Collective Bargaining and Innovation in Germany: A Case of Cooperative Industrial Relations?

JOHN T. ADDISON, PAULINO TEIXEIRA, KATALIN EVERS, and LUTZ BELLMANN*

At the level of theory, the effect of collective bargaining on innovation is disputed. The large proponderance of the U.S. evidence clearly points to adverse effects, but other-country experience suggests that certain industrial relations systems, or the wider regulatory apparatus, might even tip the balance in favor of unions. Our pooled cross section and difference-in-differences estimates provide some weak evidence that German collective bargaining *inhibits* innovation. However, in conjunction with workplace representation, there is the suggestion that it might actually foster innovative activity.

---

*The authors' affiliations are respectively, Department of Economics and Finance, Durham University Business School, Durham, England, and Department of Economics, Moore School of Business, University of South Carolina, Columbia, SC 29208. Email: ecceaddi@moore.sc.edu; Faculdade de Economia, Universidade de Coimbra, Coimbra, Portugal. Email: pteixeira@fe.uc.pt; Institut für Abeitsmarkt- und Berufsforschung, Bundesagentur für Arbeit, Nürnberg, Germany. Email: Katalin.Evers@iab.de; Friedrich-Alexander-Universität Erlangen-Nürnberg, and Institut für Arbeitsmarkt- und Berufsforschung, Bundesagentur für Arbeit, Nürnberg, Germany. Email: Lutz.Bellmann@iab.de.

Introduction

The topic of collective bargaining and investment in intangible (and tangible) capital has been the subject of considerable controversy for a number of years now. The debate remains unsettled, although theory has tended to look with more favor upon the union entity if it is located in an "appropriate" institutional setting. Theory has in one sense been channeled in this direction by empirical research pointing to a sharp dichotomy between North American findings that are almost invariably negative in respect of the union impact on innovation capital and European research that generally points to an absence of significant associations once one proceeds much beyond the raw correlations in the data.

In the present paper, we focus on the innovative activities of German establishments over the six-year observation window, 2007–2012. Our measure of innovation is the actual (or successful) introduction of some product or process innovation (although we shall also investigate *failure to innovate*). Apart from allowing us to consider a new output indicator, our choice of Germany was predicated on that nation's unique structure of cooperative industrial relations, early research seeming to offer some confirmation of the benefits of cooperation provided the level of union density is not "excessive."

We use both extensive descriptive analysis and regression techniques to evaluate the role of different institutional arrangements on innovation, while controlling for a wide array of establishment-level observables. We also tackle unobserved establishment heterogeneity by constructing different establishment subsamples and then investigating differences in changes in the incidence of innovation using appropriate comparison groups of innovating and non-innovating establishments in combination with collective bargaining (and works council) switchers and collective bargaining stayers in a difference-in-differences framework. This approach to isolating the causal effect of labor institutions, using changes in collective bargaining status as the main identification vehicle, is new in this literature. (For another approach, see the discussion of Bradley, Kim, and Tian, 2014, below.)

The structure of the paper is as follows. First, we provide a comprehensive statement of the theory of collective bargaining/unionism and innovation with a view to justifying consideration of the German case, while deriving a set of more targeted hypotheses related to that nation. Second, we examine the empirical evidence on innovation, with the goal of drawing a distinction between the North American evidence and *the rest* before examining a

still sparse extant German literature by way of scene-setting. Third, we review the unique dataset used in this inquiry and introduce the key innovation measures and explanatory variables. Fourth, we present a set of descriptive results on the frequency and continuity of the different types of innovative activity and describe the unconditional and conditional (on union/worker representation) probabilities of an establishment having a particular type of innovation. Fifth, our detailed cet. par. results are presented, together with robustness checks. A summary concludes, the burden of which is that German collective bargaining is not generally to be construed as inhibiting innovation and may indeed prove beneficial when accompanied by workplace codetermination.

Theoretical Considerations

Theory suggests that collective bargaining can have positive as well as negative effects on innovation. In the traditional model, the union-set wage is represented as an exogenous change in the price of labor, the firm in response adjusting employment along its labor demand curve. In this case, the union premium or tax is levied on labor. Union firms duly substitute away from expensive labor. The net effect is unclear. It depends on the degree of substitutability between capital and labor and the magnitude of the scale effect as the premium filters through into higher product prices and output falls.

By contrast, the more modern view is that unions tax *capital*, that firms respond unambiguously by cutting tangible and intangible capital investments, and that the wage is endogenous. The idea is that unions expropriate part of the quasi-rents that form part of the normal (i.e. competitive) returns to capital but which are vulnerable to capture once investment in specialized plant and equipment and R&D has been made. We note parenthetically that R&D expenditures have been used in the literature as a key indicator of the asset specificity of an investment (see Cavanaugh, 1989). Familiarly, such assets will continue in use as long they earn a return above their alternative use; the more specific the asset, the bigger the scope for union rent seeking. Of course, with the relation-specific capital *in situ*, higher wages are unlikely to influence the use of the asset, but firms will anticipate reduced returns to such capital and invest less.

This is the so-called “hold-up” problem, first analyzed by Grout (1984). In the simple one shot two-stage game summarized by Menezes-Filho and van Reenen (2003, p. 296), the firm first chooses a level of capital (either high or low) and in the next round the union

chooses the wage (high/low). By backward induction, the union will always choose a high wage in the second stage and, knowing this, the firm will always choose a low investment strategy at the first stage. Further, the union tax on investment will vary directly with the specificity of the asset and its longevity. The tax would vanish were the union able to commit itself to a low wage strategy by posting a bond or hostage to a third party, or where there is bargaining over investment as well as wages.[1]

However, collective bargaining is repeated over time rather than being a one-shot exercise and, abstracting from an end-game scenario (Lawrence and Lawrence, 1985), repeated games offer a solution to the hold-up problem since opportunistic behavior can in principle be appropriately punished (e.g. van der Ploeg, 1987). An important issue in the literature has been the degree to which unions discount the future. In particular, it has been argued that because union members do not have property rights in the union they will be rationally myopic and discount the future at a higher rate than shareholders. And this tendency will be reinforced by the greater influence of older workers in union councils (Hirsch and Prasad, 1995). Accordingly, much hinges in a repeated game context on the union's discount factor[2] and the success of firms in extending the union's horizon (including greater recourse to debt), as well as inefficient defensive strategies such as the maintenance of inefficient capital or plants to facilitate substantial cuts in employment as a short-run profit-maximizing response to wage demands (for a discussion, see Baldwin, 1983).

There remains a strong presumption in the unions-and-investment literature, therefore, that greater worker representation will depress investments in physical and intangible capital – the Grout result – and will be accompanied by second-best responses. Abstracting from the related possibility that union firms might license out innovations rather than develop them in house – which might lead to no difference in *patenting* as between union and nonunion regimes – a number of theoretical caveats and new developments have also to be recognized.

First, the hold-up model ignores the strategic component of innovative activity. The argument here is that much R&D is conducted by large firms that operate in oligopolistic industries. Menezes-Filho and van Reenen (2003, p. 299) argue that this strategic interaction undermines the analytical clarity of the Grout result. Drawing on Ulph and Ulph's (1994, 2001) patent race model, they illustrate the circumstances in which stronger unions can actually increase R&D spending.[3]

Second, unions can help the adoption and spread of new techniques by articulating workers' "collective voice" (Freeman and Medoff, 1984). The labor market context is important here: it is (largely) one of continuity rather than spot market contracting because of on-the-job skills specific to the firm and the costs attaching to worker mobility and turnover. Collective bargaining may be more effective than individual bargaining in overcoming workplace public goods problems and attendant free-rider problems. As the workers' agent, unions may facilitate the exercise of the workers' right to free speech, acquire information, monitor employee behavior, and formalize the workplace governance structure (see below) in such a way that better represents average workers who are more skilled. Given an appropriate response by management and a cooperative industrial relations environment, greater training, lower turnover, and better morale can help the adoption and spread of new techniques. As noted by Menezes-Filho and Van Reenen (1998: 46), if the innovations generated by R&D are adopted by the firm or if one of the purposes of R&D is to facilitate the capture of spillovers from other firms (referred to as "absorptive capacity"), then unions will affect the costs of implementation and have an indirect effect on the price of investing in R&D. Absorption will also be reflected in the innovation embedded in new plant and equipment. But there are no guarantees, and the union rule book and poor industrial relations could slow down technological adoption.

Third, and relatedly, unionism can facilitate efficient contracting in situations where there is a long-term relation between the two sides but where employer's ex ante promises to take workers' interests into account are not credible or where the reputation effects mechanism is weak. This characterization of the union as a commitment device was first advanced by Malcomson (1983). For their part, Freeman (1976, p. 364) and Freeman and Medoff (1984, p. 11) argue that the union governance apparatus of the collective voice model sketched above is quite consistent with the modern contracts literature, not least in addressing the possibility that the hold-up problem might also apply to the capture of the sunk investments of workers by the employer, leading to under-investment in human capital. Thus, the presence of a union specializing in information about the contract and in the representation of workers can prevent employers from engaging in opportunistic behavior. Further, workers may withhold effort and cooperation when the employer cannot credibly commit to take their interests into account. The formation of a union and the introduction of a system of industrial jurisprudence is one way of protecting the employees. That said, there

is a downside: the threat of credible punishment implies bargaining power, the expression of which can undermine the union voice solution to the governance (and informational) problems of continuity markets.

We will next proceed to look at more specific institutional arrangements that might be expected to influence the impact of unionism on innovation.[4] We consider in turn the role of different collective bargaining structures and the laws governing the employment relation as possible offsets to unfavorable union or firm effects on innovation. Beginning with collective bargaining structures, the most relevant analysis is that of Haucap and Wey (2004), whose framework is that of a unionized oligopoly model with two firms that are engaged in a patent race for an innovation that lowers the labor required per unit of output (i.e. a process innovation). Innovation provides the only route for achieving a competitive edge in this setting. With the introduction of a process innovation, the investment cost of the innovation is sunk and labor's productivity rises. The size of the (specific) investment cost indexes the scale of the hold-up problem confronted by the firm under unionization. The setting is a three-stage game in which a wage-bill-maximizing union sets the wage and the firm the level of employment, and where the firms compete in Cournot fashion in the product market.

But now the specific type of collective bargaining emerges as a crucial determinant of the firms' investment incentives. Haucap and Wey distinguish between three modes of unionism: decentralized, coordinated, and centralized. Decentralized bargaining is where there are two separate firm-level unions that set wages independently and non-cooperatively. Coordination refers to a situation where a common, industry union sets wages *separately* for the two firms so as to maximize the industry wage bill. Finally, centralization refers to a common union that sets a single uniform wage standard for the two firms, again so as to maximize the industry wage bill. The model shows that firms' incentives to innovate are largest under centralization and smallest under coordination. This is because coordination permits the monopoly union to exploit its hold-up potential fully by setting discriminatory wages, while the other two union types constrain union power. Under centralization since wages are set according to average productivity, once a firm innovates industry productivity will rise and along with it the wage. But the wage rises less than the productivity secured by the innovation at firm level and the innovating firm will not therefore lose the entire surplus generated. Contrast this situation with coordination, where the firm will lose all the gains of a cost-reducing innovation since the wage will rise *pari passu* with productivity. Finally, under

decentralization, the union of the now less efficient firm makes wage concessions to restore that firm's competitiveness. From this perspective, sectoral bargaining in Germany – centralized bargaining in the language of the model – offers a marginally more favorable regime for (process) innovation than the more decentralized United States.

Another recent institutional application builds on employer hold-up of *innovating employees* – rather than the more standard worker training investments. Acharya, Baghai, and Subramanian (2012) specify a game in which the employer first recruits an employee and chooses to invest in either an innovative or a routine project in period 0, each requiring the same initial investment and generating cash flow at t=2. At t=1 the employee invests firm-specific effort which affects the innovative project outcome. This effort is observable but not verifiable ex ante. At time t=1.5 each party learns whether or not the project yielded an innovation. If the employee has invested sufficient effort, it does. Familiarly, the model rules out the possibility of complete contracts at t=0 so that at point t=1.5, after the employee has made the firm-specific effort and it is known that the project has generated a successful innovation, that individual is exposed to the possibility of hold-up. The employer can threaten to fire the employee to reduce the employee's bargaining power. And the innovating employee may take steps to hold on to bargaining power, prompting the employer to replace him or her with new employees.

At this stage, the authors introduce a wrongful discharge law that allows the fired employee legal recourse in the event that the innovation was successful. Even though the commitment problem is not eradicated, the law lowers the probability of employer malfeasance and increases employees' innovative efforts, thereby encouraging firms to invest in innovative projects. Given its more encompassing dismissals protection, Germany (and some U.S. states) would again appear better protected from this form of hold-up than the United States (other U.S. states).

If the above institutional characteritics modify the standard hold-up analysis in potentially important ways, there is a specific German worker representation agency that also needs to be addressed at this point, namely the works council, or *Betriebsrat*. The works council is the second component of that nation's dual system of industrial relations – the first being the system of sectoral collective bargaining.[5] Given their location at the workplace and restricted bargaining rights, works councils are in principle an exemplary voice institution. Indeed, Freeman and Lazear (1995) contend that the machinery of the works council holds

out the prospect of an improvement in the joint surplus of the enterprise because of that body's unique information, consultation, and participation/co-determination rights. Having access to information that can verify management claims, the works council can render them credible to the workforce and preempt retaliatory behavior, resulting in increased effort flexibility. For its part, consultation allows new solutions to production and other workplace problems by virtue of the non-overlapping information sets of the two sides and the creativity of discussion. Finally, participation or co-determination rights generate an improvement in the joint surplus by providing workers with greater security, encouraging them to take a longer-run view of the prospects of the firm. The issue of the time horizon of workers is it will be recalled an important consideration in investment models.

Freeman and Lazear nevertheless argue that workers may be expected to demand too much involvement because their share in the joint surplus of the enterprise will continue to rise after that surplus has peaked. Accordingly, firms will either resist works councils or vest them with insufficient power. It is at this point that the wider industrial relations/legal context in which the German works council is embedded commends itself to Freeman and Lazear because of the limits placed on their rent seeking. In particular, works councils cannot call a strike nor can they (without authorization) negotiate terms that are settled or normally settled by collective agreements at sectoral level. At issue, is whether there is a sufficient decoupling of production from distribution issues in practice, with some theory and empirical research (e.g. Hübler and Jirjahn, 2003) suggesting that the discipline of an industry agreement makes this more likely. This argument also addresses the ambiguity concerning union strength, it being acknowledged that U.S. unions are weaker than their European counterparts.

In the light of the above, there are grounds for believing that the German model may be more favorable to innovation than the North American model, despite unionism being more powerful. To be sure it is unclear whether the dominant form of collective bargaining in Germany is intrinsically beneficial/benign or whether its negative/redistributive effects are mitigated by other institutional arrangements such as a more regulated labor market and dismissals protection (Doucouliagos and Laroche, 2013). But set within the context of the dual model, there are grounds for expecting a potentially more positive impact of collective bargaining through the expression of collective voice.

The Empirical Literature

In what follows, we examine the empirical literature on unions and innovation, excluding results for tangible capital other than in passing. We begin with a brief summary of a major cross-country review that also examines some early German studies. Next, we investigate the most recent U.S. evidence, drawing on two state-of-the-art studies. Finally, we investigate the still sparse modern German literature. A modified set of implications for our own study concludes.

Cross-Country Evidence. In a review of some 31 national studies, Menezes-Filho and van Reenen (2003) examine the impact of unionism on R&D intensity (14 studies), the output of R&D/head count of measures of innovation (5 studies), and technology diffusion/the adoption of technology (12 studies).[6] The clearest results are for R&D intensity. The North American studies all point towards strongly negative effects of unions on R&D intensity, whereas the European studies suggest either insignificant effects or material non-linearities. For example two German studies by Schnabel and Wagner report no effect of union density at industry level (1992a) but a positive effect at firm level providing union density is not too high (1994). Second, studies examining the impact of union power on counts of innovations are sparse (but see below) and point in Anglo-Saxon countries to negative but not always significant effects. The only early German study by Schnabel and Wagner (1992b) indicates positive but insignificant effects of unions (actually, works councils). Third, altogether more numerous are investigations of unions and technological diffusion but now the findings for the almost exclusively Anglo-Saxon national studies vary widely. That said, positive raw correlations between unionism and diffusion usually become insignificant when other arguments such as wages and training enter the set of covariates. The sole other-country study cited in the survey reports a negative and significant effect of German unionism – strictly 'organized labor,' namely union density interacted with works council presence – on the proportion of sales accounted for by products introduced within the previous 5 years (FitzRoy and Kraft, 1990).[7]

Recent U.S. Studies. Two studies not included in extant cross-country studies are those of Acharya, Baghai, and Subramanian (2012) and Bradley, Kim, and Tian (2013) for the United

States. From the previous section it will be recalled that Acharya, Baghai, and Subramanian argue that wrongful discharge laws spur innovation in circumstances where the employer and the employee cannot commit to a contract that prohibits either of them from acting in bad faith ex post. The model is tested using patent and financial data on 5,698 U.S. firms, 1971-1999. The authors examine the role of most important exception to the U.S. common law hire-at-will principle, namely the "good faith exception," which applies when a court determines that an employer has discharged an employee in bad faith. The base outcome indicators are the number of patents granted and the number of citations to patents. The empirical model examines the before-and-after effect of a change in the law recognizing the good faith exception on innovative activity in affected states versus the before-and-after effect in states where no such change was introduced. The authors report firstly that the adoption of the good faith clause led to an increase in the annual number of patents (citations) of 12.2 (18.8) percent vis-à-vis firms in states which did not pass this law. Secondly, innovative effort as measured by patents (citations) scaled by the number of employees, or by R&D expenditure, increased materially with the adoption of the good faith exception. Finally, the impact of the good faith exception was much stronger in innovation-intensive industries.[8]

The above study does not look at unions. The latest technique employed in seeking unbiased estimates of the effects of unions on innovation (here patenting activity) has exploited regression discontinuity methods, comparing the innovation output of firms in which unions win representation elections by a small margin of votes with that of firms in which the vote is lost by a small margin. The maintained hypothesis is that in such close-call elections, union success approximates an independent random event, unlikely to be contaminated by unobserved firm heterogeneity. In deploying this regression discontinuity design, Bradley, Kim, and Tian (2013) use NLRB union election result data, 1980-2002, matched to innovation data from the NBER Patent Citation database. Two measures of innovation are constructed, namely patent quantity and patent quality. Patent quantity is the firm's total number of patent applications filed in a given year that are eventually granted. Patent quality is the count of non-self citations received by each patent in subsequent year. The long-term nature of the innovation process is captured by relating data on labor unions and other characteristics in the current year to the innovation measures some one, two, and three years subsequent to the election result. A clear discontinuity in patent outcomes is detected at the threshold in each of the three years following elections. Specifically, the

authors' preferred regression discontinuity design results, using a local linear estimation technique, indicate declines in innovation output of 8.7 per cent in the case of patent quantity and 12.5 percent, in patent quality in the wake of election victories.[9]

The authors interpret their results as consistent with misaligned incentives produced by incomplete contracting and the hold-up problem, enhanced shirking as a result of greater protection against dismissals in union regimes leading directly to lower worker productivity, and negative selection among union workers attendant upon wage compression. The conflict with the Acharya, Baghai, and Subramanian study might be reconciled if wrongful discharge is a low intensity form of employee protection and union representation as high intensity employee protection.

Recent German Innovation Studies. Studies investigating the effect of German works councils – codetermination at the plant level[10] – have proliferated in recent years and vastly outnumber studies of the effect of collective bargaining proper. But innovation studies are sparse. The early literature involved small company samples and is not further reviewed here. In the first study using a large sample of manufacturing establishments (N=1,025) in Lower Saxony in 1994, Addison, Schnabel, and Wagner (2001) report an absence of association between the works council dummy and their two measures of innovative activity, namely whether or not the establishment introduced a new product or a new process in the previous year (see also Addison , Schnabel, and Wagner, 1996). Unfortunately, although the quality of the survey material is generally high, this is not the case for workplace union density where the imprecision of survey responses was too severe to exploit this question.

Subsequent innovation studies point to a generally favorable view of the works council entity. Canter, Gerstlberger, and Roy (2014) consider the role of human capital/training as an input into technological innovation. The authors distinguish between general and firm-specific capital in influencing innovation and the role of collective bargaining and worker representation in their provision. It is argued that general human capital – taken to include such things as training for improving teamwork and communication and training related to problem-solving skills (and hence much closer to human resource management practices than to Becker's vision of general training) – has a low priority for the firm but a high priority for the works council. On the other hand, firm-specific human capital – identified with training in machine operations and technical instruction – is held to be of key concern to employers but

of less interest to works councils since it applies to a subset of the labor force while they are representative of the entire workforce. The prediction is that general training but not specific training will be positively correlated with works council presence, while firms will undertake firm-specific training to improve the knowledge base that is required to be successful in innovation. The link between general training and innovation performance is not expected to be strong but its breadth is predicted to improve the absorptive capacities of the firm. This leads the authors to distinguish between incremental and radical innovation. It is argued that the former is likely to be facilitated by both types of training, while the latter should be more influenced by firm-specific training as this type of innovation requires a strong technical knowledge base of the employees.

Using data from a representative sample of German establishments in 2011 (n=256), the authors construct index measures of the intensity of the two types of training (plus an aggregate index of total training) and binary measures of incremental and radical innovation. Among the controls for firm-level and industry level characteristics is the existence of a sectoral collective bargaining agreement. It is found that works council presence is positively correlated with general training but not with the provision of firm-specific technical training. The coefficient estimate for the collective agreement dummy is insignificant throughout and the same is true for the interaction term between works council presence and a collective agreement. Next, logit estimates of the determinants of incremental innovations show positive and well determined coefficients all three training measures and insignificant coefficients for collective bargaining. The logits for radical innovation reveal a strong positive correlation between firm-specific training and radical innovation but a weak positive correlation for general training, although neither survives accounting for reverse causality (with successful innovators being more likely to invest in training activities).

Four German-language works council studies also merit consideration because of their recognition of the importance of type and/or strength (and weakness) of the agency. Dilger (2002) uses data from the Technology and Work Organization in Mechanical Engineering (NIFA) Panel, 1991-1998, that not only contains information on whether or not the firm has a works councils but also allows for differentiation between types of works council, including their degree of involvement as assessed by management while charting their foundation and dissolution. Although Dilger's results point to a positive but insignificant impact of the entity on product innovation, the works council effect assumes significance in circumstances where

managers consider the agency to embody greater responsibilities than legally prescribed under law. A similar result is reported by Scholl, Breitling, Janetzke, and Shajek (2013) in their study of how and to what effect works councils and employees participate in process innovations, broadly interpreted. They authors offer 44 case studies (19 drawing on (re)organization, 19 dealing with changes in personnel policy such as improvements in work-life balance, and 6 involving software innovations). The authors' path analyses support their central hypothesis that the more intense works council and employee involvement, the more successful and encompassing are process innovations of this genre.

In their analysis of approximately 1,700 responses to the Works Council Survey 2008/2009 of the WSI (*Wirtschafts- und Sozialwissenschaftliches Institut*, or Economic and Social Research Institute),[11] consisting of a random sample of private-sector companies with a works council and at least 20 employees, and separate evaluation of 26 case studies, Kriegesmann and Kley (2012) offer a potentially important qualification. Although the study suggests that works councils display a positive attitude toward innovation and are motivated to develop their own ideas on involvement in the innovation processes, the most important obstacles inhibiting innovation-oriented co-determination are also laid at the door of the agency. Here, the authors single out the contextual and specific knowledge deficits of councils.

Finally, Jirjahn (2012) returns us to the works council-collective bargaining nexus. Using information from the second wave of the Hannover Firm Panel, he examines the effect of works councils and collective bargaining on (successful) innovative activity, as indexed by the share of turnover accounted for by newly-developed products. He reports that neither works councils nor sectoral bargaining taken in isolation significantly influence innovative activity. However, allowing for the interaction between the two institutions proves decisive. Collective bargaining now has a significantly negative impact on innovation success, and although the works council own-effect remains insignificant once interacted with collective bargaining its effect is strongly positive. The principal rationalization is that where works councils are less concerned with distributional conflict their cooperative function can come to the fore and foster greater innovative success.

The modern German literature thus suggests that the institutions of industrial relations might have different effects on different types of innovation and that this may in part reflect the degree of involvement and authority of the workplace institution. The results

are mixed with respect to the interaction between works councils and collective bargaining proper, which outcome may in part reflect unobserved differences in works council type. Although our dataset does not allow us to operationalize a typology of works councils we can differentiate between innovation types. More importantly, we can examine in some detail the interaction between industrial relations institutions as well as the largely neglected issue of causation.[12] In paying close attention to the causation issue, we will follow a research strategy more in keeping with Addison, Schank, Schnabel, and Wagner's (2007) investigation of investment in physical capital. These authors used several complementary estimation strategies that exploit the formation or dissolution of a works council – comparing plants that set up (dissolved) councils with those that never (always) had a works council. No evidence was found to suggest that the formation (abandonment) of a council had an unfavorable (favorable) effect on investment. Nor for that matter were changes in works council found to have positive effects on the investment bottom line. However, the authors only examined changes in works council status between 1998 and 2000 (linked to changes in investment between 2000 and 2003), and were at pains to caution that changes in these worker representation bodies were rare events. For example just 29 (33) plants set up (dissolved) works councils compared with the 1,668 (765) plants in which they were never (always) present). *Vulgo*: identification on the basis of changes in work council status is hazardous, even if an improvement on the standard cross section dichotomous variable approach. We are on firmer ground not only in considering a longer interval but also in focusing on changes in collective bargaining when investigating the bargaining-works council nexus.

The Dataset

Our dataset is extracted from the most comprehensive establishment-level survey conducted in Germany, namely the IAB Establishment Panel *(IAB-Betriebspanel*). Designed to encompass a wide range of employment policy-related topics, including labor force composition and turnover (hiring and separations), wages, working hours, training, and public funding, as well as investment, innovation, and other business policies and developments, the Establishment Panel is an annual representative sample that currently covers some 16,000 establishments in all sectors of the economy. Most importantly for our purposes, the survey comprises a longitudinal component that is critical in our approach to identification, as

described in the next two sections of the paper. (Further details on the IAB establishment survey are to be found in Ellguth, Kohaut, and Möller, 2014, and Fischer et al., 2009.)

Our observation window covers the 2008-2013 surveys. In practice, however, we are looking at variables dated from 2007 until 2012. This is because for some key arguments the relevant information collected in year *t* pertains to year *t-1*. We do not range further back in time by reason of there being a break in the innovation measure. Specifically, prior to 2008, the questionnaire inquired of the innovation outcome *in the last two years*, rather than *in the last year* as in the 2008 though 2013 rounds.

The innovation variable is coded as a 1/0 dummy variable that indicates the presence (or absence) of the selected type of innovation. The different innovation categories are defined according to the Oslo Manual guidelines (see OECD, 2005). Briefly, establishments can engage in either process or product innovation (or no such innovation). Product innovation is divided into three distinct categories: imitative, incremental, and radical, defined respectively as the introduction of a product or service that was already available from other firms in the market, an improvement to or further development of a product or service already supplied by the establishment, and the introduction of an entirely new product or service for which a new market has been created. For their part, process innovations are new procedures developed by establishments designed to improve the production process or the supply of services.

Turning to the information on the presence or otherwise of collective bargaining, the survey allows us to distinguish between firm-level agreements, industry-wide or sectoral agreements, and individual agreements between workers and firm (i.e. no collective bargaining at all). We make no attempt to use the information on *orientation* (i.e. whether an uncovered establishment supposedly shadows the wage settlements agreed at industry level (but see Addison et al., 2012). Nor for that matter do we look at situations in which collective agreements have either recognized or implemented so-called opt-out clauses (or opening clauses) and/or company-level pacts for competitiveness. In each case, the main reason is that the relevant information is not observed on a yearly basis. Specifically, from the perspective of our observation window, information on pacts was collected in 2008 and 2009 but not in 2010 or in 2011, while the question on opt-out clauses was asked only in 2011. (The implications of opening clauses and pacts for competitiveness are discussed in Heinbach, 2007; Brändle and Heinbach, 2013; and Bellmann, Gerner, and Hübler, 2013.) Regarding the

second pillar of the German dual industrial relations system – the works council – the variable is coded as a 1/0 dummy.

Finally, we assembled a wide set of control variables from the survey. Apart from industry controls (14 industry dummies), these included variables capturing the establishment's workforce structure (its skill, gender, part-time/full-time composition and type of working arrangement), together with its size, age, state of technology, ownership, single-establishment status, share of exports in sales, expected sales development, competitive pressure, profit situation, presence of an R&D department, whether the establishment resulted from a spin-off, and whether there were any organizational developments that resulted in the integration of other establishments. In addition, since the survey contains information on the volume of total investments as well as the percentage of total investments allocated to the expansion of the establishment, we included the latter in our set of regressors. In the context of the pooled model implementation (see Table 5 below), we will also use a specific survey question contained in the 2009, 2011 and 2013 waves in which establishments were asked if they had innovation plans that were *not* actually implemented.

Our sample is restricted to plants with at least five employees operating within the private sector of the economy. Establishments from the agricultural and extractive sectors were excluded as were plants in the public utilities. Finally, the 2009 changes in industrial classification were accommodated. In particular, since sectors in the 2007 and 2008 waves are grouped using the NACE Revision 1.1, while in 2009 and 2010 the classification is based on NACE Revision 2, we decided to use the latter for all establishments coded under both systems. However for establishments in waves 2007 and/or 2008 but not 2009 or 2010, we used the ad hoc procedure of 'the most likely transition,' on the basis of observed transitions (i.e. changes in sector classification from one system to another) for all those establishments that are coded under both systems.

Preliminary Analysis

Our actual 6-year observation window, 2007–2012, allows us to examine innovation both in cross section and longitudinally. This is a necessary starting point as we need to ensure that single- and multi-observed (i.e. panel) units are not too "distinct" from the perspective of their innovation profile.

At the outset, note that our variable of interest – here the particular innovation outcome – flags whether or not an establishment actually introduced some process or product innovation. We are therefore not considering innovation inputs, such as R&D intensity, and so a majority of establishments are not expected to answer in the affirmative when they are asked about innovation *in the previous business year*. Thus, as shown in Table 1, for those establishments that are observed in each year of the sample period, the proportion always responding that they have introduced, say, an incremental innovation is 22.2 percent (=[735/3,305]*100). For those establishments observed one, two, three, four, and five times over the same interval the proportion of similar such *always*-innovators is rather volatile at 50.2, 36.7, 30.3, 25.9, and 26.8 percent, respectively. In contrast, the group of establishments that have never introduced an incremental innovation accounts for 24.1 percent (=797/3,305) of all cases in which an establishment is continually observed over the six-year span, while the corresponding proportion within the group of establishments observed one, two, three, four, and five times is equal to 49.8, 38.9, 33.9, 27.0, and 20.6 percent, respectively. It seems that although there is a fair share of establishments for whom incremental innovation is highly persistent, a sizable sub-set of German establishments is seemingly "disconnected" from this type of innovation.

[Table 1 near here]

In the case of imitative innovation, the corresponding shares of *always*- (*never*-) innovators are 4.8, 31.4, 17.7, 10.6, 7.5, and 7.2 percent (39.1, 68.6, 56.3, 51.2, 46.5, and 49.8 percent) for those establishments that were observed always, one, two, three, four, and five times, respectively. In turn, the share of *always*- (*never*-) radical innovators is as expected substantially lower (higher) than those observed for imitative innovation, at 1.2, 13.3, 5.0, 2.4, 1.6, and 2.1 percent (68.7, 86.7, 80.6, 76.9, 73.9, and 66.5 percent), respectively. The corresponding figures for process innovation are slightly larger (smaller) at 5.1, 27.7, 14.8, 10.3, 7.0, and 7.2 percent (48.7, 72.3, 63.1, 59.1, 52.7, 44.8, and 48.7 percent). Finally, the proportion of *always*-innovators of any type, that is, the proportion of establishments that have introduced either a product (incremental, imitative or radical) or process innovation continually over the 6-year span is 29.1 (=960/3,300) percent of the total number of units observed consecutively over the selected period, while for those that were observed once, twice, three, four, and five times the corresponding shares are 60.8, 47.3, 37.8, 32.4, and 33.8

percent. The shares of *never*-innovators of any type are roughly three-fifths of those in the corresponding group of *always* innovators.

Incremental innovation thus appears to be the most common type of innovation among establishments in the sample, while radical innovation is not only the least common but also the least persistent or continuous type of innovation. On the other hand, the incidence of product innovation is higher and more ongoing than process innovation, whereas a comparison of singly-observed and panel units reveals that the share of *always*-innovators is decreasing among those units that are observed up to six consecutive years. This latter result implies that pure cross-section units tend to reveal a higher incidence of innovation than panel units, a pattern that is common to all types of innovation.

Table 2 presents the conditional and unconditional probability of innovation in the pooled data. The first row of the table gives the unconditional probability of an establishment having introduced an innovation by type of innovation. The remaining rows give that probability conditional on works council and collective bargaining status. Without conditioning on any other observables, it seems that works councils and collective bargaining are associated with a higher incidence of innovation of all types, although not exactly in the same degree. For example, the incidence of incremental innovation among establishments with (without) works councils is 64.3 (41.1) percent, while in establishments with a sectoral agreement (no collective agreement) incremental innovation occurs in 48.5 (46.9) percent of the cases. The data also suggest that firm agreements are slightly more favorable to innovation than sectoral agreements.

[Table 2 near here]

Disaggregating by sector – namely, manufacturing and services in panels (b) and (c) of the table – yields a similar result. That is, innovation is more often found in establishments with works councils than otherwise, while collective bargaining coverage seems more favorable to innovation and especially so in manufacturing.

Finally, although innovation is far more common in large than small establishments, much the same institutional patterns are evident in the data. In particular, establishments with works councils and sectoral agreements are generally more favorable to innovation across all establishment size categories groups. (The details are not provided here, but full information is available from the authors upon request.)

[Table 3 near here]

Table 3 presents tetrachoric correlation coefficients (that is, the correlation between any two pairs of binary variables) for our institutional and innovation measures. These statistics were obtained using a biprobit model with no covariates included in the regression. Observe that works councils are strongly and positively associated with innovation, while the correlation between innovation and sectoral agreements is now weaker, both in absolute terms and statistical significance. Firm-level agreements in particular appear more favorable to innovation than sectoral agreements, especially in the case of incremental.

These preliminary results do not control for observable, establishment-level characteristics other than the presence of collective bargaining and worker representation institutions. We next consider whether this indicative evidence survives explicit modeling of the innovation decision. In particular, we want to know the extent to which the conjectures set in the introductory sections of this paper hold.

Regression Results Using Pooled Data

We start by modeling innovation in an exclusively pooled data framework in which our (dichotomous) innovation variable, Y_{it}, is a function of two sets of observables, say Z_{it} and Z'_{it}, where the former vector indicates the selected institutional union and worker representation categories (namely the four combinations of sectoral agreement and works council status as described below) and the latter establishment-level observables, and where subscripts *i* and *t* denote establishment and year. The Z' vector of characteristics includes workforce composition, and the export orientation, ownership, size, location, competitive pressure, and profit situation, *inter al*. (See the data section for the full description of this set.)

In practice, our first regression model is a simple pooled probit (omitting the time subscript):

$$\Pr(Y_i = 1|X_i) = \Phi(X_i\beta), \quad (1)$$

where X now denotes the full set of time-varying and time-invariant establishment-level observables (i.e. Z and Z'), β is the set of parameters to be estimated, and Φ denotes the standard normal cumulative distribution function.

In the interests of simplicity, we select establishments that are either covered or not covered by a sectoral agreement and works councils, giving a total of four possible combinations: no sectoral agreement-no works council (the reference category), no sectoral agreement-works council, sectoral agreement-no works council, and sectoral agreement-

works council. This means that a negative sign on any of the selected interaction terms implies that the respective institutional setting is unfavorably associated with innovation, in comparison with the reference group. Note that in this setting we exclude all establishments that are covered by a firm-level agreement. The goal is to increase comparability with the difference-in-difference exercise below in which we examine only the sectoral agreement case. This procedure also allows us to keep our robustness exercises more manageable. An alternative would be to use a single category – covered or not covered by a collective agreement of any type – but ultimately we considered that any amalgamation of the two groups would be less transparent. We also refrain from analyzing the separate group of firm-level agreements by reason of its modest sample size. (Firm-level agreements represent 7.5 percent of the whole sample.)

[Table 4 near here]

Table 4 presents the results of fitting a linear probability model rather than the pooled probit. This is because we subsequenty wish to allow for the inclusion of selectivity terms in the model – that is, for selection into collective agreements and works council status – and the use of a linear probability model at this stage ensures maximum comparability across our results.[13]

As indicated in the first three rows of the table, the institutional coefficient estimates are not statistically significant in one-half of the cases. At first blush, therefore, the role of the selected institutional variables seems underwhelming, particularly in the cases of imitative and radical innovation. It is nevertheless of note that for the sectoral agreements-no works council and sectoral agreements-works council combinations four out of six coefficient estimates are statistically significant at conventional levels. Since they are negative in the former combination and positive in the latter, the seeming inference is that sectoral agreements without (with) works councils are unlikely (likely) to be associated with a higher probability of innovation.[14]

Regarding the role of the other covariates, the presence of an R&D department, training, state-of-the-art equipment, a skilled workforce, export orientation, higher expected sales, and establishment size (not separately reported in the table) are strongly favorable to (or at least positively associated with) all types of innovation. Competitive pressure is also positive and highly statistically significant. On the other hand, the profit situation, the existence of spin-offs, and integration of other establishments seem to be of little relevance.

At the suggestion of a referee, we also ran the model adding a productivity variable to the set of regessors, where productivity is measured by real gross value added per full-time employee. The variable was statistically significant for one of the six innovation measures, and despite a 22 percent reduction in the number of useable observations, eight out of the nine statististically significant coefficients reported in the first three rows of Table 4 maintained their statistical significance. Changes in the remaining coefficients were trivial. In turn, re-running the model for the same reduced sample, now with the exclusion of the productivity variable, produced virtually no change in the results.[15]

We note in passing that disaggregating by sector shows that in manufacturing most institutional coefficients are again negative and predominantly insignificant, although in the case of services the effect of the sectoral agreement-no works council combination on innovation while generally negative is less pronounced than in the manufacturing sector. Furthermore, sectoral agreements in conjunction with works councils seem to be slightly more favorable to innovation in services than in the case of the manufacturing sector. (Full results by sector are available upon request.)

Two major issues arise in the context of model (1). One is the possible interdependence of sectoral agreements and works council presence, the other is the assumed exogeneity of the two variables in the innovation equation. In recognition of these issues, we next offer two alternative approaches to estimation, first by deploying a recursive multivariate probit with three equations, and second by introducing selectivity terms – or inverse Mills' ratios – in the outcome equation.

More formally, in the first case we have the following recursive, simultaneous-equations model (again omitting the time subscript):

$$Y_{i1}^{*} = X_{i1}\beta_1 + e_{i1}$$
$$Y_{i2}^{*} = X_{i2}\beta_2 + \alpha_1 Y_{i1} + e_{i2} \qquad (2)$$
$$Y_{i3}^{*} = X_{i3}\beta_3 + + \delta_1 Y_{i1} + \delta_2 Y_{i2} + e_{i3},$$

where Y_{ij}^{*} is the corresponding latent variable and Y_{ij} (the observed variable) is defined as $Y_{ij} = 1$ if $Y_{ij}^{*} > 0$, and $Y_{ij} = 0$ if $Y_{ij}^{*} \leq 0$; *j=1, 2, 3* denoting the sectoral agreement, works council, and innovation binary variables, respectively. In the actual implementation we will also include the case in which the innovation equation includes a sectoral agreements-works council combination.[16]

Our second, single-equation approach sets the innovation outcome, Y_3, as a function of a given set of X exogenous variables, plus the sectoral agreement and works council terms and the corresponding inverse Mills' ratio terms, $\lambda_i^{scb}$and λ_i^{woco}, respectively, obtained from a bivariate probit with two choice equations. In this case, we will estimate the following pooled linear probability model:[17]

$$Y_{i3} = X'_{i3}\beta'_3 + d_1 Y_{i1} + d_2 Y_{i2} + a_1\lambda_i^{scb} + a_2\lambda_i^{woco} + \mathcal{E}_{i3}. \quad (3)$$

In the context of the recursive model shown in (2), if we find that the three equations are statistically independent – or that $corr(e_{ij}, e_{ik}) = \rho_{jk} = 0$ for all $j, k = 1,2,3, j \neq k$ – then the innovation equation can indeed be estimated as a separate equation. In other words, the results from Table 4 would be sufficiently informative. For the alternative single-equation approach in model (3), involving two selection terms, the same implication would follow were $\lambda_i^{scb}$and λ_i^{woco} to prove statistically insignificant and the coefficients in the innovation equation largely insensitive to their introduction.

But it is instructive to preface this technical analysis by first looking at some descriptive evidence. In particular, one has to question whether or not some establishment-level characteristics omitted from Table 4 (i.e. not included in the corresponding set of control variables) are correlated in some obvious fashion with a particular sectoral agreement (or works council) configuration. To this end, we use question 26 of the 2009 survey (reiterated as question 24 and question 25 in the 2011 and 2013 surveys).[18] Specifically, survey respondents were first asked whether their establishments had any innovation plans that were not actually carried out, and if so which of eight possible reasons applied. Table 5 combines establishment collective agreement and works council status on the one hand with reported reason for not implementing the innovation plans on the other. Each cell of the table gives the corresponding incidence across the two institutions, namely with and without a sectoral agreement/works council. Our conjecture is that had the *organization problems* and *economic risk* (two unobserved characteristics in Table 4), for example, been inherently innate to a particular collective agreement-worker representation configuration, we would expect to observe a much more differentiated incidence of these two characteristics across the two institutional types. (The underlying hypothesis here is that these two characteristics are correlated with the innovation outcome.) Indeed, as shown in the second and fourth columns of Table 5, the mean comparison test rejects the null in only one case. That is: the null hypothesis that the incidence of 'high economic risk' and 'organizational problems' in

establishments with and without sectoral agreements is the same is never rejected, while across establishments with and without works council is rejected only in 2008. For the remaining six reasons, the null is rejected in six cases (out of 36).

[Table 5 near here]

The evidence on the interdependence between sectoral agreements and works councils can also be examined using the descriptive transition data reported in Tables 6 and 7. Two issues are examined: first, how frequent are changes in status; and, second, to what extent are the transitions in, say, sectoral agreements followed by transitions in works councils?[19]

Note that although rare, the introduction and abandonment of sectoral agreements in Table 6 is much more frequent than is the case for works councils. Indeed, the frequency is threefold that for works councils. In other words, sectoral agreement switchers amount to approximately 6 percent of the total (this is the average taken over all six columns in the table), while works council switchers are only 2 percent. The remaining 94 and 98 percent, respectively, are made up of sectoral agreement (works council) never members and always members (54.5 and 35.5 percent, and 67.4 and 30.3 percent, respectively.)

[Tables 6 and 7 near here]

Moreover, as shown in Table 7, the few observed changes in works council status can scarcely be linked with changes in the relevant sectoral agreements. The most likely event – and by a large margin – is where a scb joiner maintains its works council status (as either covered or not covered). In fact, only 4 percent of this category actually change works council status in the same year (see the first row, first column of panel (a) of Table 7), 3 percent in the following year, 4 percent two years later, and 2 percent after three and five years. At the price of some oversimplification, over a period of six years, out of 100 scb joiners roughly 10 either introduce or abandon a works council. For its part, the evidence on works council transitions in connection with scb leavers, given in panel (b) of the table, follows virtually the same pattern.

In sum, the raw descriptive data in Tables 6 and 7 do not seem to indicate any obvious interdependence between the two institutions, while the evidence taken from Table 5 indicates that unobserved establishment traits are unlikely to have substantive impact at least on failure-to-innovate decisions.

With these preliminaries behind us we next return to our formal tests of interdependence, beginning with that between sectoral agreement status and works council transitions, using the recursive multivariate probit described in model (2) above. This implementation is conducted for a pure pooled dataset. The goal is to determine whether or not the correlation across unobservables in the three equations of the system is statistically different from zero. If the (likelihood ratio) test does not reject the null of no correlation, sectoral agreements and works councils can be taken as exogenous in the innovation equation.[20]

The results of this exercise are given in Table 8. The second column of the table confirms that works councils are more likely when sectoral agreements are present, while in the third column suggests that although works council presence per se seems to be favorable to innovation no such suggestion follows in the case of sectoral agreements that, taken in isolation, do not appear to favor innovation. Only the combination of the two institutions points to greater innovative activity, as shown in the fourth column of the table. Note that for reasons of economy the material in this column presents just the coefficients of the third equation of the recursive system in which an interaction term between the two institutions is added to the right-hand-side of the innovation equation. The coefficient estimates from the sectoral agreement and works council choice equations look very similar to those presented in the second and third columns of the table.

[Table 8 near here]

The most striking result, however, is the finding that no single ρ_{jk} is statistically different from zero; nor is the null of $\rho_{21} = \rho_{31} = \rho_{32} = 0$ rejected. It cannot therefore automatically be claimed that the role played by the two institutions in innovation reported in Table 4 is simply the result of the presence of some unobserved establishment traits. Moreover, the findings from Table 8 at a pinch suggest that the presumption of exogeneity in Table 4 is ultimately harmless.

Finally, we examine the alternative approach to examining the possible interdependence between sectoral agreements and works council presence in the innovation equation based on model (3). In constructing two selectivity terms in the innovation equation, one for each institutional variable, we estimated the determinants of works councils and sectoral agreement choices using a bivariate probit framework, although as a practical matter the results are virtually the same if the estimation is run in separate equations.

[Table 9 near here]

The results of this exercise are presented in Table 9. (Recall that the comparator is Table 4 above.) As shown in the table, the selectivity term for the presence of a sectoral agreement is statistically significantly different from zero in three out of six cases (see the sixth row in the table), while the corresponding term for a works council is statistically significant – albeit marginally so – in just one instance (out of six cases, in the fifth row). But the key finding is that the impact on the sign and statistical significance of the three interaction terms is very mild, with virtually all the coefficients and statistical significance unchanged. The same holds for the remaining right-hand-side variables.

We note that the underlying biprobit specification (not reported in Table 9) contains further training and the share of part-time workers in the works council equation, while the sectoral agreement equation contains the share of high-skilled workers. The coefficients of these variables are highly statistically significant except in the case of the share of part-time workers. Otherwise the set of regressors is common. We did experiment with alternative sets of regressors and found no real sensitivity in the results. Interestingly, competitive pressure and the profit situation seem more relevant to sectoral agreements than to works council presence, while the state-of-the-art technology, for example, seems to be more keen to works council presence. The null of no interdependence between the two choice equations in the biprobit is rejected comfortably (at the 0.01 level or better). Finally, the positive sign of the selectivity term for the presence of sectoral agreements indicates that establishments that select themselves into that status have also a higher chance to innovate. For the recursive model implemented in Table 8 there was no statistical evidence favoring this presumption.

Results Based on a Difference-in-Differences Strategy

In this section, we exploit the panel structure of the data in a more direct way, that is, in a constructed difference-in-differences (DiD) framework. We focus on sectoral agreements and, by assuming that unobserved firm-specific traits are time-invariant, we compare proper comparison groups – namely sectoral agreement leavers vs. sectoral agreement always members on the one hand, and sectoral agreement joiners versus sectoral agreement never members on the other – to obtain an alternative measure of the impact of sectoral agreements on innovation. This exercise is conducted using several robustness tests designed

to evaluate the randomness of the sectoral agreement (and works councils) switching status behavior. We will supplement the analysis by providing a falsification or placebo test.

The construction of the DiD exercise can be described as follows. Firstly, we retain those establishments that are observed consecutively over the 2007-2012 observation window. Next, we define a pre-treatment and a treatment period, say, t_0 and t_1. Lastly, we select the comparison groups (e.g. sectoral agreement leavers vs. sectoral agreement always members). Our procedure then amounts to selecting 2007–2008 as the pre-treatment period (our t_0 period), and 2009–2012 as the treatment period (our t_1 period). This is the medium- to long-run case. Since this scenario has the obvious disadvantage of requiring that the included establishments be observed over six consecutive years – thus reducing the size of the estimation sample in an obvious manner – our main focus is rather on the 'pooled' case. In this alternative scenario, we require establishments to be observed only over four consecutive years and define t_0 and t_1 as consecutive 2-year intervals to obtain the pooling of three moving windows: t_0=2007-2008; t_1=2009-2010 (the first window), t_0=2008-2009; t_1=2010-2011 (the second); and t_0=2009-2010; t_1=2011-2012 (the third). This procedure allows a substantial increase sample size.[21]

Take the 'treatment' group of sectoral agreements joiners and the 'control' group of sectoral agreement never members. Having defined t_0 and t_1, we focus on the group of establishments that in t_0 are not covered by a sectoral agreement and compare the innovation incidence among those establishments that have joined a collective agreement in t_1 with the innovation incidence of those that have stayed uncovered. In other words, by running the innovation variable on sectoral agreement status (both dated in t_1) plus some control variables to take account of potential confounding factors (dated at t_0) – either using a probit or a linear probability model – we have by construction a difference-in-differences estimate of the effect of *joining* a sectoral agreement on innovative activity; and mutatis mutandis for the effect of *leaving* a sectoral agreement, in which case one needs to select the subsample of establishments covered by a sectoral agreement in t_0 and again regress innovation on sectoral agreement status, both dated in t_1.

In the interests of transparency and the obligation to avoid imposing an artificial symmetry on the effects of collective bargaining on innovation, we propose to further refine the selected subsamples. In particular, we separate establishments with a revealed history of no innovation (in t_0) from those that exhibit some propensity to innovate (in t_0). Thus, and

assuming t_0=2007-08 and t_1=2009-10, we take an establishment that has no innovation in 2007 and 2008 to be a *non-innovator*, and consider as an *innovator* a plant that introduced an innovation in either 2007 or 2008 (or in both years). Since establishments are classified as either innovators or non-innovators (but not both), this means that we will be dealing with four different scenarios outlined in Table 10.

[Tables 10 near here]

Tables 11 and 12 present the DiD estimates of the effect of joining/leaving a sectoral agreement on innovation. As mentioned earlier, the reduction in sample size forces us exclusively on sectoral agreements *and* upon a single outcome, given by the 'any type of innovation' composite. We will also report results arising exclusively from a linear probability model. Within this framework we also want to test whether sectoral bargaining switching can be taken as exogenous. To this end, we employ a similar approach to that followed in model (3) above. This means that in each scenario reported in Tables 11 and 12 we will have two columns, without and with controls for the endogeneity of sectoral agreeement transitions. The estimation sample in Table 11 includes works councils switchers, which means that in this case the corresponding selectivity terms control for the exogeneity of switching in the worker representation vehicle. In Table 12 the selectivity term accounts only for works council *presence* as all works councils switchers are dropped from the sample.

[Tables 11 near here]

The critical finding from Table 11 is that out of eight scenarios in panels (a) and (b) the sectoral agreement coefficient is statistically significant only for leavers in panel (a)/fourth column and for joiners in in panel (b)/first column. As shown by the negative coefficient in the first column of panel (b), joining a sectoral agreement without a works council being present decreases the probability of innovation in t_1 for an establishment that had introduced some type of innovation in t_0. So we again find that the combination of sectoral agreements without works councils seems not to favor innovative activity, a result consistent with our preliminary findings in Tables 3 and 4, for example. In turn, the positive coefficient in the fourth column of panel (a) shows that one cannot exclude circumstances in which leaving may also be favorable to innovation. But the predominant lack of statistical significance in 'treatment' effects in Table 11 serves more to indicate that collective bargaining does not apparently impair innovation to any material degree in Germany. Finally, there is also little tangible evidence of endogeneity of sectoral agreements and works councils playing a

determining role in our results: in only two cases (out of sixteen possibilities) does the selectivity correction term achieve statistical significance at conventional levels. Observe also that the scb coefficient barely changes after introduction of the selectivity terms.

In Table 12 we implement a slightly different procedure in which we reduce the number of scenarios to a total of four cases by dropping all works council switchers while adding a works council dummy to the model specification. The model includes again two selectivity correction terms for the possible endogeneity of sectoral agreements transitions and works council presence, respectively. As in the previous table, in t_1 we regress innovation on collective bargaining status to obtain the effect of, say, joining a collective agreement on innovation, controlling for beginning-period (i.e. t_0) works council status and other establishment-level characteristics. As indicated in the first row of the table, in no case is there evidence of a statistically significant causal relationship between sectoral agreements and innovation. The positive coefficient in the leaving vs. staying covered case is the exception, confirming the result reported in panel (a) of Table 11. Again, the scb coefficient is virtually unchanged across the columns with and without selectivity terms.

[Table 12 near here]

Perhaps not surprisingly, the evidence based on difference-in-differences is less clear-cut than in Table 4. It will be recalled that establishments are now required to be observed over a period of four consecutive years which is a rather demanding data requirement. Our DiD approach also implied a further diminution in estimation sample as we sought to increase the number of meaningful comparisons across treatment and control groups. The limitations of this empirical approach notwithstanding, it does not appear to be the case that establishments materially influence innovation with the decision to leave (join) sectoral agreements as compared with those establishments that decide to stay put, remaining covered (uncovered). Nor is it plausible to suppose that leaving a sectoral agreement when no works council is present is more favorable to innovation than the situation where one is present. And none of these results seems to be critically sensitive to endogeneity issues.

For completeness, we present a summary evaluation of the medium-term effects of joining/leaving a sectoral agreement on innovation. For the sake of argument, we ignore in this presentation any discussion of endogeneity issues. Instead, we focus exclusively on the estimates extracted from a simple exercise in which we extend the post-treatment period t_1 to 2009-2012, where the pre-treatment period t_0 comprises the 2007-08 interval. The results

are given in Table 13. All coefficient estimates are uniformly statistically insignificant, with the single exception shown in the last column of panel (b), where we report that leaving a sectoral agreement in the presence of a works council is unfavorable to innovation in the medium- to long-run.

[Table 13 near here]

Our last robustness test entails a falsification test. Essentially it asks what difference faking a change in sectoral agreement status would make to the innovation outcome. Given the structure and nature of our DiD exercise, finding a placebo is no easy task. Consider the case of scb joiners versus never scb members. For the group of placebo establishments, we have perforce to rely on all those establishments that are consecutively observed from 2007 to 2012 *and* make an actual 2009-10 non-switcher a counterfeit 2009-10 switcher. In turn, and to simplify the implementation, the comparison group will be made up exclusively of those establishments that are (a) only observed in 2007-2010 and (b) scb never members throughout this interval. All we need for this exercise is a sufficiently large number of fake switchers.

Now, had the results of the original DiD exercise using real switchers suggested that sectoral agreements were favorable to innovation, the placebos would not be expected to generate any visible effect on innovation. Since our findings have suggested an absence of effect rather than a clear negative or positive impact – implying that industrial relations institutions seem rather neutral or non-hostile – the interpretation of our falsification test is less straightforward. What seems clear though is that given that all the units in the placebo exercise are actually never scb members – to use the joiners versus never members case for illustrative purposes – the results across the two groups of scb never members and placebo scb joiners – should not be statistically different.

[Table 14 near here]

The results of this final exercise are given in Table 14. No measurable effect is detected other than for the top left cell of panel (a), namely the joining scb vs. staying covered case. Given that a placebo transition is not expected to generate any causal effect, the absence of statistical significance is anticipated. However, even if this exercise suggests that our selection of 'control' establishments of never members and always members throughout our DiD implementations is sensible, only a truly experimental/laboratory exercise

with random assignment of sectoral agreement status would fully validate a causal effect or otherwise obtained in a DiD exercise such as that conducted here.

Conclusions

This study seeks to provide an analysis of the effect of collective bargaining on innovation using both pooled data and difference-in-difference methods applied to a nationally representative set of German establishments. Since the theory is inconclusive regarding the impact of collective bargaining on innovation – albeit of late allowing more scope for country-specific institutions to play a positive role in influencing outcomes – it is appropriate to reinvestigate an exemplar of cooperative industrial relations, Germany, in which the existence of a more thorough-going workplace consensus might be expected to ameliorate if not offset the standard hold-up problem confirmed to some large degree in North American studies.

We assembled a unique dataset covering a period of six consecutive years, 2007-2012, in which complete and incomplete panel members are observed according to whether or not they introduced incremental, imitative, radical, or process innovation. Since both collective agreement and workplace codetermination status are also observed, our modeling strategy was ultimately designed to generate the effect of trade unions and works councils on innovation, free, as far as possible, from contamination stemming from selection issues associated with endogenous decisions regarding the choice of these two institutional entities.

Our analysis began with a detailed examination of the key descriptive evidence on the incidence and persistence of the various types of innovation at establishment level, including their raw correlation with the selected institutional variables. Controlling for a wide set of covariates, our pooled data estimates suggested that the conjunction of the two institutions is relatively friendly to innovation. In other words, there is no sign of any dramatic, negative impact of collective bargaining agreements on innovation for Germany as has been reported for North America. Rather, all is rather quiet on this particular front, such that the long-standing tradition of industry-wide agreements has not disrupted the observed pattern of innovative activity. We also reported that the impact of any German workplace consensus is larger for incremental than radical innovation – consistent with some past research – but no indication that the German institutions are less favorable to process than to product innovation. Training at the workplace and competitive pressure both seem to be associated with all types of innovation, but interestingly enough not the profit situation.

Our analysis of sectoral agreement and works council transitions and their relationship with innovation was conducted within a difference-in-differences framework. This procedure – which is not without difficulty as it requires establishments to be consecutively observed for a period of at least four years, a rather stringent requirement given the IAB dataset used here – has the virtue of allowing us to establish that there is no obvious statistical evidence favoring the hypothesis that the role of German institutions is fundamentally adversarial or even redistributive with respect to innovation. Rather, the suggestion is that joining sectoral agreements in the presence of a works council or leaving a sectoral agreement in their absence is not unlikely to be advantageous to innovation. However, the presence of some perverse signs and the impossibility of examining and testing some scenarios due to sample size serves as a reminder that the DiD exercise is not without its limitations. Using a falsification exercise, our final test procedure indicated that our earlier finding that institutions are not hostile to innovation, even from a medium- to long-run perspective, cannot be simply attributed to poor selection of the relevant control groups.

The comprehensive analysis offered in this study has a fairly strong bottom line: there is no convincing evidence that German collective bargaining inhibits innovation. Indeed in conjunction with works councils, collective bargaining at sectoral level might even foster innovative activity. One caveat, however, concerns our innovation measure(s). Subjective in nature, the selected dichotomous variables can only crudely proxy complex innovation choices/decisions. In particular, they cannot capture expected differences in innovation intensity (and cost). There is therefore the need to supplement the present inquiry with a parallel analysis using other indicators of innovative activity (e.g. continuous input and output measures). Finally, only truly experimental exercises have the potential to validate the most sought after causal effects.

Endnotes

1. We ignore for the moment the potential hold-up problem on the part of the employer.

2. On the importance of the neglected firm discount factor, see Addison and Chilton (1998).

3. The context is a Cournot duopoly model in which separate, firm-specific unions bargain ex post (i.e. there is no bargaining over R&D in the first stage) over wages and employment. Provided the union places sufficient weight on employment vis-à-vis wages, an increase in union bargaining power can be shown to promote employment and lead to higher market share. The firm is then supposed to raise its investment in R&D so as to protect this enhanced market share.

4. Space constraints and the profoundly unsettled state of the empirical literature rule out separate consideration of *human resource management innovation* and "transformative" industrial relations practices. But readers are referred to Kizilos and Reshef (1997) for a discussion of how workplace unionization affects worker responses to human resource management practices, to Verma and Fang (2003) for an evaluation in the spirit of Slichter, Healy, and Livernash (1960) of whether the introduction of such practices makes a workplace more innovative *and* whether the ability to innovate is related to union status, and to Black and Lynch's (2001) famous illustration of how a hypothetical union plant embracing total quality management, inter al., might outcompete nonunion establishments with the same set of practices. Suffice it to say that the literature has not established that high performance practices are distinctive with respect to unionism. Further, the relation between such innovative practices and firm performance remains opaque, not only because of ambiguities surrounding the costs of the practices in question but also because of profound causality issues that attend the largely unobserved timing (adoption and abandonment) of these industrial relations practices.

5. Works councils are the expression of codetermination at workplace level. Codetermination is also practised at company or enterprise level, where for practical purposes it can be equated with worker directors. Space constraints pre-empt a theoretical discussion of worker board level representation. The rights and responsibilities of each codetermination body are given in Addison (2009).

6. The authors also investigate productivity growth (13 studies).

7. One way of organizing the data from the various national studies is meta regression analysis. For one such attempt the reader is referred to Doucouliagos amd Laroche (2013) who investigate 27 studies from four countries (Canada, Germany, the United Kingdom, and the United States) yielding 208 partial correlations of the union-innovation association. Differences in data, measurement of technology, and econometric specification emerge as key to differences in outcomes, but one secondary and controversial result is that union impact is negative across the board, contrary to the simple average partial correlations. However, potential offsets in the form of the more encopassing systems of labor regulation/employment protection are also reported.

8. But see Autor, Donohue, and Schwab (2006) and Autor, Kerr, and Kugler (2007) for the downside of employment protection legislation and wrongful discharge procedures in lowering employment and distorting production choices.

9. The study also inquires into possible mechanisms. It is suggested that a reduction in R&D expenditures and reduced productivity of existing and newly-hired inventors, as well as the departure of innovative individuals, are the most likely culprits. There is also some suggestion that firms may redirect their innovation activities to states with less unionized workforces.

10. We do not consider codetermination at enterprise level, although the reader is referred to a key study by Kraft, Stank, and Deventer (2011) investigating the impact of the 1976 law extending worker representation on company supervisory boards to firms with at least 2,000 employees. Innovation is measured by the number of patents granted. The authors report a positive effect of codetermination at company level on firms' innovative behavior, yielding small marginal effects.

11. For further information on the WSI survey, see Brehmer and Ziegler, 2009.

12. The chief exception to this statement is the study by Canter, Gerstlberger, and Roy (2014) which also uses works councils as an instrument for a firm's total (if not general) training activities that correlate with innovation.

13. Specifically, in comparing Tables 4 and 9. As a practical matter, the results in Table 4 are virtually the same as for a pooled probit. Results for the latter specification are available from the authors upon request.

14. Replacing our dichotomous innovation variable in Table 4 with expansion investment – a very crude continuous measure of absorption innovation that is available in our dataset – and running either a pooled OLS or a panel regression yielded very weak results. Also, the coefficients in Table 4 were largely unchanged after adding the stock of capital to the set of regressors, using the procedure developed by Müller (2010). Both sets of results are available from the authors upon request.

15. The set of right-hand-side variables was also extended to include a lagged dependent variable term and again very similar results to those reported in Table 4 were obtained in respect of the sign, magnitude, and statistical significance of the coefficients. (However, given the nature of the innovation variable, which is defined as an output measure, we would register our preference for the DiD strategy presented below as a means of addressing state dependence.) Full results of these three exercises are available upon request.

16. X_1 , X_2 , and X_3 in model (2) need not to be different for identification. All that is required is sufficiently variability in the selected regressors, as is accomplished by our implementation. The standard reference for the recursive model (2) is Maddala (1983, p. 123). This model also appears in Greene (2012, p. 786).

17. This approach follows the rationale advanced in Hübler and Jirjahn (2003).

18. We are grateful to an anonymous referee for this suggestion.

19. Since woco transitions are very rare, we will not report any results related to sectoral agreement transitions subsequent to a change in works council status.

20. AIternative implementations of the recursive model (such as random effects) are computationally more demanding and are not performed. For their part, alternative lagged relationships reduce sample size, while modeling the introduction/abandonment of sectoral agreements in connection with introduction/abandonment of works councils is not compelling given the evidence contained in Tables 6 and 7.

21. Taking the t_0=2007-2008 and t_1=2009-2010 as an illustration, the observations are by construction collapsed to a single data point, given by the information on scb status and innovation, for example, in t_1. It follows that we end up with a much smaller number of observations than in Table 4. This seems to be the main disadvantage of our construction. In any event, the raw number of scb leavers and scb joiners that met the requirements of our DiD exercise (pooled case) is still quite sizeable. Specifically, we have 142 (283) scb joiners and 327 (884) scb leavers in the non-innovation (innovation) samples in a total of 5,612 (13,286) establishments (treated plus control groups).

References

Acharya, Viral. V., Ramin P. Baghai, and Krishnamurthy V. Subramanian. 2012. "Wrongful Discharge Laws and Innovation." NBER Working Paper No. 18516. Cambridge MA: National Bureau of Economic Research, November.

Addison, John T. 2009. *The Economics of Codetermination: Lessons from the German Experience*. New York: Macmillan Palgrave.

_____, and John Chilton. 1998. "Self-Enforcing Union Contracts: Efficient Investment and Employment." *Journal of Business* 71(3): 349-69.

_____,and Joachim Wagner. 1997. "The Impact of German Works Councils on Profitability and Innovation: New Evidence from Micro Data." *Jahrbücher für Nationalökonomie und Statistik* 216(1): 1-20.

_____, Claus Schnabel, and Joachim Wagner. 1996. "German Works Councils, Profits and Innovation." *Kyklos* 49(4): 555-82.

_____, Claus Schnabel, and Joachim Wagner. 2001. "Works Councils in Germany: Their Effects on Establishment Performance." *Oxford Economic Papers* 53(4): 659-94.

_____, Thorsten Schank, Claus Schnabel, and Joachim Wagner. 2007. "Do Works Councils Inhibit Investment?" *Industrial and Labor Relations Review* 60(2): 187-203.

_____, Paulino Teixeira, Katalin Evers, and Lutz Bellmann. 2012. "Is the Erosion Thesis Overblown? Evidence from the Orientation of Uncovered Employers." IZA Discussion Paper No. 6658. Bonn: Institute for the Study of Labor (Forthcoming in *Industrial Relations*).

Autor, David H., John J. Donahue III, and Stewart J. Schwab. 2006. "The Costs of Wrongful Discharge Laws." *Review of Economics and Statistics* 88(2): 211-31.

_____, William R. Kerr, and Adriana D. Kugler, 2007. "Does Employment Protection Reduce Productivity? Evidence from U.S. States." *Economic Journal* 117(521): F189-F217.

Baldwin, Carliss Y. 1983. "Productivity and Labor Unions: An Application of the Theory of Self-Enforcing Contracts." *Journal of Business* 56(2): 155-85.

Bellmann, Lutz, Hans-Dieter Gerner, and Olaf Hübler. 2013. "Investment under Company Level Pacts." IZA Discussion Paper No. 7195. Bonn: Institute for the Study of Labor. (Forthcoming in *Economic and Industrial Democracy*.)

_____, Andreas Crimmann, Katalin Evers, and Reinhard Hujer. 2013. "Regional Determinants of Establishments' Innovation Activities: A Multi-Level Approach." IZA Discussion Paper No. 7572. Bonn: Institute for the Study of Labor/Forschungsinstitut zur Zukunft der Arbeit.

Black, Sandra, and Lisa Lynch. 2001. "How to Compete: The Impact of Workplace Practices and Information Technology on Productivity." *Review of Economics and Statistics* 83(3): 434-45.

Bradley, Daniel, Incheol Kim, and Xuan Tian. 2013. "The Causal Effect of Labor Unions on Innovation." Available at SSRN: http://ssrn.com/abstract=2232351 or http://dx.doi.org/10.2139/ssrn.2232351.

Brändle, Tobias, and Wolf Dieter Heinbach. 2013. "Opening Clauses in Collective Bargaining Agreements: More Flexibility to Save Jobs? *Review of Economics* 64(2): 159-92.

Brehmer, Wolfram, and Astrid Ziegler. 2009. "WSI-Betriebsrätebefragung 2008/09 zu Innovationsfähigkeit, Arbeitsbedingungen und Gesundheit im Betrieb." Düsseldorf: Hans-Böckler-Stiftung. Available at http://www.boeckler.de/pdf/wsi_br_befragung_ergebnisse2008.pdf.

Canter, Uwe, Wolfgang Gerstlberger, and Ipsita Roy. 2014. "Works Councils, Training Activities and Innovation: A Study of German Firms." Jena Economic Research Paper No. 2014 -006. Jena: Friedrich Schiller University Jena and Max Planck Institute of Economics.

Cavanaugh, Joseph K. 1998. "Asset-Specific Investment and Unionized Labor." *Industrial Relations* 37(1): 35-50.

Dilger, Alexander. 2002. *Ökonomik betrieblicher Mitbestimmung. Die wirtschaftlichen Folgen von Betriebsräten*. Munich: Rainer Hampp Verlag.

Doucouliagos, Hristos, and Patrice Laroche. 2013. "Unions and Innovation: New Insights From the Cross-Country Evidence." *Industrial Relations* 52(2): 467-91.

Ellguth, Peter, Susanne Kohaut, and Iris Möller. 2014. "The IAB Establishment Panel: Methodological Essentials and Data Quality." *Journal for Labour Market Research* 47(1): 27-41.

Fischer, Gabriele, Florian Janik, Dana Müller, and Alexandra Schmucker. 2009. "The IAB Establishment Panel: Things Users Should Know." *Schmollers Jahrbuch* 129(11): 133-148.

FitzRoy, Felix, and Kornelius Kraft. 1990. "Innovation, Rent-Sharing and the Organization of Labor in the Federal Republic of Germany." *Small Business Economics* 2(4): 95-103.

Freeman, Richard B. 1976. "Individual Mobility and Union Voice in the Labor Market." *American Economic Review*, *Papers and Proceedings* 66(2): 361-68.

_____, and James L. Medoff. 1984. *What Do Unions Do?* New York, NY: Basic Books.

_____, and Edward P. Lazear. 1995. "An Economic Analysis of Works Councils." In *Works Councils: Consultation, Representation and Cooperation in Industrial Relations*, edited by Joel Rogers and Wolfgang Streeck, pp. 27-52. Chicago, IL: University of Chicago Press.

Gartner, Hermann, Thorsten Schank, and Claus Schnabel. 2010. "Wage Cyclicality under Different Regimes of Industrial Relations." IZA Discussion Paper No. 5228. Bonn: Institute for the Study of Labor/Forschungsinstitut zur Zukunft der Arbeit.

Greene, William H. 2012. *Econometric Analysis*. Boston, MA: Pearson.

Grout, Paul A. 1984. "Investment and Wages in the Absence of Binding Contracts: A Nash Bargaining Approach." *Econometrica* 46(2): 449-60.

Haucap, Justus, and Christian Wey. 2004. "Unionisation Structures and Innovation Incentives." *Economic Journal* 114(494): C149-C165.

Heinbach, Wolf Dieter. 2007. "Wages in Wage-Setting Regimes with Opening Clauses."*AStA - Wirtschafts- und Sozialstatistisches Archiv* 21(3): 233-245.

Hirsch, Barry T., and Kislaya Prasad. 1995. "Wage-Employment Determination and a Union Tax on Capital: Can Theory and Evidence Be Reconciled?" *Economics Letters* 48(1): 61-71.

Hübler, Olaf, and Uwe Jirjahn. 2003. "Works Councils, and Collective Bargaining in Germany: The Impact on Productivity and Wages." *Scottish Journal of Political Economy* 50(4): 471–491.

Jirjahn, Uwe. 2012. "Industrielle Beziehungen und Innovationserfolg." In *Arbeitsmarkt und Arbeitsmarktpolitik in Niedersachsen: neuere Ergebnisse*, edited by Knut Gerlach, Olaf Hübler, und Stephan Thomsen, pp. 43-53. Hannover: Niedersächsisches Institut für Wirtschaftsforschung.

_____, and Kornelius Kraft. 2011. "Do Spillovers Stimulate Incremental or Drastic Product Innovations? Evidence from German Establishment Data." *Oxford Bulletin of Economics and Statistics* 74(4): 509-38.

Kizilos, Mark, and Yonatan Reshef. 1997. "The Effects of Worker Unionization on Worker Responses to HRM Innovation." *Journal of Labor Research* 18(4): 641-56.

Kriegesmann, Bernd, and Thomas Kley. 2012. *Mitbestimmung als Innovationstreiber: Bestandsaufnahme, Konzepte und Handlungsperspektiven für Betriebsräte*. Berlin: Edition Sigma.

Kraft, Kornelius, Jörg Stank, and Ralf Dewenter. 2011. "Co-determination and Innovation." *Cambridge Journal of Economics* 35(1): 145-72.

Lawrence, Colin, and Robert Z. Lawrence. 1985. "Manufacturing Wage Dispersion: An End Game Interpretation." *Brookings Papers on Economic Activity* 1: 4-116.

Maddala, G. S. 1983. *Limited-Dependent and Qualitative Variables in Econometrics.* Cambridge: Cambridge University Press.

Malcomson, James M. 1983. "Trade Unions and Economic Efficiency." *Economic Journal* 93(369): 51-65.

Menezes-Filho, Naercio, David Ulph, and John van Reenen. 1998. "R&D and Unionism: Comparative Evidence from British Companies and Establishments." *Industrial and Labor Relations Review* 52(1): 45-63.

Menezes-Filho, Naercio, and John Van Reenen. 2003. "Unions and Innovation: A Survey of the Theory and Empirical Evidence." In *International Handbook of Trade Unions*, edited by John T. Addison and Claus Schnabel, pp. 293-334. Cheltenham, England, and Northampton MA: Edward Elgar.

Müller, Steffen. 2010. Capital Stock Approximation with the Perpetual Inventory Method: Stata Code for the IAB Establishment Panel, FDZ-Methodenreport, 02/2010. Nürnberg: Forschungsdatenzentrum, Bundesagentur für Arbeit.

OECD. 2005. *Oslo Manual: Guidelines for Collecting and Interpreting Innovation Data*. Paris: Organisation for Economic Co-operation and Development.

Schnabel, Claus, and Joachim Wagner. 1992a. "Unions and Innovative Activity in Germany." *Journal of Labor Research* 13(8): 393-406.

_____, and Joachim Wagner. 1992b. "Unions and Innovations: Evidence from German Micro Data." *Economics Letters* 39(3): 369-73.

_____, and Joachim Wagner. 1994. "Industrial Relations and Trade Union Effects on Innovation in Germany." *Labour* 8(3): 489-503.

Scholl, Wolfgang, Kai Breitling, Hanna Janetzke, and Alexandra Shajek. 2013. *Innovationserfolg durch aktive Mitbestimmung: Die Auswirkungen von Betriebsratsbeteiligung, Vertrauen und Arbeitnehmerpartizipation auf Prozessinnovationen*. Berlin: Edition Sigma.

Slichter, Sumner H., James J. Healy, and E. Robert Livernash. 1960. *The Impact of Collective Bargaining on Management*. Washington, DC: The Brookings Institution.

Ulph, Alistair M., and David T. Ulph. 1994. "Labour Markets and Innovation: Ex Post Bargaining." *European Economic Review* 38(3-5): 195-210.

_____, and David T. Ulph. 2001. "Strategic Innovation with Complete and Incomplete Labour Market Contracts." *Scandinavian Journal of Economics* 103(2): 265-82.

Verma, Anil, and Tony Fang. 2003. "Workplace Innovation and Union Status: Synergy or Strife?" In *Proceedings of the 55th Annual Meeting of the Industrial Relations Research Association*, edited by Adrienne E. Eaton, pp. 189-97. Champaign, IL: Industrial Relations Research Association., pp. 189-97.

van der Ploeg, Frederick. 1987. "Trade Unions and Investment: A Noncooperative Approach." *European Economic Review* 31(4): 1465-92.

TABLE 1
INNOVATION IN GERMANY, ALL ESTABLISHMENTS WITH AT LEAST FIVE EMPLOYEES IN THE PRIVATE SECTOR, 2007-2012

			Number of years an establishment is interviewed and answered "Yes" or "No" to the innovation question						
			1	2	3	4	5	6	Total
Number of years an establishment has introduced innovation in the previous year	Incremental	0	2,202	1,015	505	324	246	797	5,089
		1	2,185	634	255	209	172	405	3,860
		2		958	279	178	151	380	1,946
		3			451	179	143	330	1,103
		4				311	163	298	772
		5					320	360	680
		6						735	735
		Total	4,387	2,607	1,490	1,201	1,195	3,305	14,185
	Imitation	0	3012	1466	764	558	478	1,291	7,569
		1	1377	679	346	258	225	631	3,516
		2		460	225	178	174	445	1,482
		3			158	115	139	310	722
		4				90	99	251	440
		5					86	211	297
		6						160	160
		Total	4,389	2,605	1,493	1,199	1,201	3,299	14,186
	Radical	0	3802	2,098	1,148	885	797	2,269	10,999
		1	582	375	211	179	190	484	2,021
		2		129	98	81	87	239	634
		3			36	34	62	129	261
		4				19	37	88	144
		5					25	54	79
		6						38	38
		Total	4,384	2,602	1,493	1,198	1,198	3,301	14,176
	Product (any type)	0	1,854	810	401	250	192	590	4,097
		1	2,533	642	252	194	148	368	4,137
		2		1,150	307	189	140	377	2,163
		3			532	200	146	330	1,208
		4				364	190	349	903
		5					379	405	784
		6						883	883
		Total	4,387	2,602	1,492	1,197	1,195	3,302	14,175
	Process	0	3,172	1,640	877	628	534	1,603	8,454
		1	1,217	573	292	244	234	597	3,157
		2		385	163	142	144	304	1,138
		3			153	94	115	280	642
		4				84	79	193	356

		5					86	147	233
		6						167	167
		Total	4,389	2,598	1,485	1,192	1,192	3,291	14,147
	Any type of innovation (product or process)	0	1,718	754	377	229	169	530	3,777
		1	2,668	617	243	187	141	352	4,208
		2		1,230	305	187	138	358	2,218
		3			563	205	145	326	1,239
		4				387	200	354	941
		5					405	420	825
		6						960	960
		Total	4,386	2,601	1,488	1,195	1,198	3,300	14,168

Notes: Innovation is a 1/0 dummy variable, defined as equal to 1 if an establishment reports having introduced the given type of innovation in the previous year, 0 otherwise. The first cell in the table, for example, indicates that out of 4,387 establishments observed only once over the sample period, 2,202 claimed not to have introduced an incremental innovation. The corresponding row total indicates that 5,089 establishments (out of a total of 14,185 establishments) failed to introduce any incremental innovation at all. The reported results are based on the IAB establishment survey, 2008-2013 waves.

TABLE 2
SAMPLE INNOVATION INCIDENCE IN GERMANY, ALL ESTABLISHMENTS WITH AT LEAST FIVE EMPLOYEES IN THE PRIVATE SECTOR, AND IN MANUFACTURING AND SERVICES, 2007-2012 (IN PERCENT)

	Type of innovation					
	incremental	Imitation	Radical	Product	Process	Any type
(a) *Private sector*						
P(.)	49.1	28.7	11.8	55.7	24.7	58.1
P(.|cb_status=scb)	48.5	28.3	11.3	54.8	25.0	57.0
P(.|cb_status=fcb)	57.5	30.5	13.1	62.5	31.0	65.0
P(.|cb_status=nocb)	46.9	27.0	11.0	53.5	21.6	55.9
P(.|woco=0)	41.1	24.8	9.0	47.9	17.8	50.2
P(.|woco=1)	64.3	34.2	16.3	69.6	36.4	72.0
(b) *Manufacturing*						
P(.)	63.2	33.6	17.2	68.2	33.9	70.9
P(.|cb_status=scb)	68.9	34.5	19.2	72.9	39.9	75.3
P(.|cb_status=fcb)	70.2	36.2	17.2	73.7	38.3	76.6
P(.|cb_status=nocb)	57.4	30.9	15.1	63.0	27.5	65.7
P(.|woco=0)	52.6	29.5	13.6	58.6	23.6	61.4
P(.|woco=1)	75.5	36.8	20.9	78.9	44.7	81.3
(c) *Services*						
P(.)	48.5	24.0	9.0	52.6	23.4	55.1
P(.|cb_status=scb)	46.6	24.4	7.1	50.4	22.6	53.0
P(.|cb_status=fcb)	52.6	23.0	9.6	55.7	28.1	57.8
P(.|cb_status=nocb)	48.3	22.3	9.3	52.2	21.9	54.6
P(.|woco=0)	44.0	21.3	7.8	48.0	19.8	50.5
P(.|woco=1)	60.1	29.1	10.3	63.4	31.2	65.7

Notes: P(.) gives the sample probability (or the standardized proportion) of a given innovation type. It is obtained by dividing the number of cases in which an establishment reported having introduced a given type of innovation by the total number of cases observed. The conditional proportion P(.|woco=0), for example, gives the proportion of establishments that introduced a given innovation among the subset of establishments without a works council. P(.|cb_status=scb) is the corresponding probability within the subset of establishments covered by a sectoral agreement. Note also that the sectoral (firm-level) agreement dummy is equal to 0 if and only if there is no firm-level (sectoral) agreement. All variables are for the same year, which means that works council and collective bargaining status refer to the preceding year as do the innovation variables. Accordingly, waves 2008-2013 of the survey are used, while the statistics displayed are for the observation window 2007-2012.

TABLE 3
TETRACHORIC CORRELATION BETWEEN INNOVATION AND SELECTED COMBINATIONS OF WORKS COUNCIL AND COLLECTIVE BARGAINING PRESENCE, ALL ESTABLISHMENTS WITH AT LEAST FIVE EMPLOYEES IN THE PRIVATE SECTOR, 2007-2012

	Type of innovation											
	Incremental		Imitation		Radical		Product		Process		Any type	
Sectoral agreement	0.025	***	0.024	***	0.009		0.020	**	0.069	***	0.018	**
N	34,432		34,437		34,435		34,427		34,407		34,421	
Firm-level agreement	0.140	***	0.056	***	0.055	***	0.122	***	0.155	***	0.125	***
N	22,595		22,595		22,588		22,591		22,576		22,588	
No collective agreement	-0.048	***	-0.031	***	-0.018	*	-0.040	***	-0.088	***	-0.039	***
N	37,248		37,249		37,248		37,243		37,222		37,239	
Works council	0.347	***	0.166	***	0.218	***	0.331	***	0.340	***	0.338	***
N	37,348		37,350		37,349		37,343		37,322		37,339	

Notes: The reported coefficients provide the correlations between pairs of binary variables and are obtained using a biprobit model with no regressors. The works council and collective bargaining variables are dummies defined as equal to 1 if the institution is present, 0 otherwise. The sectoral (firm-level) agreement dummy is equal to 0 if and only if there is no firm-level (sectoral) agreement. All variables refer to the same year (see notes to Table 2). *, **, and *** denote statistical significance at the 0.1, 0.05, and 0.01 levels, respectively.

TABLE 4
LINEAR PROBABILITY MODELS OF THE DETERMINANTS OF INNOVATION IN GERMANY, ALL ESTABLISHMENTS WITH AT LEAST FIVE EMPLOYEES IN THE PRIVATE SECTOR, 2007-2012

	Incremental	Imitation	Radical	Product	Process	Any type
No collective agreement-no works council (reference)						
No sectoral agreement-works council	-0.006	-0.007	-0.025 **	-0.002	0.002	0.003
	(0.016)	(0.016)	(0.011)	(0.016)	(0.015)	(0.015)
Sectoral agreement-no works council	-0.038 ***	-0.013	-0.006	-0.038 ***	-0.027 ***	-0.04 ***
	(0.010)	(0.009)	(0.005)	(0.010)	(0.007)	(0.01)
Sectoral agreement-works council	0.038 ***	-0.002	-0.003	0.032 **	0.025 **	0.026 *
	(0.014)	(0.013)	(0.010)	(0.014)	(0.012)	(0.013)
No/minor pressure (reference)						
Pressure: medium	0.040 ***	0.036 ***	0.010 *	0.045 ***	0.011	0.051 ***
	(0.010)	(0.009)	(0.006)	(0.010)	(0.008)	(0.01)
Pressure: substantial, which doesn't endanger the continued existence	0.069 ***	0.068 ***	0.023 ***	0.073 ***	0.047 ***	0.08 ***
	(0.011)	(0.010)	(0.007)	(0.011)	(0.009)	(0.011)
Pressure: substantial, which endanger the continued existence	0.046 ***	0.063 ***	0.012	0.051 ***	0.031 ***	0.053 ***
	(0.013)	(0.012)	(0.008)	(0.013)	(0.010)	(0.013)
Profit situation: sufficient/unsatisfactory (reference)						
Profit situation: (very) good	0.024 ***	0.007	0.010 *	0.014	0.012	0.015 *
	(0.009)	(0.008)	(0.006)	(0.009)	(0.007)	(0.009)
Profit situation: satisfactory	0.010	0.003	0.006	0.006	0.009	0.007
	(0.009)	(0.008)	(0.006)	(0.009)	(0.007)	(0.009)
No spin-offs	-0.020	-0.003	-0.004	-0.012	-0.019	-0.012
	(0.017)	(0.018)	(0.012)	(0.017)	(0.016)	(0.017)
Integration of other establishments	0.041 **	0.036 *	0.024	0.062 ***	0.053 ***	0.062 ***
	(0.020)	(0.021)	(0.015)	(0.019)	(0.019)	(0.018)
No R&D dept. (reference)						
R&D dept. in establishment	0.269 ***	0.105 ***	0.139 ***	0.235 ***	0.152 ***	0.222 ***
	(0.012)	(0.012)	(0.010)	(0.011)	(0.012)	(0.011)
R&D dept. in enterprise	0.097 ***	0.004	0.045 **	0.082 ***	0.064 ***	0.085 ***
	(0.023)	(0.023)	(0.018)	(0.023)	(0.023)	(0.022)
Individually owned	-0.036 ***	-0.001	0.000	-0.028 **	-0.017 **	-0.032 **

	(0.012)	(0.010)	(0.006)	(0.012)	(0.008)	(0.012)
Further training	0.083 ***	0.046 ***	0.021 ***	0.092 ***	0.044 ***	0.094 ***
	(0.008)	(0.007)	(0.005)	(0.008)	(0.006)	(0.008)
Expected business volume development: increase (reference)						
Expected business volume development: unchanged	-0.046 ***	-0.041 ***	-0.012 **	-0.052 ***	-0.025 ***	-0.053 ***
	(0.007)	(0.007)	(0.005)	(0.007)	(0.006)	(0.007)
Expected business volume development: decrease	-0.057 ***	-0.039 ***	-0.012 **	-0.054 ***	-0.021 ***	-0.047 ***
	(0.009)	(0.009)	(0.006)	(0.009)	(0.008)	(0.009)
State of the technical equipment: state-of-the-art (reference)						
State of the technical equipment: rather new	-0.028 ***	-0.020 **	-0.021 ***	-0.022 **	-0.058 ***	-0.03 ***
	(0.009)	(0.009)	(0.006)	(0.009)	(0.008)	(0.009)
State of the technical equipment: medium or worse	-0.065 ***	-0.033 ***	-0.032 ***	-0.051 ***	-0.091 ***	-0.061 ***
	(0.011)	(0.010)	(0.007)	(0.011)	(0.009)	(0.01)
Share of part-time workers	-0.000	0.000 **	0.000	0.000	-0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Share of fixed-term contract workers	0.001 **	0.001 *	0.000 *	0.001 **	0.000	0.001 **
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Share of high-skilled workers	0.002 ***	0.001 **	0.001 ***	0.001 ***	0.000	0.001 ***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Single-establishment	-0.019 *	-0.049 ***	-0.020 ***	-0.031 ***	-0.029 ***	-0.031 ***
	(0.010)	(0.009)	(0.007)	(0.010)	(0.009)	(0.01)
Foreign ownership	-0.001	-0.044 ***	-0.024 **	-0.017	-0.010	-0.023 *
	(0.015)	(0.016)	(0.012)	(0.014)	(0.015)	(0.014)
Western Germany	0.078 ***	0.020 **	0.007	0.069 ***	0.054 ***	0.073 ***
	(0.009)	(0.008)	(0.005)	(0.009)	(0.007)	(0.009)
Share of exports	0.005 ***	0.003 ***	0.003 ***	0.005 ***	0.003 ***	0.005 ***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
Share of exports squared	0.000 ***	0.000 ***	0.000 ***	0.000 ***	0.000 ***	0.000 ***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Share of expansion-investment	0.001 ***	0.001 ***	0.001 ***	0.001 ***	0.002 ***	0.001 ***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Constant	0.335 ***	0.171 ***	0.051 ***	0.377 ***	0.174 ***	0.396 ***
	(0.029)	(0.028)	(0.019)	(0.029)	(0.025)	(0.029)

Time dummies	yes	yes	yes	yes	yes	Yes
Size dummies	yes	yes	yes	yes	yes	yes
Industry dummies	yes	yes	yes	yes	yes	yes
R^2	0.21	0.08	0.10	0.19	0.16	0.19
Number of establishments	9,093	9,095	9,094	9,095	9,090	9,094
Number of observations	26,476	26,485	26,482	26,477	26,468	26,478

Notes: Clustered (by establishment) standard errors in parentheses. The model specification is given by equation (1) in the text. *, **, and *** denote statistical significance at the 0.1, 0.05, and 0.01 levels, respectively.

TABLE 5
REASONS FOR AN ESTABLISHMENT NOT IMPLEMENTING INNOVATION PLANS BY COLLECTIVE BARGAINING AND WORKS COUNCIL REGIME, 2008, 2010, AND 2010 (IN PERCENT)

	High investment costs	High economic risk	Lack of sources for financing	Organizational problems	Shortages of qualIfied personnel	Lack of market acceptance by customers	Long licensing procedures	Other	N
2008									
Sectoral agreement	52.0	29.1	13.4	25.7	16.2	8.4	11.2	17.9	179
No sectoral agreement	43.6	35.5	20.4	24.6	19.9	11.4	12.3	17.1	211
t-test									
Works council	53.9	25.4	11.9	27.5	13.0	10.9	12.4	19.7	193
No works council	43.4	38.1	20.5	25.4	21.3	10.2	13.9	14.3	244
t-test	Ho rejected	Ho rejected	Ho rejected		Ho rejected				
2010									
sectoral agreement	45.2	27.1	12.4	32.8	20.3	7.3	12.4	18.6	177
No sectoral agreement	41.0	27.1	16.6	28.6	22.3	7.5	12.7	18.4	332
t-test									
Works council	47.4	26.7	12.9	27.6	19.4	8.2	12.9	19.4	232
No works council	40.8	27.2	17.1	29.8	22.3	6.4	12.4	17.3	346
t-test									
2012									
sectoral agreement	42.5	24.1	6.9	35.1	20.1	10.3	13.2	22.4	174
No sectoral agreement	38.5	25.2	14.3	39.1	23.0	6.5	17.1	14.3	322
t-test			Ho rejected			Ho rejected			
Works council	43.5	22.6	7.4	34.3	22.6	9.6	15.2	20.0	230
No works council	37.8	25.3	13.8	39.7	23.1	6.3	14.7	15.6	320
t-test			Ho rejected						

Notes: The top cell in the first column indicates that 52.0 percent of all establishments covered by a sectoral agreement that have not implemented their innovation plans responded that their high cost was a reason for not activating them. The reported results are based on questions referring to the previous business year, meaning that they were actually obtained using the 2009, 2011, and 2013 IAB surveys. *t-test* denotes the mean comparison test, with the null given by the no difference in the mean.

TABLE 6
SECTORAL AGREEMENT AND WORKS COUNCIL ANNUAL TRANSITIONS (IN PERCENT)

	2007-2008	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013	Average
a) Sectoral agreement transitions							
0->0	48.9	49.5	54.0	57.6	58.4	58.8	54.5
0->1	5.0	4.3	1.5	1.3	2.1	1.7	2.7
1->1	41.5	41.3	41.1	38.9	37.6	36.7	39.5
1->0	4.7	4.9	3.4	2.2	1.9	2.7	3.3
Total	100	100	100	100	100	100	100
b) Works council transitions							
0->0	65.4	66.2	66.6	68.7	68.7	69.0	67.4
0->1	1.0	1.4	1.2	0.8	0.9	0.8	1.0
1->1	32.2	31.3	31.4	29.8	29.7	29.7	30.7
1->0	1.4	1.0	0.8	0.7	0.7	0.5	0.9
Total	100	100	100	100	100	100	100

TABLE 7
WORKS COUNCIL TRANSITIONS OF SECTORAL AGREEMENT JOINERS AND LEAVERS BY YEAR (IN PERCENT)

	Year of works council introduction or abandonment					
	In the same year	1-year after	2-years after	3-years after	4-years after	5-years after
scb_joiner (0-1)						
2007-2008 joiner	3.6	2.7	3.7	2.4	0.0	1.6
2008-2009 joiner	3.9	1.6	1.2	0.0	0.0	
2009-2010 joiner	7.5	6.2	0.0	2.1		
2010-2011 joiner	2.8	0.0	0.0			
2011-2012 joiner	0.9	1.2				
2012-2013 joiner	3.2					
	3.6	2.3	1.2	1.5	0.0	1.6
scb_leaver (1-0)						
2007-2008 leaver	4.2	3.4	2.4	1.4	0.8	0.0
2008-2009 leaver	3.0	2.7	3.0	0.6	1.3	
2009-2010 leaver	3.2	0.0	0.8	0.0		
2010-2011 leaver	2.6	1.0	1.1			
2011-2012 leaver	1.0	0.0				
2012-2013 leaver	1.3					
	2.6	1.4	1.8	0.6	1.1	0.0

Notes: The percentage value reported in the top left cell (i.e. 4 percent) is obtained by dividing the 10 works council joiners by 276, which is the total number of sectoral agreement joiners that are observed in both 2007 and 2008. The value in the adjacent cell in the same row (i.e. 3 percent) is obtained dividing 6 by 217. The latter number subtracts the 59 (i.e. 276 - 217) establishments that were rotated out of the panel in the 2009 survey.

TABLE 8
SUMMARY RESULTS OF THE RECURSIVE MULTIVARIATE PROBIT MODEL

	Sectoral agreement (first equation)	Works council (second equation)	Innovation (Any type) (third equation)	
			Alternative 1: without an interaction term	Alternative 2: with an interaction term
Sectoral agreement	---------	0.58 ***	-0.05	-0.12 **
		(0.07)	(0.53)	(0.055)
Works council	---------	---------	0.09 **	-0.03
			(0.047)	(0.05)
Interaction term: sectoral agreement-works council	---------	---------	---------	0.22 ***
				(0.04)
ρ_{21}	0.04	0.04	0.04	0.04
	(0.04)	(0.04)	(0.04)	(0.04)
ρ_{31}	-0.05	-0.05	-0.05	-0.02
	(0.03)	(0.03)	(0.03)	(0.03)
ρ_{32}	-0.02	-0.02	-0.02	-0.01
	(0.03)	(0.03)	(0.03)	(0.02)
Log likelihood	-32,191.44	-32,191.44	-32,191.44	-32,178.36
N	21,777	21,777	21,777	21,777
Linear prediction	0.34	0.87	0.23	0.23
	(0.06)	(0.09)	(0.07)	(0.07)
Marginal success probability	0.39	0.3	0.57	0.57
Joint probability Pr(depvar_j = 1) for j=1, 2, 3)	0.11	0.11	0.11	0.11
Joint probability Pr(depvar_j = 0) for j=1, 2, 3	0.22	0.22	0.22	0.22

Notes: Each equation *j* in the system described in model (2) in the text includes a set K_j of assumed exogenous regressors dated in year *t-1* (i.e. lagged one year). The null hypothesis of $\rho_{21} = \rho_{31} = \rho_{32} = 0$ is not rejected at conventional levels as the chi-square statistic of the corresponding likelihood ratio test is equal to 1.74 (p-value=0.63) and to 1.24 (p-value=0.75) in Alternative 1 and Alternative 2, respectively. $\rho_{jk}, j, k = 1,2,3, j \neq k$, denotes the correlation between the residuals in the j^{th} and k^{th} equations in the system. The fourth column presents just the coefficients of the third equation of the recursive system in which an sectoral agreement-works council interaction term is added to the righ-hand-side of the innovation equation. All the results were obtained using the mvprobit procedure available in Stata 13. Standard errors are in parentheses.

TABLE 9

LINEAR PROBABILITY MODELS OF THE DETERMINANTS OF INNOVATION IN GERMANY WITH SELECTIVITY TERMS, ALL ESTABLISHMENTS WITH AT LEAST FIVE EMPLOYEES IN THE PRIVATE SECTOR, 2007-2012

	Incremental	Imitation	Radical	Product	Process	Any type
No collective agreement-no works council (reference)						
No sectoral agreement-works council	0.019	-0.008	-0.034 **	0.019	0.008	0.018
	(0.024)	(0.023)	(0.016)	(0.023)	(0.022)	(0.022)
Sectoral agreement-no works council	-0.047 ***	-0.007	-0.002	-0.037 **	-0.026 **	-0.038 **
	(0.015)	(0.013)	(0.008)	(0.015)	(0.011)	(0.015)
Sectoral agreement-works council	0.061 ***	-0.011	-0.005	0.047 **	0.039 **	0.042 **
	(0.020)	(0.019)	(0.014)	(0.020)	(0.018)	(0.019)
Works council's selectivity term	-0.030 *	0.022	-0.001	-0.027	0.014	-0.027
	(0.017)	(0.015)	(0.011)	(0.017)	(0.015)	(0.017)
Sectoral agreement's selectivity term	0.102 ***	0.016	0.008	0.096 ***	0.007	0.105 ***
	(0.030)	(0.031)	(0.022)	(0.029)	(0.028)	(0.029)
No/minor pressure (reference)						
Pressure: medium	0.027 *	0.022	0.014	0.034 **	0.021 *	0.044 ***
	(0.015)	(0.013)	(0.009)	(0.015)	(0.012)	(0.015)
Pressure: substantial, which doesn't endanger the continued existence	0.061 ***	0.056 ***	0.021 **	0.062 ***	0.056 ***	0.072 ***
	(0.016)	(0.015)	(0.010)	(0.017)	(0.014)	(0.016)
Pressure: substantial, which endanger the continued existence	0.030	0.054 ***	0.005	0.041 **	0.033 **	0.037 *
	(0.019)	(0.017)	(0.011)	(0.019)	(0.015)	(0.019)
Profit situation: sufficient/unsatisfactory (reference)						
Profit situation: (very) good	0.005	0.001	-0.002	-0.001	-0.003	-0.004
	(0.014)	(0.013)	(0.009)	(0.013)	(0.011)	(0.013)
Profit situation: satisfactory	0.002	-0.001	-0.004	-0.001	0.005	0.001
	(0.013)	(0.013)	(0.009)	(0.013)	(0.011)	(0.013)
No spin-offs	-0.016	0.024	0.013	0.003	-0.039	-0.006
	(0.028)	(0.028)	(0.019)	(0.028)	(0.027)	(0.027)
Integration of other establishments	0.078 **	0.003	0.033	0.087 ***	0.049	0.083 ***
	(0.033)	(0.035)	(0.027)	(0.032)	(0.033)	(0.031)
No R&D dept. (reference)						
R&D dept. in establishment	0.262 ***	0.108 ***	0.141 ***	0.238 ***	0.126 ***	0.226 ***
	(0.017)	(0.018)	(0.014)	(0.016)	(0.017)	(0.016)

R&D dept. in enterprise	0.127 ***	0.011	0.063 **	0.113 ***	0.090 ***	0.116 ***
	(0.037)	(0.036)	(0.031)	(0.036)	(0.035)	(0.036)
Individually owned	0.007	-0.011	0.001	0.008	-0.036 *	0.006
	(0.024)	(0.022)	(0.015)	(0.025)	(0.019)	(0.025)
Further training	0.081 ***	0.046 ***	0.026 ***	0.093 ***	0.042 ***	0.098 ***
	(0.012)	(0.010)	(0.006)	(0.012)	(0.009)	(0.012)
Expected business volume development: increase (reference)						
Expected business volume development: unchanged	-0.048 ***	-0.033 ***	-0.015 **	-0.055 ***	-0.019 **	-0.057 ***
	(0.011)	(0.010)	(0.007)	(0.011)	(0.009)	(0.011)
Expected business volume development: decrease	-0.068 ***	-0.038 ***	-0.013	-0.066 ***	-0.009	-0.058 ***
	(0.013)	(0.012)	(0.009)	(0.013)	(0.011)	(0.013)
State of the technical equipment: state-of-the-art (reference)						
State of the technical equipment: rather new	-0.041 ***	-0.027 **	-0.030 ***	-0.031 **	-0.076 ***	-0.041 ***
	(0.013)	(0.013)	(0.010)	(0.013)	(0.012)	(0.013)
State of the technical equipment: medium or worse	-0.077 ***	-0.042 ***	-0.048 ***	-0.064 ***	-0.121 ***	-0.077 ***
	(0.016)	(0.015)	(0.010)	(0.016)	(0.014)	(0.015)
Share of part-time workers	-0.000	0.001 *	-0.000	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Share of fixed-term contract workers	0.001	0.001 *	0.000	0.001 *	0.000	0.001 *
	(0.001)	(0.000)	(0.000)	(0.001)	(0.000)	(0.001)
Share of high-skilled workers	0.001 *	0.000	0.001 ***	0.001 *	0.000	0.001
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Single-establishment	-0.041 ***	-0.069 ***	-0.021 **	-0.052 ***	-0.041 ***	-0.055 ***
	(0.015)	(0.015)	(0.010)	(0.015)	(0.014)	(0.015)
Foreign ownership	0.007	-0.025	-0.026	-0.005	0.007	-0.012
	(0.021)	(0.023)	(0.017)	(0.020)	(0.022)	(0.020)
Western Germany	0.106 ***	0.042 ***	0.008	0.095 ***	0.057 ***	0.106 ***
	(0.016)	(0.016)	(0.011)	(0.016)	(0.014)	(0.016)
Share of exports	0.004 ***	0.004 ***	0.002 ***	0.004 ***	0.003 ***	0.004 ***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Share of exports squared	-0.000 ***	-0.000 ***	-0.000 ***	-0.000 ***	-0.000 ***	-0.000 ***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Share of expansion investment	0.001 ***	0.001 ***	0.000 ***	0.001 ***	0.002 ***	0.001 ***

	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Constant	0.261 ***	0.084	0.044	0.283 ***	0.183 ***	0.297 ***
	(0.064)	(0.061)	(0.044)	(0.063)	(0.058)	(0.063)
Time dummies	yes	yes	yes	yes	yes	yes
Size dummies	yes	yes	yes	yes	yes	yes
Industry dummies	yes	yes	yes	yes	yes	yes
R^2	0.22	0.09	0.10	0.20	0.16	0.21
Number of establishments	4,867	4,867	4,866	4,866	4,866	4,866
Number of observations	11,527	11,528	11,527	11,526	11,526	11,529

Notes: Clustered (by establishment) standard errors in parentheses. The model specification is given by equation (3) in the text, with the two selectivity terms for the presence of works council and sectoral agreement being derived from a biprobit that uses a non-common set of regressors in the corresponding choice equations. (See text for the description of the procedure.) The null of no interdependence between the two equations in the biprobit is rejected comfortabaly at the 0.01 level. *, **, and *** denote statistical significance at the 0.1, 0.05, and 0.01 levels, respectively.

TABLE 10
THE SELECTION OF SUBSAMPLES

	Subsample [Given by the sectoral bargaining and innovation status in t_0 (i.e. 2007-2008)]	*Sectoral bargaining status in t_1* [i.e. 2009-2010]	*Outcome* Innovation in t_1 [i.e. 2009-2010]	*Interpretation* A positive coefficient on the scb variable means that:
Case 1	Establishments that are both *non-innovators* and *not covered* by a sectoral agreement; that is, Innov=0 in both 2007 and 2008 scb=0 in both 2007 and 2008	1/0 dummy (1 if scb=1 in both 2009 and 2010); 0 if scb=0 in both 2009 and 2010)	1/0 dummy (1 if Innov=1 in either 2009 or 2010, or in both; 0 otherwise)	Joining a sectoral agreement increases the probability of innovation for plant without any innovation at all in t_0
Case 2	Establishments that are both *non-innovators* and *covered* by a sectoral agreement; that is, Innov=0 in both 2007 and 2008 scb=1 in both 2007 and 2008	1/0 dummy (1 if scb=0 in both 2009 and 2010); 0 if scb=1 in both 2009 and 2010)	1/0 dummy (1 if Innov=1 in either 2009 or 2010, or in both years; 0 otherwise)	Leaving sectoral agreement decreases the probability of innovation for plant without any innovation at all in t_0
Case 3	Establishments that are both *innovators* and *not covered* by a sectoral agreement; that is, Innov=1 in either 2007 and 2008 (or in both) scb=0 in both 2007 and 2008	1/0 dummy (1 if scb=1 in both 2009 and 2010); 0 if scb=0 in both 2009 and 2010)	1/0 dummy (1 if Innov=1 in either 2009 or 2010, or in both years; 0 otherwise)	Joining a sectoral agreement increases the probability of innovation for plant with some innovation in t_0
Case 4	Establishments that are both *innovators* and *covered* by a sectoral agreement, that is, Innov=1 in either 2007 and 2008 (or in both years) scb=1 in both 2007 and 2008	1/0 dummy (1 if scb=0 in both 2009 and 2010); 0 if scb=1 in both 2009 and 2010)	1/0 dummy (1 if Innov=1 in either 2009 or 2010, or in both years; 0 otherwise)	Leaving sectoral agreement increases the probability of innovation for plant with some innovation in t_0

Note: This table illustrates the case in which the selected observation window is given by t_0=2007-2008 and t_1= 2009-2010.

TABLE 11
THE DIFFERENCE-IN-DIFFERENCES EFFECT OF JOINING/LEAVING SECTORAL COLLECTIVE BARGAINING AGREEMENTS ON THE PROBABILITY OF ANY TYPE OF INNOVATION IN GERMANY, FOR INNOVATING AND NON-INNOVATING ESTABLISHMENTS WITH AT LEAST FIVE EMPLOYEES, PRIVATE SECTOR, 2007-2012, POOLED CASE

(a) Non-innovators sample

	Without woco (in t_0)				*With woco* (in t_0)			
	Joining scb vs. Staying uncovered		*Leaving scb vs. Staying covered*		*Joining scb vs. Staying uncovered*		*Leaving scb vs. Staying covered*	
Scb coefficient			-0.02	-0.02	-0.08	-0.08	0.09***	0.09**
Works council's selectivity term			----------	56.80*	----------	-0.27	----------	-0.33
Sectoral agreement's selectivity term			----------	-1.73	----------	0.4	----------	1.80 ***
R^2			0.57	0.61	0.14	0.14	0.05	0.05
N			82	82	520	520	3,914	3,914

(b) Innovators sample

	Without works council (in t_0)				*With works council* (in t_0)			
	Joining scb vs. Staying uncovered		*Leaving scb vs. Staying covered*		*Joining scb vs. Staying uncovered*		*Leaving scb vs. Staying covered*	
scb coefficient	-0.43**	-0.43*	0.09	0.10	-0.002	-0.002	0.004	0.004
works council's selectivity term	----------	3.55	----------	34.69	----------	-0.73	----------	1.63
sectoral agreement's selectivity term	----------	2.12	----------	0.81	----------	0.03	----------	0.19
R^2	0.72	0.73	0.32	0.33	0.10	0.10	0.08	0.08
N	58	58	154	154	1,146	1,146	9,498	9,498

Notes: In each panel, the reported coefficients are obtained by running a linear probability model. Both the dependent variable – any type of innovation – and the sectoral collective bargaining agreement variable are dated in t_1. The control variables are in first differences. See Table 10 for full details on model implementation and interpretation. No estimates could be obtained for the joining scb vs. staying uncovered case in panel (a). Similarly to the implementation in Table 9, the selectivity terms are derived from a biprobit that models now the works council and sectoral agreement switching decisions. The null of no interdependence across the two equations in the biprobit is always rejected at the 0.01 level. *, **, and *** denote statistical significance at the 0.1, 0.05, and 0.01 levels, respectively.

TABLE 12
THE DIFFERENCE-IN-DIFFERENCES EFFECT OF JOINING/LEAVING SECTORAL COLLECTIVE BARGAINING AGREEMENTS ON THE PROBABILITY OF ANY TYPE OF INNOVATION IN GERMANY, FOR INNOVATING AND NON-INNOVATING ESTABLISHMENTS WITH AT LEAST FIVE EMPLOYEES, PRIVATE SECTOR, 2007-2012, POOLED CASE WITH NO WORKS COUNCIL SWITCHERS

	Non-innovator				*Innovator*			
	Joining scb vs. Staying uncovered		*Leaving scb vs. Staying covered*		*Joining scb vs. Staying uncovered*		*Leaving scb vs. Staying covered*	
Scb coefficient	-0.09		0.09***	0.09***	-0.002	-0.005	0.001	0.001
Works council's selectivity term	----------		----------	-0.56	----------	-1.32	----------	2.40
Sectoral agreement's selectivity term	----------		----------	1.11	----------	0.15	----------	-0.40
Works council (in t_0)	0.10		0.07	0.07	0.04	0.04	-0.06*	-0.06*
R^2	0.14		0.05	0.05	0.09	0.10	0.09	0.09
N	518		3,905	3,905	1,162	1,162	9,403	9,403

Notes: See notes to Table 11. No estimates could be obtained for the joining scb vs. staying uncovered/non-innovator case in the second column. The selectivity terms are derived from a biprobit that models, respectively, works council presence and sectoral agreement transitions. The null of no interdependence across the two equations in the biprobit is always rejected at the 0.01 level. *, **, and *** denote statistical significance at the 0.1, 0.05, and 0.01 levels, respectively.

TABLE 13

MEDIUM-TO LONG-RUN EFFECTS OF JOINING/LEAVING SECTORAL COLLECTIVE BARGAINING AGREEMENTS ON THE PROBABILITY OF ANY TYPE OF INNOVATION IN GERMANY, FOR INNOVATING AND NON-INNOVATING ESTABLISHMENTS WITH AT LEAST FIVE EMPLOYEES, PRIVATE SECTOR, 2007-2012

(a) Non-innovators sample

	Without works council		*With works council*	
	Joining scb vs. Staying uncovered	*Leaving scb vs. Staying covered*	*Joining scb vs. Staying uncovered*	*Leaving scb vs. Staying covered*
Scb coefficient	0.16	0.17		
R^2	0.14	0.19		
N	310	188		

(b) Innovators sample

	Without works council		*With works council*	
	Joining scb vs. Staying uncovered	*Leaving scb vs. Staying covered*	*Joining scb vs. Staying uncovered*	*Leaving scb vs. Staying covered*
Scb coefficient	0.14	-0.04	0.16	-0.38***
R^2	0.09	0.21	0.24	0.23
N	644	229	107	301

Notes: The pre-treatment period t_0 comprises the 2007-08 interval; t_1=2009-12 is the post-treatment period. No estimates could be obtained for the last two columns in panel (a). See the text for a full description of the experiment.

TABLE 14
THE DIFFERENCE-IN-DIFFERENCES EFFECTS USING PLACEBOS

(a) Non-innovators sample

	Without works council		*With works council*	
	Joining scb vs. Staying uncovered	*Leaving scb vs. Staying covered*	*Joining scb vs. Staying uncovered*	*Leaving scb vs. Staying covered*
scb coefficient	0.49**	-0.16		-0.32
R^2	0.14	0.24		0.45
N	388	242		92

(b) Innovators sample

	Without works council		*With works council*	
	Joining scb vs. Staying uncovered	*Leaving scb vs. Staying covered*	*Joining scb vs. Staying uncovered*	*Leaving scb vs. Staying covered*
scb coefficient	0.15	0.09	0.26	-0.06
R^2	0.13	0.23	0.33	0.16
N	848	290	153	427

Note: See the text for a full description of the experiment. No estimates could be obtained for the third column in panel (a).