The Effect of Temporary Workers and Works Councils on Process Innovation

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Abstract

Purpose – This study aims to investigate the effects of temporary workers and works councils on process innovations at manufacturing sites. The impact of temporary workers, commonly viewed as a means of operational flexibility and cost savings, on firms' ability to innovate is underexplored. Works councils represent and help integrate temporary workers, but are often equated with unions, which have been criticized as barriers to innovation, especially in the US.

Design/methodology/approach – The authors use secondary data collected by the Institute for Employment Research (IAB) of the German Federal Employment Agency. Specifically, the authors conduct a series of regression analyses using 11-year panel data covering the period 2009–2019 with 11,641 manufacturing site-year observations.

Findings – The results suggest that the use of temporary workers initially promotes process innovation, but at too high a level, it impairs firms' ability to innovate. Furthermore, the results suggest that works councils have a positive impact on innovation and dampen the curvilinear effect found with respect to temporary workers.

Originality/value – Research has largely focused on the cost and flexibility benefits of temporary workers. The authors analyze the effectiveness of temporary workers in terms of innovativeness. By including works councils, the study also consider the contextual environment in which temporary workers are employed. Finally, the results reject the assumption that works councils have a similar negative impact as unions on innovation; in fact, the authors find the opposite.

Keywords Process innovation, Temporary workers, Work councils, Employee representation, Precarious work

Paper type Research paper

1. Introduction

Process innovation is an important driver of economic growth and can create competitive advantage. Process innovation results from a firm's human capital, and this research explores how a key trend related to human capital, the increase in the use of temporary workers (e.g. Wiengarten *et al.*, 2021), influences process innovation.

Operations management scholars often argue that temporary labor contracts benefit firms by allowing them to respond quickly to changing market conditions by hiring and firing workers expediently without violating labor contracts and labor laws (Kesavan *et al.*, 2016; Stratman *et al.*, 2004). And it has been proposed that workers who have worked at

This study uses the Establishment Panel data from the IAB (1993–2020). Data access was provided via on-site use at the German Institute for Economic Research (DIW) and at the Research Data Centre (FDZ) of the German Federal Employment Agency (BA) at the Institute for Employment Research (IAB) and remote data access (Project numbers: fdz1710 and fdz1711).

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multiple sites – which should be the case for temporary workers – can contribute more innovative ideas (Cornelius *et al.*, 2021). The potential disadvantages of temporary workers are hardly discussed in operations management (Wiengarten *et al.*, 2021). Yet, temporary workers are more likely to be cognitively distanced from the organization and hence unlikely to be motivated to accumulate or apply the knowledge, skills and abilities that foster innovation (Burbano and Chiles, 2021). Too much flexibility in work design has also been shown to have negative effects, such as a reduction in social cohesion and trust, which could hinder innovation (e.g. Giannetti and Madia, 2013; de Stefano *et al.*, 2018).

In addition to temporary workers not having a connection to the organization (Burbano and Chiles, 2021), many also lack a means of expressing themselves through some form of representation (Reinecke and Donaghey, 2021). Workers who have no means of representing themselves, no voice, are unlikely to participate in improving the organization (Zhou *et al.*, 2019). Traditionally, this representation was addressed via a union, and some still maintain that the best way to create the working conditions that would foster process innovation is via unionization (Kuruvilla and Li, 2021). Yet rates of unionization globally continue to fall and currently in the Organisation for Economic Co-operation and Development (OECD) countries stand at less than 16% of the workforce (OCED, 2022).

Process innovation is and will remain a critical part of effective operations management and this innovation is dependent on the workforce. Simultaneously, the increase in temporary work means more workers are potentially distanced from their organizations and the decrease in unionization means that many workers do not have a form of representation. The need to continuously innovate to improve processes seems at odds with the increase in temporary workers; especially since in most operational contexts, the workers will not be represented by a union. Therefore, our examination of the role of temporary workers in process innovation considers an alternative path to giving (temporary) workers representation, the works council.

Several European countries have established systems of works councils, to protect workers before and during their employment. A works council is a group of elected workers within a firm who represent the workforce – including temporary workers – to the employer. The impact of employee representation on organizational innovation is typically studied using the context of unionization in the United States, where a negative relationship between unions and innovation performance is suggested (Acs and Audretsch, 1987; Audretsch and von der Schulenburg, 1990; Bradley *et al.*, 2016; Hirsch and Link, 1987). However, works councils differ from unions in that a works council is always site specific. This can be true of a union in the United States, but in Germany a union is always for a firm or industry. Equally, and perhaps more importantly for this study, works councils do not cover some of the key cost issues associated with unions specifically wages and benefits. A works council is then a localized means of worker representation with a focus on how work is done, not remuneration, benefits and the like. Works councils may provide an alternative path to representation for temporary workers, allowing firms to benefit from both labor force flexibility and process innovation.

We ask three interrelated research questions to address these issues:

RQ1. How do temporary workers affect process innovation performance?

RQ2. How do works councils affect process innovation performance?

RQ3. How does the simultaneous presence and absence of temporary workers and works councils affect process innovation performance?

To explore our research questions, we utilize longitudinal data from 4,212 German manufacturing sites. The data were collected between 2009 and 2019 by the Institute for Employment Research (IAB) of the German Federal Employment Agency. Our results suggest an inverted U-shaped relationship between temporary workers and process

innovation. The presence of works councils has a positive effect on the process innovation. Firms with works councils can use significantly more temporary workers before they experience negative effects on their process innovation.

2. Literature review

2.1 Temporary workers and process innovation

Temporary workers provide firms with operational flexibility to respond to fluctuations in demand, to reduce overhead costs or to replace temporarily absent permanent employees (Cappelli and Keller, 2012; Cappelli and Neumark, 2004; Kalleberg, 2001). Temporary workers can be hired and fired as needed. Temporary contracts can take different forms and durations depending on the needs of the organization. They can be short-term contracts, used and renewed to be adaptable in case of unexpected changes (Cappelli and Keller, 2012). *Temporary work* is employment "*whereby workers are engaged only for a specific period of time, [which] includes fixed-term, project- or task-based contracts, as well as seasonal or casual work, including day labour*" (ILO, 2016).

New workers, such as temporary workers, can enrich the flow of new information and knowledge from the external environment into the organization, supporting the development of new or revised design and technical concepts related to organizational processes (Tempest, 2009). Information exchange with the external environment was suggested by Cummings and O'Connell (1978) as an important influencing factor for idea generation, and March (1991) observed that newcomers' ideas and information are usually not redundant with the organization's knowledge base. Hence, it has been consistently recognized that organizations need new employees to become and remain innovative (Herstad *et al.*, 2015; Jain *et al.*, 2008).

Organizational creativity theory suggests that innovation is not just the result of the inflow of new ideas, but also depends on how these ideas are transformed and implemented (Utterback, 1971). It is the composition of abilities, knowledge and motivation within the workforce that influences creative behavior (Woodman *et al.*, 1993). Therefore, it is the synthesis of both ideas and the ability to translate them into practical benefits that generates value (Utterback, 1971; Woodman *et al.*, 1993). Organizational experience, a shared culture, the ability to solve problems as a team, and the existence and knowledge of codified procedures are important factors that enable turning the ideas of others, such as temporary workers, into solutions and implementing those solutions (Hatch and Mowery, 1998; Khazanchi *et al.*, 2007; Mohaghegh and Furlan, 2020; Woodman *et al.*, 1993).

However, there is a tipping point associated with integrating and socializing temporary workers that can affect performance (de Stefano *et al.*, 2018). An increasing proportion of temporary workers in the organization reduces group cohesion, which can hinder the workforce's ability to build on and implement ideas (Woodman *et al.*, 1993). Temporary workers are typically outside of formal integration policies. Therefore, the task of integration is often left to the permanent employees working alongside them (Broschak and Davis-Blake, 2006), and the fewer permanent employees in the organization, the more difficult integration becomes. Woodman *et al.* (1993) therefore postulated that when group cohesion is reduced, for instance, by integrating temporary employees into the permanent workforce, group performance is reduced due to process, coordination or motivation losses. Similarly, the human resource literature suggests workers' motivation to perform well decreases with reductions in the long-term prospects and rewards offered, as is the case with temporary workers (Heckman, 2000; Methot *et al.*, 2018; Wright *et al.*, 2003).

Temporary workers' new ideas require an environment in which permanent employees can leverage these new ideas and translate them into solutions. Thus, following the logic of

organizational creativity theory, temporary workers bring new ideas to firms, and firms' permanent staffs can use their knowledge of organizational processes and hierarchies to evaluate the usefulness of their ideas and integrate them into existing processes. We therefore conclude that when the proportion of temporary workers is very low and very high, the process of innovation generation can be impaired.

H1. There is an inverted U-shaped relationship between temporary workers and process innovation.

2.2 Temporary workers, works councils and process innovation

Organizational creativity theory further suggests that worker representation is part of a structure that enhances the creative performance of organizations (Edwards and Wright, 2001; Woodman *et al.*, 1993). Recent human resource management research appears to have largely ignored the impact of employee representation (Zhou *et al.*, 2019). But as one of the few studies, Zhou *et al.* (2019) suggests that direct voice mechanisms support organizational innovation through a moderated positive effect of high-performance work systems.

Employee representation refers to a situation in which employees are given a direct say in the firm. Formal employee representation vis-à-vis employers is organized differently in Germany compared to the US In the US system, unions negotiate directly with employers over working conditions, wages, benefits, pensions and health plans. In Germany, unions operate at the industry-level and negotiate a collective agreement with employer associations [1]. A collective agreement sets out the framework and regulations for wages, special payments, vacation entitlement, working conditions, etc. Managers then meet with their works councils to adapt these sectoral collective agreements to local operating conditions which include work procedures, work environment, vocational training, organizational restructuring, personnel selection, and dismissal both for permanent and temporary workers (see German Works Council Constitution Act).

The works council is considered to be an implementation of employee representation at the site or firm level (Brewster *et al.*, 2019). Works councils are made up of elected employees of the firm. Like unions in the US, the employees who form and serve on works councils are usually blue-collar workers. The German Works Constitution Act grants works councils explicit co-determination or veto rights that give them considerable bargaining power. A works council can prevent the introduction of technical equipment to monitor performance and behavior, decide on the design of occupational health and safety, and has a right of co-determination in changes to organization, working methods and production processes. The works council is also involved in dismissals. Every dismissal must be agreed with the works council and can be contested if it is considered unfair.

Works councils have a direct say in the firm, while trade unions determine the framework conditions and regulations at industry level. Works councils are located at the site or firm level and are, from the employers' point of view, the entity with which they must negotiate when it comes to organizational changes and restructuring. Trade unions usually support the establishment of a works council and offer information and advice. Collective agreements negotiated by a union must apply to all employees of a firm who are members of the union. The development of works councils has been mainly a European phenomenon, at least until 2021, when the first major works council was established in the US by Starbucks employees.

A few studies have investigated works councils in the context of innovation (e.g. FitzRoy and Kraft, 1990; Addison *et al.*, 2001). But many had econometric flaws (Frege, 2002) and Kraft and Lang (2008) argue that only Addison *et al.* (2004) attempted to consider endogeneity in evaluating the organizational impact of works councils, but their sample size was small (30 sites with works councils) and time-limited (one year of data). The link between works councils and organizational innovation thus deserves further attention.

The theoretical discussion of the impact of works councils on innovation bears some relation to the discussion of unions and innovation but differs in that works councils have no right to demand wage adjustments. The literature on unions in the US and innovation has put forward competing theories.

First, scholars argue that worker protection measures can increase employee effort by signaling acceptance of mistakes in the innovation process (e.g. Freeman and Medoff, 1979; Bradley *et al.*, 2016). Because innovation is a process characterized by experimentation and failure risk (Choo *et al.*, 2021; Mackelprang *et al.*, 2015), unions may provide protection to workers to motivate and encourage innovation (Acharya *et al.*, 2014). Similarly, Acharya *et al.* (2014) show that laws that protect workers from unfair dismissal spur innovation. Works councils also provide workers with protection from unfair dismissal and their introduction significantly reduces workers' concerns about job security (Kraft and Lang, 2008). Work councils could then increase process innovation.

However, studies examining the relationship between unions and innovation performance (e.g. Bradley *et al.*, 2016; Hirsch and Link, 1987) provide compelling reasons to suggest that works councils may be detrimental to innovation. Manso (2011) agrees that tolerating failure and thus protecting workers promotes innovation but adds that the best motivation comes from a combination of short-term tolerance for failure and long-term rewards for success. Works councils cannot provide such rewards. Supporting this argument, workers' motivation decreases when the long-term prospects and rewards offered are reduced (Heckman, 2000; Methot *et al.*, 2018; Wright *et al.*, 2003).

A related argument is that works councils reduce the likelihood of layoffs, leading to workers having less incentives to perform at their optimum, which could lead to lower worker productivity (e.g. Bradley *et al.*, 2016 with respect to unions). Works councils that prevent workers from being punished for shirking (e.g. by firing them) may therefore hinder innovation by not motivating workers to exert high levels of effort and persistence. Similarly, unionization may lead to a reduction in wage inequality (Frandsen, 2012), which reduces workers' incentives to innovate. It has also been argued that a securely employed workforce has lower employee dynamics and knowledge flow (Eriksson *et al.*, 2014; Keum, 2020), a situation that hinders the communication of innovative ideas and their implementation. Finally, it is argued that unions will start appropriating innovation rents by demanding higher wages once the innovation process has begun and costs have fallen/sales have increased, which hampers firms' incentives to innovate.

Theoretical and empirical arguments suggest that works councils do affect innovation performance. However, the direction is debatable. They may either foster an environment in which workers are willing to take risks and innovate; or they may encourage shirking because non-performance is not punished. We argue that works councils are important to managers and should have a significant impact on process innovations, while the direction of the effect is unknown. We follow the example of Wissuwa *et al.* (2022) and offer the following directionally indetermined hypothesis.

H2. The presence of works councils has an impact on process innovation.

Employers with a works council require the consent of the works council if they wish to deploy a temporary worker, replace a temporary worker or extend the deployment of a temporary worker. The works council actively monitors and ensures the equality of temporary employees with permanent employees and the fulfillment of obligations towards temporary and permanent employees. Works councils mediate between employees and employers, help better integrate newcomers and act as a source of information for newcomers with questions [2].

Works councils thus help reduce the cost of integrating temporary workers in two ways. First, they reduce the cost of integrating temporary workers into the firm when the number of

temporary workers increases. Second, the entire integration–cost curve is shifted outward because the works council automatically promotes the integration of temporary workers without incurring new integration-specific costs. Thus, integration is not left solely to the permanent employees (Broschak and Davis-Blake, 2006). Because of their influence on the integration of temporary workers into the firm, it is likely that firms with works councils will have more innovations from temporary workers compared to firms without works councils.

H3a. *The* inverted U-shaped relationship between temporary workers and process innovation is more pronounced in firms with works councils than in firms without works councils.

And compared to firms without works councils, process innovation output in firms with works councils will peak at a significantly higher proportion of temporary workers. In summary, the inability of firms to turn new ideas into innovations manifests itself much more slowly in firms with works councils.

H3b. The peak of process innovation is reached later in firms with works councils than in firms without works councils.

Figure 1 illustrates our research model.

3. Methods

3.1 Data and sample

We tested our hypotheses on manufacturing sites using the IAB Establishment Panel data, which is collected by the IAB of the German Federal Employment Agency. The IAB annually collects information on personnel, production and management at sites across the entire German economy using a standardized and pre-tested survey. The basis for the sample is the quarterly establishment file of the Federal Employment Agency, which contains around two million sites. Each year, around 15,500 sites are selected according to size, sector, state and age in order to obtain a sample that is representative of the German economy. Sites included in the sample are tracked over time, with new sites added each year to replace those that drop out of the sample due to attrition.

The IAB collects data annually between June and October. Prior to data collection, sites receive an announcement letter from the Federal Employment Agency, a recommendation letter from the Confederation of German Employers' Associations and a privacy statement. To protect anonymity, the names of sites are not shared with researchers using the database, nor is it possible to link to specific sites based on the data in the database. The sites are usually interviewed in person. But, if desired, they can complete the questionnaire themselves on paper.

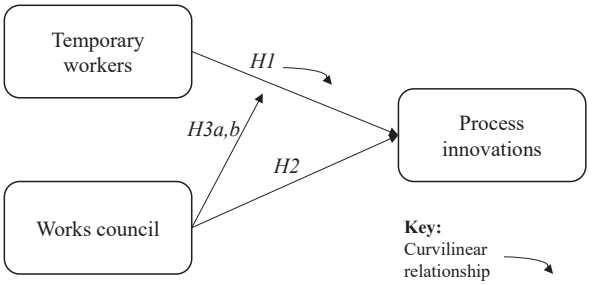


Figure 1.
Research model

As the questionnaire contains a relatively large number of questions on figures, it is possible that questionnaires will be filled in afterward. Depending on the size of the site, the IAB may ask several respondents to complete the questionnaire. Ellguth *et al.* (2014) list that of the respondents who reported their status, more than 71% are board members or their deputies, about 25% are department heads and about 4% are employees. After the responses are received, they are validated by filter questions, plausibility checks (e.g. a relatively high stated per capita income leads to a check of the response) and consistency checks (e.g. comparing the number of employees with the number of employees subject to social security contributions; comparing the figures with previous years to detect errors/implausibilities). For further information, please refer to the IAB Establishment Panel Guide by Fischer *et al.* (2009) and the article on methods and data quality by Ellguth *et al.* (2014).

The level of analysis provided by the dataset is the manufacturing site. A manufacturing site is defined as a distinct entity with a business address, a federal registration number and a German Industrial Classification (WZ 2008) code between 4 and 16 (corresponding to ISIC 10–30). In this context, the advantages of surveying manufacturing sites versus firms are that works councils exist primarily at the site level and that multiple sites of the same manufacturing firm may have different levels of temporary workers and process innovation. A similar approach to the level of analysis was taken by Li *et al.* (2017), who used Statistics Canada's Work Place Survey.

The IAB began longitudinal data collection in 1993. From the multi-wave data set, we selected data from 2009–2019 to test our hypotheses because only this period contained questions relevant to this study. We used all available data and omitted observations (not sites) with missing data. Because not all of the sites surveyed were from the manufacturing sector and not all sites participated in the survey multiple times, the unbalanced panel dataset available for this study consists of 4,212 manufacturing sites with 11,641 site-year observations. On average, each site was observed about 2.8 times between 2010 and 2020. Table 1 shows the observations per sector in the dataset.

3.2 Measure and estimation approaches

Process innovation (ProcInno) is our dependent variable. To measure innovation performance, previous studies have taken various approaches, including using patent data (Sørensen and Stuart, 2000), counting reports on innovation launches (Greve, 2003) or conducting surveys (Li *et al.*, 2017). Process innovations are regularly evaluated through

Manufacturing sector	Firm-year observations	Percent
Producers of food and beverages	1,037	8.91
Textiles, clothing and leather	350	3.01
Wood products, paper, cardboard and allied products	729	6.26
Chemical, pharmaceutical products; coking plant and allied products	734	6.31
Rubber and miscellaneous plastics products	943	8.10
Glass, ceramics and concrete products	592	5.09
Metal production/processing	977	8.39
Producers of metal, steel and light alloy	1,620	13.92
Electronic and optical goods	646	5.55
Electrical equipment	650	5.58
Mechanical engineering	1,914	16.44
Motor vehicles/parts	832	7.15
Furniture and allied products	617	5.30
	11,641	*100*

Table 1. Firm-year observations per manufacturing sector

surveys, as they are otherwise difficult to capture (e.g. Ettlie and Reza, 1992; Fritsch and Meschede, 2001; Li *et al.*, 2017). In this analysis, we used the IAB survey measure of process innovation, which is similar to the process innovation measure used in Li *et al.* (2017). It asks respondents whether their site developed or implemented procedures that "noticeably improved production processes" in the last fiscal year [3]. While all explanatory variables of interest are objective, our dependent measure of innovation is binary, which is a limitation of the data. In general, measurement error in the independent variables is of greater concern than measurement error in the dependent variable, assuming that measurement error in the dependent variable is not correlated with the explanatory variables (Wooldridge, 2010), which can be assumed for our variables of interest. However, the results will be conservative and biased towards null results.

The number of *temporary workers* (temps) as reported for each site is the explanatory variable. For our main analysis, we used the directly reported number of temporary workers and did not merge this with the number of agency and contract workers, but included the number of agency and contract workers as controls in the model (see Wiengarten *et al.*, 2021 for a similar approach). For further exploration, we re-estimated our models with agency, contract and temporary workers together (see online Appendix A; Table A2). Note that we follow Certo *et al.* (2020) in this study and do not use ratios such as dividing the number of temporary workers by the number of employees. Certo *et al.* (2020) show that previous use of ratios in management studies likely led to biased results. Their argument is that the use of ratios results in the numerator being multiplied by the inverse (i.e. $1/x$) of the denominator leading to the numerators usually being orthogonal to the corresponding ratios, since $1/x$ is nonlinear. They conclude that regressions are likely to lead to biased estimates when ratios are used.

To operationalize *works council* (wrks_coun), respondents were asked whether their production site has a works council elected in accordance with the Works Constitution Act.

Two mechanisms could lead to endogeneity problems in our study. First, endogeneity could arise because temporary workers or works councils and process innovations have a reciprocal causal relationship. We accounted for this in part by observing temporary workers and works councils at time t and process innovations at time $t+1$, $t+2$ or $t+3$. Second, process innovation performance and our explanatory variables might be correlated because a common antecedent generates a spurious correlation. Therefore, we selected and included control variables that could provide an alternative explanation for the relationship between the focal variables but that are not bad controls (Angrist and Pischke, 2008). Bad controls would be variables that are caused by changes in works councils or temporary workers.

To reduce the likelihood of this affecting our estimates, we included all control variables at time t along with the explanatory variables. First, we included *innovation performance* at t as a control since we assume the level of process innovation performance at times $t+1$, $t+2$ or $t+3$ is determined to a large extent by the past level. Second, we included the number of *agency workers, contract (freelance) workers* and *part-time workers,* as the employee structure affects voting rights and thus could influence whether a works council is established, as well as innovation and the number of temporary workers used. We added the total number of employees with simple tasks defined as *blue-collar workers* to account for the diversity of educational backgrounds on the site, which has been shown to affect innovation (Schubert and Tavassoli, 2019) and likely affects workers' willingness to form works councils. To bring these numbers back into perspective, we included the total *number of employees*. In addition, we included the total number of *employees* who *left* the site in year t as there is a wealth of research on the impact of employee turnover on innovation (Sharma *et al.*, 2021), while employee turnover may also affect the ability of workers to form a works council and the use of temporary workers in a firm. We also added a dummy variable control to check whether the site had forms of *worker representation other than a works council* (e.g. a workforce

spokesperson, roundtable, etc.), which might affect the formation of works councils and process innovations. Next, we included two dummy variables to determine whether a site belongs to an industry *collective bargaining agreement* or a firm collective bargaining agreement with a union, with "no collective bargaining agreement" serving as the baseline because unions affect the formation of works councils and have been shown to affect firm innovation (Bradley *et al.*, 2016; Schnabel *et al.*, 1997) In addition, we included the *sum of all investments* made in the site, as this can explain significant variations in process innovations (Hall *et al.*, 2016). To put the sum of investments in perspective, we included *business volume* in the fiscal year. We added the monetary value of *intermediate inputs* to account for the production site's position in the supply chain relative to its business volume. Next, we added two dummy variables to account for current *competitive pressure* in the industry (Roberts, 1999) at three levels: no pressure, moderate pressure or substantial pressure, with "no pressure" serving as the baseline. Finally, we added year dummies to account for the *effects of time*. We did not control for education level or age, as these variables are the result of using temporary workers in t. The list of items can be found in online Appendix B.

Table 2 contains the means, standard deviations and correlations for all variables. Several of the control variables show high collinearity with other variables, which is due to the use of non-scaled variables as recommended by Certo *et al.* (2020). This may suggest that some of the control variables partly contain similar information as others. This was expected since we control for the total number of employees to put the variables into perspective, and most subcategories of employment as part of the theoretical model. Multicollinearity is usually only a problem when the variables of interest (temporary workers and works councils) are affected, which is not the case here. So, we should be able to interpret our estimates of interest without problems. Nevertheless, we performed a robustness test in our analysis and removed

		Mean	S.D.	1	2	3	4	5	6
1	*Process innovation*	0.38	0.48						
2	*Temporary workers*	13.92	53.62	0.012					
3	*Works council*	0.52	0.50	0.164	0.153				
4	*Contract workers*	2.88	13.25	0.044	0.236	0.071			
5	*Agency workers*	16.83	112.38	0.089	0.254	0.112	0.279		
6	*Part-time workers*	24.27	128.88	0.107	0.473	0.123	0.342	0.399	
7	*Blue-collar workers*	53.35	197.15	0.137	0.405	0.190	0.130	0.257	0.481
8	*Number of employees*	437.17	2034.43	0.100	0.453	0.127	0.367	0.559	0.876
9	*Employees left*	11.85	44.96	0.100	0.581	0.126	0.296	0.467	0.751
10	*Other forms of employee representation*	0.10	0.30	0.044	0.043	−0.105	0.045	0.044	0.108
11	*Investments*	5,200,673	6.96e07	0.051	0.248	0.594	0.307	0.305	0.737
12	*Business volume*	1.26e08	1.52e09	0.062	0.338	0.072	0.349	0.549	0.833
13	*Intermediate inputs*	9.31e09	1.28e11	0.058	0.058	0.065	0.342	0.545	0.809

		7	8	9	10	11	12
8	*Number of employees*	0.445					
9	*Employees left*	0.510	0.832				
10	*Other forms of employee representation*	0.032	0.104	0.095			
11	*Investments*	0.147	0.811	0.586	0.084		
12	*Business volume*	0.316	0.961	0.744	0.096	0.897	
13	*Intermediate inputs*	0.278	0.945	0.723	0.010	0.895	0.994

Note(s): All correlations significance at the 0.01 level; the lower five rows are a continuation of the correlations table to the right, the numbers on the top relate to the variable names

Table 2. Descriptive statistics and correlations between the variables

a site's business volume from the list of variables on the right-hand side, since it contains almost the same information as total number of employees, which is our scaling variable. Our estimates of interest remain qualitatively stable with respect to this variable decision (see online Appendix A; Table A1), providing some support for the assumption that multicollinearity did not significantly affect our hypothesis testing.

Next, we investigated the use of fixed and random effects to account for unobserved confounders such as industry sector. We performed the Durbin–Wu–Hausman test to examine whether the random effects specification should be used instead of the fixed effects specification. The results rejected the null hypothesis that the random effects model was preferable (ProcInno at $t+1$: Chi2 = 1612.01, ProcInno at $t+2$: Chi2 = 661.11, ProcInno at $t+3$: Chi2 = 506.06, $p < 0.01$).

Because controls and lagged explanatory variables may not eliminate all endogeneity problems, we used an approach that employs instruments based on lags of the putative endogenous variables (Roodman, 2009) – the system generalized method of moments (GMM) estimator for dynamic panels (Hansen, 1982). The GMM estimator is useful in this case because it obtains instruments from within the dataset, as the IAB does not disclose the identity of the production sites, a search for instruments outside the dataset was impossible. The estimator uses first differences to eliminate the fixed effects of production sites from annual observations, which allows for the development of an estimator that instruments the differenced variables with all available lagged values (Wooldridge, 2010). In the present case, one endogenous variable of interest, works council, is highly persistent, suggesting that lagged levels are only weakly correlated with first differenced instruments for the variable. In such situations, it is recommended that the system GMM estimator of Blundell and Bond (1998) be used. The system GMM complements the standard difference GMM (Arellano and Bond, 1991) by estimating differences and levels simultaneously.

It could be argued that a logit or probit model would have been appropriate here as well given the binary dependent variable. Hence, it is useful to note that the GMM estimator for dynamic panels does not impose distributional assumptions on the errors. This also allows for the estimation of binary dependent variables such as the binary process innovation variable (Wooldridge, 2010). Further, linear probability models have been shown to provide unbiased estimates with correct standard errors and can sometimes even be superior to logistic regression (please see Deke, 2014). Finally, the GMM estimator allowed us to use instruments within the dataset and thus account for endogeneity issues, which would have been challenging when predicting effects using logit or probit regression.

4. Analyses and results

We treated all explanatory variables in the model as endogenous accounting for sites and employees' simultaneous choice of firm-level factors and innovation outcomes. Except for our time dummies, passage of time is exogenous. We first conducted the Arellano–Bond serial correlation tests to determine the first valid lags without identified serial correlation. Next, we used those and deeper lags to instrument all our explanatory variables. We used one to five lagged periods for each variable as a source for instruments to prevent problems linked with too many instruments (Roodman, 2009). When the Hansen (1982) test statistic for overidentifying restrictions still indicated endogenous instruments, we adjusted the lags further until the assumption of exogenous instruments was supported. Finally, we used the Windmeijer (2005) finite-sample correction for the two-step covariance matrix. This makes the two-step robust estimations more efficient than one-step robust in system GMM (Roodman, 2009).

For each model in the analyses, we included all data available in the dataset. Therefore, the number of observations varies across models because manufacturing sites may not have reported all relevant variables in all years or sites may have dropped out after one or more

rounds of the survey. The more years that elapse between the observation of our dependent and independent variables, the fewer firms were generally available for our analyses.

Table 3 presents the estimates of our main specifications. We estimated our models with a lag between the explanatory variables and process innovation of one year, two years and three years. For each lagged model, we first entered the squared term of the temporary workers and then the interaction terms. We report results with a one-year lag between independent and dependent variables. Results with a two-year lag are relatively consistent, while those obtained with a three-year lag become largely insignificant. The observed patterns for the control variables are broadly consistent with our expectations in terms of direction, but several estimates do not reach the significance level. We find that past innovations help explain future innovations ($p < 0.01$). The use of contract workers ($p < 0.05$) and blue-collar workers ($p < 0.10$) explain the number of process innovations in sites. We find that more investments lead to more process innovation ($p < 0.01$), but sites with more turnover seem to innovate more slowly ($p < 0.10$). Finally, the closer a firm is to the end customer, as indicated by the monetary value of intermediate inputs, the more successful it appears to be at innovating its processes ($p < 0.10$).

Hypothesis 1 predicts an inverted U-shaped relationship between temporary workers and process innovation. The results support this hypothesis as we find a positive effect of temporary workers ($p < 0.01$) and a negative effect of the squared term of temporary workers ($p < 0.01$) on ProcInno, in the one and two years lagged models. To check the robustness of the inverted U-shape, we estimated the turning point at 784.42, which is within the data range for temporary employment (0; 2,311) but higher than the average employment of 437 employees at the sites in our sample. This suggests that we observe a turning point when works councils are estimated at means (noting that as a dummy variable, the mean level of works council does not occur in practice) that is at the relatively high end of the sample.

Hypothesis 2 predicts that works councils have an impact on process innovation. We find that the presence of works councils have a positive effect on process innovation in all lagged models, with the probability of process innovation increasing between 20.1 and 25.4 percentage points.

H3a suggests that the inverted U-shaped curve in H1 is steeper at sites with works councils than in those without works councils. The test for steepening is equivalent to the test for whether γ_6 is significant. Steepening is present if γ_6 is negative. The results of a significantly positive γ_6 ($p < 0.05$) refute our expectations formulated in hypothesis 3a and indicate a flattening of the curve as can be seen in Figure 2.

Next, H3b predicts a turning point shift. We tested for the presence of a turning point shift using equation (1) – the mere significance of γ_6 is not a sufficient condition here, see Haans *et al.* (2016).

$$\frac{\delta Temps}{\delta WorksCouncil} = \frac{\gamma_2\gamma_7 - \gamma_6}{2(\gamma_4 + \gamma_7 WorksCouncil)^2} \quad with\ WorksCouncil(low) = \{0\}\ and\ WorksCouncil(high)\ \{1.0\} \tag{1}$$

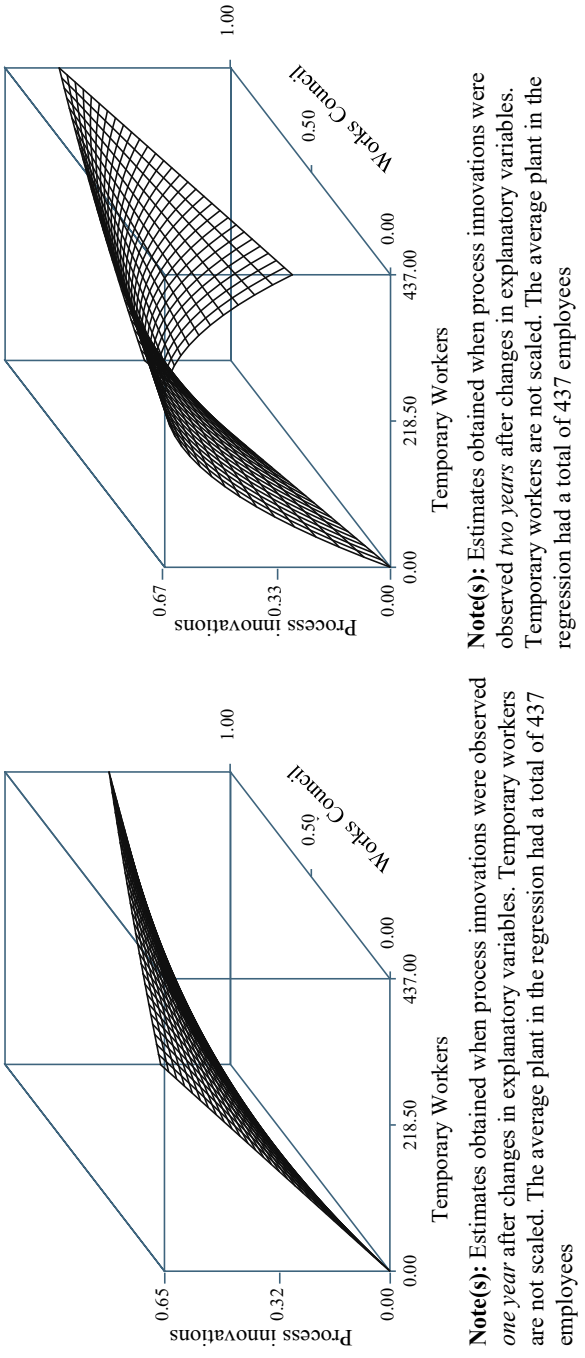
The results of the equation were significantly different from 0 at the 0 value ($p > 0.01$), supporting the assumption of a turning point shift as formulated in H3b for the models lagged by one and two years.

Finally, we performed two robustness tests. First, we replicated our results by removing annual site revenue from our formula, as it showed the highest correlation with the number of employees. In a second test, we combined temporary, agency and contract workers in one measure to examine whether the inclusion of other types of temporary employment would

Table 3.
Regression estimates on works council and process innovations in the three years following the election of works councils

Endogenous variables at t	Process innovation (*t*+1) Coefficient (*z*)	Process innovation (*t*+1) Coefficient (*z*)	Process innovation (*t*+1) Coefficient (*z*)	Process innovation (*t*+2) Coefficient (*z*)	Process innovation (*t*+2) Coefficient (*z*)	Process innovation (*t*+2) Coefficient (*z*)	Process innovation (*t*+3) Coefficient (*z*)	Process innovation (*t*+3) Coefficient (*z*)	Process innovation (*t*+3) Coefficient (*z*)
Process innovation	0.328*** (5.30)	0.293*** (5.68)	0.109*** (3.24)	0.213*** (3.93)	0.289*** (5.42)	0.089*** (2.58)	0.265*** (5.46)	0.270*** (5.61)	0.143*** (3.96)
Temporary workers	6.54e-06 (0.08)	0.000* (1.83)	0.002*** (5.70)	0.000* (1.86)	0.000** (2.48)	0.005*** (3.55)	0.000 (1.64)	0.000* (1.83)	0.002 (0.90)
Temporary workers^2		−2.46e-07* (−1.76)	−1.39e-06*** (−6.60)		−2.75e-07** (−2.10)	−0.000** (−2.53)		−2.72e-07 (−1.62)	−6.39e-07 (−0.11)
Works council	0.238*** (3.27)	0.231*** (3.72)	0.220*** (3.67)	0.232*** (2.68)	0.156** (2.04)	0.250*** (3.92)	0.256*** (3.30)	0.248*** (3.13)	0.268*** (3.96)
Temps × wrks_coun			−0.002*** (−4.00)			−0.005*** (−3.09)			−0.002 (−0.74)
Temps^2 × wrks_coun			1.24e-06*** (5.00)			0.000** (2.47)			4.90e-07 (0.09)
Contract workers	0.000 (0.98)	0.000 (0.41)	0.000** (2.14)	0.000* (1.71)	0.000 (0.49)	0.000 (0.58)	0.000 (1.32)	0.000* (1.84)	0.000** (2.33)
Agency workers	0.000* (1.79)	0.000 (1.63)	0.000 (0.22)	0.000 (1.08)	0.000 (1.04)	0.000 (0.87)	−0.000 (−0.34)	−0.000 (−0.70)	−0.000 (−1.14)
Part-time workers	0.000* (1.70)	0.000 (0.76)	−0.000 (−0.61)	0.000 (0.26)	0.000 (0.51)	0.000 (0.21)	0.000 (0.83)	−0.000 (−0.23)	−5.83e-06 (-0·04)
Blue collar workers	0.000 (0.83)	0.000 (0.62)	0.000* (1.91)	0.000*** (2.68)	0.000 (1.46)	0.000 (1.55)	0.000 (0.89)	0.000 (1.01)	0.000 (0.99)
Number of employees	4.93e−07 (0.03)	7.85e−06 (0.44)	0.000 (0.50)	−0.000 (−1.03)	−0.000 (−1.14)	−7.40e−06 (−0.36)	2.58e−06 (0.12)	9.48−e06 (0.41)	0.000 (0.88)
Employees left	0.000 (1.39)	0.000 (1.02)	0.000 (0.24)	0.000 (0.65)	0.000* (1.88)	0.000 (1.25)	0.000 (0.52)	0.000 (0.74)	0.000 (0.91)
Other forms of employee representation	0.079 (0.28)	0.017 (0.28)	0.093** (2.15)	0.051 (0.79)	0.209*** (3.05)	0.143*** (2.91)	0.192*** (2.99)	0.162*** (2.56)	0.000 (0.124)
Collective bargaining agreement (Industry level)	0.045 (0.59)	0.026 (0.37)	0.057 (1.00)	−0.011 (−0.13)	0.057 (0.75)	0.053 (0.87)	0.056 (0.76)	0.046 (0.60)	0.044 (0.70)
Collective bargaining agreement (Firm level)	0.109 (1.26)	0.070 (0.85)	0.029 (0.43)	0.021 (0.19)	0.035 (0.36)	0.084 (1.12)	0.048 (0.53)	−0.023 (−0.25)	−0.026 (−0.34)
Investments	2.61−10 (1.37)	2.99e−10* (1.65)	5.38e−10*** (2.56)	3.52e−10 (1.46)	3.78e−10* (1.84)	4.61e−10* (1.90)	4.86e−11 (0.12)	3.18e−11 (0.07)	3.97e−11 (0.09)
Business volume	−3.59e−11 (1.37)	−3.13e−11 (−0.78)	−1.07e−10 (−1.38)	−2.52e−11 (−0.37)	−2.61e−12 (−0.06)	−2.37e−11 (−0.42)	−4.73e−11 (−0.39)	−7.91e−11 (−0.68)	−1.24e−10 (−1.06)
Intermediate inputs	5.59e−11 (0.18)	−3.26e−14 (−0.09)	7.28e-13 (1.39)	3.68e−11 (0.66)	−1.36e−13 (−0.32)	4.28e−17 (0.00)	3.40e-13 (0.27)	6.64e−13 (0.56)	1.01e−12 (0.86)
Competitive pressure (medium)	−0.201** (−2.49)	−0.214*** (−2.79)	−0.084 (−1.31)	−0.101 (−0.95)	−0.090 (−1.00)	0.022 (0.33)	−0.056 (−0.59)	−0.074 (−0.78)	−0.038 (−0.54)
Competitive pressure (strong)	−0.060 (−1.17)	−0.068 (1.52)	−0.042 (−1.22)	0.020 (0.40)	−0.076 (−1.63)	−0.028 (−0.79)	−0.038 (−0.87)	−0.051 (−1.12)	−0.028 (−0.77)
Time	incl	incl	incl	incl	incl	incl	incl	incl	incl
Wald χ^2	426.54***	262.39***	3,362.68***	133.30***	237.94***	2,861.74***	1,501.00***	1,651.48***	2,442.27***
Number of obs	9,953	9,952	9,953	8,178	8,178	8,178	6,628	6,628	6,628
Number of sites	3,418	3,418	3,418	2,863	2,863	2,863	2,398	2,398	2,398
p-value first insig. AR (#)	0.467 (3)	0.463 (3)	0.480 (2)	0.283 (3)	0.105 (3)	0.715 (4)	0.541 (2)	0.515 (2)	0.848 (2)
Lags used	3 4	3 4	4 9	4 5	3 4	3 8	3 5	3 5	3 8
Hansen test	0.296	0.154	0.191	0.133	0.222	0.131	0.109	0.117	0.107

Note(s): ***, ** and * indicate significance at the 0.01, 0.05 and 0.1 levels, respectively, the first column of each lagged model shows the linear effect of temporary workers and works council on innovation, while the second column contains the squared value of temporary workers and the third column the interaction effects; all endogenous variables are entered as non-scaled variables following the recommendations in Certo *et al.* (2020), denominators are entered as controls. Note that each model considers all data available in the unbalanced panel. The number of observations varies from model to model because not all firms reported in all years. For example, firms that ceased operations after two years or did not participate in the survey anymore were excluded from the models accounting for process innovations in *t*+2 and *t*+3



Note(s): Estimates obtained when process innovations were observed *one year* after changes in explanatory variables. Temporary workers are not scaled. The average plant in the regression had a total of 437 employees

Note(s): Estimates obtained when process innovations were observed *two years* after changes in explanatory variables. Temporary workers are not scaled. The average plant in the regression had a total of 437 employees

Figure 2.
The interactive effect of temporary workers and works council in manufacturing plants on process innovations

affect our results. The results are reported in the online Appendix A and suggest that our estimates do not suffer strongly from multicollinearity problems. Adding temporary, agency and contract workers jointly weakens the strength of the estimates. However, they remain significant and in the expected direction. This result is consistent with our expectations, as agency and contract workers are often not represented in works councils and, as formulated in Wiengarten *et al.* (2021), these workers have a different contractual relationship with the production site that may either be long term (as would be legally allowed for contract workers) or nonexistent (as agency workers typically have a contract with their agency rather than the production site).

5. Discussion

Under the umbrella of social sustainability in general and occupational health and safety in particular, the disadvantages of temporary workers in operations management have been studied without conclusive results (Wiengarten and Longoni, 2018). Wiengarten *et al.* (2021) argue that excessive use of atypical forms of work could be detrimental to firm performance, outweighing the initial cost and flexibility benefits. And the literature on precarious work emphasizes that while firms reap all the benefits of temporary work, the true costs of such employment relationships are borne by workers, their families and society (Koranyi *et al.*, 2018; Rönnblad *et al.*, 2019). However, it has also been recognized that temporary work is not necessarily precarious and therefore can be beneficial to both firms and workers.

In the operations management literature, the benefits of flexible labor contracts are usually seen in terms of flexibility. We add another performance dimension to the discussion, process innovation. Our results suggest that an increase in the number of temporary workers increases process innovation up to a certain level, but beyond that innovation performance starts to suffer.

We also investigate whether worker representation in the form of a works council influences process innovation. Our results support the theory of organizational creativity indicating that works councils have a significant positive effect on innovation performance, and that works councils, as an organizational context factor, moderate the influence of temporary workers on innovation.

5.1 Managerial implications

We find that high levels of temporary workers can be detrimental to innovation in firm processes. Our estimates suggest that for sites without a works council, a turning point can be observed at a share of about 57 percent of temporary workers in the workforce. We conclude that the new ideas that temporary workers can bring to the firm appear to wear out quickly, and when temporary workers are used at very high levels in a firm, they can harm organizational process innovation.

Our results further suggest that works councils have a positive impact on process innovation, with an increased probability of between 20.1 and 25.4 percentage points. This is a relatively high value, and the results remain stable across different specifications. This contrasts with anecdotal arguments that works councils generally have a negative impact on firm performance, which has led managers to actively avoid the establishment of works councils, particularly in the US but also in Europe. Our results should instead be encouraging to managers and a signal to those trying to combat workforce trends that want to give workers a means of representation.

Finally, the interaction between works councils and temporary workers indicates that the works council postpones the point at which the increase in temporary workers further hinders process innovation. Building on empirical work in numerous disciplines that has

provided a wealth of evidence that atypical work arrangements harm workers (Ferrie *et al.*, 1998, 2001; Ojala and Pyöriä, 2019), recent research suggests that this may ultimately harm firm performance as well (Riley *et al.*, 2017; Wiengarten *et al.*, 2021). It seems best for managers to encourage their workforce to establish works councils, and to use temporary workers on a very limited basis, as managers can overshoot the mark. There are other ways to make the workforce more flexible, such as the German "Arbeitszeitkonto," which is an instrument that employers can use to implement flexible working time models. Employees can temporarily work more or less than contractually agreed and compensate for the overtime or absences later. The monthly pay remains the same.

5.2 Theoretical implications

Organizational creativity theory states that innovation emerges from or is influenced by an interplay of individual, group and organizational characteristics. We examined and applied this theory at the level of the manufacturing site. Changing the composition of the workforce by using temporary workers or replacing full-time workers changes organizational characteristics including knowledge, culture, resources, compensation, structure and possibly strategy (Woodman *et al.*, 1993). To date, the primary emphasis has been that increasing the proportion of temporary workers could have negative effects, in the form of differences in pay/rewards between full-time and part-time workers, which could lead to potential conflict between current workers and temporary workers. It could also lead to demotivation of both types of workers due to differences in pay and working conditions, and lead to full-time contracts being converted to or replaced by temporary contracts. These arguments are used by Wiengarten *et al.* (2021) and Fisher and Connelly (2017) to propose that the long-term use of precarious work will harm performance.

Our results show that hiring temporary workers increases process innovation at low to moderate levels, while it is detrimental to process innovation at high levels. We suggest that temporary workers bring new ideas to firms and motivate full-time workers to use and implement these ideas to develop new process solutions. Receiving and hiring new staff may stimulate the emergence of new ideas, while the new employees are unlikely to be able to turn those ideas into solutions because they are unfamiliar with organizational processes.

Moreover, previous research, especially with US firm-level data, has highlighted the complex role of unions in influencing firm innovation, while works councils (whose popularity and power could be growing) have been largely neglected. Works councils, which are established at the site level, do not affect wages, but they can have a significant impact on working conditions. We found that works councils have a positive impact on process innovation. Previous research has shown that workers' voices and participation rights significantly affect the quality of workers' job performance (FitzRoy and Nolan, 2021; Gallie, 2013). Works councils provide workers with such a voice and a right to participate, which are critical elements for innovation and performance (Brewster *et al.*, 2019). Our findings confirm this notion in the form of works councils. A relatively older stream of literature has highlighted the performance disadvantages of unions (Acs and Audretsch, 1987; Audretsch and von der Schulenburg, 1990; Bradley *et al.*, 2016; Hirsch and Link, 1987). Our results in terms of works councils and process innovation suggest otherwise.

Finally, we found that firms can get the most out of their temporary workers by giving them an opportunity for representation. Moderate levels of temporary workers combined with works council representation have the greatest benefit on innovation performance. This is consistent with the fundamentals of organizational creativity theory. At the organizational level, the theory predicts an increase in creativity through an inclusive and open culture, the availability of resources and a supportive structure to create a positive work environment.

6. Limitations and conclusion

The strength of this research is the archival data collected by the German IAB. The IAB takes great care to ensure the accuracy of the data collected. The dataset is also the study's greatest limitation. Our measures were constrained by the questions used in the Institute's annual surveys and the IAB does not disclose the identity of the sites in the dataset, forcing us to rely only on their measures. The limits of the IAB dataset are most evident in the dependent variable which is both self-reported and dichotomous. Hence, we could not adequately capture different levels of process innovation. Equally, innovation has been divided into radical versus incremental, architectural versus component, or exploitative and explorative innovations (see Garcia and Calantone, 2002 for an overview and Azadegan and Wagner, 2011). Our data cannot address these nuances, hence future research should explore if the various levels or types of innovation differ in terms of their association with temporary workers and works councils. Similarly, the data did not allow us to determine what jobs the temporary workers did at the site. We did control for the number of workers at the site, but it would still be useful and provide further insight if future studies identified the job that the temporary workers were doing. Finally, we used non-scaled variables in our analyses to limit the risk of biased estimates (Certo *et al.*, 2020). However, this raises new issues, such as multicollinearity, that we sought to address but could only partially resolve.

Organizational creativity theory helped us speculate about the mechanisms linking temporary workers, works councils and process innovation, but further research, especially qualitative research, is needed to help us better understand the mechanisms and thus refine our theories. Despite these limitations, we believe that our study makes a valuable contribution to our domain and can serve as a springboard for further studies in this direction. The operations management literature often views workers merely as inputs in the input–transformation–output process. However, as this study shows, this treatment of people is not only ethically questionable but has also led managers off course in their use of these resources.

Notes

1. An employer association is an association of employers (entrepreneurs) for the purpose of joint representation of interests vis-à-vis unions and the state.
2. It is also possible for temporary workers to participate directly in the works council. All employees who have been employed by the firm for at least three months are eligible to vote, and any employee who has been employed by the firm for at least six months can register as a candidate and be elected.
3. The IAB questionnaires can be downloaded here: https://fdz.iab.de/en/betriebsdaten/iab-establishment-panel-iab-bp-version-9320-v1/; a summary of the questions used for the purposes of this study is available in the online Appendix A

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Appendix
The supplementary material for this article can be found online.

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