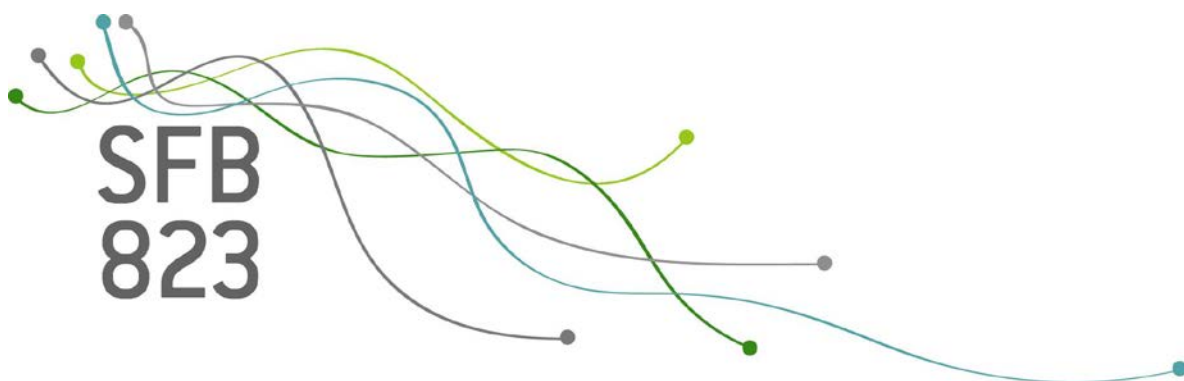# Employee representation and innovation – disentangling the effect of legal and voluntary representation institutions in Germany

Kornelius Kraft, Alexander Lammers

Employee Representation and Innovation – Disentangling the effect of legal and voluntary representation institutions in Germany

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Abstract

This paper studies the effect of employee representation bodies provided by management on product and process innovations. In contrast to statutory forms of co-determination such as works councils, participative practices initiated by management are not equipped with any legally granted rights at all. Such alternative forms of employee representation are far less frequently and thoroughly analyzed than works councils. We compare the effects of these co-determination institutions established voluntarily with those initiated on a legal basis on different kinds of innovation measures. We differentiate between process and product (incremental and radical) innovations. To tackle endogeneity, the estimations are based on recursive bivariate and multivariate probit models. Results show that employee representation provided voluntarily by management supports incremental as well as radical product and process innovations. The effect is much more pronounced when endogeneity is taken into account. Works councils, however, only exhibit a positive effect on incremental innovations. Moreover, the results point to a substitutive relationship between both types of employee representation.

JEL classification: J50, J53, M14, O31, C35

Keywords: Voluntary employee representative, works council, employee involvement, innovation, recursive bivariate probit, recursive multivariate probit

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1 Introduction

Technological progress is essential for economic growth and the competitiveness of firms in a rapidly evolving global environment (Penrose 1959). Since the growth of firms and economies crucially depends on innovation, there is keen interest among scholars, practitioners and politicians alike in factors that may support or indeed inhibit innovation. In his seminal work, Romer (1990) explains that faster technological growth in the economy is associated with a larger human-capital stock. The generation of new knowledge, as well as implementation of external knowledge, is largely determined by the motivation and commitment of workers. This relation influences how efficiently human capital is used (Vandenbussche et al. 2006). We study how voluntary employee representation and statutory representation contribute to the process of knowledge generation within establishments. More precisely, we investigate the relevance of these institutions for innovation within firms and differentiate the analysis between incremental versus radical product and process innovation. Another unique aspect of our research is our comparison between voluntarily provided representation and statutory representation such as works councils, which are elected by the workforce. Endogenous decisions for either implementing an alternative voice or a vote for a works council are taken into account.

Determinants of financial and non-financial mechanisms for driving firms' innovations by activating human capital have been studied a lot.[1] Many articles have been written on the effects of unions, legally initiated non-union representative institutions like works councils and codetermination on supervisory boards.[2] Furthermore, literature exists on the efficiency of organizational incentive schemes initiated by management, including profit sharing, quality circles and flatter hierarchies.[3] These measures are considered in various combinations within the employee involvement literature (Bender et al. 2018, Bloom and Van Reenen 2011, Zwick 2004). The literature on voluntarily provided employee representation is rather scarce; in the context of technological progress there is only one single study available.[4] Our paper

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[1] See Belloc (2012) for an extensive survey on corporate governance and innovation subdivided according to corporate ownership, corporate finance and labor factors. With respect to modern growth theory, see Aghion et al. (1998) and Dasgupta (2010).

[2] Addison (2009) provides a comprehensive survey on unions and codetermination in general. See Kaufman and Taras (2016) for a summary on non-union representation.

[3] These organizational measures are usually defined in the employee involvement (EI) literature as high performance work practices (Cappelli and Neumark 2001).

[4] A summary regarding employee-driven innovation via works councils, unions and various management practices is provided by De Spiegelaere and Van Gyes 2012. In this context, however, management-implemented employee representation is not considered.

contributes to the literature twofold. First, we expand knowledge of the effects of management-initiated employee representation with firm-specific bargaining rights on performance with a focus on innovation. Compared to studies on management-provided incentive schemes, we study a more formalized organizational measure. Management-initiated representation is not equipped with any statutory rights at all, although these committees have a more formalized structure than loosely defined management practices. Their composition and structure varies between establishments, and the main difference with respect to codetermination is that alternative representation bodies are created by the management. When introducing such an institution, employers must recognize the need and value of more consultation with the employees. Secondly, we contribute to the industrial relations literature in Germany. To this end, we investigate the impact of this committee on technological progress compared with the effect of statutory employee representation in Germany (works councils).

The analysis is based on data of the German IAB Establishment Panel provided by the Federal Employment Agency over the years 2010-2016. Regarding technological progress, the IAB Establishment Panel provides information on different measures of innovations. Incremental innovations are improvements to existing products already included in a firm's portfolio. Radical innovations are completely new products or services for which a new market had to be created. Process innovations are measured as a noticeably improved production process or service. We tackle two problems arising from the use of observational data. First, we take into account possible reverse causality effects and unobserved confounders. Secondly, we additionally use instrumental variables as exclusion restrictions to provide a causal interpretation of employee representation on technological progress. The first step of the analysis of voluntary employee representation is based on recursive bivariate probit models. This nonlinear class of estimators is appropriate for estimating endogenous binary variables affecting binary outcomes.[5] In a subsequent step we include the existence of works councils as an additional representative body provided by the legislator, which is introduced at the demand of the workforce and has considerable codetermination rights.[6] This enables us to compare the effect of an institution equipped with considerable legal rights and an institution whose participation in decision-making is granted voluntarily. This part of the empirical study

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[5] For further reference see the paper by Marra and Radice (2011) regarding unobserved confounding and the application of recursive bivariate probit models.

[6] In particular, the works councils possess co-determination rights regarding the introduction of new production technologies. These rights are outlined in the Works Constitution Act (WCA). For a very comprehensive overview see Kaufman and Taras (2016, chapter 17).

is based on a multivariate probit approach. In both estimation frameworks, the application of exclusion restrictions (i.e. instrumental variables) allows a causal interpretation.

Our baseline results show a positive relationship between management-implemented employee representation and both product and process innovation. Findings are also robust when endogeneity of representation is taken into account. Works councils only have a positive effect on incremental product innovation. Moreover, and in line with previous research (e.g. Ertelt et al. 2017), we also find a substitutional relationship between works councils and alternative employee representation. The paper proceeds as follows. In the next section we give a short overview of the related literature regarding management-implemented employee representation and works councils. In section three we describe theoretical arguments and links between the existence of alternative forms of employee representation and technological progress. The empirical part describes the data, econometric models and presents the results. The last section draws a conclusion.

2 Literature

Our research contributes to two strands of literature. First, we expand knowledge of the industrial relations literature in Germany. Secondly, as alternative representation (AVO) is implemented by the management, it might be seen as an institutionalized management practice to improve performance. In this view, our contribution is also related to the high-performance work practices literature.[7]

Up to now, the industrial relations literature in Germany has primarily focused on employee participation provided by legislation and implemented at establishment level via works councils (Addison et al. 2010). The works councils (WOCO) are equipped with extensive information, consultation and codetermination (veto) rights and can be set up in establishments with five or more employees at the request of the workers. Thus, works councils are mandatory but not automatically present in every firm. The empirical results are mixed, but overall the impact of works councils on innovation appears to be limited. Addison et al. (1996) show that works councils have a positive effect on product innovation but not on process innovation. In contrast, Addison et al. (2001) find that councils influence neither product nor process innovation. More modern research points to positive interaction effects of

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[7] A very important difference, however, is that we do not aggregate different practices like flatter hierarchies, teamwork, flexible work time or home-office usage as it is usually done in this literature. Appelbaum (2003) argues that at least a combination of three measures builds up a HPWP system. Instead we rely on a straightforward definition whether the establishment has a company-specific employee representation.

the presence of a works council and coverage with a collective-bargaining agreement (Addison et al. 2017).

Knowledge of the relation between voluntary employee participation and technological progress is not so well developed. Participation might involve all employees or only a subgroup, perhaps consisting of senior employees or persons employed in specific departments. Often they are engaged in quality circles, teams or semi-autonomous work groups. Some groups are introduced by the management to manage a specific task, such as the introduction or improvement of a new technology. Voluntary employee participation can be divided into monetary and non-monetary forms. As a monetary form of employee involvement, profit sharing has been widely considered, but with a focus on productivity (e.g. Kraft and Lang 2016) and to a smaller degree profitability. Innovation in this context is only analyzed by Aerts et al. (2015) who find a positive impact on product innovation, but no significant impact on process innovation if a conditional difference-in-differences methodology is applied. Non-monetary participative practices are considered by Ichniowski et al. (1997), Delaney and Godard (2002), as well as Black and Lynch (2001), who find positive effects of involvement practices on productivity but not on innovation.

Zwick (2003) considers the effect of non-monetary participative management practices on productivity using German data and taking endogeneity into account. By means of factor analysis he finds positive effects of employee representation on productivity. Studies based on this methodology usually find a positive impact of various management practices and firm performance measured by labor productivity (e.g. Bender et al. 2018, Wolf and Zwick 2008). Experimental studies also exist that allow for a causal interpretation. For instance, Bloom et al. (2013) find strong causal effects for participative management practices in Indian textile plants. Finally, Cooke (1994) investigates the effectiveness of employee involvement programs in unionized firms. He finds that unionized firms provide a better environment for participation programs than non-union firms. However, all studies in this overview have in common that innovation output is usually not considered and the voluntary schemes are not compared with institutions initialized by the legislator. Most importantly, however, they do not focus on company-specific (i.e. alternative) employee representation but instead aggregate and look exclusively at different types of management practices.

Up to now there exists only a very small literature on alternative employee representation in Germany. Due to the rather formally stipulated structure of works councils, they tend to be

bureaucratic, so there might be more pronounced effects on innovations stemming from management-implemented representation (Addison et al. 2001). In this view, management might introduce this form of employee representation as a consequence of inflexibility on the part of the works council regarding dispute resolution among high-skilled workers. In this context, e.g. Damanpour (1991) already points to the detrimental effects of inflexible work structures and centralization with regard to knowledge generation.

Hauser-Ditz et al. (2013) and Ellguth (2005, 2009) explain different determinants of the existence of company-specific employee representation. They found that one important factor is dissatisfaction with existing schemes such as the works council. Moreover, studies show that the likelihood of their existence rises with firm size and that alternative schemes appear to be more common in western Germany. Furthermore, the literature indicates that such bodies play an important role in activating human capital of employees (Ellguth 2005, Hauser-Ditz et al. 2013, Stettes 2010). A recent study by Ertelt et al. (2017) focuses on factors explaining the introduction of alternative employee representation. They show that works councils are more stable institutions and that an alternative voice is often established in order to fulfill a specific purpose. Moreover, statutory and voluntary representation appear to be substitutive. In this context, Hertwig (2011) defines different types of alternative representation bodies and discusses how they might interfere with the existence and introduction of works councils. Besides productivity, one paper explicitly considers innovation. By using cross-sectional data, Stettes (2010) finds that firms which have an alternative representation body and were innovative in the past two years are 1.5 times more likely to carry out a process innovation in the next year compared to firms, which have no such representation body at all. For product innovations he finds no effects. Our contribution differs in two main aspects. First, we take the very likely problem of endogeneity between works councils and alternative employee representation into account. Second, we use a comprehensive panel dataset in combination with the application of an econometric framework which allows us to draw a causal conclusion.

3 Theoretical Considerations

Alternative employee representation is establishment-specific and takes various forms (Hertwig 2011). Thus, a dominant organizational model that applies to all forms does not exist. However, all voluntary schemes share a common basis. Unlike codetermination via unions or works councils, their introduction is initiated by the employer, who it can be

assumed will see a strategic advantage in the existence of this institution for the firm. The specific aim of the implementation may differ between establishments, but one area in which the management notices deficiencies and room for improvement might be low productivity or an absence of innovations. In this respect, alternative employee representation is implemented to foster technological progress via two channels. First, they focus on increasing effort and motivation of employees. Secondly, they improve efficiency by implementing effective two-way communication between management and the workforce. This in turn would lead to a competitive advantage.

Since a long time the literature has discussed the relation between worker representation and communication. According to the exit-voice theory, dissatisfied employees are more likely to talk about concerns and grievances ("voice") instead of quitting the job ("exit") when an institutionalized representation is present. This is the fundamental explanation of Freeman and Medoff (1984) as to why "voice" might benefit firms. Unlike Freeman and Medoff, however, our definition of voice is not necessarily connected with unions, but rather provided by the management themselves. This helps in problem-solving, reduces workers' dissatisfaction with specific circumstances, increases job motivation by strengthening trust and hence employee turnover should be reduced. Lower employee turnover should increase performance, as necessary firm-specific human capital for the innovation process is retained. This employee satisfaction (i.e. voice) argument should be especially relevant for alternative representation since these committees might be more sensitive to local shop-floor issues than unions or works councils. Moreover, it is well known that engaged and motivated employees who feel strongly committed to the organization tend to be more productive (Seifert et al. 2016). Thus, management has incentives to implement organizational institutions which also serve the creation of an atmosphere of trust and cooperation. Firms might also have aims other than employee turnover or worker satisfaction in mind when they introduce worker representation bodies. Another important reason might be the introduction of an efficient two-way communication channel. In this context, Lee and Choi (2003) as well as Zoghi (2010) already point to the relevance of information sharing and effective communication during the discovery of new knowledge. Ultimately, innovations may be stimulated by enhanced and more efficient communication. However, advantages might be heterogeneous and determinants of such beneficial effects might be the particularities of the production process like increased necessity for communication and cooperation. Nevertheless, the qualification level of the employees may also play an important role within this process.

While product innovations predominantly benefit the employees, this does not have to be the case with process innovations. However, process innovation helps to improve the competitiveness of firms, secures their survival and increases output, which may well also benefit the workers. In principle, employees may affect process innovation in two ways: negatively by resistance to technological progress and positively by information collection and provision. However, employees might oppose technological progress if it is connected with the introduction of new work organization and retraining. The training will in all likelihood be rather firm-specific and increase the risk of the employees. There exist some reasons for opposing process innovation, but whether employees are really able to prevent process innovations is unclear. However, they may impede its introduction, reject cooperation on its implementation and slow down the innovation process. Unions and their representatives on the firm level[8] are frequently hostile towards technological progress (e.g. Ulph and Ulph 1988). This is particularly the case where process innovation is considered. The most important reason for resistance is the fear of employees being replaced by capital. On the one hand, this concern is not without reason as this does actually take place for certain employees.[9]

Alternative representation bodies may help to reduce the resistance problem and support information collection and dissemination. The management can emphasize the positive aspects of technological progress and may offer (temporary) job security. From management's point of view, communication with alternative representation institutions is in all likelihood less controversial than dialogue with works councils, which are introduced at the request of the workforce and have far-reaching veto rights in the case of technological progress. Besides reducing resistance against it, employee representation might also have a positive impact on process innovation. It is the workforce who operates the production technology, so it is quite likely that they become aware of shortcomings during their day-to-

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[8] In our case this is relevant, as the works councils are provided with extensive codetermination rights and they have an explicit veto right if new technologies are introduced. Most works councils are dominated by union members, although this does not have to be the case.

[9] In fact, that is often observed in jobs with a high degree of routine tasks as well as jobs relying heavily on unskilled labor. See in this context the intensive debate regarding industry 4.0 and digitization (e.g. Brynjolfsson and McAfee 2014, Acemoglu and Restrepo 2017). Turning to other empirical results regarding technological progress, Harrison et al. (2014) show that process innovations do not reduce the number of jobs and that product innovations stimulate employment. Dachs and Peters (2014) find that the employment growth effect of product innovations is higher in foreign-owned firms. Evangelista and Vezzani (2012) enlarge the standard innovation variables (process and product) by organizational innovations and show that the indirect effects of innovation by increasing competitiveness of firms is the most important positive factor for employment.

day experience. The existence of an efficient voice channel offers room for the enhancement of existing processes or for the implementation of totally new processes.

Perhaps less obvious is a possible positive impact on product innovation. Employees who are engaged in the production process may acquire information, which the management has not. Furthermore, employees become familiar with the specific goods for which they are responsible and may acquire knowledge of ways to improve the quality or add specific new features to existing products. By intensifying two-way communication with the workforce, it is therefore possible to use internal resources that have not been applied so far. Moreover, the employees of marketing and sales divisions with close contact to customers presumably have first-hand information on their preferences. The customers will not hesitate to report any shortcomings of the products and their preferences for future products. This knowledge can be collected by a communication body and transmitted to the R&D department, perhaps resulting in improvements to existing products or the introduction of entirely new products. Furthermore, it becomes easier for the R&D department to assess the economic potential of a product improvement such as potential market gains. While such an interactive process would appear to be self-evident, with a representation body it is institutionalized and will probably facilitate communication with management on the one hand and between departments on the other. Furthermore, Kesting and Ulhoi (2010) argue that employee representation might also enhance the probability of radical product innovations. This may be the case as employees' social networks and contacts produce external knowledge that is not otherwise available to firm members including the management. Such new knowledge is crucial for out-of-the-box thinking and hence for the implementation of radically new products. In summary, information disclosure is expected to have a positive effect on innovation. Ultimately, knowledge of the production technology, customer behaviour and industry peculiarities might facilitate product improvements (i.e. incremental innovation) or the introduction of entirely new products (i.e. radical innovation).

4 Empirical Test

The data basis for our analysis is the German IAB (Institute for Employment Research) Establishment Panel.[10] This panel has been conducted on an annual basis since 1993 in West Germany and since 1996 in East Germany and covers roughly 16,000 establishments per year. The panel is designed to lead to a representative sample regarding a number of criteria

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[10] A comprehensive overview regarding the sample and survey design as well as data access is provided by Ellguth et al. (2014).

including industries and establishment sizes, with every German company employing at least one person covered by social insurance could potentially be present in the sample. The survey asks about a wide variety of firm and labor market variables, but unfortunately not all questions are posed every year.

For our analysis we require information about innovations realized on the establishment level. Questions on the implementation of new products and processes are included on the basis of a consistent definition since the questionnaire year 2008 and are directed to the previous year.[11] Regarding co-determination, the IAB Establishment Panel offers information on works councils, management-implemented employee representation and union coverage. Thus, we can investigate the relationship between alternative and legally defined workplace participation and innovation in more detail. Moreover, the data allows us to exploit the panel structure by using leads of the dependent variables as well as industry, state and federal state fixed effects. Due to potential confounding effects of the financial crisis and its impact on innovation, we remove the year 2009 from our sample.[12] Since works councils are the form of employee representations initialized on the basis of the WCA and can only be elected in establishments with five or more employees, we drop all establishments below this threshold. Moreover, we focus on manufacturing and knowledge-intensive service industries. With respect to the knowledge-intensive service industries we follow the definition proposed by Peters and Rammer (2013).[13] Manufacturing and knowledge-intensive service industries are innovation-orientated and therefore suited for an empirical test on the effects of alternative representation institutions and works councils. Summing up, we are left with an unbalanced panel dataset ranging from the years 2010 to 2016, comprising 6,309 observations of 2,617 establishments.

In order to test the hypotheses regarding employee representation and innovation, we rely on a consistent definition of the different innovation measures. First, we distinguish between product and process innovation and, moreover, the IAB Establishment Panel enables us to distinguish between incremental and radical product innovations as well.[14] The IAB panel

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[11] The same items are also surveyed in the years 2001, 2004 and 2007, however with a lag of two years. In order to prevent measurement errors and thus inducing endogeneity, we rely only on the one year lag questions.

[12] In this context, Hausman and Johnston (2014) argue that the development of new innovations and technologies has become crucial during the financial crisis in order to stay competitive. Zouaghi et al. (2018) show that innovation performance during the financial crisis also varies between high and low tech industries.

[13] For NACE Rev. 2.0 knowledge-intensive services include divisions 58 to 66 and 69 to 73. The manufacturing industries include divisions 10 to 33.

[14] Comprehensive definitions regarding specific types of innovations can be found in the OECD/Eurostat Oslo Manual (OECD/Eurostat 2005).

includes the following question: "Have you started to offer a completely new product or service in the business year of … for which a new market had to be created?"). In line with Dahlin and Behrens (2009) we regard this kind of innovation as radical. Moreover, and in accordance with the Eurostat Oslo Manual, incremental product innovations are defined as the improvement of an existing product and process innovations as new procedures in order to improve the production process. These innovation variables are coded as a 0/1 dummy variable indicating the presence of the corresponding type of innovation in the previous year.[15]

Regarding our variables of interest, the IAB panel collects information on management-implemented representation institutions as well as works councils. We use the question whether the "establishment has another company-specific form of employee representation" and define a 0/1 dummy variable indicating the existence of such a representation committee in the corresponding firm and year. As outlined above, these institutions may serve very different and establishment-specific purposes. They may represent the whole workforce or parts of it and may be installed permanently or only temporarily to solve specific problems (Hertwig 2011). Unfortunately the IAB panel does not provide further information regarding these types of employee representation, which does not allow us to distinguish their purposes and composition in more detail. Additionally, information on works councils is regularly collected and coded as a 0/1 dummy variable for existence as well.

In our analysis we include a number of control variables. In accordance with the literature on employee representation, we use variables capturing the structure of the workforce such as the share of qualified blue-collar workers and the share of female workers. We also include several establishment-size dummy variables to measure and control for size effects according to the Schumpeterian hypotheses of innovation (Schumpeter 1942).[16] Since innovations of any type crucially depend on human-capital of the workforce, we add a dummy variable whether the establishment "releases staff for the purpose of participating in internal or external training courses and […] covers the expense for these in full or at least in part". This variable measures further training activities and we expect this variable to have a significantly positive effect on all kinds of innovations. Another dummy variable expresses whether the firm is covered by a collective bargaining agreement. Following the rationale of Hübler and

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[15] Since our innovation variables are questioned with a one year lag, we take two leads of these dependent variables, thus explaining innovations in the next year.
16 Schumpeter (1942) claims that an increasing firm size increases innovations proportionally. The empirical literature regarding firm size supports this hypothesis. See for example Cohen (2010).

Jirjahn (2003), coverage by a collective bargaining agreement shifts distributional conflicts to the industry level, (via collective bargaining agreements) and employee representation is concentrated on generating rather than redistributing economic rents. In order to take account of a firm's age we add a dummy variable which takes unit value if the establishment was founded before 1990. Since the study by Coad et al. (2016) finds that younger firms tend to execute riskier R&D investments, we expect that this dummy variable has a significant effect for radical innovations.

Before we present the results of the models that take endogeneity into account, we start with simple probit regressions. Possible endogeneity is ignored and the works council status is included by a 0/1 dummy variable (unit value in the case of existence). In addition, our estimation models take year, industry and federal state fixed effects into account. Standard errors are clustered at the establishment level in order to account for establishment-specific production or innovation shocks. Table 1 shows the descriptive statistics.

Table 1: Descriptive statistics; (N=6,309)

Variable	Mean	SD
Incremental Innovation	.674	.469
Radical Innovation	.178	.382
Process Innovation	.382	.486
Works Council Presence	.592	.491
Alternative repr. Presence	.101	.302
Firm size dummy (20-99)	.363	.481
Firm size dummy (100-249)	.257	.437
Firm size dummy (250-499)	.157	.363
Firm size dummy (500+)	.141	.348
Further Training	.868	.338
Share of female workers	.304	.213
Share of high-skilled workers	.141	.186
Collective Bargaining agreement	.401	.490
Founded before 1990	.523	.499
AVO presence in industry in year t	.098	.035
Firm is branch of company	.223	.417
WOCO presence in industry in year t	.433	.165
Share of fixed-term workers	.088	.118

The descriptive statistics reveal that more than half of firms develop an incremental innovation (improvement of a product or service that had already been part of the portfolio). Radical innovations, however, are far less common, although every third firm develops a process innovation. Considering the relevant employee representation variables, it turns out that works councils are much more prevalent (exist in more than every second establishment) than alternative representation introduced by management, which is only present in roughly 10 percent of the establishments. Almost 90 percent of the observed establishments release staff for the purpose of further training, highlighting the importance of further development of human capital for manufacturing and knowledge-intensive service industries. At the mean, our sample indicates that roughly 14 percent of the employees are high-skilled. Finally, the firms report that on average their share of employees with a fixed-term contract is only 9 percent. Around 40 percent of the observations are covered by a collective bargaining agreement and roughly one half of the sample establishments are established before 1990. The four coefficients at the bottom of the table denote the exclusion restrictions used in the recursive bivariate and multivariate regressions. They are described in more detail in the next sections.

4.1 Baseline results

In the following we present baseline results (regression-adjusted correlations) for employee representation and technological progress. Endogeneity is controlled for in the next section. For all three kinds of innovations we distinguish two specifications. First, we insert management-implemented workplace representation into the equation (table 2, column (1), (3) and (5) for incremental, radical as well as process innovation). Secondly, we additionally include the voice channel, which is based on the legal framework of the Works Constitution Act (i.e. works councils), in the model (table 2, column (2), (4) and (6) for each kind of innovation measure).

Our interest lies in the explanation of the underlying unobserved propensity to employ the corresponding type of innovation (which is the continuous random variable $INNO^*$), but we only observe the binary variable $INNO$ which either takes value 1 or 0, thus:

$$INNO = \begin{cases} 1 \; if \; INNO^* > 0 \\ 0 \; if \; INNO^* \leq 0 \end{cases} \qquad (1)$$

In the case where $INNO^*$ crosses the threshold, we observe $INNO$ and vice versa.[17] We assume an underlying normal distribution, i.e. $\epsilon \sim N(0,1)$ of the error term and apply probit models as follows:

$$P\big(INNO_{i,t+1} = 1 \big| X_{i,t}\big) = \Phi\big(\beta_0 + \gamma_1 AVO_{i,t} + \gamma_2 WOCO_{i,t} + \delta X_{i,t} + \delta_t + \epsilon_{i,t}\big) \qquad (2)$$

The observed type of innovation is explained by a set of control variables contained in the X vector as depicted in table 2. The coefficients of interest are γ_1 and γ_2 measuring the management-implemented and works council representation scheme. However, as explained above we start with a specification including only the alternative institution variable and subsequently add the works council dummy variable.

Table 2: Univariate Probit estimates for incremental, radical and process innovation (average marginal effects presented)

Dependent Variable	Incremental Innovation		Radical Innovation		Process Innovation	
	(1)	(2)	(3)	(4)	(5)	(6)
Alternative representation	.075***	.079***	.032*	.025	.073***	.071***
	(.022)	(.022)	(.019)	(.019)	(.024)	(.024)
Works council	-	.019	-	-.032*	-	-.010
	-	(.021)	-	(.017)	-	(.022)
Size of the firm: 20-99	.092***	.087***	.045**	.048***	.098***	.099***
	(.030)	(.030)	(.018)	(.017)	(.024)	(.024)
Size of the firm: 100-249	.179***	.167***	.061***	.073***	.176***	.180***
	(.033)	(.035)	(.020)	(.021)	(.028)	(.029)
Size of the firm: 250-499	.234***	.221***	.118***	.135***	.310***	.316***
	(.035)	(.038)	(.025)	(.027)	(.032)	(.034)
Size of the firm: 500+	.308***	.295***	.169***	.190***	.394***	.400***
	(.036)	(.039)	(.029)	(.031)	(.035)	(.038)
Further training	.138***	.135***	.065***	.068***	.079***	.080***
	(.021)	(.021)	(.015)	(.015)	(.021)	(.021)
Share of female workers	.061	.066	.110***	.101**	.108**	.105**
	(.049)	(.050)	(.041)	(.041)	(.051)	(.051)
Share of high-skilled workers	.335***	.329***	.201***	.208***	.159***	.161***
	(.060)	(.060)	(.044)	(.045)	(.057)	(.057)
Collective bargaining	.023	.019	-.001	.005	.023	.025
	(.019)	(.020)	(.014)	(.015)	(.019)	(.020)
Founded before 1990	-.017	-.018	-.009	-.008	-.012	-.011
	(.020)	(.020)	(.015)	(.015)	(.020)	(.020)
Constant	-.676***	-.676***	-1.659***	-1.654***	-1.739***	-1.739***
	(.187)	(.187)	(.217)	(.212)	(.206)	(.205)
Industry dummies	Yes	Yes	Yes	Yes	Yes	Yes
Time dummies	Yes	Yes	Yes	Yes	Yes	Yes
State dummies	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	.1296	.1298	.0741	.0751	.0950	.0951
Log Likelihood	-3464.245	-3463.411	-2734.459	-2731.466	-3797.059	-3796.847
Obs.	6,309	6,309	6,309	6,309	6,309	6,309

Notes: Cluster-robust standard errors at the establishment level in parentheses. Calculated using the delta method.
Significance: *, **, and *** denote statistical significance at the .1, .05 and .01 level respectively.

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[17] This is well known as the index function model to model binary dependent variables (Cameron and Trivedi 2005).

Results show that the existence of management-implemented forms of employee representation is indeed positively correlated with product (both incremental as well as radical) and process innovation. The effect ranges from 7.1 to 7.9 percentage points for process and incremental product innovations and 3.2 percentage points for radical product innovation. If the works council variable is added, the results for the alternative representation bodies do not change much for incremental and process innovations, but differ in the case of radical innovations.

The dummy variable indicating the existence of a works council shows a negative coefficient for radical product innovation. All other coefficients exhibit the expected signs too. There is a significantly positive effect of the further training variable, indicating that more human capital promotes innovation. The share of female workers has a positive effect on radical and process innovation and a higher share of high-skilled employees increase the probability for every kind of innovation. Collective bargaining and the dummy variable indicating older establishments founded before 1990 are not significantly different from zero. All size dummies are positive and increasing which implies that the probability of innovation is higher in bigger establishments. All estimates include industry, time and federal state fixed effects.

4.2 Endogeneity of employee representation

We now turn to the identification of a causal effect of both forms of employee representation (voluntary as well as on a legislative basis) on the likelihood of innovation. The univariate probit estimates presented above neglect endogeneity problems (i.e. omitted variables bias as well as simultaneity), however provide a good basis for comparisons. Hence, innovativeness and alternative representation might be determined by an unobserved exogenous factor, e.g. management quality. Better managed establishments will be more innovative and are interested in efficient communication with the employees, leading to a positive correlation of our most important variable.[18]

In another view, the simple one-way direction from existence of worker representation institution to innovation success might be quite misleading (i.e. simultaneity). At least more complicated causality relations should be taken into account and the robustness of the results should be tested. Such relations could affect the results in two ways: On the one hand it is possible that the alternative voice coefficient in the univariate probit regression underestimates the true effect. This is the case if such institutions are introduced to induce

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[18] Chen et al. (2015) show that management ability is indeed correlated with innovation.

innovation activity when the establishment is currently not very innovative. In our context, the alternative representation institution is then implemented because the innovation output is low and management intends to increase it through intensified communication with the workforce. On the other hand, alternative voice might overestimate the true effect if the management in question is innovative with respect to new products and processes, and simultaneously also prefers innovative organizational structures. In this view, establishments which have just developed and introduced one or more innovations might establish an employee representation committee in order to facilitate the handling of the new products or process innovations and in particular the process innovation at the establishment. We also consider unobserved worker behavior. Employees might dislike process innovation and thus vote for the adoption of a works council if they fear job losses connected with the introduction of a process innovation. Similarly, they might dislike retraining and new organization schemes following product innovation. Whatever the relation is, all cases are plausible and a possible endogeneity problem of the dummy variable standing for the types of employee representation scheme exists.

In the presence of endogeneity, an instrumental variable (IV) framework should be used. However, in the case of endogenous dummy variables, the standard IV approach is not applicable. Instead, we follow the method proposed by Heckman (1978) for dealing with nonlinear models. We apply recursive bivariate as well as multivariate probit models which account for unobserved correlations between the innovation measure and the presence of employee representation (Freedman and Sekhon 2010, Greene 2003). The suitability of a recursive bivariate probit model in accommodating endogenous binary explanatory variables is well explained by Maddala (1986) and Wooldridge (2010). These models are typically applied in the case where the outcome of interest (innovation measures) is a dummy variable and the interesting determinants of the outcome (employee representation institutions) are dichotomous variables as well.[19] They address endogeneity directly by estimating coefficients of multiple equations simultaneously via maximum likelihood. In this way the models capture the effect of unobservable factors (e.g. the quality of the management) by modeling the correlation between the error terms of the equations. Furthermore, our dependent variables (incremental and radical product innovation; process innovation) are measured with a lead.

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[19] See MacDonald and Shields (2004) for an example in health economics in which the authors test how problem drinking affects the employment status. Another example is Kassouf and Hoffmann (2006) where the authors investigate determinants of work-related injuries, Farace and Mazzotta (2011) test how knowledge affects innovations in small and medium sized firms. Finally, and more related to our topic, Savignac (2008) tests how financial constraints affect innovations.

This is done as an additional way of dealing with simultaneity of our variables. This lagged structure in the models intends to facilitate an identification of the direction of the effect from workplace representation to innovation.

We start by describing the initial recursive bivariate model, treating only the alternative representation as endogenous. Instead of relying on a two-step approach, the recursive bivariate probit model takes account of possible endogeneity during the process of simultaneous maximization of the log-likelihood function. Following the proposed specification by Greene (2003), our model consists of two equations: a treatment equation for the endogenous binary variable (existence of alternative employee representation) and a binary outcome equation for the corresponding innovation type (incremental, radical, and process):

$$INNO^*_{i,t+1} = \beta_1 X_{i,t} + \gamma AVO_{i,t} + \theta_t + \epsilon_{1i,t}$$
$$AVO^*_{i,t} = \beta_2 X_{i,t} + \lambda_1 z_{i,t} + \theta_t + \epsilon_{2i,t}$$
$$\begin{pmatrix} \epsilon_1 \\ \epsilon_2 \end{pmatrix} \sim N \left[\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} 1 & \rho \\ \rho & 1 \end{pmatrix} \right] \quad\quad (3)$$

The $INNO^*$ and AVO^* coefficients in this framework are latent variables describing the underlying propensity of alternative voice existence and the propensity of the corresponding type of innovation. The matrix $X_{i,t}$ contains the same set of control variables in all two equations as discussed above. The parameter of interest in the first equation is γ capturing the effects of alternative representation. The idiosyncratic error terms $\epsilon_{1i,t}$ and $\epsilon_{2i,t}$ are distributed as bivariate normal with mean zero and unit variance. However, they are allowed to be correlated with parameter ρ, thus taking account of unobserved characteristics of the same establishment between both equations.[20] This coefficient measures the correlation between alternative voice existence and innovations after factoring out all effects of the explanatory variables. If $\rho \neq 0$, then $\epsilon_{1i,t}$ and $AVO_{i,t+1}$ are correlated, implying inconsistency of univariate probit estimates thus motivating the use of the bivariate probit model. A likelihood ratio test of the significance of ρ can be used as a direct test of endogeneity between both equations (Wooldridge 2010, p.478, Knapp and Seaks 1998).[21] A negative ρ would imply a negative correlation between equations, standing for unobserved factors which make the

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[20] Filippini et al. (2018) provide a further discussion regarding the interpretation of the rho coefficient in the bivariate as well as the recursive bivariate probit model.
[21] The null and alternative hypotheses in this case are: $H_0: \rho = 0$ against $H_1: \rho \neq 0$, where H_1 corresponds to endogeneity of $AVO_{i,t+1}$ in the first equation. The test compares the log-likelihood of the bivariate probit model with the sum of the log-likelihoods of two univariate separate probit models.

observation of the existence of alternative representation institutions more likely and innovation success less likely. A positive ρ, vice versa, affects the likelihood for both cases in a positive way. Additionally, a set of time dummies θ_t is included.

We now turn to the identification of γ. Basically, there are three positions: On the one hand, Heckman (1978) argues that a full rank regressor matrix is sufficient for identification. On the other hand, Maddala (1983) as well as Han and Vytlacil (2017) argue that the parameter of interest is identified if there is at least one varying exogenous parameter in the regressor matrix $X_{i,t}$. In contrast, Wilde (2000) points out that the parameter of interest is identified even if the same sets of exogenous variables appear in both equations without exclusion restriction. There just has to be enough sufficient variation in the coefficients. We are convinced that exclusion restrictions in any case facilitate the identification of a causal relation. Thus, we include instrumental variables (exclusion restrictions) in the employee representation equations. Summing up: To allow for a causal interpretation of our main variables of interest, we apply recursive bivariate and multivariate probit models, make use of instrumental variables to explain the existence of worker representation and furthermore continue to base the specifications on lagged explanatory variables.

With respect to the AVO* equation, we use two instrumental variables. First, we use the share of establishments in an industry which have an AVO in the corresponding year. Secondly, we use a 0/1 dummy variable indicating whether the establishment is a branch of a company. These exclusion restrictions in the first equation are denoted as z_1. These variables are likely to be correlated with the existence of alternative representation in a specific establishment (e.g. industry peculiarities common to all establishments operating in that industry), but do not simultaneously affect the propensity to innovate in any other way.[22]

In a final step we additionally account for the existence of works councils as the second way to organize voice of the workforce. Therefore, we add an additional treatment equation for works councils to the regression framework. This subsequent recursive multivariate probit model is estimated via simulated maximum likelihood (Cappellari and Jenkins 2003). As described above, there is still an endogeneity problem regarding the alternative employee representation and the innovation measure. Additionally, the works council might also be endogenous with respect to innovations. We also apply exclusion restrictions in the works

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[22] Such types of instruments are well established in the literature. See for instance Machin and Wadhwani (1991) who use the union density in a specific industry as an instrument for union presence. Fisman and Svensson (2007) also use industry-location averages as instruments.

council equation. We use the share of works council existence within a specific industry in year t as well as the share of workers on a fixed-term contract. Moreover, unobserved correlations between the two forms of employee representation are also quite likely. The two forms of employee representation could be substitutive, as the management looks for a communication channel itself if the one based on the legal framework (works council) has not been introduced by the workforce.[23] The relation between types of representation, however, could also be complementary.

Thus, the previous bivariate model is extended as follows: We introduce a third equation, where $WOCO^*$ indicates the existence of a works council. Again, X contains a set of control variables and z_2 being the exclusion restrictions for the works council equation. In the first equation, γ and δ are the coefficients of interest. Moreover, the same rationale as for the bivariate probit applies to the multivariate probit model (Greene 2003).

$$INNO^*_{i,t+1} = \beta_1 X_{i,t} + \gamma AVO_{i,t} + \delta WOCO_{i,t} + \theta_t + \epsilon_{1i,t}$$

$$AVO^*_{i,t} = \beta_2 X_{i,t} + \lambda_1 z_{1i,t} + \theta_t + \epsilon_{2i,t}$$

$$WOCO^*_{i,t} = \beta_3 X_{i,t} + \lambda_2 z_{2i,t} + \theta_t + \epsilon_{3i,t}$$

$$\begin{pmatrix} \epsilon_1 \\ \epsilon_2 \\ \epsilon_3 \end{pmatrix} \sim N \left[\begin{pmatrix} 0 \\ 0 \\ 0 \end{pmatrix}, = \begin{pmatrix} 1 & \rho_{12} & \rho_{13} \\ \rho_{12} & 1 & \rho_{23} \\ \rho_{13} & \rho_{23} & 1 \end{pmatrix} \right]$$

(4)

The multivariate probit system of equations is estimated via the simulated maximum likelihood (SML) estimator of Geweke (1991). The reason is that standard numerical approximations for multivariate models based on the Newton-Raphson framework are inefficient and yield poor results (Cappellari and Jenkins 2003). In order for the consistency of the SML estimator, resampling is required. In order to be asymptotically equivalent to the true maximum likelihood estimator, Hajivassiliou and Ruud (1994) recommend setting the number of draws (simulations) equal to the square root of the sample size. In our case we simulate each model 81 times.

4.3 Results for bivariate and multivariate models

In this section we present results from the recursive bivariate and the multivariate regression framework. By applying recursive multivariate probit models, we additionally consider the work council type of representation as endogenous. Moreover, this estimation framework

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[23] A substitutive relationship might exist when the management tries to avoid works councils which are associated with strong bargaining rights on the establishment level. Thus, an increasing threat of a works council results in the implementation of alternative representation to avoid works councils.

allows us to measure unobserved correlations between both types of representation. This enables us to interpret their relationship (i.e. substitutes or complements) more clearly. Marginal effects are presented and the standard errors of the coefficients are again calculated using the delta method. Moreover, we cluster the standard errors at the establishment level in order to account for establishment-specific shocks. Finally, we include industry, time and state fixed effects in the regression models. Table 3 shows the results for the recursive bivariate probit approach for all three kinds of innovation.

Table 3: Recursive bivariate probit estimates for incremental, radical and process innovation (marginal effects are presented)

Dependent variable	Incremental Innovation		Radical Innovation		Process Innovation	
	(Selection)	(Outcome)	(Selection)	(Outcome)	(Selection)	(Outcome)
Alternative representation	-	.288***	-	.366***	-	.345**
	-	(.091)	-	(.115)	-	(.133)
Works council	-.152***	.064*	-.154***	-.003	-.154***	.024
	(.027)	(.037)	(.018)	(.018)	(.018)	(.026)
Alternative rep. share in industry	.629***	-	.600***	-	.579***	-
	(.167)	-	(.167)	-	(.173)	-
Branch of company	.012	-	.012	-	.015	-
	(.014)	-	(.014)	-	(.014)	-
Size of the firm: 20-99	.015	.068**	.015	.043**	.016	.089***
	(.013)	(.031)	(.012)	(.019)	(.012)	(.025)
Size of the firm: 100-249	.040**	.133***	.041**	.061***	.043***	.158***
	(.016)	(.041)	(.016)	(.022)	(.016)	(.032)
Size of the firm: 250-499	.068***	.177***	.066***	.115***	.067***	.280***
	(.022)	(.050)	(.021)	(.028)	(.021)	(.041)
Size of the firm: 500+	.152***	.231***	.155***	.149***	.155***	.341***
	(.027)	(.065)	(.026)	(.032)	(.026)	(.052)
Further training	.038***	.112***	.042***	.060***	.039***	.065***
	(.011)	(.027)	(.010)	(.016)	(.011)	(.022)
Share of female workers	-.013	.065	-.016	.098**	-.011	.101**
	(.031)	(.048)	(.032)	(.040)	(.018)	(.049)
Share of high-skilled workers	.024	.306***	.024	.197***	.026	.148**
	(.034)	(.063)	(.033)	(.045)	(.034)	(.056)
Collective bargaining	.010	.015	.007	.004	.009	.021
	(.012)	(.019)	(.012)	(.014)	(.012)	(.019)
Founded before 1990	.012	-.021	.013	-.011	.011	-.014
	(.013)	(.019)	(.013)	(.015)	(.013)	(.019)
Constant	-1.974***	-.659***	-1.99***	-1.62***	-1.94***	1.71***
	(.296)	(.187)	(.280)	(.214)	(.294)	(.207)
Industry dummies	Yes		Yes		Yes	
Times dummies	Yes		Yes		Yes	
State dummies	Yes		Yes		Yes	
ρ	-.599		-.597***		-.445*	
	(.462)		(.197)		(.253)	
Log Likelihood	-5300.098		-4566.660		-5634.067	
Obs.	6,309		6,309		6,309	

Notes: Cluster-robust standard errors at the establishment level in parentheses.
Significance: *, **, and *** denote statistical significance at the .1, .05 and .01 level respectively.
The correlation coefficient ρ measures the correlation in the error terms between the selection and the outcome equation.

When accounting for endogeneity of management-implemented representation using the recursive bivariate probit approach, the influence on innovation of these committees is much more pronounced than univariate probit estimation. Alternative employee representation increases the likelihood of an incremental product innovation by a magnitude of 29 percentage points. The effect is significant at the 1% level. Alternative representation increases the likelihood of a radical innovation by 37 percentage points and the likelihood of a process innovation by roughly 35 percentage points.[24]

However, the ρ coefficient indicates that there might be no endogeneity in the incremental innovation specification present since it is not different from zero. For all other specifications, ρ is significant and the results have to be interpreted in connection with these negative ρ coefficients (significant in two out of three cases). There are different interpretations. One reason for this result might be that alternative representation institutions are more often adopted in times of crisis to enhance an establishment's performance. Accounting for these unobserved confounders (e.g. management quality, unobserved organizational crisis) leads to a more pronounced effect of alternative representation on innovation. This negative correlation in the baseline univariate probit estimates is measured in the alternative voice coefficient which is therefore much smaller. On the other hand, results might indicate that insufficient innovation activities might motivate the management to implement an alternative voice to improve technological progress.

The interpretation of the other coefficients is similar to the univariate probit case. Moreover, in the bivariate probit estimation, the coefficient for the works council indicates a weak impact on incremental innovations. The likelihood of an incremental innovation increases by about 6 percentage points if a works council is present in the establishment. Since there is no effect on radical innovations estimated, the results are in line with the study by Jirjahn and Kraft (2011), who also find a supporting effect of works councils on incremental but no effect on radical innovation. In view of this, the rights of the works council (which are outlined by the Works Constitution Act) might be too inflexible to foster radically new ideas. We discuss further implications and potential policy implications regarding these aspects in the conclusion of this paper.

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[24] Stettes (2010) finds no effects of alternative committees on product innovations.

Table 4: Recursive Multivariate Probit estimates for incremental, radical and process innovation

Dependent variable	Incremental Innovation			Radical Innovation			Process Innovation		
	Selection WOCO	Selection AVO	Outcome [ME]	Selection WOCO	Selection AVO	Outcome [ME]	Selection WOCO	Selection AVO	Outcome [ME]
Alternative representation	-	-	.596* [.164] (.327)	-	-	.811* [.246] (.441)	-	-	.742** [.264] (.363)
Works council	-	-	.301* [.096] (.175)	-	-	-.230 [-.056] (.261)	-	-	.062 [.021] (.247)
Alternative rep. share in industry	-	3.71*** (1.51)	-	-	3.61*** (.112)	-	-	3.53*** (1.15)	-
Branch of company	-	.059 (0.58)	-	-	.065 (.058)	-	-	.072 (.060)	-
Works council share in industry	2.38*** (.859)	-	-	2.39*** (.878)	-	-	2.43*** (.865)	-	-
Share of fixed term workers	-1.79*** (.227)	-	-	-1.74*** (.228)	-	-	-1.76*** (.227)	-	-
Size of the firm: 20-99	.991*** (.098)	-.006 (.089)	.189** [.057] (.076)	.989*** (.097)	-.008 (.09)	.273*** [.067] (.105)	.991*** (.098)	-.006 (.089)	.308*** [.101] (.089)
Size of the firm: 100-249	1.96*** (.103)	-.116 (.097)	.351*** [.105] (.122)	1.96*** (.103)	-.117 (.098)	.426** [.110] (.169)	1.96*** (.103)	-.109 (.097)	.515*** [.173] (.154)
Size of the firm: 250-499	2.43*** (.111)	-.065 (.105)	.501*** [.144] (.138)	2.43*** (.111)	-.079 (.105)	.661*** [.185] (.188)	2.42*** (.111)	-.071 (.104)	.856*** [.300] (.174)
Size of the firm: 500+	3.077*** (.135)	.205** (.079)	.756*** [.206] (.141)	3.09*** (.135)	.254** (.079)	.301*** [.233] (.186)	3.09*** (.135)	.254 (.106)	1.04** [.365] (.172)
Further training	.397*** (.066)	.205** (.079)	.367*** [.120] (.059)	.399*** (.066)	.215*** (.079)	.302*** [.066] (.074)	.400*** (.065)	.205** (.079)	.207*** [.069] (.062)
Share of female workers	-.899*** (.133)	.146 (.148)	.266** [.082] (.123)	-.916*** (.134)	.128 (.151)	.364*** [.088] (.154)	-.902*** (.137)	.146 (.146)	.311** [.105] (.132)
Share of high-skilled workers	1.00*** (.154)	-.054 (.157)	.997*** [.308] (.148)	.997*** (.155)	-.048 (.158)	.881*** [.213] (.148)	1.00*** (.155)	-.043 (.157)	.450*** [.152] (.137)
Collective bargaining	.869*** (.048)	-.128** (.052)	.014 [.004] (.058)	.877*** (.047)	-.138*** (.052)	.054 [.013] (.071)	.875*** (.047)	-.129** (.052)	.062 [.021] (.067)
Founded before 1990	.052 (.051)	.053 (.058)	-.064 [-.020] (.046)	.045 (.050)	.057 (.057)	-.038 [-.009] (.048)	.049 (.050)	.049 (.058)	-.041 [-.014] (.043)
constant	-2.48*** (.298)	-1.957*** (.219)	-.679*** (.147)	-2.49*** (.304)	-1.94*** (.219)	-1.64*** (.180)	-2.49*** (.299)	-1.91*** (.228)	-1.73*** (.157)
Industry dummies		Yes			Yes			Yes	
Times dummies		Yes			Yes			Yes	
State dummies		Yes			Yes			Yes	
$\rho_{21}, \rho_{31}, \rho_{32}$		-.149,-.120,-.467*** (.178,.113,.033)			-.373,.109,-.469*** (.231,.174,.033)			-.273,-.016,-.470*** (.202,.161,.032)	
LR test for $\rho_{21}, \rho_{31}, \rho_{32} = 0$		177.532			176.943			177.148	
Log Likelihood		-7791.9561			-7060.3054			-8125.5834	
Obs.		6,309			6,309			6,309	

Notes: Cluster-robust standard errors at the establishment level in parentheses. Significance: *, **, and *** denote statistical significance at the .1, .05 and .01 level respectively.
The correlation coefficient ρ measures the correlation in the error terms between selection equation and the outcome equation.
ME in brackets denotes the average marginal effect for the outcome equation. Level of significance according to the estimated coefficient.

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In the final step we present the results for all three equations using the multivariate probit approach. In this framework we take both the relationship between representation provided by the legislator and representation initiated by the management into account. Average marginal effects are presented for the outcome equation and are in line with the results of the bivariate probit estimates. Moreover, this framework allows us to also control for unobserved correlations affecting the likelihood of both representation schemes. Discussed in the theoretical section, the institutions might be substitutive, which can be tested by the coefficient rho, which is reported at the bottom of the table.

Similarly to the bivariate probit models, the results of multivariate probit results also support the hypothesis that endogeneity is a problem in the initial univariate probit estimates. When we additionally control for a possible endogenous determination of works councils, the coefficient of the alternative representation is again positive. We find significantly positive effects of alternative representation institutions on innovations for all three specifications. Alternative representation increases the likelihood of an incremental innovation by 16.4 percentage points and the works council by roughly 10 percentage points. The likelihood of a radical innovation is increased by roughly 25 percentage points and the likelihood of a process innovation by 26 percentage points when alternative institutions are present in the establishment.

The coefficient ρ_{32} indicates a highly negative correlation between alternative representation and co-determination rights provided by the legislator, thus indicating a substitutive relationship. Thus, the framework controls for unobserved correlations between representation regimes when all control variables are factored out. The coefficient ρ_{21} indicates a negative correlation between the existence of alternative voice and the corresponding type of innovation, implying that alternative voice is less likely when an innovation is more likely (or vice versa). The interpretation of the ρ_{31} coefficient follows the same rationale; however it is also not significant.[25] Hence, the explicit control for possible endogeneity has a strong effect on the results which indicates the relevance of bivariate and multivariate probit models. The weak link between works councils and innovation again is in line with earlier results on works councils. Still, the effects of this institution on innovation are rather limited (e.g. Addison et al. 2001, Jirjahn and Kraft 2011). The results of the control variables are mainly as expected:

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[25] However, we also conduct a likelihood ratio test provided by Monfardini and Radice (2008) on the joint significance of the rho coefficients. This test allows us to reject the null hypothesis (i.e. exogeneity) in all specifications. Hence the application of the recursive multivariate probit framework to take endogeneity into account is appropriate in our case.

innovativeness increases with firm size, further training and the share of high-skilled workers. The share of female workers also has a positive impact.

5 Conclusions

Establishments today have to deal with increased market competition in combination with challenges arising from technological changes such as artificial intelligence, big data and the use of robotics within the production process. One crucial factor in staying competitive in changing environments is the efficient usage and activation of employees' human capital (i.e. implicit firm-specific knowledge). We investigate how management-implemented employee representation affects the process of knowledge creation and thus technological progress in German establishments. The effects of alternative worker representation, which are voluntary and usually initiated by the management, are rarely investigated. In particular, the impact on innovation is neglected and, furthermore, a comparison with the influence of works councils is interesting. As works councils are institutionalized by the legislator and adopted if the workforce votes for them, differences to bodies introduced voluntarily by the management are quite likely. To the best of our knowledge, ours is the first study to explicitly model this relationship between statutory and non-statutory employee representation in Germany, especially with respect to establishments' innovative behavior.

We show that a more efficient bilateral communication channel between management and the workforce increases the likelihood of technological progress. On the one hand, the management can make more efficient decisions building upon specific shop-floor knowledge. On the other hand, employees are able to bundle needs and grievances and discuss them efficiently with the management. For our analysis we use 2,617 establishments sampled from the IAB Establishment Panel (6,309 observations) and first apply simple probit estimations to draw an initial insight into the effect of both types of employee representation. We use three different dependent variables measuring incremental as well as radical product and process innovations. In the case of univariate probit estimations, however, endogeneity might be a severe problem. To take account of this, we first take the lead of the dependent variables to make the channel stemming from employee representation to innovations more clear. As a second step we apply recursive bivariate and multivariate probit models, which take endogeneity problems of a binary variable affecting a binary outcome into account. In this context, we make use of exclusion restrictions (i.e. instrumental variables) allowing for a causal interpretation of the effects. Results show that endogeneity is indeed a problem and the

effects are quite different when we control for this problem. The true effect is highly underestimated in the univariate probit case. In all specifications we find significantly positive effects of alternative representation institutions on process innovation. The impact on incremental and radical product innovation is also positive, but only weakly significant. Works councils have a weakly significant impact on the likelihood of incremental product innovation. Due to their legally defined structure they might, however, be too inflexible regarding new products. Thus, works councils are associated with a negative coefficient for the impact on radical innovation.

The large effect of alternative representation bodies in the case of process innovation can be interpreted in two ways: First, involvement of the employees seems to have the strongest impact when their workplaces are directly affected. Probably, workers can contribute with information and knowledge that the management in many cases does not have. Secondly, the alternative representation bodies may reduce resistance to technological progress in the production process. This may be a major reason for the introduction of such two-way communication channels. In any case we think information collection and communication at the workplace is valuable for innovation development. Alternative representation is company-specific and in a sense better designed to address any problems specific to an establishment. As expected, further training as well as a large share of high-qualified workers are also associated with a higher probability of innovative behavior.

We also find a substitutive relationship between both types of representation. However, the particular reason for this is still unknown. A reasonable guess is that the management tries to avoid works councils with strong bargaining rights and therefore voluntarily implements alternative representation. This might be a possible approach for future research.

References

Acemoglu, D. and P. Restrepo (2017), Robots and Jobs: Evidence from Us Labor Markets, NBER Working Paper No. w23285.

Addison, J. (2009). The economics of codetermination: Lessons from the German experience. Springer.

Addison, J. T., C. Schnabel and J. Wagner (1996), German works councils, profits, and innovation, Kyklos, 49(4), 555-582.

Addison, J. T., C. Schnabel and J. Wagner (2001), Works councils in Germany: their effects on establishment Performance, Oxford economic papers, 53(4), 659-694.

Addison, J. T., P. Teixeira, K. Evers and L. Bellmann (2017), Collective bargaining and innovation in Germany: A Case of Cooperative Industrial Relations? Industrial Relations: A Journal of Economy and Society, 56(1), 73-121.

Addison, J. T., P. Teixeira and T. Zwick (2010), German works councils and the anatomy of wages, Industrial and Labor Relations Review, 63(2), 247-270.

Aerts, K., K. Kraft and J. Lang (2015), Profit sharing and innovation, Industrial and Corporate Change, 24(6), 1377-1392.

Aghion, P., P. Howitt, P. W. Howitt, M. Brant-Collett and C. García-Peñalosa (1998), Endogenous Growth Theory. MIT Press.

Appelbaum, E., T. Bailey, P. B. Berg, A. L. Kalleberg and T. A. Bailey (2000), Manufacturing advantage: Why high-performance work systems pay off. Cornell University Press.

Belloc, F. (2012), Corporate governance and innovation: A survey, Journal of Economic Surveys, 26(5), 835-864.

Bender, S., N. Bloom, D. Card, J. Van Reenen and S. Wolter (2018), Management practices, workforce selection, and productivity, Journal of Labor Economics, 36(1), 371-409.

Black, S. E. and L. M. Lynch (2001), How to compete: the impact of workplace practices and information technology on productivity, The Review of Economics and Statistics, 83(3), 434-445.

Bloom, N., B. Eifert, A. Mahajan, D. McKenzie and J. Roberts (2013), Does management matter? Evidence from India, The Quarterly Journal of Economics, 128(1), 1-51.

Bloom, N. and J. Van Reenen (2011), Human resource management and productivity. In Handbook of labor economics(Vol. 4, pp. 1697-1767). Elsevier.

Brynjolfsson, E. and A. McAfee (2014), The second machine age: Work, progress, and prosperity in a time of brilliant technologies. WW Norton and Company.

Cameron, A. C. and P. K. Trivedi (2005), Microeconometrics: methods and applications. Cambridge university press.

Cappellari, L., and S. P. Jenkins (2003), Multivariate probit regression using simulated maximum likelihood, The Stata Journal, 3(3), 278-294.

Cappelli, P. and D. Neumark (2001), Do "high-performance" work practices improve establishment-level outcomes? Industrial and Labor Relations Review, 54(4), 737-775.

Chen, Y., E. J. Podolski and M. Veeraraghavan (2015), Does managerial ability facilitate corporate innovative success? Journal of empirical finance, 34, 313-326.

Coad, A., A. Segarra and M. Teruel (2016), Innovation and firm growth: Does firm age play a role? Research Policy, 45(2), 387-400.

Cohen, W. M. (2010), Fifty years of empirical studies of innovative activity and performance. In Handbook of the Economics of Innovation (Vol. 1, pp. 129-213). North-Holland.

Cooke, W. N. (1994), Employee participation programs, group-based incentives, and company performance: A union-nonunion comparison, Industrial and Labor Relations Review, 47(4), 594-609.

Dachs, B. and B. Peters (2014), Innovation, employment growth, and foreign ownership of firms: A European perspective, Research Policy, 43(1), 214-232.

Dahlin, K. B. and D. M. Behrens (2005), When is an invention really radical? Defining and measuring technological radicalness, Research Policy, 34(5), 717-737.

Damanpour, F. (1991), Organizational innovation: A meta-analysis of effects of determinants and moderators, Academy of Management Journal, 34(3), 555-590.

Dasgupta, D. (2010), Modern growth theory, Oxford University Press.

De Spiegelaere, S. and G. Van Gyes (2012), Employee-Driven Innovation and Industrial Relations, Employee Driven Innovation (pp. 230-245). Palgrave Macmillan, London.

Delaney, J. T. and J. Godard (2002), An industrial relations perspective on the high-performance paradigm, Human Resource Management Review, 11(4), 395-429.

Ellguth, P. (2005), Betriebe ohne Betriebsrat - welche Rolle spielen betriebsspezifische Formen der Mitarbeitervertretung, Industrielle Beziehungen, 12 (2), 149-176.

Ellguth, P. (2009). Betriebsspezifische Formen der Mitarbeitervertretung - Welche betriebe, welche Personal-politischen Wirkungen? Industrielle Beziehungen, 16(2), 109-135.

Ellguth, P., S. Kohaut and I. Möller (2014), The IAB Establishment Panel - methodological essentials and data Quality, Journal for Labour Market Research, 47(1-2), 27-41.

Ertelt, S., B. Hirsch and C. Schnabel (2017), Betriebsräte und andere Formen der betrieblichen Mitarbeitervertretung–Substitute oder Komplemente, Industrielle Beziehungen, 24(3), 297-321.

Evangelista, R. and A. Vezzani (2012), The impact of technological and organizational innovations on employment in European firms, Industrial and Corporate Change, 21(4), 871-899.

Filippini, M., W. H. Greene, N. Kumar and A. L. Martinez-Cruz (2018), A note on the different interpretation of the correlation parameters in the Bivariate Probit and the Recursive Bivariate Probit, Economics Letters, 167, 104-107.

Fisman, R., and J. Svensson (2007), Are corruption and taxation really harmful to growth? Firm level evidence, Journal of Development Economics, 83(1), 63-75.

Freedman, D. A., and J. S. Sekhon (2010), Endogeneity in probit response models, Political Analysis, 18(2), 138-150.

Freeman, R.B. and J. L. Medoff (1984), What Do Unions Do? New York: Basic Books.

Geweke, J. (1991), Efficient simulation from the multivariate normal and student-t distributions subject to linear constraints and the evaluation of constraint probabilities. Computing science and statistics: Proceedings of the 23rd symposium on the interface Interface Foundation of North America, Inc., Fairfax Station, VA, 571-578.

Greene, W. H. (2003), Econometric analysis. Pearson Education India.

Hajivassiliou, V. A., and P. A. Ruud (1994), Classical estimation methods for LDV models using simulation, Handbook of econometrics, 4, 2383-2441.

Han, S., and E. J. Vytlacil (2017), Identification in a generalization of bivariate probit models with dummy endogenous regressors, Journal of Econometrics, 199(1), 63-73.

Harrison, R., J. Jaumandreu, J. Mairesse and B. Peters (2014), Does innovation stimulate employment? A firm level analysis using comparable micro-data from four European countries, International Journal of Industrial Organization, 35, 29-43.

Hauser-Ditz, A., M. Hertwig and L. Pries (2013), Collective employee representation in German companies: Coverage and contextual conditions, Employee Relations, 35(5), 509-526.

Hausman, A., and W. J. Johnston (2014), The role of innovation in driving the economy: Lessons from the global financial crisis, Journal of Business Research, 67(1), 2720-2726.

Heckman, J. J. (1978), Dummy endogenous variables in a simultaneous equation system, Econometrica 46: 931-959

Hertwig, M. (2011), Patterns, ideologies and strategies of non-statutory employee representation in German private sector companies, Industrial Relations Journal, 42(6), 530-546.

Hübler, O. and U. Jirjahn (2003), Works councils and collective bargaining in Germany: the impact on productivity and wages, Scottish Journal of Political Economy, 50(4), 471-491.

Ichniowski, C., K. Shaw and G. Prennushi (1997), The effects of human resource management practices on productivity: A study of steel finishing lines, The American Economic Review, 87(3). 291-313.

Jirjahn, U., and K. Kraft (2011), Do spillovers stimulate incremental or drastic product innovations? Evidence from German establishment data, Oxford Bulletin of Economics and Statistics, 73(4), 509-538.

Kassouf, A. L. and R. Hoffmann (2006), Work-related injuries involving children and adolescents: Application of a recursive bivariate probit model, Brazilian Review of Econometrics, 26(1), 105-126.

Kaufman, B. E. and D. G. Taras (2016), Nonunion employee representation: history, contemporary practice and policy. Routledge.

Kesting, P. and J. P. Ulhøi (2010), Employee-driven innovation: extending the license to foster innovation, Management Decision, 48(1), 65-84.

Knapp, L. G. and T. G. Seaks (1998), A Hausman test for a dummy variable in probit, Applied Economics Letters, 5(5), 321-323.

Kraft, K. and J. Lang (2016), Just a Question of Selection? The Causal Effect of Profit Sharing on a Firm's Performance, Industrial Relations: A Journal of Economy and Society, 55(3), 444-467.

Kraft, K., J. Stank, J. and R. Dewenter (2009), Co-determination and innovation, Cambridge Journal of Economics, 35(1), 145-172.

Lee, H. and B. Choi (2003), Knowledge management enablers, processes, and organizational performance: An integrative view and empirical examination, Journal of management information systems, 20(1), 179-228.

MacDonald, Z. and M. A. Shields (2004), Does problem drinking affect employment? Evidence from England, Health economics, 13(2), 139-155.

Machin, S. and S. Wadhwani (1991), The effects of unions on organisational change and employment, The Economic Journal, 101(407), 835-854.

Maddala, G. S. (1986), Limited-dependent and qualitative variables in econometrics (No. 3). Cambridge university press.

Marra, G. and R. Radice (2011), Estimation of a semiparametric recursive bivariate probit model in the presence of endogeneity, Canadian Journal of Statistics, 39(2), 259-279.

Monfardini, C. and R. Radice (2008), Testing exogeneity in the bivariate probit model: A Monte Carlo study, Oxford Bulletin of Economics and Statistics, 70(2), 271-282.

Penrose, E. (1959), The Theory of the Growth of the Firm. Basil Blackwell, Oxford, UK.

Peters, B. and C. Rammer (2013), Innovation panel surveys in Germany, Handbook on Innovation Indicators and Measurement, Cheltenham: Edward Elgar, 135-177.

Romer, P. M. (1990), Endogenous technological change, Journal of political Economy, 98(5, Part 2), 71-102.

Savignac, F. (2008), Impact of Financial Constraints on Innovation: What Can Be Learned from a Direct Measure, Economics of Innovation and New Technologies, 17(6), 553-569.

Schumpeter, J. (1942), Socialism, capitalism and democracy. Harper and Brothers.

Seifert, M., J. Brockner, E. C. Bianchi and H. Moon (2016), How workplace fairness affects employee commitment, MIT Sloan Management Review, 57(2), 15.

Stettes, O. (2010), Verbreitung und ökonomische Effekte von Betriebsräten und alternativen Mitbestimmungsformen in der Industrie und deren Verbundbranchen, Sozialer Fortschritt, 59(8), 199-209.

Ulph, A. and D. Ulph (1988), Bargaining structures and delay in innovation, The Scandinavian Journal of Economics, 475-491.

Vandenbussche, J., P. Aghion and C. Meghir (2006), Growth, distance to frontier and composition of human capital, Journal of economic growth, 11(2), 97-127.

Wilde, J. (2000), Identification of multiple equation probit models with endogenous dummy regressors, Economics letters, 69(3), 309-312.

Wolf, E. and T. Zwick (2008). Reassessing the productivity impact of employee involvement and financial incentives, Schmalenbach Business Review, 60(2), 160-181.

Wooldridge (2010), Econometric Analysis of Cross Section and Panel Data: Second Edition.

Zoghi, C., R. D. Mohr and P. B. Meyer (2010), Workplace organization and innovation, Canadian Journal of Economics, 43(2), 622-639.

Zouaghi, F., M. Sánchez and M. G. Martínez (2018), Did the global financial crisis impact firms' innovation performance? The role of internal and external knowledge capabilities in high and low tech industries, Technological Forecasting and Social Change, 132, 92-104.

Zwick, T. (2004), Employee participation and productivity, Labour Economics, 11(6), 715-740.