend their capabilities to perform tasks (Cognilytica, 2018). Instead of being exclusively programmed by engineers, many cobots are trained by humans manipulating the arms (Walch, 2019). Cobots thus not only extend but also rely on the skills of low- and middle-skilled workers. For example, the car manufacturer Mercedes Benz, replaced some robots with cobots at one of its plants, where now "cobot arms guided by human workers pick up and place heavy parts, becoming an extension of the worker's body" (Wilson & Daugherty, 2018). This change not only reintegrated workers into assembly processes but also allowed Mercedes Benz greater customization of cars demanded by its most profitable customers (Wilson & Daugherty, 2018).

Four Policy Ideas for Inclusive Technological Change

(1) Stronger Work Councils – Fostering the Adoption of Employment-Friendly Automation Technologies on the Firm-Level

Work councils currently play a limited role in automation decisions. Work councils are workplace-level, democratically elected worker organizations, giving workers a say in management decisions.[3] Workplaces with five employees or more have a right to set up a works council (Work Constitutions Act, 2001). Work councils have extensive rights in the areas of individual human resources issues and social issues affecting all employees (work rules, working hours and overtime, etc.). But their right on economic and technology issues are more limited (Pulton, 2020). In particular, work councils' information and consultation rights on innovation questions are currently too narrow and static to give them an active role in broad-scale and continuous technological transformations. Consequently, in a survey conducted by the union IG Metall (2019), more than half of the work councils said they were not informed about or involved in the development of automation strategies.

Stronger work councils could promote more employment-friendly automation decisions. With respect to technology issues, work councils currently only have 'enforceable codetermination' rights (i.e., their veto cannot be ignored by the employer) on the compensation for negative effects of new work processes and technologies. Extending enforceable codetermination rights to participatory processes on technology decisions could help in making technological change more inclusive, if it allows employers to identify labor-augmenting technology solutions that are as productive as their labor-substituting alternatives. A potential limitation of the scope of this policy change is that recently, the number of workers in companies with work councils has been declining, to 41% of workers in West Germany and 36% in East Germany (Ellguth & Kohaut, 2019). This policy proposal is developed in greater detail in the last section of the report.

(2) Introducing an Automation Tax – Increasing Capital Taxation to Disincentivize the Adoption of "So-So" Technologies

Some automation technologies may have negligible productivity effects but harmful effects for workers. In the framework developed by Acemoglu & Restrepo (2020) the overall employment effect of automation technologies depends on whether the negative replacement effect is offset by the positive productivity effect (increased productivity leads to an expansion of the economy and thus increased demand for labor non-automated tasks). Therefore, what Acemoglu & Restrepo (2020) call "so-so" technologies could be particularly harmful to workers: technologies sufficiently productive to be adopted and displace labor but not so productive to reinstate labor through a growing economy. As artificial intelligence starts to expand to areas where humans are relatively good (e.g., image and

[3] Together with and board-level codetermination sectoral bargaining between trade unions and employers' associations, work councils represent the three pillars of industrial relations in Germany.

speech recognition), there is a risk that many new technologies are of the so-so type (Acemoglu & Restrepo, 2020).

A higher capital tax (or tax on automation technologies) could disincentivize the adoption of these "so-so" technologies. A tax code biased towards capital – i.e., taxes on capital are too low and taxes on labor are too high – reinforces the adoption of capital-intensive technologies. Acemoglu, Manera & Restrepo (2020) document that that taxation is indeed biased towards capital in the United States. Similarly rigorous evidence for the German context is lacking. However, Germany's labor taxes (including social security contributions) are among the highest in the OECD, especially for low incomes (OECD, 2018b). Therefore, a similar pattern of excessive automation may exist in Germany and an additional tax could restore automation to its socially optimal levels. Note that capital is more mobile than labor in particular multinationals can legally shift profits to other locations to avoid taxation. To date, most countries have sought to prevent this tax base erosion with lower capital taxation: the corporate income tax rates fell in all but one OECD country between 2000 and 2020 (OECD, 2020). However, with international negotiations such as the OECD/G20 Inclusive Framework on BEPS approaching agreement, governments may soon have other instruments to tackle tax avoidance, allowing them to reallocate some of the tax burden from labor to capital (Rodrik & Stantcheva, 2021). An automation tax (or "robot tax" for political messaging) might be more efficient in preventing "so-so" technologies than a blanket capital tax rate increase. However, it is potentially difficult to effectively distinguish between automation and non-automation technologies for taxation purposes, and therefore a general increase of capital taxation could be preferable due its higher administrative feasibility.

(3) Directed Research Funding – Steer Technological Change into a Worker-Friendly Direction

The German government could prioritize employment-friendly technologies in its innovation policies. As described above, the German government is deeply involved in innovation processes through its funding of research institutions and activities. It could leverage this position to promote technologies for which forecasting suggests that they complement rather than substitute workers. For example, the German government currently promotes sixteen "key technologies", including electromobility, renewable energies, and medical technologies (BMWi, 2021a). In determining these prioritized technologies, the government could factor in the results of a "prospective employment test" as recently suggested by Rodrik & Stantcheva (2021). On a more micro-level, it is already common practice that research grant applicants have to provide an assessment of the likely social and environmental impact of their work. This could be refined to explicitly include expected employment effects to help grantmaking institutions make funding decisions aligned with employment objectives.

(4) A Social Wealth Fund[4] – Sharing Capital Gains from Automation More Equally

The adoption of automation technologies may further increase the capital share of income. In the framework by Acemoglu & Restrepo (2018) automation decreases the labor share if countervailing forces, namely the productivity effect and creation of new tasks are not sufficiently strong. Autor & Salomons (2018) find automation has indeed decreased the labor share in 19 countries, including Germany, between 1970 and 2007. Similarly, Stiebele et al. (2020) show that the adoption of robots contributed to the declining labor share through market concentration at firms with especially low labor shares. Since capital incomes are even more unequally distributed than labor incomes, an increasing capital share will further increase inequality (although primarily on the upper end of the distribution).

A sovereign (or 'social') wealth fund, distributing the dividends from stocks, bonds, and real estate directly to workers, could help spread the capital gains from automation more widely. A government-owned portfolio whose dividends are paid out to low- and middle-income workers would redirect increased capital gains to those whose incomes fell due to automation (Smith, 2017). The Alaska Permanent Fund is an example of direct dividend payments from a government-managed fund to citizens. It is financed through oil revenues and distributes half of its yearly profits to citizens (with the other half being reinvested) (Bönke et al., 2019). In the absence of revenues from natural resources, the sovereign wealth fund could finance the purchase of assets through new capital taxes (e.g., an automation tax as described above). Alternatively, the government could require that a share of stocks from initial public offerings are channeled into the fund (Varoufakis, 2016) or that companies directly issue new shares to the fund on an annual basis (Bruenig, 2017). The management of the fund could be modeled after Germany's existing sovereign wealth fund, introduced in 2017 to finance nuclear waste management (Kenfo, 2021). The idea of a social wealth fund differs the other proposals in the sense that it likely does not directly influence the direction of technological but rather acts a form of insurance against it: if capital shares and incomes increase due to automation, the public automatically benefits. However, dividend payments may still be perceived as market incomes,

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[4] The term 'social wealth fund' (instead of sovereign wealth fund) goes back to Bruenig (2017). The idea that the German government could set up a wealth fund whose dividends are directly distributed to citizens was first put forward by Corneo (2016).

especially if each citizen receives an account with a non-transferable share of ownership which they manage themselves (e.g., they can choose to reinvest dividends into the fund or other stocks). If the government distributes dividend incomes through its tax system, the proposal is arguably not much different from regular redistribution – although it may still more appeal to people's sense of ownership (quite literally) than regular transfers.[5] It would also take time until the fund reaches a size sufficiently large to pay a significant yearly dividend. Harnack (2019) calculates that in order to be able to pay every adult 800 Euros and every child 400 Euros per year, the fund would have to grow to 59% of Germany's GDP in 2018. Even if the dividend payments are targeted towards low- and middle-income groups, the short-term effects would likely not be significant.

Empirical Strategy

I conducted a randomized survey experiment with German workers at high risk of automation to better understand how they perceive technological change, measure support for the four policy proposals, and test the feasibility of a new narrative of technological change.

Survey Design

Population of Interest

I focus on workers whose occupations are at high risk of automation and who constitute a significant share of the German workforce. There are several reasons to focus on this group of workers. First, as they are predicted to be the most affected by automation, their policy preferences are of particular interest for policy design. Second, as outlined above, automation especially threatens the occupations of low- and middle-wage workers. These workers represent core constituencies of the SPD and other progressive parties. They are also a large, electorally relevant group with relatively high levels of political engagement and are prone to shift to right-wing populist parties when exposed to automation (Kurer & Palier, 2019; Kurer, 2020). Third, one may argue that middle-wage jobs provide "good job" externalities by, for example, providing upward social mobility to low- wage workers (Stantcheva & Rodrik, 2020) and should therefore be of special attention to policymakers.

For the purpose of this study, ISCO-08 occupation-level automation exposure is determined by existing estimates from the literature. In particular, I merged the risk estimates from Frey &

[5] My initial proposal to directly improve workers' (capital) market incomes through subsidized employee stock options, turned out to face too many administrative barriers in the German context of low stock ownership rates and low share of publicly traded corporations.

Osborne (2017) and Webb (2020) into a 'combined risk score' (see the appendix for a detailed description of the data and merging process). Definitions and methods vary between these papers but have in common that they measure the extent to which the tasks in particular occupations could theoretically be automated with the available technology. The effective threat of automation for a particular job will also depend on factors such as regulatory frameworks, technology diffusion, and firm-level policies for automation decisions. However, in the absence of better data, they represent a good proxy for automation risk.

Among the occupations with above-median automation risk (as determined by the combined risk score), I selected the 30 largest occupations, representing 45% of the workers subject to social security deductions in Germany. To select occupations that are not only at high risk of automation but also relevant for the German workforce, I combined the occupation-level risk estimates with recent employment statistics from the German Federal Employment Agency. The targeted occupations are listed in the appendix. According to Frey & Osborne (2017) estimates, their (unweighted) mean risk of computerization is 81%.

Sampling and Survey Weights

To generate a sampling frame and recruit a sample of workers in these high-risk occupations, I used targeted Facebook and Instagram advertisements (using a similar sampling design as Schneider & Harknett, 2019). Practically, this means that Facebook users who Facebook believes work in these occupations (in most cases because users provided this information in their profiles), were shown an ad in their news feed, which linked to the electronic survey hosted on Qualtrics.[6] To increase response rates, the ads were personalized with custom text and pictures for each occupation and respondents were given the option to enter a lottery for an Amazon gift card.[7] Example advertisements are included in the appendix. Compared to other sampling frames and survey recruitment channels, Facebook has the advantage that I could directly address my population of interest. Sampling frames of workers in different occupations do not readily exist. Constructing the sample through other means would have, therefore, likely required a costly enrolment exercise that targets workers more broadly and filters out those in occupations that are not of interest.

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[6] It is not possible to directly target ISCO-08 occupations. However, in all but three of initially selected occupations, it was possible to target ads based on occupation titles very similar to the official ISCO-08 occupation title. I replaced the three occupations with the three next largest occupations. See appendix for details.

[7] In piloting, I conducted A/B tests on (minor) variations of the advertisement text to improve response rates.

Advertisements generated a sample of 321 respondents. Using an advertisement budget of 4,473 US Dollars, a total of 1,589,468 persons were shown the Facebook ads for my survey. Out of these, 2.2% clicked on the link to the survey. 683 (8%) of the persons who visited the website consented to participate and contributed some survey data. 321 completed the survey (however, a complete survey response may still contain some skipped questions). 46 respondents reported not working in any of the targeted occupations and were therefore excluded from analysis. The appendix provides a comparison of the response rates to Schneider & Harknett (2019). Piloting ran from January 16th to January 19th, 2021. Data collection began on January 20th and was completed on February 8th, 2021.

I used survey weight adjustments to correct for potential sampling frame error and non-response bias following a similar approach as Schneider & Harknett (2019). There may be concerns that a non-random subset of workers in high-risk occupations actively uses Facebook (sample frame error) and that a non-random subset of the workers who are shown the ad for the survey decided to participate (non-response bias). To address these concerns, I first stratified all respondents into cells defined by gender (male, female) and age group (18-34, 35-44, 45-65+). I did the same for respondents of the representative German Socio-Economic Panel (SOEP) who work in one of the 30 targeted occupations. I then calculated the ratio of the proportion of the SOEP data in each cell to the proportion of my sample in the same cell. Respondents in age-gender groups that are underrepresented compared to the SOEP data, which serves as a gold standard, receive thus a higher weight whereas respondents in overrepresented age-gender groups receive a lower weight. Second, I calculated the proportion of each ISCO-08 occupation in the employment statistics of the targeted ISCO-08 occupations from the German Federal Employment Agency as well as the proportion of each ISCO-08 occupation in my sample data. I then again took the ratio of these two values. The intention is that respondents from occupations that are underrepresented in my sample receive a higher weight while over-represented occupations receive a lower weight.

I also corrected survey weights for attrition using a similar method as in Himelein (2014). While in a normal range for an online survey, the attrition rate of 51% is relatively high, and there may be concerns that a non-random subset of respondents completed the survey. Using a Lasso regression, I first modeled the probability that a respondent completes the survey using baseline characteristics and data from time stamps collected on each page (number of clicks, time of first click, time of last click, and time until submission). I then ranked all individuals by the predicted response probability and group them into quintiles. Finally, I calculated the attrition adjustment factor as the reciprocal of the true average response rate in each of these quintiles. The survey weight is multiplied by this attrition adjustment factor. The purpose of this adjustment is to give respondents who are similar to respondents who dropped out but did in fact complete the survey more weight.

The survey weight adjustments and attrition correction correct for potential biases in the data, and therefore all reported estimates use these survey weights. However, I confirmed that – unless otherwise noted – all results are qualitatively the same without the use of survey weights.

Intervention and Randomization

Half of the respondents were randomly allocated to see a short informational text about technological change. The text provided information about past effects of technological change on income inequality, recent advances in robotics and artificial intelligence, and *occupation-specific information* on automation exposure. The text generally emphasized the human agency over type and direction of innovation (see the questionnaire in the appendix for the full treatment text).[8] Randomization was done directly through the survey form on Qualtrics, stratified by occupation.

Data and Main Outcome Variables

The survey was divided into three sections: (1) demographic information and baseline perceptions of technological change, (2) post-intervention support for different protective policies, and (3) post-intervention perceptions of automation risk and technological change.

Section (1) collected key demographic and socioeconomic information of respondents (age, gender, income group, education, and employment status). This information was not only required for the calculation of survey weights, but also for balance checks and potential subgroup analyses. I also confirmed the ISCO-08 occupation of each respondent in this section.

In section (2), I asked respondents to rate eight policy proposals: four redistributive policies and four directly addressing market incomes. Redistributive policies were selected largely based on their salience in the policy discourse on technological change. They included a more generous unemployment scheme, funding for retraining, a universal basic income, and a wealth tax. Market-income policies include the four policy proposals described above, namely a 'robot tax' (i.e., increasing taxation on capital), improving the role of work councils in firm-level technology adoption, setting up

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[8] In piloting, I showed respondents the text in the form of animated video (sentences appeared after each other). The hope was that a video would be more captivating for respondents than a four-paragraph treatment text. However, the video led to differential attrition with respondents in the treatment group dropping out at higher rates than respondents in the control group. Therefore, I decided to display the information as a regular text.

sovereign welfare fund that distributes dividend payments directly to citizens, and directing research funding to employment friendly policies. Following Zhang (2019) and Jeffrey (2020), I used a Likert scale to measure support for these policies. However, I also introduced a "budget restriction" to force respondents to choose between the different policies: respondents were given a maximum 16 "votes" which they could allocate across the eight proposals. Giving a proposal four votes was equivalent to "strongly agree" and no votes to "strongly disagree". Respondents could also give less than 16 votes in total. Finally, I included measures of agreement with value statements about earning one's income self-sufficiently vs. improving one's income through redistribution.

In section (3), I asked respondents to assess how likely they think it is that their job will be automated. I used wording that allows me to directly compare their assessment with the expert predictions by Frey & Osborne (2017). To account for the fact that workers may plan to adjust to technology shocks along a wide range of dimensions, I also asked respondents to assess the likelihood of a variety of career events over the next decade, including unemployment, changing occupations, retiring, retraining, demotion, and starting self-employment. I also included a few additional questions that capture how respondents perceive technological change more generally.

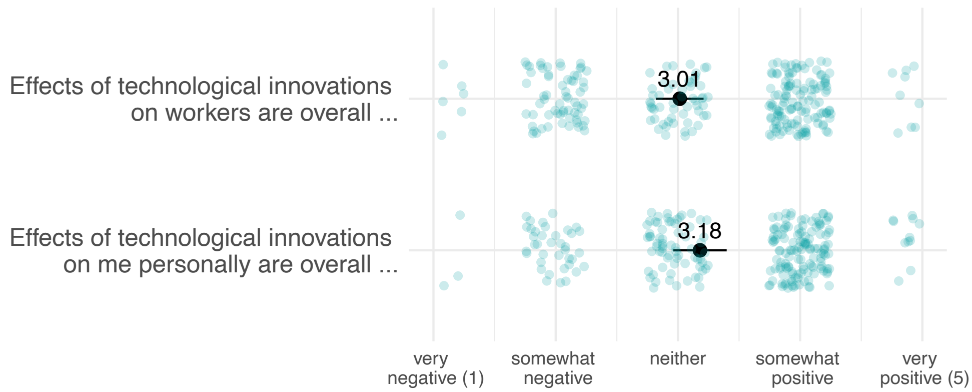
Descriptive Evidence

This section presents descriptive evidence from pre-treatment outcomes and post-treatment outcomes from the control group.

Perceptions of Technological Change

Views of technological change are overall neutral or slightly positive (figure 3). Workers appear to assess the effects on themselves more positively than the effects on all workers, but the difference is not statistically significant. Considering that the respondents all work in occupations at high risk of automation in the future, this favorable assessment of technological innovations is surprising. In fact, a simple OLS regression analysis using data from the Socio-Economic Panel shows that already now, workers with a high predicted automation risk are significantly more likely to experience workplace change, are more worried about their job security, and report lower dissatisfaction with their work (see appendix for regression table). Note also that there is not a lot of variance in baseline views to exploit for subgroup analyses, with few respondents having very negative or very positive views.

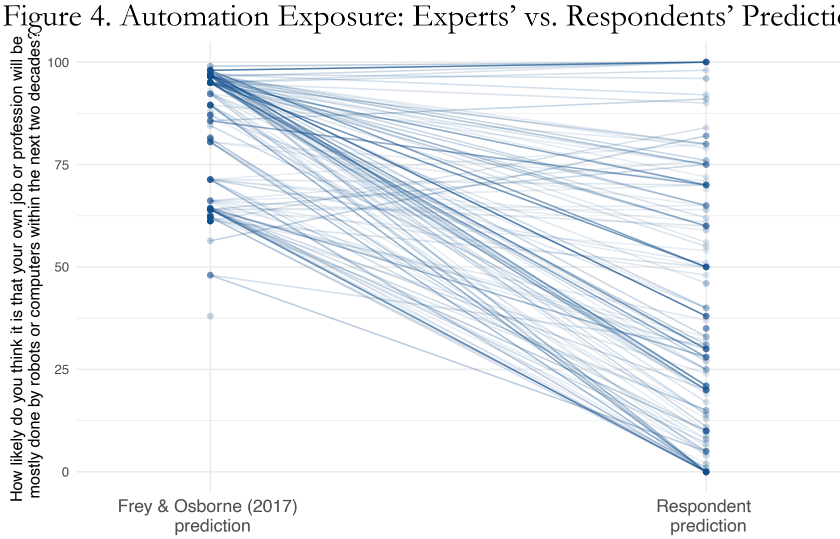
Figure 3. Baseline Perceptions of the Effects of Technological Change.



Error bars represent 95% confidence intervals. Mean estimates use survey weights. Green points show underlying raw distribution (including random noise added to visually display densities).

However, workers also seem to grossly underestimate their occupations' exposure to automation technologies compared to expert predictions. They may therefore not draw a connection between technological change and their dissatisfaction with their work. Figure 4 contrasts respondent predictions with occupation-specific expert predictions as aggregated by Frey & Osborne (2017). The negative slope of the lines shows workers tend to underestimate their exposure to automation technologies in the future. They underestimate their automation exposure by on average 44 percentage points (with the 95% confidence interval ranging from 35 to 52 percentage points). Qualitative data support this finding. For example, one operator of packing machines, an occupation with an automation risk of 98% according to Frey & Osborne (2017), wrote: "I do not believe that my job can be automated – humans are simply too good."

Figure 4. Automation Exposure: Experts' vs. Respondents' Predictions.

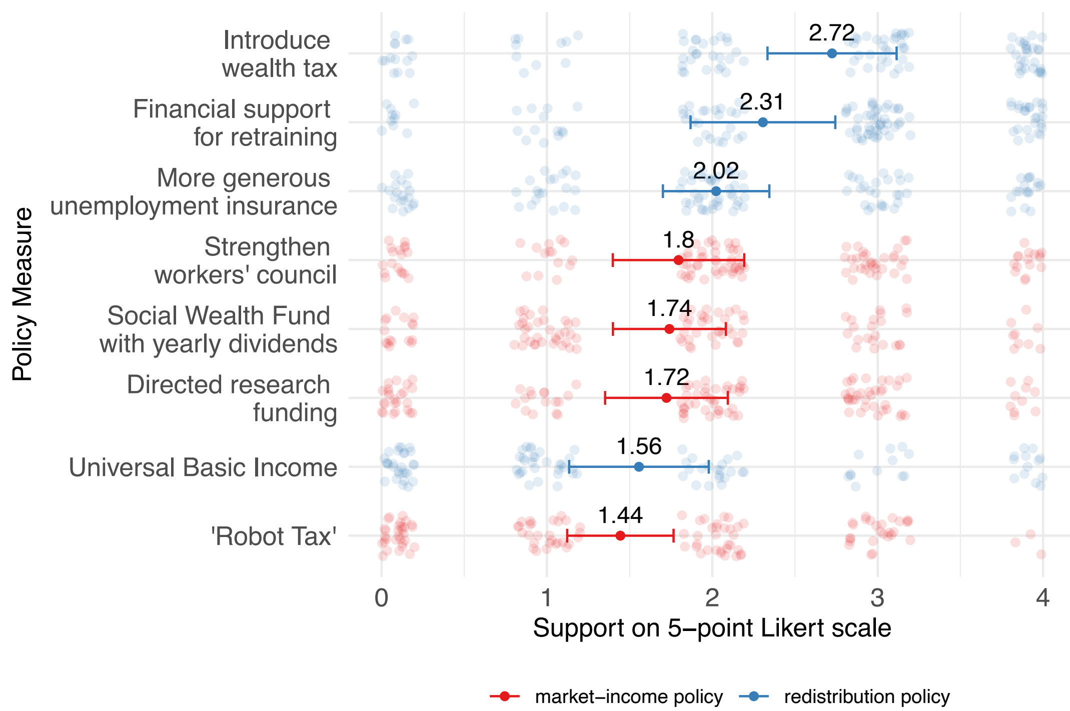


Transparency of lines and points are scaled by respondents' survey weight.

Policy Preferences

The introduction of a wealth tax is the most preferred policy proposal in the control group. The wealth tax received statistically more support than most other proposals.

Figure 5. Support for Policy Proposals in Control Group.



Error bars show 95% confidence intervals. Mean estimates use survey weights. Other points show the raw distribution (including random noise). Respondents had a budget constraint of 16 "votes" (i.e., they could allocate 16 votes across the eight proposals). They could give each proposal a maximum of four votes and could also give less than 16 votes in total. Giving a proposal four votes was labeled as "strongly agree" and giving no votes labeled as "strongly disagree". The survey questionnaire included a one-sentence explanation of each of the proposals as shown in the appendix. Proposals were shown to respondents in random order.

When asked directly, respondents express a strong preference for earning their incomes self-sufficiently rather than relying on transfers. Redistribution policies, colored in blue in figure 5, appear to generally have more support than market-income policies. However, workers may not perceive the different policies as distinctly market-income or redistribution policies. When asked directly, more people agree that the government should reduce inequality in gross incomes rather than net incomes, albeit the difference is not statistically significant (figure 6). Further, respondents express a strong preference to not be dependent on transfers.

Figure 6. Redistribution vs. Market Incomes.

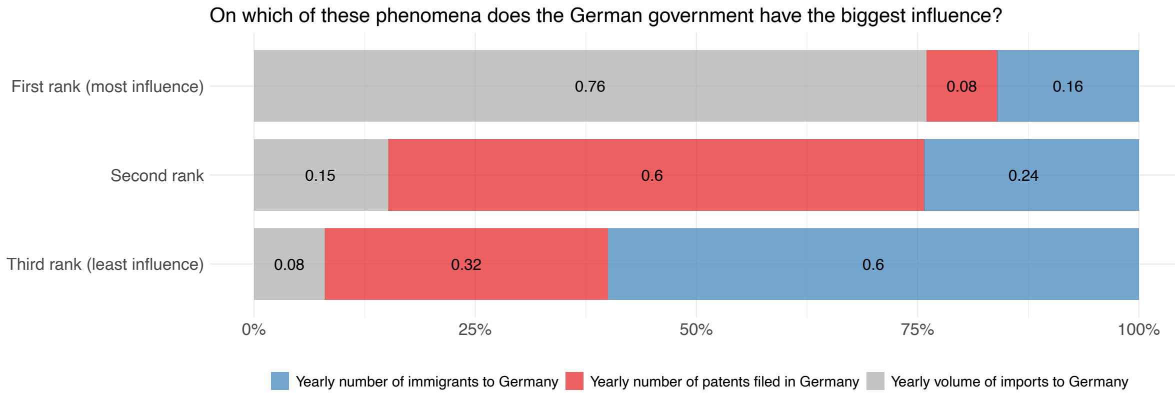
Error bars denote 95% confidence intervals. Mean estimates use survey weights. Green points show raw distribution.

Respondents believe the government have some influence on technological change. Workers may have a preference for higher gross incomes but may also have little confidence in the government's ability to influencing technological change and reduce market-level income inequality. Figure 7 shows respondents are generally more likely than not to agree with the view that the government has an influence on the speed and worker-friendliness of new innovations. As figure 8 illustrates, respondents also think the German government has more influence on the yearly number of patents filed in Germany than the yearly number of immigrants to Germany. This is striking as "Fluchtursachenbekämpfung" (i.e., addressing the causes of migration in destination countries) is a big topic in public debate and official government position (BMZ, 2021), whereas the idea of directing technological change, as discussed above, is largely absent. As expected, the government is credited the largest influence on international trade (proxied by the annual volume of imports to Germany).

Figure 7. Government's Influence on the Speed and Direction of Technological Change.

Error bars denote 95% confidence intervals. Estimates use survey weights. Green points show the raw distribution.

Figure 8. Government's Influence on Different Labor Market Shocks.



Estimates use survey weights.

Treatment Effects

Statistical Balance

Randomization yielded roughly similar – or balanced – treatment and control groups in pre-treatment socio-economic characteristics. As before, respondents who said that they did not pay attention to the survey (N=3) as well as respondents who reported an occupation not included in the list of targeted occupations (N=46) are excluded from the analysis. The treatment group appears to be slightly less likely to have a vocational degree and politically lean somewhat more to the left but none of the differences are statistically significant.

Estimation

To estimate the effects of the intervention, I calculate the difference in outcomes between the treatment and control group (see appendix for regression equation)**.** While doing so, I control for the occupation-specific automation probability from Frey & Osborne (2017) and the combined risk score with Webb (2020), as respondents in the treatment group are shown these predictions (i.e., treatment varies by these parameters). I also control for demographic and socio-economic variables including gender, age, education, income, occupation, political orientation, and baseline perceptions of technological change (as shown in table 1). As respondents could skip individual questions on baseline characteristics, I added dummy variables indicating missing data to nevertheless include all respondents who answered the outcome question in the regression. I report treatment effects both with and without these control variables in the appendix but estimates with covariates are my main result, especially as randomization did not produce a perfectly balanced sample. Since randomization was administered on the individual level, I do not cluster standard errors (but report heteroskedasticity robust standard errors).

Table 1. Statistical Balance.

	Control	Treatment	Difference
	Mean SE	Mean SE	Mean difference p-value
Gender (female = 1)	0.53 0.06	0.47 0.06	-0.06 0.49
Age	43.49 1.51	44.91 1.36	1.42 0.49
Income group (1 to 6, poor to rich)	3.24 0.16	3.24 0.19	0.00 1.00
Tertiary degree (yes = 1)	0.05 0.02	0.06 0.04	0.01 0.79
Vocational training (yes = 1)	0.56 0.05	0.43 0.06	-0.12 0.13
Political orientation (1 to 5, left to right)	3.01 0.08	2.87 0.08	-0.14 0.22
Voted SPD (yes = 1)	0.11 0.03	0.09 0.03	-0.02 0.66
Assessment of technological change, general (1 to 5, negative to positive)	3.11 0.11	3.12 0.16	0.02 0.93
Assessment of technological change, personal (1 to 5, negative to positive)	3.13 0.13	3.13 0.13	-0.01 0.97
N	150	141	

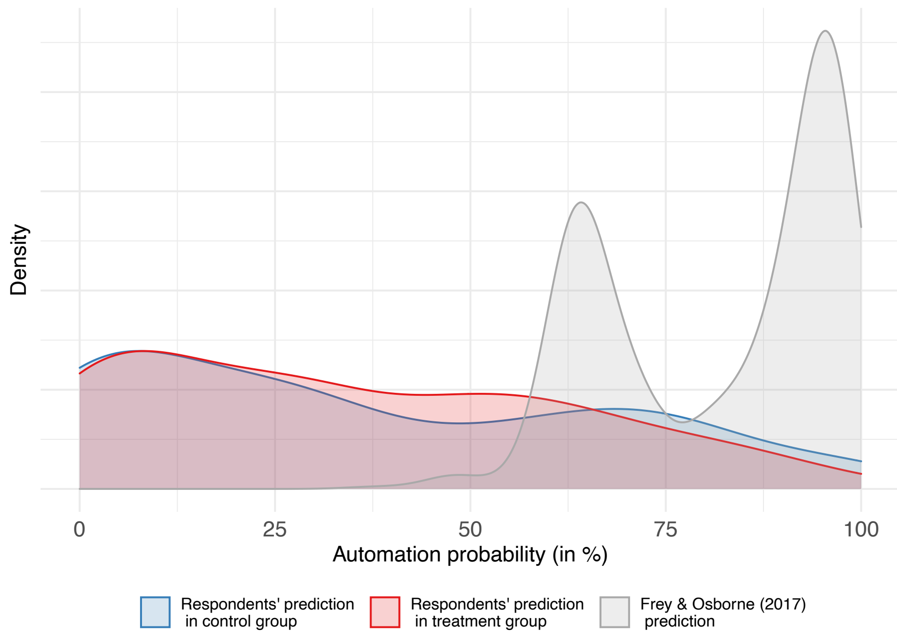
Questions on the general and personal assessment of technological change were asked pre-treatment. Sample sizes vary slightly between questions if respondents skipped questions. The reported N refers to the number of respondents who progressed far enough in the survey to answer questions on outcomes (and can therefore be included in treatment estimates). The table shows weighted estimates; unweighted estimates are equally balanced.

Treatment Effects on Perceptions of Technological Change

Informing workers about their occupation-specific exposure to automation technologies does not cause them to update their beliefs about their automation risks. As figure 9 illustrates, the treatment did not induce large shifts in respondents' predicted automation risks. If anything, it appears as if the treatment *lowered* respondents' prediction. However, as the regression table in the appendix shows, the difference is not statistically significantly different from zero.

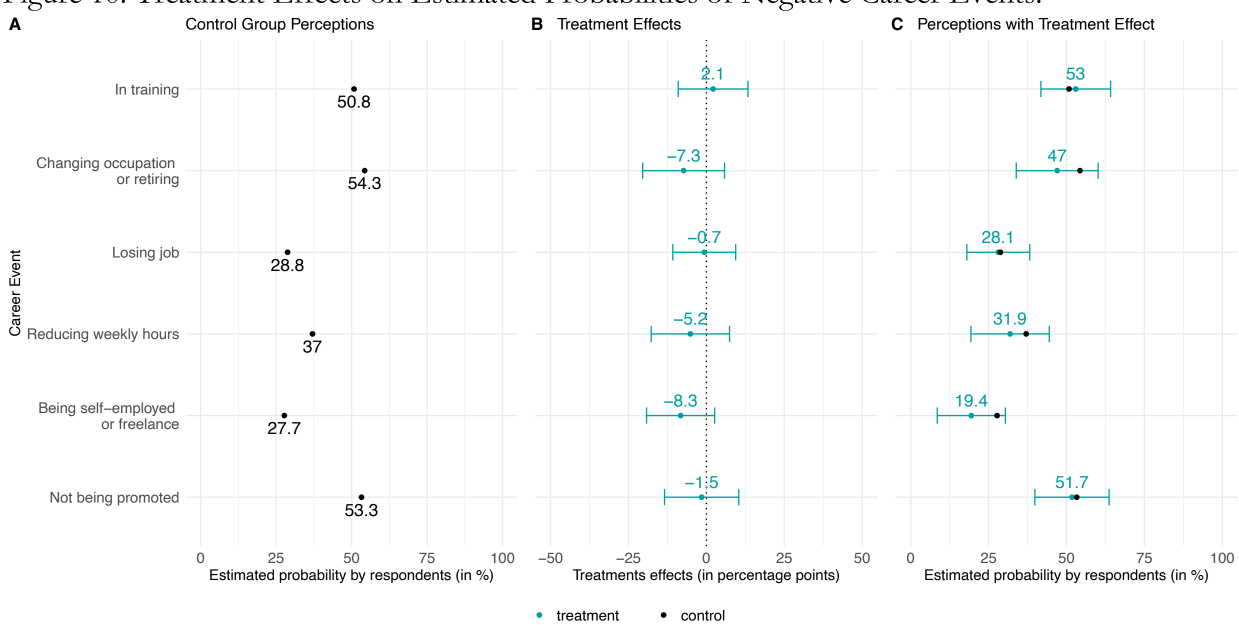
Similarly, the treatment did not lead respondents to consider a diverse set of (negative) career events more likely. Panel A in figure 10 shows that respondents in the control group consider it relatively likely that they will get training for additional qualifications, will not be promoted, and will change occupation or retire within the next ten years. They consider it less likely that they lose their job, reduce their weekly hours, or are self-employed. Panel B and C show that the treatment did not cause these assessments to be significantly different from the assessments in the control group. The full regression results are included in the appendix.

Figure 9. Distribution of Predicted Automation Risk in Treatment and Control Groups.



The survey question read: "How likely do you think it is that your own job or profession will be mostly done by robots or computers within the next two decades?" For technical reasons, density estimates do not use survey weights.

Figure 10. Treatment Effects on Estimated Probabilities of Negative Career Events.



Estimates use survey weights. Treatment effects are estimated in an OLS regression as shown in the appendix. Error bars show 95% confidence intervals of *treatment effects*. If zero in panel B or the baseline support level in panel C are within the error bar, this means there was no statistically significant effect on the perceived probability of this event. For treatment estimates without control variables see the appendix. The survey question read: "How likely is it that you will experience the following career changes within the next ten years?".

Treatment Effects on Policy Support

The treatment increased the support for stronger work councils and lowered the support for a wealth tax. Providing respondents with their occupation-specific automation exposure as well as a narrative that stressed the influence of the government and society on technological change increased the support for work councils playing a larger role in automation decisions (figure 11). With treatment effects, work councils appear to be the most popular policy proposal. Other market-income policies did not become significantly more popular. One potential explanation for this pattern is that work councils are well-known, whereas the other market-income policies represent novel policy ideas. The treatment also decreased the support for a wealth tax. Note however that the wealth tax remained a popular policy due to its high baseline support.[9]

There are two possible explanations for the significant effects on policy support and the lack of significant effects on automation beliefs. First, the informational element of the treatment may not have been effective while the narrative element may have been effective. In other words, the treatment may have caused respondents to view technological change as malleable to policy while their view on the likely exposure of their occupation remained unchanged.[10] Second, respondents may distinguish between the effects technologies have on other workers in their occupation and the effects on them personally. This hypothesis is supported by the fact that respondents appear to view the effects of technological innovations on them more positively than the effects on the society at large (figure 3). If their policy preferences are at least partly driven by altruistic motivations, respondents may update their policy preferences even if they do not consider it more likely to need protection themselves.

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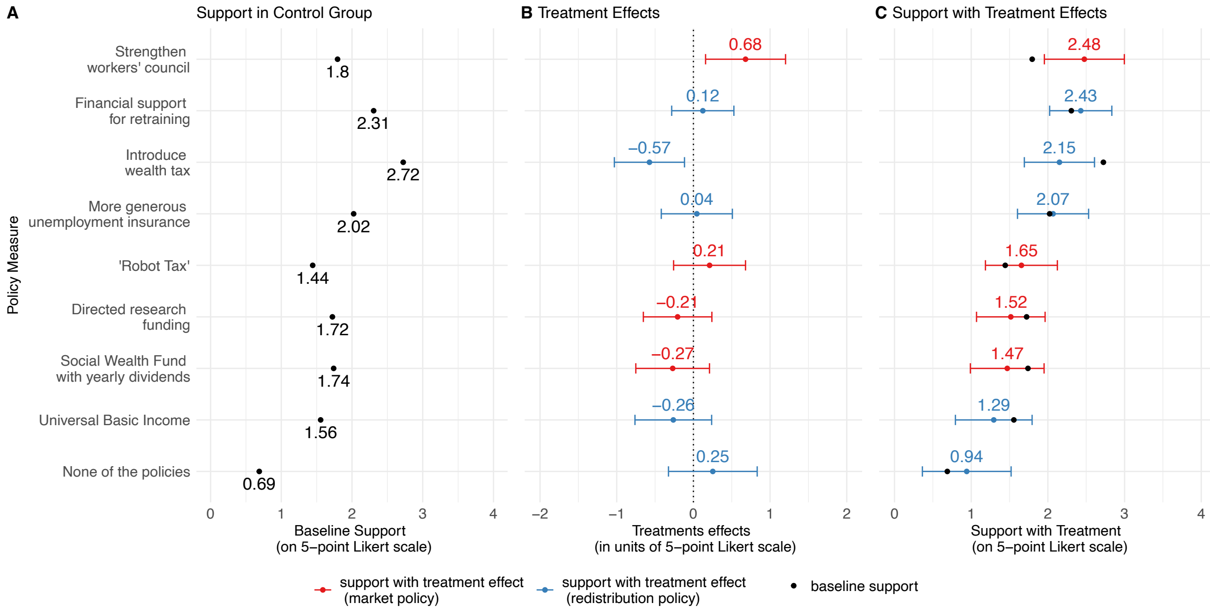
[9] If no survey weights are used, these estimates change slightly. The effect on work council reduces somewhat in size and ceases to be statistically significant. However, strengthening work councils remains the most popular market-income policy, and the second-most popular policy overall. Also, the effect on the robot tax becomes statistically significant. All other results are the same.

[10] I initially planned to include two treatment groups: One group would have been shown the text with the occupation-specific automation risk and the other group would have been shown the same information, but the text would have emphasized human agency over technological change. This would have made it possible to disentangle the effects of providing information on automation risks and providing a different narrative of technological change. However, piloting showed that much fewer respondents clicked on the posted advertisements than expected. This means the sample size is significantly smaller than expected, leaving me underpowered for this initial study design. Therefore, I decided to drop the first treatment arm and only have one treatment group which incorporates both the 'information treatment' and 'narrative treatment.'

Figure 11. Treatment Effects on Reported Policy Support.



Estimates use survey weights. Treatment effects are estimated in an OLS regression as shown in the appendix. Error bars show 95% confidence intervals of treatment effects. If zero in panel B or the baseline support level in panel C are within the error bar, this means there was no statistically significant effect on the support of this policy. For treatment estimates without control variables see the appendix. Respondents had a budget of 16 votes which they could allocate across 8 proposals. Giving a proposal four votes was labeled as "strongly agree" and giving no votes labeled as "strongly disagree". "None of the policies" represent unused votes. The survey questionnaire included a one-sentence explanation of each of the proposals as shown in the appendix. Proposals were shown to respondents in random order.

Policy Recommendations

Recommendation 1: Make Improving Market Incomes a Central Campaign Topic

Recommendation

Progressive parties and policymakers should make decreasing market income inequality a central topic in the debate on the future of work in Germany. Over the long run, it should adopt a narrative that politicizes technological change and develop progressive industrial and innovation policies.

Technical Correctness, Political Support and Implementation

Voters are concerned with income inequality. As previously mentioned, data from the European Social Survey (2020) show that the share of German respondents who either 'agree' or 'strongly agree' with the statement that the government should reduce differences in income levels rose from 52% in 2002 to 71 % in 2016. In my sample of workers with high exposure to automation technologies, the share of workers agreeing or strongly agreeing with the statement is even higher (83%). The concern with income inequality was also present in many of the respondents' qualitative comments. For example, one respondent wrote in the open text field that "many of our society's problems would be resolved if there was more equality".

In particular, my survey suggests that workers are concerned about market income inequality. A robust finding from the survey is that, at least according to their stated preferences, it is important for workers to earn their incomes self-sufficiently rather than depend on social transfers. An effective campaign may therefore appeal to workers' sense of autonomy rather than paint a picture of "economic losers" that deserve compensation.

A large share of respondents stated that inequality will feature in their voting decision in the next federal election. 42% of the respondents in the control group agree or strongly agree with the following statement: "For my voting decision in the next federal election, the topic inequality in Germany will play a large role." Only 11% of respondents in the control group disagreed or strongly disagreed, with the remaining respondents being neutral.

The precise messaging for public campaigns should be tested and refined in focus group interviews and further experiments. The survey experiment conducted for this report provides one data point and should be complemented with further evidence. In particular, this study demonstrated how online survey experiments can be used to quickly and cost-effectively test the political appeal of different messages.

The evidence on the effectiveness of public campaigns focused on the negative effects of automation is not conclusive. On the one hand, workers believe the number of patents filed in Germany can be influenced more easily than the number of migrants arriving in Germany. Also, the treatment revealed latent demand for stronger participation of workers in firm-level automation decisions. On the other hand, the treatment did not lead to meaningful changes in workers' perception of technological change and voting intentions. For example, the share of respondents reporting an intention to vote for one of the progressive parties in the next federal election was the same across the treatment and control groups. The treatment provided as part of the experiment is a poor proxy for a full-fledged campaign, but these finding suggests that a campaign fully focused on the risks or automation may not be an effective mobilization strategy at this point. To the extent that market income inequality is driven by automation and recommendations 2 and 3 are adopted, automation risk will still be part of the campaign, but saliency should be given to inequality.

Nevertheless, progressive parties should develop and advocate for policies for inclusive technological change in the long-term. While likely still too nascent of an idea to be the primary topic of a campaign in September 2021, the need to build a new narrative on technological change and expand the progressive policy toolkit with industrial and innovation policies remains acute. Practically, for example, think tanks and foundations associated with the SPD, such as the Friedrich Ebert Foundation or the Hans Böckler Foundation could launch research programs to further develop specific policy proposals in this area and provide a platform for interested thought leaders to connect. Through reports and events, they could plant the intellectual seeds that, at a later point, a campaign focused on the general public may reap.

Recommendation 2: Introduce Procedural Codetermination Rights for Work Councils

The survey showed there is latent demand for a stronger role of workers in firm-level technology adoption. Recommendations 2 and 3 develop this proposal in greater detail.

Status Quo

Work councils have three main types of rights, as set out in the Works Constitution Act (WCA): information rights, consultation rights, and codetermination rights. (1) Information rights are the most basic rights and demand that the work council is to be informed of the employer's views and plans (Pulton, 2020). (2) Consultation rights, depending on the specific topic, can mean that the work council needs to be heard, that its views need to be taken into account, or that it has the right to make a recommendation to the employer (Pulton, 2020). (3) Codetermination rights take two forms: (a) the work council can block the actions of the employer by refusing its consent, but the employer can substitute the work council's consent by applying to the labor court and (b) the work council can block the actions of the employer, and the only way for the employer to overcome its veto is through a decision of the so-called 'conciliation committee' (Pulton, 2020). The reconciliation committee is made up of equal numbers of representatives of the work council and the employer, with an independent chair jointly appointed by both parties (WCA section 76).[11]

Work councils have information and consultation rights regarding changes in equipment and work processes. Employers need to inform the work council in time of its plans for the "construction of new buildings, technical equipment, working procedures, and workplaces" (WCA section 90). The employer needs to discuss the impact his planned activities on workers so that any emerging recommendations and concerns can be taken into account in planning. In companies with 100 employees or more, the workers also have information and consultation rights on planned

[11] If the workers and employer cannot agree on a chair, the labor court appoints the chair.

investments and changes to working methods through the so-called 'economic committee' of the work council (WCA section 106).

In some cases, work councils have codetermination rights regarding the compensation for the negative effects of new technologies. If changes in plant operations are planned that likely negatively impact workers, work councils at firms with 20 or more employees have two additional rights (WCA sections 111-112). Changes that, if negative, are covered by these rights include "fundamental changes in work organization, operations, or equipment" and the "introduction of new work methods or processes". In these cases, the work council can seek a so-called 'reconciliation of interest', which is an agreement with the employer on when and how the changes will take place so that they minimize disadvantages for workers. However, a reconciliation of interest is voluntary, and the employer cannot be forced to accept it (Pulton, 2020). In addition, it can negotiate a so-called 'social plan' which falls in the codetermination category (3b) described above (i.e., a conciliation committee can impose an agreement). A social plan seeks to compensate workers for the negative impact and typically covers issues such as "compensation for redundancy, rights to retraining, earnings protection in the case of job changes, and payments for additional travelling costs" (Pulton, 2020).

Despite these information and consultation rights, few work councils report being informed or involved in the development of innovation and automation strategies. In a survey of 1957 work councils conducted by the union IG Metall (2019), only a minority of work councils said they are generally (12%) or sometimes (36%) informed on-time of workplace changes related to the 'digital transformation' (automation, artificial intelligence, robotics, etc.). An even smaller share is actively involved in the development and implementation of these projects (IG Metall, 2019). A survey by the trade union Verdi (2019) found similar results: 57% of work councils members report that they are not involved in the planning or implementation of innovation projects (and in the case of artificial intelligence projects in particular, 68% report not being involved).

Current information and consultation rights are too narrow and static to give work councils a role in broad-scale and continuous technological transformations. The Works Constitution Act was first passed in 1952 and last amended in 2001 (Addison, 2009). As the report by the German Enquete Commission on Artificial Intelligence (2020) states, the Works Constitution Act still reflects a mostly analogous world. In particular, work councils' rights are built on the idea that introducing a new technology to work processes is a clearly delineated, one-off event, and once introduced, the technology largely remains unchanged. Therefore, the rights do not provide work councils with the adequate tools to be informed or involved in broad and continuous innovation processes in areas such as automation, AI, and robotics. The German Association of Trade Unions recently made a similar argument (DGB, 2021b). Even the Confederation of German Employers' Associations has called current work council rights too inflexible to deal with the digital transformation – albeit likely with a different motive (BDA, 2021). The survey of work council members by Verdi (2019) further supports this analysis: The most commonly cited reason for not being involved in innovation processes was a "lack of interest on behalf of the management" (66% agreed and only 6% disagreed with this statement). Moreover, 88% think work councils need stronger rights to play a meaningful role in the introduction and implementation of artificial intelligence at the workplace.

Recommendation

Progressive parties should advocate for providing work councils with a procedural codetermination right.[12] A procedural codetermination right means that work councils can propose – and with the support of the reconciliation committee potentially enforce[13] – participatory processes and consultation formats on innovation questions relevant for the company. At the same time, the employer cannot set up or implement participatory processes on technology questions without the agreement of the work council (or decision by the conciliation committee). Procedural codetermination expands work councils' existing information and consultation rights. Instead of being reliant on employers' goodwill to not only pro forma comply with information and consultation obligations, work councils with procedural codetermination rights can design information and consultation channels on technology questions to their needs and therefore enforce the meaningful engagement of the employer. And instead of relying on the employer's definition of what constitutes a change to "technical equipment" or "working procedures", work councils can identify and proactively start plant-level conversations on important technology questions. While the existing codetermination rights allow work councils to demand compensation for negatively affected workers once an investment decision has already been made, a procedural codetermination right is more forward-looking, giving workers a stronger role in the decision process early on. For example, a work council at a car manufacturer might propose a session with shop-floor workers and plant managers to discuss different robotics solutions – ranging from traditional robots to cobots. They may also propose

[12] The term "procedural codetermination" was first used by the German Trade Union Confederation (DGB, 2009) but has to date not yet been used widely used or been developed into a full policy proposal.
[13] This means "procedural codetermination" falls in the (3b) category in the earlier classification of rights.

to set up an in-house 'innovation space', a format that will be further described below. Note that the codetermination right covers the formats in which new technologies are discussed between the employer and employees, but it does not cover the actual technology decision, which remains with the employer. To prevent excessive use by work councils, the number of working hours employees and managers can spend on participatory processes should be capped in proportion to firm size (similarly to how currently the number of work council members is set in proportion to firm size in section 38 of the WCA).

Technical Correctness

Work councils with procedural codetermination rights can lead to the adoption of technologies that complement rather than substitute workers, and consequently decrease market income inequality in the medium-term. Managers may have private information about the economic situation of the company and available technology options, leading workers to distrust the employer if it claims that the adoption of new technologies are necessary to improve the company's productivity (Jirjahn, 2010). Workers, on the other hand, may have private information about how work processes and jobs could be improved but may not share them if they are unaware of technology options or are concerned the information will be used against them (Freeman & Lazaer, 1995; Jirjahn, 2010). Procedural codetermination rights foster meaningful information exchange and trust between workers and managers and can help identify technology options that not only increase productivity but also complement rather than substitute workers. This can translate into positive effects on labor demand, wages, and – as jobs with high automation potential are predominantly found in middle-income occupations – inequality.

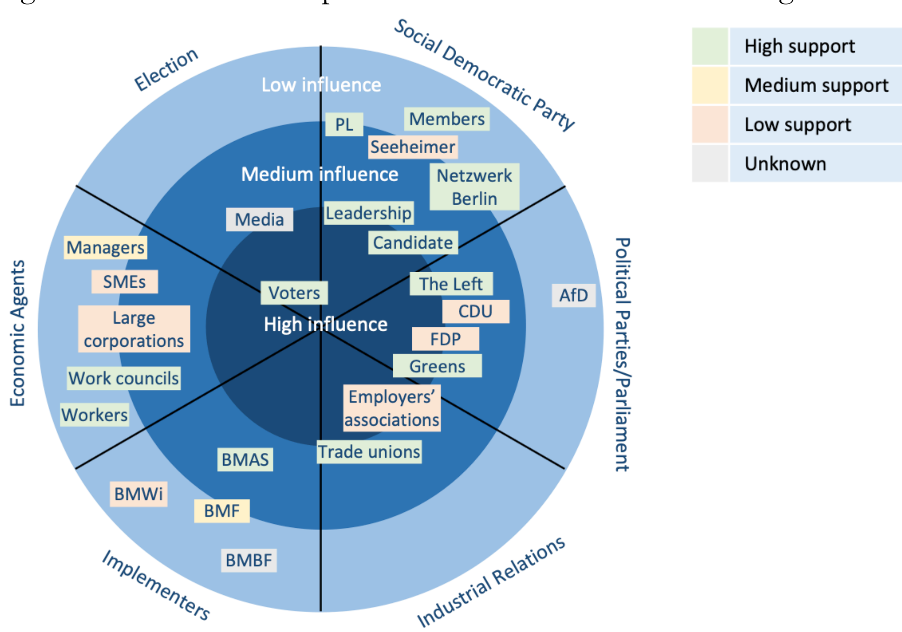
In line with this theory of change, previous literature finds that work councils have positive effects on productivity and wages, and do not inhibit investments. The literature on the productivity effects of work councils in Germany initially produced mixed findings (Addison, 2009). However, more recent studies, leveraging larger datasets and improved econometric techniques, converge on modest, but positive, firm-level productivity effects (Addison 2009; Jirjhan 2010; Müller & Stegmer 2017). The main explanation of these findings is that information, consultation, and codetermination rights enable plant-level cooperation, similar to the theory of change described above. Addison et al. (2007), using establishment-level data, find that the formation of work councils (or their dissolution) do not have negative (or positive) effects on investments. As the proposed policy only improves work councils bargaining power with respect to participatory processes, and not with respect to the actual investment decisions, it is unlikely to lead to hold up by work councils and thus underinvestment of firms.

The low and declining coverage of work councils is a limitation of this proposal. In 2019, the share of companies with work councils was only 9% (Ellguth & Kohaut, 2019). Since most large companies have work councils, this still meant that 41% of workers in West and 36% in East Germany were represented by work councils (in 1996, these shares were at 51 and 43% respectively) (Ellguth & Kohaut, 2019). Nevertheless, the introduction of procedural codetermination rights would not benefit all workers in Germany, especially in medium and small companies. An amendment to the Work Constitutions Act recently proposed (but not yet passed) by the Ministry of Labor and Social Affairs attempts to lower the barriers by simplifying the election procedure and provide more stringent employment protection for workers initiating a vote on a work council (BMAS, 2020).

Political Support

The experiment showed there is latent demand among voters for giving workers more say in firm-level technology adoption. Out of the market-income policies included the survey, the most popular policy in the treatment group is strengthening work councils' rights. While it is only one data point, it does suggest improving worker representation is an attractive policy to include in political messaging on the future of work.

Figure 12. Stakeholder Map for Procedural Codetermination Rights.



The figure maps stakeholders by their domain of influence, their strength of influence, and support level for procedural codetermination. See appendix for more details on each actor.

However, work councils tend to be unpopular with employers' associations. A stakeholder analysis (figure 12 and appendix) identified employers' associations as a critical actor due to their high levels of opposition and influence. Employers' associations have in the past called for curtailing work councils' rights and increasing the number of votes required for setting up new work councils (Müller & Stegmeier, 2020). Their views need to be taken seriously, as they represent a well-funded and well-organized advocacy group, whose campaigns can influence the public opinion on economic policy issues (Nuernbergk, 2006). Their opposition can appear puzzling considering that most literature finds that work councils not only improve productivity and but also modestly increase firm profits (e.g., Steffen & Neuschäffer, 2020). Müller & Stegmeier (2020) argue this phenomenon might be explained by positive average profitability effects but negative median effects. Therefore, employer associations, which operate on a majority of votes, might oppose work councils even though they are beneficial for the economy overall. A feasible political strategy could attempt to break employers' alliance by identifying firms that benefit from work councils and get them to publicly back the proposal. Another strategy is to combine procedural codetermination rights with the proposal to scale the 'innovation spaces' program, which essentially represents a government subsidy for firm level-participation processes.

Implementation

Introducing procedural codetermination does not face any significant barriers in administrative implementation. The proposal builds on existing institutions and mechanisms, such as work councils (and conciliation committees in case employers and workers cannot agree on a proposal for participatory processes). Procedural codetermination rights would be introduced through an amendment of the Work Constitutions Act which could be initiated by the Ministry of Labor and passed by the German Bundestag. This amendment would come at no direct financial cost to the government. Firms have a higher cost as they bear personnel costs when managers and workers spend time on participatory processes but, if the theory of change holds up, are compensated through productivity gains.

Monitoring and Evaluation

Progressive actors should collect further evidence on why work councils are not more involved in firm-level innovation decisions. The theory of change assumes that currently, work councils are not more heavily involved in innovation processes because they cannot adequately leverage their information and consultation rights. There is sufficient evidence for this assumption to include the proposal in the program for the next election. However, it is possible that other constraints are at work. For example, my survey experiment suggests that workers have little information on the exposure of their occupations to automation technologies, and so work councils may simply not be motivated to use their existing information and consultation rights more actively. Therefore, progressive actors should use the time until the election in September 2021 to complement existing quantitative survey evidence (Verdi, 2019, IG Metall, 2020) with qualitative interviews with work council members, workers, and trade unions to confirm that the inadequacy of rights is indeed an important constraint.

Once implemented, the impact of the policy should be evaluated using a difference-in-difference study. Unfortunately, German law does not allow for a random allocation of procedural codetermination rights of any kind (e.g., also not through staggered rollout). However, the reform could and should be evaluated using a difference-in-difference design. In particular, using firm panel data from the Institute for Employment Research, an evaluation could measure firm-level changes in outcomes such as productivity, employment, wage structures, labor share, and investments in firms with work councils before and after the reform, controlling for changes observed in firms without work councils. This research design is not perfect as the two groups differ along many dimensions that also matter for wages. Companies may also self-select into the treatment by establishing work councils after the reform. Yet, a recent study of a reform of board-level codetermination rights in 1994 (Jäger et al., 2020) demonstrates that if carefully implemented and supported by a range of robustness checks, the research design can yield reliable results. If implemented one to three years after the law change, the then ruling government would still have a year to make adjustments to the policy before the next federal election in 2025.

Recommendation 3: Scale up the 'Innovation Spaces' Program

Status Quo

The Federal Ministry for Labor and Social Affairs runs a small program called 'innovation spaces' ('Experimentierräume'), that allows managers and workers develop and test new working methods and technologies in a structured format. The declared goal of these company-level innovation spaces is to provide a "protected space" for the development of "innovative, tailored, and consensual solutions for firms and employees" in the context of the "digital transformation of the economy" (BMAS, 2017). The aims of innovation spaces are to bring different actors in the company together, encourage experimentation and iterative improvement, and identify solutions that can be adopted by the company at large (BMAS, 2021a). To qualify, firms need to submit a project proposal to the Ministry of Labor that describes the particular question that will be addressed and the planned activities (including budget) for the innovation space. An extensive range of topics are eligible (e.g., agile working methods, digital technologies for retraining, or the use of 'big data'). The proposal needs to be signed by at least one manager and one lower-level employee. Within some basic parameters,[14] participants can structure of the innovation spaces according to their needs. Based on the published information, it usually takes the form of a sequence of workshops, sometimes facilitated by an external coach. If the application is successful, the Ministry of Labor covers 70% of the associated personnel and resource costs for three years – up to a maximum of 1.5 million euros (the remaining 30% need to be paid by the employer). Currently, all innovation spaces need to be conducted in partnership with a research institute that monitors the activities. The program is still very small: since its inception in 2017, only 17 innovation spaces have been completed (eleven innovation spaces are still ongoing).

An example may help illustrate how innovation spaces can work in practice. Four nursing homes jointly participated in the 'innovation space' program to test how new technologies could improve elderly care and working conditions of nurses. The innovation space started with a quantitative survey of all staff to understand current challenges in care provision and baseline perceptions of digital technologies. Based on these findings and some consultations with experts, participants found that first, voice input systems could lighten the administrative burden related to the documentation of care, and second, that sensors in mattresses could improve the safety of the elderly. Subsequently, nurses could test these new technologies on a small scale at their workplace. A final survey will complete the innovation space and inform investment decisions (BMAS, 2021b).

Recommendation

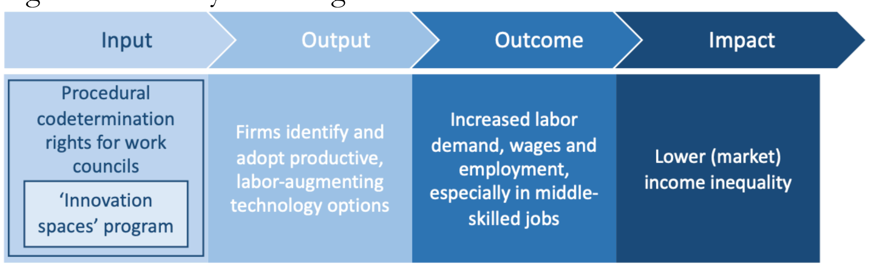
Progressive parties should advocate for a gradual scale up the 'innovation space' program. In particular, it should incrementally increase the available funding for the program and discontinue the mandatory participation of research institutes in all innovation spaces. To not undermine work councils (in the case procedural codetermination rights are not introduced anyway), the participation of at least one member of the work council should be mandatory in firms where work councils exist.

[14] For example, innovation space participants have to meet at least four times (BMAS, 2017).

Technical Correctness

The primary theory of change for the 'innovation space' scheme is the same as for procedural codetermination rights. Setting up an in-house innovation space could be one way for work councils to exercise their procedural codetermination right, and therefore, the underlying theory of change is very similar (see figure 12). Workers may have private information on how to improve their productivity through technology. Hence, innovation spaces can help managers identify labor-augmenting technology options that are more productive than the available labor-substituting options. This would improve labor demand in these jobs, and consequently wages.

Figure 13. Theory of Change.



The available qualitative evidence on the program suggests that it can facilitate the emergence of labor-augmenting technology solutions. Companies' experiences shared on the program website (BMAS, 2021a) show that very few companies prioritized what likely are labor-substituting technologies. Note, for example, how in the case of elderly care homes, the introduction of care robots did not play any role despite often being labelled as the future of elderly care. Instead, the favored technologies are ones that make nurses more productive (voice input for repots, sensors for mattresses). Similarly, participating manufacturing companies did not focus on automation, but for example, on digital assistance programs (e.g., the machinery manufacturer AGT GmbH developed an app that gave assembly workers easier access to construction plans and product documentations on the shopfloor). This suggests that the 'innovation spaces' program can expand the set of technology options faced by managers and lead to the adoption of more employment-friendly solutions. Note, however, that there is likely a selection bias in which firms decided to participate in the program so far, and the information on the program's website may not capture the full picture.[15] Finally, some technological innovations may not be suitable for testing in an innovation space if a small-scale installation comes with large-fixed costs.

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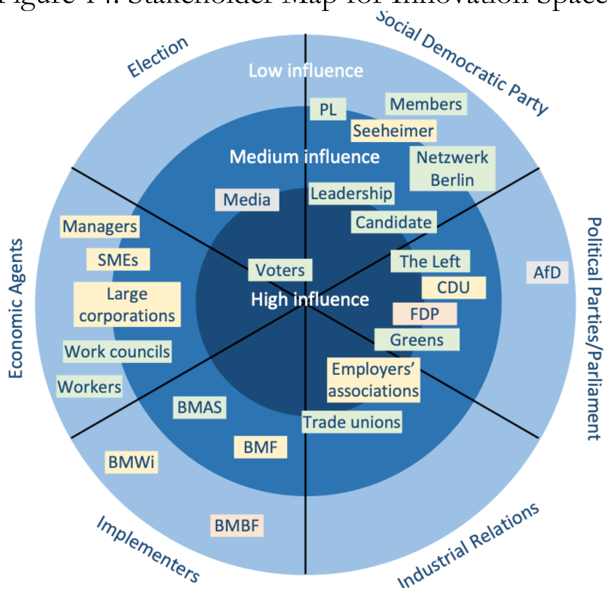
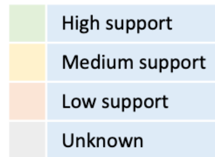
[15] Unfortunately, the participating research organizations appear to not have published any reports.

Political Support

Figure 14. Stakeholder Map for Innovation Spaces.





The figure maps stakeholders by their domain of influence, their strength of influence, and support level for procedural codetermination. See appendix for more details on each actor.

Innovation spaces are likely attractive to a wide range of economic agents. Firms without work councils, which are predominantly small and medium-sized firms,[16] might see innovation spaces as an effective way to strengthen employer-employee collaboration on technology issues without having to accept the "package deal" of a work council (i.e., the establishment of a work council might have undesired implications on dimensions of employer-employee relationships unrelated to technology questions). Work councils, found in 90% of firms with more than 500 employees (Ellguth & Kohaut, 2019), might consider innovation spaces a welcome opportunity to get more involved in technology questions without adding to their existing workload. In the survey by Verdi (2019), 69% of work council members said they are not more involved in innovation processes because they are already overstretched.[17] Through joint funding by the Ministry of Labor and the employer, the 'innovation space' program would unlock additional resources for workers and work councils.

Crucially, the 'innovation space' program is less likely to face strong opposition by employers and employer associations. In the past, employer associations have called for more flexible and tailored approaches to codetermination, especially in the context of the digital transformation (BDA,

[16] Around 10% of firms with 50 employees or less and 52% of firms with 51-250 employees have a work council (Ellguth & Kohaut, 2019).

[17] The maximum number of hours that workers can allocate to work council activities is dependent on firm size.

2021).[18] In addition, concerns regarding the personnel costs caused by work hours allocated to work council activities may be addressed with the government covering 70% of the costs of innovation spaces (BDA, 2020).

Implementation

I recommend a gradual scale-up of the program to allow for continuous improvement and adaptation. Only few companies have so far participated in the program. Once scaled, administrative bottlenecks might emerge, for example in application processing, program activity documentation reviews, or the disbursement of payments. Monitoring and evaluation may also show that certain features of the program do not work as intended. To allow for sufficient flexibility and time to address these issues, I recommend successively increasing the available funding over the 4 years of the legislative term (a tentative budget for the program is included in the appendix). This approach also has the advantage that if the initial take up of the program is lower than expected, there will be no large allocated but unused funds, which could be exploited by political opponents. Responding to overdemand could be sold as a political success.

Monitoring and Evaluation

A random subset of innovation spaces should be monitored by a research institute. Mandatory involvement of research institutes in all innovation spaces was useful in early stages of the program but would likely become a constraint once the program is scaled. Nevertheless, the Ministry of Labor should commission a research institute to continuously collect qualitative data on a random subset of approved innovation spaces. The research institute should also interview some firms that did not apply. The ministry itself should collect data on basic firm characteristics, topics addressed, and reported outcomes of the innovation spaces by firms. These data can help to make adjustments to the program along the way (e.g., in the application process, the required structure for innovation spaces, or the maximum funding per firm).

The impact of the program should be evaluated using a regression discontinuity and a difference-in-difference design. If many firms apply and applications are assessed on a common score, the effectiveness of the program could be evaluated by comparing the outcomes of firms whose applications were barely successful to firms whose scores fell just below the eligibility threshold. As

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[18] The specific program hast not yet received any attention in the public debate on the future of work in Germany, and therefore, there are no direct statements on it by employers' associations.

this would only estimate the impact of the program on a small, self-selected set of firms, however, the program should also be evaluated using a difference-in-difference design, similar to the evaluation of procedural codetermination (keeping in mind the challenges arising from variation in treatment timing, e.g., Goodman-Bacon, 2018). The continuation of the scale-up after three years, as outlined in the appendix, should be made contingent on positive results from the impact evaluation.

Final Recommendations

Procedural codetermination rights and innovation spaces compensate each other's weaknesses and would therefore ideally be implemented together. Procedural codetermination rights are likely more politically supportable, if they are paired with a subsidy for a particular form of a participatory process. Procedural codetermination might also be more effective, if the new power of work councils is channeled into what, on the basis of available qualitative evidence, seems like a promising form of worker participation. The limited coverage of work councils is also less problematic if there is an alternative, less-strings-attached form of worker participation available to all firms, including small and medium-sized firms. The 'innovation space' program, on the other hand, would benefit from a boost in take-up if paired with procedural codetermination rights. Since workers can use their procedural codetermination rights to demand that a firm applies for the 'innovation space' program, the program has teeth without imposing a particular form of worker participation on all companies.

Directed research funding, increased capital taxation, and promoting stock ownership by workers (i.e., through a social wealth fund) remain promising ideas to make technological change more inclusive but need to be developed further. Progressive parties should, in partnership with affiliated think tanks, foundations, and research institutions, further develop and – if deemed feasible – popularize these proposals. The policies have in common that they can promote market incomes of those currently left behind, thus tackling inequality directly where it is created.

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Appendix

Problem Diagnosis

Figure 15. Real Gross Hourly Wages by Decile. Source: Grabka & Schröder (2019).

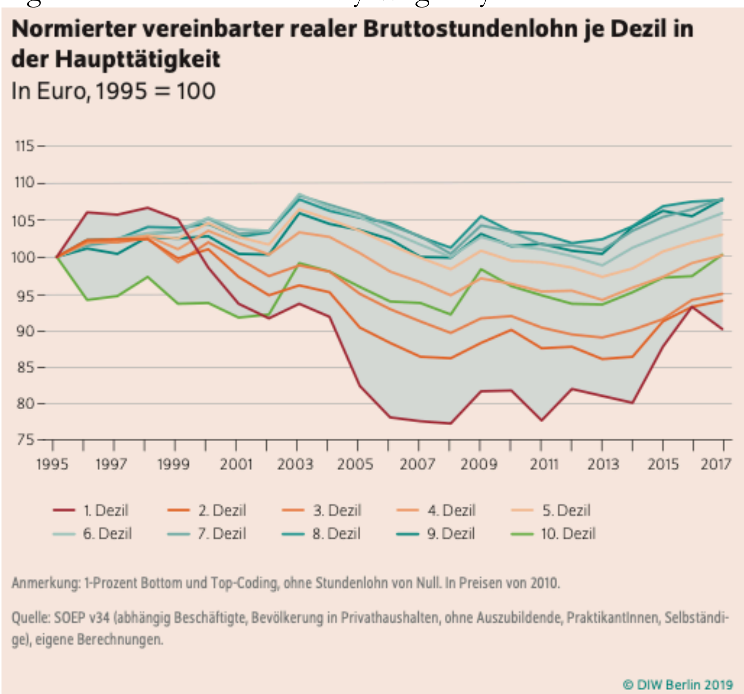
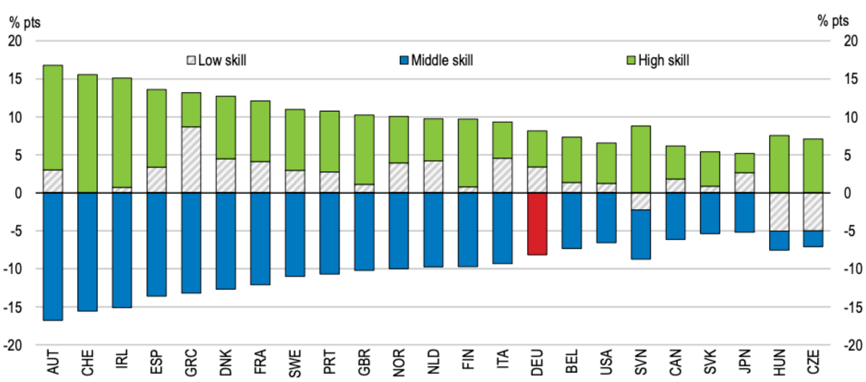


Figure 16. Declining Employment Share in Middle-Skilled Jobs. Source: OECD (2018b).

Figure 30. The share of middle-skilled jobs in employment has declined

Percentage point change in the share in total employment between1995 and 2015



Note: High-skilled occupations include jobs classified under the ISCO-88 major groups 1, 2, and 3. These are legislators, senior officials, and managers (group 1), professionals (group 2), and technicians and associate professionals (group 3). Middle-skilled occupations include jobs classified under the ISCO-88 major groups 4, 7, and 8. These are clerks (group 4), craft and related trades workers (group 7), and plant and machine operators and assemblers (group 8). Low-skilled occupations include jobs classified under the ISCO-88 major groups 5 and 9. These are service workers, shop and market sales workers (group 5), and elementary occupations (group 9).

Source: OECD (2017), *OECD Employment Outlook 2017*.

StatLink http://dx.doi.org/10.1787/888933737723

Selecting Occupations for Sampling

The survey experiment focuses on workers whose occupations are at high risk of automation and who constitute a significant share of the German workforce.

To determine ISCO-08 occupation-level automation exposure, I used the existing estimates by Frey & Osborne (2017) and Webb (2020). The two papers use two different methods to measure the extent to which the tasks in particular occupations could theoretically be automated with the available technology. To identify the extent to which occupations (using the 2010 O*NET task descriptions and classification by the US Labor Department) have a high probability of automation, Frey & Osborne (2017) first asked machine learning and robotics researchers to hand-label occupations where they are confident that the occupation will certainly be fully automated or will certainly not be fully automated. Second, they describe all O*NET occupations in terms of "engineering bottlenecks" to automation, such as the level of perception, dexterity, creativity, or social intelligence required to perform them. Third, they fit a logistic model on the occupations hand-labeled by experts, where the "bottleneck" variables predict automatability, and then use the fitted model to predict the automation risk of the remaining O*NET occupations. Webb (2020) uses a different approach, exploiting patent data to measure the exposure of different occupations to artificial intelligence. In particular, Webb (2020) measures the overlap in verb-noun pairs extracted both from occupations' task descriptions and patent descriptions.

I merged the risk estimates from Frey & Osborne (2017) and Webb (2020) into a 'combined risk score'. The purpose of this 'expert voting' approach, combining estimates derived from different approaches, is to get more robust predictions of automation exposure. Frey & Osborne use the O*NET-SOC taxonomy of occupations. To convert their predicted probability of automation to the ISCO-08 level, I used the crosswalk developed by the US Bureau of Labor Statistics. In cases where several SOC/O*NET occupations mapped to one ISCO-08 occupation, I took the mean probability of automation (the variance of the probability within these groups tended to be small). In cases where several ISCO-08 occupations mapped to the same SOC/O*NET occupation, the more granular ISCO-08 occupations all took the same probability value. Webb (2020) uses the occupational classification developed by Dorn (2009) and extended by Deming (2017). To convert Webb's (2020) AI exposure scores to the ISCO-08 level, I used Webb's (2020) crosswalk to SOC/O*NET occupation, and then again the crosswalk by the US Bureau of Labor Statistics. I rescaled the Webb

(2020) scores to values between 0 and 1, and for each ISCO-08 occupation, calculated the mean risk scores from the two studies. I call this the 'combined risk score'.

To select occupations that are not only at high risk of automation but also relevant for the German workforce, I combined the occupation-level risk estimates with recent employment statistics. More precisely, I merged the ISCO-08-level dataset of automation risk scores with employment statistics from the German Federal Employment Agency from March 31, 2020. The number of full-time positions on December 31, 2019 was only slightly larger than on March 31, 2020 (33,740,124 compared to 33,648,183), suggesting that they still reflect the underlying structure economy rather than the impact of COVID-19 related restrictions. Since the employment statistics are published using Germany's own classification of occupation ('Klassifikation der Berufe 2010'), I again first converted them to the ISCO-08 level using a crosswalk provided by the Federal Employment Agency.

Among the occupations with above-median automation risk (as determined by the combined risk score), I selected the 30 largest occupations, representing 45% of the workers subject to social security deductions in Germany. The targeted occupations are listed in table 2. Since I could not effectively target three of the initially selected occupations, I replaced them with the three next-largest occupations.

Table 2. Selected Occupations.

	ISCO-08	ISCO-08 English	Number of workers	Frey & Osborne (2017)	Webb (2020)	Combined risk score
1	5223	Shop sales assistants	1882517	0.95	0.11	0.53
2	4110	General office clerks	1262284	0.97	0.16	0.57
3	4322	Production clerks	1062341	0.88	0.22	0.55
4	8183	Packing, bottling and labelling machine operators	1058007	0.98	0.25	0.62
5	9329	Manufacturing laborer not elsewhere classified	973387	0.81	0.42	0.62
6	9321	Hand packers	950681	0.38	0.92	0.65
*	8157	Laundry machine operators	708884	0.71	0.63	0.67
7	8331	Bus and tram drivers	704480	0.61	0.58	0.60
8	7233	Agricultural and industrial machinery mechanics and repairers	578983	0.62	0.63	0.63
9	7223	Metal working machine tool setters and operators	559538	0.87	0.76	0.82
10	3359	Regulatory government associate professionals not elsewhere classified	509093	0.94	0.93	0.93
11	4321	Stock clerks	474459	0.86	0.52	0.69
12	4211	Bank tellers and related clerks	424854	0.97	0.13	0.55
13	7412	Electrical mechanics and fitters	400863	0.64	0.65	0.65

14	4311	Accounting and bookkeeping clerks	383586	0.97	0.23	0.60
15	7231	Motor vehicle mechanics and repairers	381628	0.64	0.45	0.54
*	3119	Physical and engineering science technicians not elsewhere classified	373515	0.41	0.80	0.61
16	3313	Accounting associate professionals	306439	0.98	0.13	0.56
17	4132	Data entry clerks	285794	0.99	0.94	0.96
18	4223	Telephone switchboard operators	285794	0.97	0.34	0.65
19	8160	Food and related products machine operators	252364	0.82	0.54	0.68
20	8211	Mechanical machinery assemblers	243969	0.81	0.55	0.68
21	7422	Information and communications technology installers and servicers	243593	0.63	0.70	0.66
22	8189	Stationary plant and machine operators not elsewhere classified	230345	0.92	0.76	0.84
*	8182	Steam engine and boiler operators	225619	0.89	0.75	0.82
23	8219	Assemblers not elsewhere classified	216219	0.97	0.55	0.76
24	3118	Draughtspersons	210885	0.56	0.76	0.66
25	7214	Structural-metal preparers and erectors	209671	0.71	0.33	0.52
26	7221	Blacksmiths, hammersmiths and forging press workers	202260	0.93	0.92	0.92
27	5414	Security guards	190340	0.90	0.83	0.86
28	2514	Applications programmers	184073	0.48	0.94	0.71
29	3321	Insurance representatives	179538	0.66	0.59	0.63
30	7511	Butchers, fishmongers and related food preparers	175994	0.85	0.26	0.55
			Sum: 16331997	Mean: 0.81	Mean: 0.54	

"Laundry machine operators", "Physical and engineering science technicians not elsewhere classified", and "Steam engine and boiler operators" were therefore excluded from the study and not included in the reported sum and mean.

Example Advertisements on Facebook Newsfeed

Mechanical machine assemblers

Insurance representatives

Each occupation was targeted with a custom ad. Pictures were taken from license-free databases such as pexels.com, unsplash.com and pixabay.com.

Background on Survey Sampling with Facebook

Facebook can be used to generate representative samples in Germany. First, previous research documented that sampling through Facebook ads led to representative samples in other contexts (Zhang et al., 2017; Zagheni et al. 2017) and that associations in non-random Facebook samples generally resemble those estimated from standard data sets (Schneider & Harknett, 2019; Bhutta, 2012). Second, with 32 million users (39% of the population), the penetration rate of Facebook in Germany is relatively high, especially compared to other social media platforms, and exhibits less selection bias than opt-in panels (Schneider & Harknett, 2019). Third, it is worth mentioning that traditional alternatives, such as random digit dialing, suffer from increasingly low response rates. For instance, the response rate for phone surveys conducted by the Pew Research Center in the US declined from 36% in 1997 to 9% in 2016 and are likely not much higher in Germany (Keeter et al. 2017). Fourth, to the extent that confounders are correlated with observables, I correct for non-response bias and sampling frame error through weight adjustments.

Survey Response Rates

Survey response rates were lower than expected. Schneider & Harknett (2019), who used a similar approach to sample respondents by employer in the United States, provide a useful benchmark. The comparison shows that click rates and consent/participation rates were much lower in my study. Potential reasons are cultural differences between the United States and Germany (i.e., due to privacy concerns, German workers might be more hesitant to share their data in a survey advertised on Facebook). Facebook ads with employer names may also be more salient to users than ads with occupation titles.

Table 3. Response Rates in Comparison with Schneider & Harknett (2019).

	Schneider & Harknett	SYPA
Budget spent (USD)	75000	4473
Total unique ad views	3270228	1589468
Total clicks	179563	9327
Persons contributing some data	39918	683
Persons contributing some data after screening	32142	na
Completed survey responses (includes skipped questions)	17828	321
Unique ad views per USD spent	43.6	355.3
Clicks per ad view	0.055	0.006
Contributing some data if clicked	0.222	0.073
Completing the survey if contributing some data	0.447	0.470

Measures to Promote Data Quality

Several measures were taken to ensure high-quality survey responses. First, I used Qualtrics features that detect multiple responses by the same person as well as responses by bots (none were detected, likely because the survey was not listed on any search engines and was only accessible to people with the link to the survey). Second, following the example of Alesina et al. (2018), I appealed to respondents' sense of responsibility by stating that "it is very important for the success of our research that [they] answer honestly and read the questions very carefully before answering" (Alesina et al., 2018). I also informed respondents that rushed or incoherent answers will be detected and flagged using statistical methods. Before randomization and providing the informational treatment, I asked respondents whether they have paid attention to the preceding questions and whether they believe that their responses should be counted in the analysis (Alesina et al., 2018). The purpose of this question is to prompt respondents to pay attention to subsequent questions, regardless of whether they answer it honestly (Meade & Craig, 2012). For important survey questions, such as the question on policy preferences, I alerted respondents to fact that the time they spend on the page is recorded and showed a timer at the bottom of the page. The survey form itself contained constraints on certain answers (e.g., probabilities between 0 and 100) and the order in which answer options were presented to respondents was randomized (e.g., the order at which policy proposals were shown to respondents was randomized). Question types varied (e.g., single choice, sliding a bar to provide numeric responses, ranking options, etc.) to keep respondents engaged. Survey questions were roughly ordered by their importance in light of likely high attrition rates.

Survey Questionnaire

Block 1: Socio-Economic Information

- What is your age?
- What is your gender?
- What is your occupation? (single choice from ISCO-08 occupation titles; asked to confirm twice)
- In which Bundesland do you live?
- What is your highest level of education?
- What is your employment status?
- How many people live in your household?
- What was your monthly net household income in the last year (including wages, transfers, capital incomes *after deduction of taxes and pensions*)? (single choice, six income brackets)
- On questions on economic and social policy, where in the political spectrum do you see yourself?

- Did you vote in the last federal election?
- If yes: For which political party did you vote?
- Do you think that technological changes like digital transformation have overall positive or negative effects on all workers in Germany? (5-point Likert scale)
- Do you think that technological changes like digital transformation have overall positive or negative effects on your personally? (5-point Likert scale)

Block 2: Treatment and Control

A random half of the respondents has been shown the following informational text.

[Page 1] **Automation has impacted German workers in the past few decades**. For example, industrial robots have reduced the need for factory workers and computers have reduced the demand for secretaries.
This wave of firms automating jobs has led to an increase in income inequality in Germany, some economists argue. Especially the owners of capital have benefitted.
Today, researchers make advancements in machine learning, artificial intelligence, and robotics, increase the pace of automation. Computers and robots are trained to perform tasks that typically require human intelligence. For the first time, people with a university education are also thought to be at risk.

[Page 2] **Will firm managers have technologies available to automate your job if the current direction of research is maintained?** New studies from researchers at the University of Oxford and Stanford University predict the likelihood of different jobs becoming automated in the next two decades.
According to their research, [respondent's occupation] have a high likelihood of becoming automated.
One study estimates that the chance of your job being automated is [predicted likelihood for respondent's occupation being automated according to Frey & Osborne (2017)].
[Respondent's combined risk score percentile] percent of workers in Germany have a lower risk of being automation than [Respondent's occupation].
The studies examined hundreds of occupations. For each occupation, the researchers noted the types of tasks workers perform and the skills required. By weighing these factors, as well as engineering challenges, the researchers assessed the degree to which computers and machines could do these jobs.

[Page 3] **However, technological changes do not necessarily have to be bad for workers.**
Instead of automating jobs, researchers could also develop technologies that create new jobs or make workers more productive. Economic incentives and social norms all have an influence on which technologies are developed and adopted.

Block 3: Outcome Measures

- What do you think of the following policy proposals? Please vote by clicking the bar or directly entering your votes in the text field. You have 16 votes in total. You can allocate your votes to the proposals. The more votes you give to a proposal, the more you support the proposal.

You can each proposal a maximum of four votes.

  - People who lost their jobs because of technological changes should get easier access to unemployment insurance (e.g., by not requiring the depletion of personal funds before accessing benefits).
  - Workers benefit from the profits earned by companies through automation by the state holding stocks for them and distributing dividend payments equally each year [Social Welfare Fund]
  - Introduce a 'right to retraining' (financial support for a second vocational training).
  - Companies that want to replace workers with automation technology need to pay a 'robot tax'.
  - People whose occupation is affected by technological change and want to get further training receive financial support.
  - The government prioritizes the funding of technologies for which it is expected that they complement rather than replace current jobs.
  - Each citizen receives an unconditional basic income of 800 Euros a month (to finance it, other social transfers like unemployment insurance, child and housing allowances are reduced).
  - The role of work councils in the adoption of automating technologies will be strengthened so that worker-friendly technologies are promoted.
  - Net assets of more than 1 million are taxed with an 1% annual wealth tax.

- How likely do you think it is that your own job or profession will be mostly done by robots or computers within the next two decades? Please estimate the probability on a scale of 0 to 100, with 0 meaning that it will definitely not happen, and 100 meaning that it will definitely happen. (numeric, >0, <100)
- How likely do you think it is that you experience the following professional changes in the next ten years? Please estimate the probability on a scale of 0 to 100, with 0 meaning that it will definitely not happen, and 100 meaning that it will definitely happen. (numeric, >0, <100)
  - You lose your job.
  - You stop working in your occupation and start working in a new occupation.
  - You do not received a promotion.
  - You attend courses or seminars to gain additional vocational training.
  - You work as a freelancer/self-employed.
  - You reduce your weekly working hours.
- Do you agree or disagree with the following statements? (5-point Likert scale)
  - The government should try to directly reduce inequality in gross wages.
  - The government should try to reduce inequality in disposable incomes through taxes and transfers.
  - It is important for me, that I earn enough income through my work and don't depent on transfers.
  - It is important for me that I have enough disposable income – whether through my work or transfers is not important.
- Who are you planning to vote for in the next federal election in October 2021?
- Do you agree or disagree with the following statements? (5-point Likert scale)
  - The government has influence on the speed at which new technologies are developed and adopted at workplaces.
  - The government has influence on whether technological changes have positive or

negative effects on workers.

- What do you think: On which of these phenomena does the German government have the biggest influence: Please rank from top to bottom, starting with the development on which the government has the most influence on.
    - Volume of annual imports to Germany
    - Yearly number of immigrants to Germany
    - Yearly number of patents filed in Germany
- Do you agree or disagree with the following statements? (5-point Likert scale)
    - For my voting decision in the next federal election Germany, inequality in Germany plays a major role.
    - I find the information on automation presented in this survey trustworthy.
    - The government should take measures to reduce income inequality. (question from EVS)
- Optional: Is there anything else you would like to tell us? (open text field)

Regression Equation

To estimate the effects of the intervention on main outcomes, I use the following OLS regression model:

$$Outcome_{ij} = \beta_0 + \beta_1 Treatment_i + \beta_2 F\&OAutomationProb_j + \beta_3 CombinedRiskScore_j + \boldsymbol{X}_i \gamma + \varepsilon_i$$

Where $Outcome_i$ is the outcome of interest and $Treatment_i$ is a dummy for whether the respondent i (in occupation j) is in the treatment group. I control for the occupation-specific automation probability from Frey & Osborne (2017) ($F\&OAutomationProb_j$) and the combined risk score with Webb (2020) ($CombinedRiskScore_j$) as respondents in the treatment group are shown these predictions (i.e., treatment varies by these parameters). X_i is a vector of demographic and socio-economic variables including gender, age, education, income, occupation, political orientation, and baseline perceptions of technological change (as shown in table 1). Estimated were calculated both in R and Stata with consistent results. The analysis code is available on GitHub.

Supportive Evidence from German Socio-Economic Panel (SOEP)

Table 4. OLS Regression of Outcomes on Automation Risk Score.

	(1) New tech at work? (1 = yes)	(2) Work satisfaction (out of 10)	(3) Income satisfaction (out of 10)	(4) Worried about job security? (1=yes)	(5) Voted AfD? (1 = yes)	(7) Refugees good for economy? (out of 10)
F&O automation risk (from 0 to 1)	0.0970*	-0.390*	-0.109	0.179***	0.0382	-0.850***
	(0.0387)	(0.198)	(0.181)	(0.0476)	(0.0208)	(0.241)
Age (in years)	-0.00179***	-0.00200	0.00531*	-0.00169***	0.00000260	0.00543
	(0.000489)	(0.00206)	(0.00253)	(0.000491)	(0.000313)	(0.00293)
Whether male	0.0341*	-0.0572	-0.0328	-0.00299	0.0501***	0.225*
	(0.0134)	(0.0484)	(0.0591)	(0.0137)	(0.00820)	(0.0929)
Years of education	0.00917***	0.00759	0.120***	-0.0191***	-0.0119***	0.294***
	(0.00248)	(0.00931)	(0.0120)	(0.00274)	(0.00151)	(0.0163)
Constant	0.103*	7.303***	5.350***	0.517***	0.195***	1.849***
	(0.0470)	(0.177)	(0.206)	(0.0571)	(0.0264)	(0.293)
N	13127	13336	13518	13350	11172	13430

SOEP survey data from 2018. Standard errors are clustered on the ISCO-08 level. Columns 1, 4, and 5 show linear probability models. All estimates use survey weights.

Treatment Effects

Table 5. Treatment Effects on Perceptions of Automation Risk.

	(1) Respondent's automation prediction (0 to 100)	(2) Respondent's automation prediction (0 to 100)	(3) Respondent's automation prediction (0 to 100)
Treatment (1 = yes)	-0.0814	1.262	-1.543
	(7.206)	(6.293)	(4.958)
F&O (2017) automation score (0 to 1)		0.661**	1.445***
		(0.216)	(0.291)
Combined risk score (0 to 1)		0.357	0.785
		(0.183)	(0.590)
Demographic and occupation controls	No	No	Yes
N	291	291	291

Estimates use survey weights. Standard errors in parentheses are heteroskedasticity robust errors. Combined risk score is the mean of the Frey & Osborne (2017) and Webb (2020) automation risk scores. I control for the occupation-specific automation risk scores as respondents in the treatment group are shown these predictions (i.e., treatment varies by these parameters). The survey question read: "How likely do you think it is that your own job or profession will be mostly done by robots or computers within the next two decades?".

Table 6. Treatment Effects on Perceived Probability of Major Career Events.

	(1) Mean of all events	(2) Mean of all events	(3) Job loss	(4) Job loss	(5) Occupation change or retirement	(6) Occupation change or retirement	(7) No promotion	(8) No promotion	(9) Training	(10) Training	(11) Self-employment, freelance	(12) Self-employment, freelance	(13) Reduce hours	(14) Reduce hours
Treatment	-1.562	-3.409	2.680	-0.698	-3.088	-7.322	-0.189	-1.528	1.680	2.144	-6.488	-8.281	-4.258	-5.155
(1 = yes)	(3.448)	(3.196)	(6.923)	(5.151)	(7.522)	(6.703)	(7.700)	(6.077)	(7.315)	(5.707)	(6.785)	(5.574)	(6.569)	(6.414)
F&O automation	0.192	0.443**	0.266	-0.567	0.703*	0.841*	0.828**	1.137**	-0.795**	1.057*	0.0218	0.135	0.122	-0.00470
score (0 to 1)	(0.130)	(0.154)	(0.239)	(0.459)	(0.274)	(0.396)	(0.271)	(0.368)	(0.277)	(0.449)	(0.224)	(0.568)	(0.221)	(0.373)
Combined risk score	0.0993	-0.441	-0.126	0.445	0.102	1.095	0.117	-1.862*	0.371	-3.767***	0.140	0.641	0.0150	0.967
(0 to 1)	(0.0929)	(0.314)	(0.167)	(0.689)	(0.232)	(0.686)	(0.217)	(0.842)	(0.208)	(0.706)	(0.179)	(0.944)	(0.193)	(0.726)
Demographic and occupation controls	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
N	291	291	291	291	291	291	291	291	291	291	291	291	291	291

Estimates use survey weights. Standard errors in parentheses are heteroskedasticity robust errors. Sample size is smaller than in balance table as not everybody who was assigned a treatment group also answered the relevant outcome questions. Combined risk score is the mean of the Frey & Osborne (2017) and Webb (2020) automation risk scores. I control for the occupation-specific automation risk scores as respondents in the treatment group are shown these predictions (i.e., treatment varies by these parameters. Outcomes are coded in percent from 0 to 100. Demographic controls are those include in the statistical balance table. The survey question read: "How likely is it that you will experience the following career changes within the next ten years?".

Table 7. Treatment Effects on Support of Policy Measures.

	(1) Social Wealth Fund	(2) Social Wealth Fund	(3) Unempl. Insurance	(4) Unempl. insurance	(5) Robot Tax	(6) Robot Tax	(7) Training support	(8) Training Support	(9) Directed research funding	(10) Directed research funding	(11) UBI	(12) UBI	(13) Wealth tax	(14) Wealth tax	(15) Stronger work council	(16) Stronger work council	(17) Mean of market policies	(18) Mean of market policies
Treatment (1 = yes)	-0.471	-0.270	-0.151	0.0446	0.0385	0.211	0.412	0.123	-0.171	-0.206	-0.395	-0.262	-0.443	-0.573*	0.778*	0.680*	0.0435	0.104
	(0.314)	(0.245)	(0.318)	(0.237)	(0.343)	(0.239)	(0.306)	(0.207)	(0.308)	(0.228)	(0.287)	(0.255)	(0.356)	(0.233)	(0.336)	(0.266)	(0.104)	(0.101)
F&O automation Score (0 to1)	0.0145	0.0136	0.0288*	0.0367	-0.0101	-0.0561**	-0.00416	0.0480*	0.00853	-0.0120	0.00965	0.0301	0.0140	0.00854	-0.00774	0.0382*	0.00130	-0.00406
	(0.0112)	(0.0424)	(0.0136)	(0.0216)	(0.0159)	(0.0188)	(0.0125)	(0.0236)	(0.0112)	(0.0314)	(0.0114)	(0.0165)	(0.0152)	(0.0139)	(0.0120)	(0.0194)	(0.00387)	(0.00961)
Combined risk score (0 to 1)	-0.00626	0.0385	0.00809	-0.0388	-0.0103	0.0616	0.0163	-0.121**	-0.00186	0.0132	-0.0209**	0.0208	0.000307	0.0241	0.00525	-0.0930*	-0.00328	0.00506
	(0.00930)	(0.0599)	(0.00885)	(0.0354)	(0.0100)	(0.0457)	(0.00987)	(0.0363)	(0.00825)	(0.0489)	(0.00778)	(0.0484)	(0.00823)	(0.0341)	(0.00940)	(0.0407)	(0.00321)	(0.0171)
Demographic and occupation controls	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
N	291	291	291	291	291	291	291	291	291	291	291	291	291	291	291	291	291	291

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Estimates use survey weights. Standard errors in parentheses are heteroskedasticity robust errors. Sample size is smaller than in balance table as not everybody who was assigned a treatment group also answered the relevant outcome questions. Combined risk score is the mean of the Frey & Osborne (2017) and Webb (2020) automation risk scores. I control for the occupation-specific automation risk scores as respondents in the treatment group are shown these predictions (i.e., treatment varies by these parameters. Outcomes are coded in percent from 0 to 4. Respondents had a budget of 16 votes which they could allocate across 8 proposals. Giving a proposal four votes was labeled as "strongly agree" and giving no votes labeled as "strongly disagree". The survey questionnaire included a one-sentence explanation of each of the proposals as shown in the appendix. Proposals were shown to respondents in random order. Demographic controls are those include in the statistical balance table. Columns 17 and 18 show the effect on the mean support for a social wealth fund, a robot tax, directed research funding, and stronger work councils.

Tentative Budget for 'Innovation Spaces' Program

The purpose of this tentative budget is to assess if the program could be scaled at reasonable cost. It rests on a number of assumptions as some data on the program's current costs are not publicly available (e.g., average project budget, personnel costs for application processing, etc.). If recommendation 3 is adopted, the Ministry of Labor should write a more detailed budget.

The program could reach 80,000 companies (21% of all companies with more than 10 employees) at a cost of 2 billion Euros (7% of the total R&D government funding). An average innovation space budget of 25,000 Euros (or 75,000 Euros for the three-year project) may seem low. However, as most firms in Germany are very small (e.g., 88% have annual sales of 1 million Euro or less) (Destatis, 2020), 25,000 Euros represents a large subsidy for worker participation for these firms. Decreasing administrative costs per firm represent efficiencies gained in scale (e.g., through the set-up of a digital application platform).

	Current	Year 1	Year 2	Year 3	Year 4
Direct program costs					
Number of participating firms	28	400	5000	20000	80000
(as share of total firms with more than 10 employees in 2018)	*0.0%*	*0.1%*	*1.3%*	*5.3%*	*21.1%*
Average project budget (**per firm** in €)	25000	25000	25000	25000	25000
Total direct program cost (in mio €)	**0.7**	**10**	**125**	**500**	**2000**
Administrative costs					
Personnel and resource cost for application processing, payment disbursements, communications, etc. (**per firm** in €)	1000	500	250	250	250
Total administrative costs (in mio €)	**0.028**	**0.2**	**1.25**	**5**	**20**
M&E costs					
Analysis of application and project documentation data	5000	10000	10000	10000	10000
Qualitative monitoring of 20 randomly selected firms by external research institute (in €)	30000	30000	30000	30000	30000
Quantitative impact evaluation by external research institute (in €)	0	0	50000	0	50000
Total M&E costs (in mio €)	**0.03**	**0.03**	**0.08**	**0.03**	**0.08**
Total					
Total (in mio €)	**0.758**	**10.23**	**126.33**	**505.03**	**2020.08**
(as a share of total government R&D funding in 2018	*0.0%*	*0.0%*	*0.4%*	*1.7%*	*6.9%*
(as a share of the total federal budget in 2018)	*0.0%*	*0.0%*	*0.0%*	*0.1%*	*0.6%*

Data sources: BMBF (2020a), BMAS (2017), Statista (2020).