Hollowed Out: Technological Change, Labor Market Polarization, and Trade Union Decline

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Abstract

Following recent work on how between-group heterogeneity decreases the probability of developing encompassing institutions, I argue that labor market polarization across western democracies has contributed to trade union decline. Labor market polarization, an increase in employment in high- and low-wage occupations but a decline in routine task, middle wage occupations, is caused by technological change and creates a workforce that is more heterogeneous in its preferences for union representation, reducing the possibility of cross-skill-group support for unions. I test this argument using data for 21 OECD countries 1969-2010 and linked employer-employee German data 1993-2007. In the former, I find a robust, positive relationship between routine task employment and union density. In the latter, I find that firms with more heterogeneous workforces are more likely to withdraw from collective agreements and that industries with high between-firm skill heterogeneity have lower collective agreement participation.

1 Introduction

The effect of technological change on political and social institutions has been the subject of much work in the comparative political economy of advanced western democracies. Over the past few decades, technological change has contributed to a shift from largely industrial economies with male workforces, to largely service-based economies with more demographically heterogeneous workforces in western democracies (Esping-Andersen, 1999; Häusermann, 2010). This has drawn increased attention to the possibility of new economic cleavages between different workforce demographics. One of these is an 'Insider-Outsider' cleavage between labor market 'insiders,' those with secure employment and labor market 'outsiders,' those with insecure employment (Lindbeck & Snower, 2001; Rueda, 2005; Emmenegger, Häusermann, Palier, & Seeleib-Kaiser, 2012). Scholars have demonstrated how political preferences between these groups have diverged (Rueda, 2007) and how this new cleavage has impacted social spending and welfare state reform (Häusermann, 2010; Rueda, 2014).

Yet while these and related works have made important contributions to comparative political economy, there have been fewer attempts to theorize and test for mechanisms linking technological change to the development of new economic cleavages and the evolution of political and economic institutions. In this paper, I develop a new mechanism to explain how technological change affects collective action between different skill groups of workers, which I use to examine the decline of one of the most important political-economic institutions: trade unions.

I explain trade union decline as the result of a new economic cleavage between high and low-skills workers over support for unions, which I argue is the result of technological-change-induced labor market 'polarization.' Previous work argued that the effect of deindustrialization on trade unions came largely through worker attrition, where unionized jobs in industry were lost and replaced by non-unionized jobs. But technological change has a differential effect on the bargaining leverage of different skill groups of workers. It has caused labor market polarization, an increase in demand for low-wage and high-wage jobs but a decline in formerly middle-wage, routine task jobs (Goos, Manning, & Salomons, 2014). Routine task jobs are those in which a worker performs a conceptually simple, repeated task, which can be programmed as an algorithm and performed by a machine, given sufficient computing power.

Before massive increases in computing power in recent decades, industrial production required a high number of workers performing routine task jobs. These workers had similar skills and were concentrated in large work places, giving them more homogeneous preferences for and ability to support strong unions. As routine task employment can be replaced by computer-driven machines, workplaces become more heterogenous. Workers with more heterogeneous skills and wage demands will be less likely to join together to support trade unions. At the same time, the decline in routine task employment opportunities has increased the competitive pool for lower-skills jobs, limiting these workers' leverage to push for union representation.

I also address an additional possible explanation for labor market polarization and trade union decline: job offshoring. The debate between technology vs. trade as explanations for manufacturing decline has been ongoing for several decades in labor economics (Freeman, 1995; Wood, 1995). Yet recent work has shown that technological change and trade have different effects on employment, with technological change more responsible for labor market polarization (Autor, Dorn, & Hansen, 2015). Because technological change is more directly responsible for labor market polarization, we might expect technological change to be more directly related to union decline than offshoring.

My theory follows recent work in political science on institutional development, which has shown that greater between-group heterogeneity decreases the probability of developing encompassing institutions. This research builds on Olson's (1965) theory of collective action by showing that there can still be collective action and provision of collective goods in a large overall population, but that the social groups of which that whole is comprised must be similar enough in their core interests. Recent work in political science shows that inequalities between subgroups have a detrimental effect on the development of a variety of types of encompassing institutions (Baldwin & Huber, 2010; Ahlquist, 2010; Lupu & Pontusson, 2011).

I set myself two tasks in this paper. The first is to mediate between decline in routine task employment and employment offshoring as explanations for trade union decline at the national level. In order to do this, I analyze data for 21 OECD countries 1969-2010 and show that there is a consistent, within-country positive correlation between routine task employment and union density, which is robust to the inclusion of offshoring and a measure of industrial employment. Contrary to trade-based theories of union decline, but consistent with work which shows that offshoring is not primarily responsible for labor market polarization, the measure of offshoring is not robustly correlated with union decline.

Although cross-national data can help demonstrate the broad applicability of routine task employment as an explanation of trade union decline, it cannot provide strong evidence for the heterogeneity mechanism specified by the theory. In order to do this, we need data at the level of analysis specified by the theory: the bargaining unit. For this, I use two linked employer-employee firm-level datasets from Germany 1993-2007: 1) a firm-level panel dataset, in which firms are observed for several consecutive years and 2) a representative industry-level sample of firms. In firm-level regressions, I find that greater heterogeneity in worker skill profiles and higher average worker skill levels are associated with higher and lower probabilities of withdrawal from collective agreements respectively. Net these skill effects, higher levels of routine task employment are at best an inconsistent predictor of maintaining a collective agreement. When the data are aggregated at the industry-level, I find relatively robust evidence that higher within-industry, between-firm skill heterogeneity is associated with lower participation in collective agreements, suggesting that the heterogeneity mechanism may also operate between firms.

This paper can contribute to our understanding of several important topics in comparative political economy. First, this paper can contribute to our understanding of both the causes and effects of economic cleavages. Technological change has increased employment opportunities and wages for high-skills workers, which has reduced their dependence on forming a coalition with lower-skills workers to form unions and increase their bargaining power. Second, one of the most consistent explanations given for increasing inequality across advanced democracies is that this is due to a decline in trade union strength. While some authors have argued that technological change is directly responsible for increased inequality (Autor, Katz, & Kearney 2008), this has been disputed by others (Kristal & Cohen, forthcoming). My results suggest that whether or not technological change has a direct effect on inequality, it very likely has at least an indirect effect through its effect on trade unions.

This paper proceeds as follows: Section 2 reviews literature on trade union decline as well as that on occupational change and labor market polarization. In section 3, I present my arguments linking technological change, labor market polarization, and offshorability to trade union decline. In Section 4, I discuss how to bring the theory to data. Section 5 presents the cross-national data, methods, and results. Section 6 presents the German firm-level data as well as firm- and industry-level analyses. Section 7 concludes with a discussion of some broader implications of these results.

2 Technological Change, Offshoring, and Trade Unions

Trade unions are a core topic in work on collective action. Mancur Olson dedicated an entire chapter of *The Logic of Collective Action* to them, arguing that unions were originally only successful in organzing smaller workplaces and that it was not until closed shop laws were enacted, which mandated that workers join the union in order to be able to work in a unionized workplace, that they became nationally successful in the United States.[1] Recent work in political science has enriched our understanding of the sources of broad-based collective action success by emphasizing the importance of inequality between component groups. Although small groups may form in accordance with Olson's logic, the likelihood that these groups will join together to form large scale collective action federations will be a function of their differences in resources. John Ahlquist (2010) argues that centralized trade union confederations were more likely to develop in countries in which unions developed a centralized strike fund, which is itself a positive function of resource equality between unions. Kate Baldwin and John Huber (2010) argue that public goods spending will be higher in countries in which there is relative economic equality among various ethnic groups.

One of the questions that much of this literature raises is: what is the source of the between-group inequality? It may be sensible to take between-group inequality as exogenous when studying ethnic heterogeneity, where countries' borders were often imposed by western powers with minimal regard to ethnic composition, but it makes less sense when a constantly changing factor, like technology, affects the degree of heterogeneity. Recent work on trade union decline has, however incorporated the effects of technological change. The primary theory of how technology affects employment is Skill-Biased Technological Change (SBTC), which holds that the demand for workers increases linearly with their skill levels (Goldin & Katz, 2008). SBTC-based theories of trade union decline incorporate this shifting demand for skills and how it differentially affects the preferences for unionization of different skill groups of workers, thus endogenizing between-group preference heterogeneity.[2]

[1] While this explanation may be correct for the United States, it is difficult to reconcile with high union membership in Scandinavian countries, where it is non-compulsory.

[2] This built on work explaining trade union decline as a function of deindustrialization, where the mechanism of union decline was worker attrition, that unionized jobs in industry were lost and replaced by non-unionized jobs (Hirsch, 2008; Lee, 2005). The problems with this attrition explanation were that there also had been union decline within manufacturing and that there was no explanation for why new jobs in the post-industrial era were non-unionized (Wallerstein & Western, 2000).

The basic argument in these theories is that higher-skill workers do not want to be represented by unions, which will attempt to level wage increases across skill groups, giving them lower wage increases than they would get under individual bargaining. As technological change improves high-skills workers' non-union options, it removes their incentive to form a coalition with unskilled workers to support unions (Acemoglu, Aghion, & Violante, 2001). Dinlersoz & Greenwood (2012) argue that skilled workers are more heterogeneous than unskilled workers and will be less likely to form unions due to their interest heterogeneity. These explanations are similar to those on the decline of centralized wage bargaining in Europe in the 1980s and 1990s. Technological change gave rise to 'diversified quality production,' which increased the value of high-skills workers and necessitated a greater connection between individual/team performance and monetary rewards. This strained centralized wage bargaining systems, which had produced similar wage increases across sectors, regardless of productivity increases (Pontusson & Swenson, 1996; Iversen, 1996).

But while these previous explanations ground their arguments in worker skill heterogeneity and endogenize between-skill-group heterogeneity, the mechanisms that they posit are inconsistent with recent work in labor economics on how technological change affects different types of jobs. In contrast to SBTC, which predicts a linearly increasing relationship between skills and worker benefits from technological change, recent work has shown that technological change has a polarizing effect on employment, increasing employment at the high and low-ends of the wage spectrum while decreasing that in the middle. In a seminal paper, Autor, Levy, & Murnane (2003) argue that improvements in computing power led to a decline in employment in occupations rich in performance of discrete, repetitive 'routine' tasks, which were central in many manufacturing and clerical jobs.[3] These tasks can be

[3]According to the authors, a task "is routine if it can be accomplished by machines following explicit programmed rules." This includes "many manual tasks...such as monitoring the temperature of a steel finishing line or moving a windshield into place on an assembly line," but also cognitive tasks, such as "calculating, coordinating, and communicating functions of bookkeepers, cashiers, telephone operators, and other handlers of repetitive information-processing tasks." (1283-4).

written as algorithms and as computing power improves, performed by machines. There has been both employment polarization, with employment increasing for occupations at the top and bottom of the early 1980s wage distribution, but declining for those occupations in the middle, and wage polarization, with wages also increasing for occupations at the top and bottom of the early 1980s wage distribution, but declining for those in the middle. This empirical regularity has been found across western democracies.[4]

Other recent work has suggested another possible source of labor market polarization: job offshoring. Many of the same types of jobs replaceable through new technology can also be offshored and several authors have argued that offshoring rather than technological change may be responsible for labor market polarization (Blinder & Krueger, 2013; Van Reenan, 2011). Additionally, many other types of routine task jobs, such as textile work, are not as easily automated, but can be easily be offshored. Because of this, we might expect labor market polarization to be the result of employers' increased ability to offshore production. Recent work, however suggests that labor market polarization is more attributable to technological change than offshoring (Michaels, Natraj, & Van Reenen, 2014; Autor, Dorn, and Hansen, 2015). This is because offshoring has more homogeneous effects across the skill distribution. Whereas technological change has affected largely middle-wage, routine task workers, offshoring also affects high-skill professions, such as accounting, engineering, and computer programming. When factories are closed due to offshoring, local economies also contract, affecting low-skill workers in retail, restaurants, and local small businesses.

3 A Polarization-Based Theory of Trade Union Decline

The effect of technological change on labor has changed over time. It has not always been labor-replacing. During the first industrial revolution in the 18th and 19th centuries, technological change was often labor-enhancing, creating new demand for unskilled labor. Eco-

[4] See Autor, Katz, & Kearney (2008) on polarization in the United States, Goos & Manning (2007) on polarization in the UK, Spitz-Oener (2006) on polarization in Germany, and Goos, Manning, & Salomons (2014) on polarization in 16 European countries.

nomic historians have noted that unskilled workers were among the greatest beneficiaries of the industrial revolution, as the combination of capital and unskilled labor substituted for skilled labor (Katz & Margo, 2014). One-man artisan jobs became jobs for dozens of workers, each performing specific, repeated tasks. The reliance on unskilled manpower for existing tasks declined somewhat with the transition to electricity, but the progression of industry and the development of fordist production methods meant that many new types of unskilled, routine task jobs were required. Fordist production created very favorable conditions for collective action among low-skills laborers. Their low skill differentials mean that they had similar abilities to increase their wages through individual bargaining. As production required high worker concentration in large workplaces, low-skills workers had both the similarity of interest and opportunity necessary to create and support strong unions.

With improvements in computing power in recent decades however, technological change has become low-skill-labor-replacing rather than complementing. The polarization of employment into high and low-wage occupations and 'hollowing out' of the middle part of the wage distribution may affect both individual preferences for unionization and the distribution of preferences for unionization across the skill spectrum. High and low-skill groups should have different preferences for unions, which level wages both across and within skill groups, and between firms in multi-firm agreements (Freeman & Medoff, 1984). New technology increases the demand for both programmers and engineers, who create and maintain new technology, as well as for personnel and business managers to manage what are often more complicated production networks. This gives these workers a great deal of individual wage bargaining power and less desire to be represented by unions. Low-skills workers may have relatively high demand for unions as their wages are relatively low and their tasks have not been replaceable by technology, but not a coalition partner with which to press management for union representation.[5]

[5] Wallerstein (1990) gives a similar explanation for the maintenance of centralized collective bargaining across multiple unions, arguing that when workers are compliments in production, a wage increase by any

These differences in preferences based on individual bargaining power will also create difficulties in achieving collective action between skill groups. Labor market polarization creates a cleavage between low- and high-skills workers over between-group redistribution. As the distance between skill groups in commanded wages increases, they should be less likely to agree on union representation, which redistributes between groups by aiming for parity in wage increases. Low-skills workers will want wage redistribution, but high-skills workers will not and know that they have high individual bargaining power outside of a union setting.[6] Furthermore, as demand for high-skills workers increases due to their importance for developing and operating new technology, their wages increase and the wage gap between high-skills and low-skills workers increases. Assuming that redistribution raises the median wage toward the mean, the amount that is redistributed from them to low-skills workers increases with the wage gap. Redistribution has greater 'bite' for high-skills workers and they should be more averse to a redistributive institution, such as unions.

4 Data Requirements and Hypotheses

There are several issues with bringing this theory to data. The most important question is: at which level of analysis does the theory apply? My theory best applies at the level at which collective bargaining occurs. Workers in the bargaining unit choose whether they will be covered by a collective agreement.[7] The bargaining unit is often the establishment,

single union reduces shareholders' optimal level of investment and decreases the wages of all workers. Centralized wage setters choose wages below the equilibrium of decentralized wage setting, increasing investment, growth, and jobs. But when workers are less complimentary in production, high-skills workers have less incentive to participate as their future wage gains are less dependent on low-skills workers.

[6] High-skills workers may however be able to agree on union representation when they are in workplaces with largely other high-skills workers, as there would be less concern about redistribution. In contrast to the theory of Acemoglu, Aghion, & Violante, in which high-skill workers do not want to unionize, according to this logic, they only oppose unionization when they would have to form a union with low-skills workers. This can make sense of the fact that collective bargaining institutions have been quite stable among firms in the core German manufacturing industries, which tend to employ relatively high-skills workers (Thelen, 2014).

[7] This choice may be indirect, where management formally chooses whether to participate in a collective agreement, but the workers choose whether or not to apply pressure on them to do so.

although it may also be multiple establishments within a single firm or multiple firms within industry or region. Furthermore, the theory applies to workers' collective choice to be represented by a union through a collective agreement, rather than an individual's choice to become a union member.

Because I want both to assess the general applicability of the importance of routine task employment for union strength and test the mechanisms of the theory, which applies at the bargaining level, I analyze two different types of data: 1) union density and the routine task composition of employment in cross-national data from 20 OECD countries 1969-2010 and 2) firm- and industry-level data on collective agreement participation from Germany 1993-2007. The cross-national data analysis can help us mediate between technological change and offshoring as general explanations for trade union decline and see whether these are robust to other important covariates. In order to test the effect of workforce heterogeneity on collective agreement participation, I analyze survey data from German firms 1993-2007 linked with social security records on their workers' skill profiles. I test the following two hypotheses, which capture respectively the general relationship between routine task employment and trade union strength and the specific relationship of between-skill group heterogeneity and the probability of collective agreement participation. The former can be tested in both country and firm-level data while the latter can only be tested in firm-level data.

H_1: *Higher levels of routine task employment will be associated with higher levels of union density and with higher probability of participation in collective agreements.*

H_2: *Greater between-worker skill heterogeneity within a bargaining unit will be associated with lower probability of participation in collective agreements.*

A competing task-based explanation for employment change is 'offshorability,' the idea that certain job tasks can be offshored because they require little face-to-face interaction with customers and/or are not site-specific.[8] Many tasks that can be automated can also

[8] Blinder and Krueger (2013, S97) define offshorability as "The ability to perform one's work duties (for the same employer and customers) from abroad."

be offshored. For offshorable jobs, employers have increased ability to 'threaten' workers with job loss, which can in turn put downward pressure on union wage premia, making unions less attractive to workers and deterring them from joining, or making them reluctant to support plant unionization. As noted above, however, recent research has shown that offshoring has a more homogeneous effect on employment across the wage distribution because high-skills jobs can also be offshored. Because of this, we should expect a weaker link between offshoring and union strength.

*H_3: Higher levels of offshorability will **not** be associated with higher levels of union density or higher probability of participation in collective agreements.*

While there has been decreased demand for workers performing routine tasks, there has been increased demand for workers in lower-paying jobs, largely in the service sector. We might think that because of this increased demand, these workers will have more leverage to demand union representation, especially because these jobs tend to have similar skill requirements. Although the demand for low-skills workers in service professions has increased, the supply of workers competing for these positions has also increased. With the elimination of middle-wage, routine task jobs, formerly routine task-performing workers increasingly compete with low-skills workers for low-wage jobs, creating a pool of reserve labor and suppressing individual bargaining power in these jobs.[9] This gives employers greater leverage over these workers. But this is less the case for higher-skills workers, who are necessary to realize the benefits of technology and thus less individually replaceable. Provided that they are in homogenous workplaces, we might expect high-skills workers to be *more likely* to agree on collective representation. Because this leverage increases with the skill composition of the workforce, we can state the following hypothesis, to be tested in

[9] According to Acemoglu and Autor (2011, 64), "medium skill workers previously performing routine tasks are a closer substitute for low skill workers employed in manual and service occupations than they are for high skill workers in professional, managerial, and technical occupations. Indeed the substantial movement of medium skill high school and some college workers out of clerical and production positions and into service occupations after 1980 may be read as prima facie evidence that the comparative advantage of middle skill workers (particularly middle skill males) is relatively greater in low rather than high skill tasks." See also Jaimovich and Siu, n.d.

the firm-level data:

H_4: Greater average skill levels of workers within a bargaining unit will be associated with higher probability of participation in collective agreements.

5 Cross-National Analysis

In order to mediate between routine task employment and offshorability as general explanations for trade union decline, I use time series cross-sectional data for 21 OECD countries 1969-2010. The main explanatory variables in this analysis are country-year measures of the task content of occupational employment, measured by 'routine task intensity' and 'offshorability'. In order to construct these, I use two data sources: information on occupational employment by country-year for nine one-digit ISCO occupations, which comes from the International Labour Organization's LABORSTA database[10] and data on the task content of occupations from Autor, Levy, & Murnane (2003) and Goos, Manning, & Salomons (2014).[11] In order to construct occupational routine task intensity, Autor, Levy, & Murnane used codings of occupations for five types of tasks (routine abstract, routine manual, service, non-routine abstract, non-routine manual), which they derived from the Dictionary of Occupational Tasks (DOT) for American census occupations. Their routine task intensity measure is a difference between the occupation's level of routine tasks (such as "finger dexterity" and "set limits, tolerances, and standards") and the sum of abstract and manual tasks. The offshorability measure was developed by Goos, Manning, and Salomons and is based on three different codings: Blinder & Krueger's (2013) survey-based measure,

[10]http://laborsta.ilo.org/. The ILO occupation data comes largely from country reports on yearly occupational employment. Many countries changed their classification system for reporting occupational employment in the 80s and 90s, going from the ISCO-68 system, which had seven one-digit occupational categories to the ISCO-88 system, which has nine. The ISCO-88 classifications include "Craft and related trade workers," "Plant and machines operators and assemblers," and "Elementary occupations" as separate categories while ISCO-68 collapses these into one category.

[11]These task content data are at the two-digit ISCO level. I collapsed the two-digit categories into the ISCO one-digit categories in the employment data by averaging the two-digit scores within each one-digit category.

Firpo, Fortin, & Lemieux's (2011) O*NET measure,[12] and a measure created by the authors from reports on actual instances of occupational offshoring in different industries from the European Restructuring Monitor. For each country-year, I create the variables **RTE** and **Off,** and generate their values by weighing each one-digit occupational category's share of total employment by its routine task intensity and offshorability scores. Higher RTE and Off scores indicate a higher share of employment in routine task/offshorability-intensive occupations.[13]

Data on union density and union institutional variables come from the ICTWSS database (Visser, 2013). These include wage bargaining coordination (**Coor**) and presence of works councils (**WrkCn**), which Scruggs & Lange (2002) argue should stabilize union density. I use union density as the dependent variable both because it is the most common measure of union strength in the cross-national literature and because while the theory applies to workers' collective choice within a bargaining unit, cross-national data on bargaining coverage is only sparsely available.[14] Of course, the individual decision to become a union member may be influenced by somewhat different factors than workers' collective decision to be represented by a union. But as with the collective choice, the individual's choice to be a union member will be influenced by those around him or her. In any case, we should view union density as a proxy for the underlying variable of interest, participation in collective bargaining when the decision is made by workers and management in the firm.

My primary control is for percentage of employment in industry (**IndPerc),** as I argue

[12] O*NET is to successor scheme to DOT for occupational classifications.

[13] Two drawbacks with these data are that there is likely to be a good deal of within-occupation task heterogeneity and that the DOT and O*NET job content measures are updated infrequently (Spitz-Oener, 2006; Autor & Handel, 2013). Nevertheless, these variables continue to be widely used by labor economists in employment research because they appear to be highly correlated with time-variant measures developed for individual countries (Autor, 2014).

[14] Theoretically, it would also make sense to limit the dependent variable to union density in the private sector, as unionized workers in the public sector can use political power to strengthen themselves. Data coverage on strictly public or private sector union density is however only available for about 35% of the country-year observations in my dataset and I choose not to use this given the poor data coverage. I include public sector employment as a control in my regressions.

that specifically routine task employment, whether in industry, clerical, or other occupations will be associated with a decline in union density. I include a measure of left parties' share of the cabinet (**Party**), as Brady (2007) argues that left governments should be more favorable toward unions and a dichotomous indicator for whether there is federalism (**Fed**), which may decrease unions' ability to broadly organize.[15] Outward foreign direct investment (**FDI**) may weaken unions by allowing employers to threaten offshoring, thereby causing them to engage in concession bargaining and weakening workers' desire to pay dues (Choi, 2001; Slaughter, 2007). Higher levels of trade (**Trade**) and capital account openness (**Kmob**) reduce barriers to selling products produced in other countries in the domestic market, which may also encourage employment offshoring. Under high levels of unemployment (**Unemp**), workers may be more willing to take any available job, whether or not it is covered by a union contract and union members may withdraw their membership to avoid paying dues.[16] I also include an indicator for whether the country has a union-controlled Ghent system of unemployment insurance (**Ghent**), in which participation in unemployment insurance is tied to union membership, as Western (1997) has shown that countries with Ghent systems have higher union density. I also include a measure of immigration inflows (**Imm**), which Lee (2005) finds to be negatively correlated with union density and total employment (**Emp**), which Wallerstein (1989) argues should be negatively correlated with optimal union density. Finally, I included a measure of percentage of total employment in the public sector (**PubEmp**). Public sector unionization should be higher than private sector unionization because the government is more insulated from market forces and public sector employees can use political power to affect the choice of their supervisors.

This results in an unbalanced panel of 21 countries 1969-2010, as the employment data

[15] These variables come from the Comparative Political Dataset (Armingeon, Weisstanner, Engler, Potolidis, & Gerber, 2012).

[16] Data on trade flows, capital account openness, GDP, and unemployment come from the Comparative Welfare States Dataset and the sources therein (Brady, Stephens, & Huber, 2014).

are not available for some countries until the late 1980s or early 1990s.[17] A Wooldridge test for autocorrelation on my preferred specification could not reject the null hypothesis of no autocorrelation in the data. Unit root tests could not rule out non-stationarity in at least one of the panels. Given these, as well as substantial country differences in union density levels due to historical developments prior to my period of study, I model the data using OLS with country fixed effects, panel corrected standard errors, and a Prais-Winsten transformation to address autocorrelation. I regress union density on both contemporaneous covariates (Table 3) and covariates lagged by one year (Table 4). I include an additional model where I include fixed effects for five-year windows (1969-74, 1975-79,...,2005-2010) to address the possibility of period effects (Tables 3 and 4, Column 7). The estimating equations for the respective basic models are:

$$UD_{it} = \beta_0 + \beta_1 RTE_{it} + \beta_2 Off_{it} + \mathbf{X}_{it}^{'}\beta_3 + \gamma_i + \epsilon_{it} \tag{1}$$

where UD_{it} is union density for country i in year t, β_0 is a constant, β_1 an estimate of the correlation between Routine Task Employment and union density, β_2 an estimate of the correlation between Offshorability and union density, $\mathbf{X}_{it}^{'}$ a vector of control variables, γ_i a series of country fixed effects, and ϵ_{it} a country and year-specific error term. If H_1 is correct, β_1 will be positive. If H_3 is correct, β_2 will be indistinguishable from zero.[18]

[17] Employment data is only available for France 2002-2007, Italy 1992-2007, Germany 1992-2007, Switzerland 1991-2007, and the UK 1991-2007.

[18] Despite the use of lagged covariates in Table 4, there is a concern that these estimates are biased by reverse causality, that strong unions are able to slow the decline of routine task employment, knowing that this would make organizing workers more difficult. I address this concern in the supplementary appendix (table 1) with an instrumental variable regression, where I instrument routine task employment with a measure of average computing power.

5.1 Results

Tables 3 and 4 present regression results of union density on contemporaneous values of the covariates and covariates lagged by one period respectively. Model 1 in both tables includes RTE, industrial employment and fixed effects, model 2 replaces RTE with Offshorability, while model 3 includes both.[19] In both sets of regressions, β_1 is positive and significant in models 1 and 3, with a one standard deviation increase in RTE associated with 15-20% higher union density. β_2 displays the correct sign in three of the four regressions, but only one of these estimates is statistically significant, suggesting, in accordance with H_3, that employment offshorability is not a primary driver of the decline in union density. Models 4-6 add the controls to each of these respective models, while model 7 adds 5-year period fixed effects. The results for the focal variables are very similar. Despite the collinearity between RTE, industrial employment, and offshorability, the magnitudes on RTE are relatively consistent, while the coefficients on offshorability are relatively small with inconsistent signs and almost never statistically significant. The magnitude on RTE is reduced somewhat by inclusion of the control variables, but it remains statistically significant at at least $p < .05$.

Among the covariates, public employment and the Ghent system have a consistently positive association with union density, consistent with previous work. Trade and capital mobility display consistently negative signs and the latter is often statistically significant, suggesting a stronger negative relationship between trade and union density than in several previous works on union density. In contrast to Brady (2007), I do not find a consistent relationship between cabinet partisanship and union strength. Higher levels of unemployment are associated with higher levels of union density in the contemporaneous covariate models but not the lagged models, which may mean that union density is less elastic than

[19] I include these variables separately before I include them together due to high collinearity. The correlation between RTE and industrial employment is .79, the correlation between RTE and offshorability is .83, and the correlation between industrial employment and offshorability is .73. See Table 2 for full correlations between the variables.

employment in response to economic downturns.

6 German Firm-Level Analysis

Given the coarseness of cross-national data and the application of the theory at the bargaining unit level, the previous analysis cannot mediate between the various theoretical mechanisms underlying H_2 and H_4. In order to investigate these mechanisms, I turn to linked employer-employee data from Germany 1993-2007. I analyze collective bargaining participation in these data at two different levels of analysis: 1) at the firm-level, for which I use indicators of whether the firm participates in a firm-level or industry-level collective agreement 2) at the industry-level, for which I use the percentage of firms within industrial sectors participating in an industry-level or firm-level collective agreement. There are two primary reasons for conducting the industry-level analysis: 1) workers may select into firms based upon a combination of observed and unobserved characteristics, potentially biasing these results in unobservable ways. This selection problem should be reduced at the industry level. 2) The mechanisms may operate between firms. This is especially possible in Germany, given the preponderance of industry-level collective agreements.[20]

In Germany, firms make the decision to participate in collective agreements primarily by being a member of an employers' association, which concludes an industry-wide agreement with a major union, typically at federal state level.[21] Although the employer makes the decision to participate in a collective agreement, this will be a function of employer and worker preferences and power resources as explained above. There are two types of

[20]Recent work on wage inequality in Germany finds that a growing percentage of wage inequality is due to firm-specific components, rather than worker-specific components such as skills, tasks, experience, etc. (Card, Heining, & Kline, 2013). In other words, strong firms pay high wages and weaker firms pay lower wages, with workers likely sorting into good/bad firms based on their standing within their education, occupation, experience level, etc.

[21]German establishments have historically signed only one collective agreement, which covers all of their workers. This has begun to change, however following a 2010 Supreme Court ruling, which held that establishments could be covered by multiple agreements. The current grand coalition government has considered a law which would mandate no more than one collective agreement per workplace (that of the largest union), in part in response to persistent strikes by minority railway and pilot unions in 2015.

collective agreements: industry-level and firm-level. As we can see in figure 3, the former predominate, but were consistently declining during the period of analysis. Thelen and van Wijnberg (2003) argue that industrial agreements have declined because employers have withdrawn from employers' associations, not wanting to pay their higher wage rates. Silvia and Schroeder (2007) agree that this decline is due to employers' withdrawal from employers' associations, but that it was largely small employers, who were being squeezed on cost, who withdrew from these.

Industry-level agreements set pay grades for different types of work. These can be exceeded, but firms cannot pay below these grades for given work, unless the agreement contains an 'opening clause,' which allows firms to pay below the prescribed wages under certain conditions. This typically happens when they face economic hardship.[22] Firm-level agreements are far less common, although they often occur at firms with large numbers of workers and several establishments, such as Volkswagen. Although the logic of the theory developed above applies best to firm-level agreements, industry-level agreements have the same wage-leveling feature. A similar logic should apply because low-wage workers will be paid more than under individual bargaining.

One important issue concerns the external validity of the German case. The German collective bargaining landscape is most similar to those in the Nordic countries. In both Germany and the Nordic countries, firms decide whether to participate in collective agreements and union membership is non-compulsory. Basic industry-level collective agreements, which specify minimum wages and working conditions, apply to almost all firms in the Nordic countries. National unions enforce participation by threatening collective action, for which the legal framework is more favorable than in Germany (Author). As in Germany, there is substantial latitude for conducting local and firm-level agreements. My theory would best apply to this firm-level choice to have an additional firm-level collective agreement. If the workforce is more heterogeneous or workers have lower bargaining

[22] On the proliferation of opening clauses in German collective agreements, see Silvia & Schroeder (2007).

power with respect to management, we would expect these firms to be more likely to have only the industry-level collective agreement.[23] The theory should also apply reasonably well to the US, UK, and Canada because these countries require a formal worker vote for union representation within the bargaining unit. It would apply less well to France, Spain, or The Netherlands however, as whether or not a firm is covered by a collective agreement is typically not determined by the workers. These countries have high collective bargaining coverage, but this is because the ministry of labor in each of these countries extends collective agreements to most firms within sectors (Blanpain, 2005).

This section uses two datasets: the linked employer-employee LIAB cross-section model version 2 and the LIAB longitudinal model version 2 (both 1993-2007) from the Institute for Employment Research (*Institut für Arbeit und Berufsforschung*, IAB). Data access was provided via on-site use at the Research Data Centre (*Forschungsdatenzentrum*, FDZ) of the German Federal Employment Agency (*Bundesministerium für Arbeit*, BA) at the IAB in both Ann Arbor, Michigan and Berlin, Germany. This cross-sectional model consists of the IAB Establishment Panel (*Betriebspanel*), a yearly survey of between 4,500 and 16,000 firms with questions on firm performance, employment, training, etc., and social security records drawn for each of the firm's employees each year on June 30, containing information on sex, level of school completion, and occupation. Firms are selected in a stratified random sample according to industry, federal state, and size.[24] It is compulsory for employers to report the individual data, allowing creation of full firm-year profiles of each firm's workforce characteristics. The longitudinal version of the dataset draws yearly individual biographies for firms that are present in most or all 15 years of the firm survey, allowing for the creation of a panel dataset of firms.

I create two dichotomous dependent variables: 1) an indicator for whether the firm

[23] Representatives of the Swedish LO confirmed to me that it is very unlikely for there to be additional firm or local-level collective agreements in lower-wage sectors, such as hotels or fast food. Firm-level collective agreements are much more likely in industry (C.M. Johnson & T. With, personal communication, November 28, 2013).

[24] Large firms are oversampled, as are those in industry.

participates in an industry-level collective agreement 2) an indicator for whether a firm participates in *either* an industry- or firm-level collective agreement. I create four variables to test H_{1-4}; a measure of the mean routine task content of occupations (**RTE**) to test H_1, a measure of the standard deviation of workers' educational profiles (**SDQual**) to capture worker skill heterogeneity to test H_2, a measure of the mean education level of employees (**MQual**) to test H_3, and a measure of the mean occupational offshorability (**Off**) to test H_4. An ideal measure of skill would consist of multiple components, such as scarcity of and demand for the tasks that the worker performs, work experience, and education and qualifications. Rather than develop a complicated coding scheme, I use a relatively simple proxy, education qualification, which is in the individual record data. This is a six-category variable, where '1' is sub-secondary education and the highest category '6' is college degree or higher, with the middle categories being various levels of vocational training. If H_2 is correct, a higher standard deviation of workers' education levels will be associated with greater probability of withdrawal from industry- and firm-level collective agreements.[25] If H_3 is correct, higher mean education will be associated decreased probability of withdrawal from industry and firm-level collective agreements.

I generated measures of RTE and Offshorability by merging the Goos, Manning, & Salomons (2014) task data into the LIAB individual data using a crosswalk provided by the FDZ.[26] Additionally, I include a variety of control variables and fixed effects. Previous work on the determinants of German firm participation in industry-level contracts has found that participation rate increases with size of the firm (**Size**), as small firms are less able to pay the wage premia (Silvia and Schroeder 2007) and the percentage of goods exported (**Exp**).[27] I include additional covariates for the percentage of female workers

[25]Michaels, Natraj, & Van Reenan (2013) find a similar U-shaped relationship between occupational employment level and education as other authors have between occupational employment and wages, namely that employment has increased in both low- and high-education occupations, but declined in middle-education occupations. Recent work on the German training system has also shown that the number of multi-year apprenticeships, the middle categories of the education variable, has been declining as firms have become increasingly unwilling to make this investment (Thelen, 2014).

[26]I thank Dani Hochfellner of the FDZ in Ann Arbor for providing this crosswalk.

[27]Studies of the determinants of German firms' participation in collective agreements using FDZ data

(**PercFem**), firm profitability (**Profit**), and whether there is a works council (**WrkCn**). Two of the most important covariates include the mean age of the workforce (**Age**) and whether the firm was founded before 1990 (**New**). These variables help pick up cohort and legacy effects. We might expect that long established firms with older workforces would be more likely to maintain collective agreements than younger firms and firms with youthful workforces. I also include fixed effects for industrial sector, federal state, and an interaction of these. The latter are particularly important as industry-level collective agreements are typically concluded at the industry-federal state level. Standard errors are clustered at the firm-level.[28] Unfortunately, there is no indicator for whether or not an establishment is a member of an employers' association, so I cannot analyze whether this is a prerequisite for collective agreement withdrawal, as argued by Thelen and van Wijnberg (2003) and Silvia and Schroeder (2007). Nevertheless, if collective agreements are the main purpose of employers' association membership, we should expect worker skill heterogeneity to have a similar effect on employers' decision to participate in these.

I use Cox Proportional Hazard regression to model the firm-level panel data, setting the data as duration data and modeling the time until a 'failure' in the dependent variable, a firm withdrawing from either an industry- or firm-level collective agreement.[29] I treat the firm's first year in the dataset as its year of origin. As many firms have multiple failures, there are multiple possibilities to account for duration: (1) single-record data, modeling time until the first failure, after which the firm drops out of the analysis,[30] (2) single-

include Kohaut & Schnabel (2003), Addison, Bryson, Teixeira, Pahnke, & Bellmann (2009), and Raess (2013).

[28]There are sampling weights in the data, although I do not use them as they were generated for a different classification of industries than that which I use. Furthermore, firms are sampled with respect to industry, federal state, and firm size, each of which I include as covariates in unweighted regression models, consistent with the advice of Winship & Radbill (1994) on including variables for generating sampling weights as covariates in regression models vs. weighted regression.

[29]I treat the data as event history data because I view participation in collective agreements as part of a long-term process, where the explanatory variables have a cumulative effect over years resulting in withdrawal or non-withdrawal. There are also numerous firms which either never participate or always participate in collective agreements. These drop out in panel fixed effects regressions, due to the collinearity between the fixed effect and the dependent variable, greatly reducing the number of observations. For all of these reasons, I model the data using event history analysis rather than panel fixed effects.

[30]Single-record data means that a new spell begins after each failure while multiple-record allows a firm to have multiple failures with the clock continuously running.

record data, where a firm drops out of the dataset after not participating in a collective agreement, but reenters the next time it participates in a collective agreement, (3) single-record data, counting each non-signing as a failure,[31] or (4) multiple-record data, with the clock continuously running from the first year the firm is present in the data. Given that there is no obvious choice among these and for the sake of robustness, I present the regressions in each of these four ways.[32] The estimating equation is:

$$h(t, \mathbf{X}) = h_0(t) \exp\left(\sum_{i=1993}^{p} \beta_i X_i\right) \tag{2}$$

where $h(x)$ is a hazard function of time and covariates, with $h_0(t)$ the baseline hazard rate, p a year {1994, 1995,...,2007}, and X_i a matrix of covariates.

6.1 Firm-Level Analysis

Tables 3 and 4 present firm-level regressions to test $H_1 - H_4$. In table 3, a firm is coded experiencing an event when it withdraws from an industry-level collective agreement and in table 4, it is coded as experiencing an event when it withdraws from either an industry-level or a firm-level collective agreement. In both tables, the data are treated as one-spell, single-record data (type (1) from above) in columns 1 and 2.[33] Likewise, the data are treated as type (2) above for both tables in columns 3 and 4. The regression coefficients are hazard ratios, with values greater than 1 indicating higher probability and values less than 1 lower probability of collective agreement withdrawal in a given period. These gives the odds of failure with a one-unit increase of the independent variable; a hazard ratio of 2 would indicate that with a one-unit increase in the independent variable, twice as many firms

[31]The difference between (2) and (3) is that in (3), the firm does not drop out of the dataset in consecutive years of non-participation.

[32]I present only my preferred specifications, regression types (1) and (2) in the body of the paper, with types (3) and (4) in the supplementary appendix (tables 4 and 5).

[33]Firms whose first instance in the dataset is having either a firm-level agreement or no collective agreement are considered to have experienced an event in the first period and they drop out of the dataset after this.

experiencing events in any given period, whereas a hazard ratio of .95 would 95% as many firms experiencing events in any given period.

Table 3 presents the results for industry-level agreements. As predicted in H_2, the measure of worker skill heterogeneity **SDQual** consistently has a hazard ratio greater than one. With an increase in one unit of SDQual, a firm has between 2 and 7% higher probability of withdrawing from a collective agreement in a given period. Consistent with H_3, the measure of worker skill level **MQual** consistently has a hazard ratio less than one. With a one-unit increase in MQual, firms are between 3 and 7% less likely to withdraw from a collective agreement in a given period. While higher levels of RTE are associated with lower probability of withdrawal, consistent with H_1, this result is only significant in the one-spell regressions. This could mean is that percentage of employees performing routine tasks has a detectable effect on collective agreement withdrawal only in earlier periods, when routine employment is a more prevalent form of employment, but that this is not the case if observations from later years in the period of analysis are included.[34] **Off** has a hazard ratio greater that one, consistent with the possibility that task offshorability gives employers greater leverage over workers and unions. These results are statistically significant at $p < .1$ in only two of the models, however. Surprisingly, few of the control variables are ever significant and all hazard ratios are very close to 1.

Table 4 presents regression results where a firm experiences a failure when it drops from having *either* an industry- *or* firm-level collective agreement to having no collective agreement. The results for the two main variables, **SDQual** and **MQual** are very similar to those in table 3 in both magnitude and significance. The other results are also fairly consistent with table 3. RTE consistently displays a hazard ratio less than one, but is only significant in the single-record models, while the hazard ratios on offshorability are inconsistent. The control variables have more detectible effects in these regressions, although not always in the expected direction. Higher levels of exports are associated with lower prob-

[34] Recall that in models 1 and 2, a firm drops out of the dataset entirely after it experiences its first failure.

ability of withdrawal, consistent with Raess (2013), but this is only significant in model 2. New firms have higher probabilities of withdrawal, consistent with previous work showing that older firms are more likely to participate in collective bargaining agreements and suggesting the presence of legacy effects in older firms (Kohaut & Schnabel, 2003; Addison, Bryson, Teixeira, Pahnke, & Bellmann, 2009). More counterintuitively, firms with higher levels of profitability and with older workforces are more likely to withdraw from collective agreements.

6.2 Industry-Level Analysis

In Tables 5 and 6, I aggregate the firm-level LIAB Cross-Section data at the 36-category industry-level. The difference between the LIAB Cross-Section data and the LIAB Longitudinal data in the previous section is that the cross-section data are sampled to be representative of the German economy for each year, with firms not necessarily appearing in the data in consecutive years.[35] The dependent variable is either the percentage of firms within industrial sector participating in an industry-level agreement or the percentage of firms participating in either an industry-level or a firm-level agreement. As with the cross-national data, I include two types of models: (1) models where the predictors are contemporaneous with the dependent variable and (2) models where the predictors are lagged by one-period, to help address both reverse causation and the possibility that there might be a lagged effect of the independent variables. In addition to the four main variables from the firm-level analysis, I include controls for mean employment, mean percentage exports, and fixed effects for industry and year. I generate a value for each of these variables for each of 36 industries in each year from weighted firm-level observations. In order to generate the measure of between-firm skill heterogeneity (**SDQual**), I take the within-industry standard deviation of each firm's mean skill profile. Standard errors are clustered by industry.

Tables 5 and 6 present the results for participation in either industry-level (columns

[35] As in the longitudinal data, firms are sampled with respect to industry, size, and federal state.

1 and 2) or industry and firm-level (columns 3 and 4) collective agreements with contemporaneous and lagged covariates respectively. If H_2 and H_3 are correct, **SDQual** and **MQual** should have negative and positive signs respectively, with higher within-industry, between-firm standard deviations of workers' skills being associated with lower rates of participation in collective agreements and higher industry-level mean workers' skills being associated with higher rates of participation in collective agreements. The signs on **SDQual** are always negative as predicted, but fall short of statistical significance in the contemporaneous models for industry-level collective agreements. A one-unit increase in industry-level between-firm skill standard deviation is associated with 6-11% lower participation in the two types of collective agreements. The coefficients for **MQual** are positive in accordance with H_3, but only reach significance in the models with lagged covariates and combined industry and firm-level collective agreements. The results for **RTE** and **Off** are also inconsistent. The signs switch and most are statistically insignificant. Mean employment displays a positive sign across all regressions, but is only statistically significant in models where industry and firm-level collective agreements are combined. In contrast to the finding of Raess (2013), mean exports displays a negative sign and is significant in both models, meaning that higher levels of exports are associated with lower levels of participation in collective agreements.

7 Discussion and Conclusion

One of the central aims of this article was to distinguish between different mechanisms through which technological change affects unions. The results from the German data analysis show that between-worker heterogeneity and between-firm worker heterogeneity play an important role in collective bargaining participation and suggest that increased differences between workers and between firms are an important part of explanations of union decline. But they also show that routine task employment is a less consistent predictor of collective agreement maintenance at the firm and industry-level than in the cross-national data. One possible explanation for this is that union density is an imperfect proxy and is capturing something other than the effect of worker bargaining power.[36] It could be that there is a response by workers or unions to the possibility of their tasks becoming redundant and that German firms change the task content of jobs within occupations. In this case, occupations remain the same, but their task content does not; they become less routine task intense. If this is the case, a richer, time-variant measure of job task content, which unfortunately is not currently available, might help distinguish this. Developing such a measure is an important area for future research.

What do these results mean for our understanding of increasing economic inequality across advanced democracies? One of the most robust findings across labor economics, sociology, and political science is the negative relationship between union strength and both wage and income inequality.[37] Others have argued for a direct effect of technological change on inequality (Autor, Katz, & Kearney 2008), but this relationship has been disputed (Kristal & Cohen, forthcoming). My results suggest an indirect causal pathway: that technological change, regardless of what direct effect it has on inequality, has an indirect positive effect on inequality through its negative effect on trade unions. Future work on inequality should account for the multiple pathways through which technological change can affect inequality.

What do these results mean for economic cleavages and the future of worker solidarity? What do they mean for the future of unions, both organizationally and politically? They are not particularly positive if we believe that the workforce will continue to become more heterogeneous, with higher-skills workers benefitting from future technological change and lower-skills workers increasingly at risk of losing their jobs. Consistent with recent work by Iversen and Soskice (2015), these results suggest that higher-skills workers are less willing

[36]Another possibility is that RTE and offshorability have the predicted effect when included separately from the skill variables, although tables 2 and 3 in the supplementary appendix show that this is not the case.

[37]For recent work in these respective fields, see Card, Heining, & Kline (2013), Western & Rosenfeld (2011), and Scheve & Stasavage (2009).

to participate in redistributive coalitions, given their increased individual opportunity and leverage with employers. While the prospects of mass union revitalization may therefore be bleak, American unions have been successful in using political action to attain favorable legislation at the local level, such as living wage laws (Fine 2005). Although it may be increasingly difficult for unions to organize workers across entire sectors or to push for favorable national legislation, they may be able to achieve organizational and political success at the local and regional level.

One response to the problem of labor market polarization would be to adapt the task content of jobs to changing needs, ensuring that workers are trained to complement the tasks that machines can do (Autor, 2014). Multi-skilling, where workers learn multiple parts of a production process, are trained to do multiple tasks, and train to adapt to future changes in production would make individual workers more valuable. But it is not clear that training can fully address the problem of declining employment in well-paying jobs for less-educated individuals. If individuals are trained for multiple jobs, there will be lower overall demand for labor. And it is also not clear that many of these jobs will not be replaced by machines as technology continues to improve. Using a machine learning model, Frey & Osborne (2013) predict that 47% of current, largely low-skills jobs in the United States will be replaceable by technology in the coming decades.

If these predictions become reality, what will happen to workers who have a difficult time finding stable employment in advanced democracies? One recent suggestion, which has found some support even in conservative circles (Gordon, 2014), is to introduce a basic minimum income for those who no longer have the skills to be usefully employed. Many countries effectively have a basic minimum income through disability payments, which are often subject to poor oversight (Autor & Duggan, 2006). But there is a real question as to whether people will be satisfied with this. Political dissatisfaction continues to grow and populist right parties across Europe have been able to increase their support in part by appealing to dissatisfaction and fear about economic globalization and declining employment opportunities.

How will we respond to these changes? Will we use regulations and government-sponsored employment to boost employment above what the market would otherwise create or will we choose to allow market forces to work and soften harsh outcomes through a basic minimum income or other types of supplemental programs, such as earned income tax credits? Another possibility is that we can do nothing. But as we are seeing with the rise of populist right parties in many western democracies, this is not without consequence.

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Tables

Table 1: **Cross-National Union Density**

Covariates	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Intercept	31.67(7.70)***	25.77(6.12)***	30.35(7.47)***	18.57(2.84)***	14.63(2.27)**	17.88(2.76)***	14.25(2.15)**
RTE	16.80(4.22)***		19.16(3.87)***	10.88(2.59)***		12.64(2.41)**	12.01(2.23)**
Off		6.05(1.16)	-7.51(-1.20)		4.44(0.90)	-4.81(-0.78)	-4.09(-0.64)
IndPerc	.20(1.61)	.45(3.77)***	.23(1.88)*	.40(2.67)***	.57(4.36)***	.42(2.83)***	.18(1.07)
PubEmp				.72(2.69)***	.83(3.01)***	.73(2.68)***	1.14(4.18)***
FDI				-.57(-0.35)	-.74(-0.44)	-.54(-0.32)	.18(0.08)
Kmob				-.84(-1.48)	-1.12(-1.94)*	-.87(-1.53)	-.73(-1.34)
Trade				-.04(-1.96)**	-.06(-2.58)***	-.04(-1.93)*	-.01(-0.22)
Ghent				18.15(4.63)***	18.98(4.93)***	32.30(8.02)***	15.38(4.18)***
Coor				.09(0.52)	.10(0.56)	.10(0.59)	.06(0.35)
WrkCn				-.39(-0.57)	-.22(-0.30)	-.40(-0.58)	-.36(-0.47)
Party				.06(0.45)	.08(0.55)	.06(0.44)	.11(0.78)
Fed				1.04(1.46)	.76(1.09)	1.10(1.52)	1.60(2.10)**
Imm				-.00(-0.26)	-.00(0.31)	-.00(-0.33)	.00(0.78)
Emp				.00(0.57)	.00(0.31)	.00(0.45)	.00(0.42)
GDP				-.00(-1.97)**	-.00(-1.77)*	-.00(-1.90)*	-.00(-1.16)
Unemp				.45(2.91)***	.50(3.33)***	.44(2.87)***	.43(2.84)***
N	588	588	588	524	524	524	524
R^2	.80	.80	.80	.84	.86	.85	.88

Note: All models with Country Fixed Effects, Prais-Winsten Transformation, and Panel Corrected Standard Errors. Model 7 with five-year period fixed effects. z-statistics in parentheses. * $p < .1$, ** $p < .05$, *** $p < .01$

Table 2: **German Firm Participation in Industry-Level Collective Agreements**

Covariates	(1)	(2)	(3)	(4)
SDQual	1.04(2.57)***	1.07(3.37)***	1.02(2.33)**	1.03(2.77)***
MQual	.96(-3.73)***	.93(-4.03)***	.97(-3.61)***	.97(-3.52)***
RTE	.97(-2.20)**	.97(-1.69)*	.99(-1.43)	.99(-0.74)
Off	1.02(1.70)*	1.01(0.79)	1.01(1.42)	1.01(1.65)*
Exp		1.00(-0.89)		1.00(-0.52)
Size		1.00(0.14)		1.00(-0.61)
New		1.03(1.32)		1.02(1.93)*
Profit		1.01(1.54)		1.01(2.74)***
Age		1.00(1.45)		1.00(1.53)
PercFem		1.01(0.30)		1.00(-0.21)
WrkCn		1.00(0.15)		1.00(0.18)
N	35789	14768	47907	22075
Regression Type	SR	SR	SR-D	SR-D

Note: Cox Proportional Hazard Regressions with fixed effects for industrial sector, federal state, and industrial sector X federal state. Standard errors clustered by firm. Hazard ratios reported with t-statistics in parentheses. **SR:** Set as one-spell single-record data. **SR-D:** Set as single-record data, where the firm drops out at failure, but reenters when it signs next industry-level collective agreement. $p < .1$, ** $p < .05$, *** $p < .01$

Table 3: **German Firm Participation in Industry+Firm-Level Collective Agreements**

Covariates	(1)	(2)	(3)	(4)
SDQual	1.05(3.82)***	1.06(3.21)***	1.04(4.39)***	1.04(4.24)***
MQual	.97(-2.99)***	.95(-2.84)***	.98(-3.31)***	.97(-3.22)***
RTE	.97(-2.30)**	.97(-1.67)*	.99(-1.62)	.99(-0.78)
Off	1.01(0.64)	1.00(0.00)	.99(-0.64)	1.00(-0.15)
Exp		.999(-1.66)*		1.00(-0.91)
Size		1.01(1.03)		1.00(-0.41)
New		1.02(1.28)		1.02(2.02)**
Profit		1.01(1.61)		1.01(1.66)*
Age		1.00(2.64)***		1.00(1.63)*
PercFem		1.04(1.16)		.99(-0.50)
WrkCn		1.00(-0.08)		1.01(0.74)
N	43881	18518	53942	25529
Regression Type	SR	SR	SR-D	SR-D

Note: Cox Proportional Hazard Regressions with fixed effects for industrial sector, federal state, and industrial sector X federal state. Standard errors clustered by firm. Hazard ratios reported with t-statistics in parentheses. **SR:** Set as one-spell single-record data. **SR-D:** Set as single-record data, where the firm drops out at failure, but reenters when it signs next industry-level collective agreement. $p < .1$, ** $p < .05$, *** $p < .01$

Table 4: **German Firm Participation in Collective Agreements: Industry-Level Analysis**

Covariates	(1)	(2)	(3)	(4)
Constant	1.01(10.31)***	1.01(10.89)***	.91(13.59)***	.89(11.60)***
SDQual	-.06(-1.36)	-.06(-1.27)	-.07(-2.13)**	-.06(-1.74)*
MQual	.10(0.13)	.00(-0.07)	.06(1.50)	.05(1.17)
RTE	.03(0.97)	.04(1.32)	.07(2.32)**	.10(2.43)**
Off	-.04(-1.14)	-.06(-1.27)	-.07(-1.99)*	-.09(-2.13)**
MeanEmp		.00(1.67)		.00(2.96)***
Exp		-.00(-0.61)		-.00(-0.29)
N	510	510	510	510
DV	Ind	Ind	Ind+Firm	Ind+Firm

Note: Regressions contain fixed effects for industry and year. Standard errors clustered by sector. Dependent Variable percentage of firms participating in either industry-level collective agreements (columns 1 and 2) or industry- *or* firm-level collective agreement (columns 3 and 4).

$p < .1$, ** $p < .05$, *** $p < .01$