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Corporate Governance and Employee Power in the Boardroom

An Applied Game Theoretical Analysis

Benjamin Balsmeier/Andreas Bermig/
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Abstract

The discussion about employee representation on supervisory boards has received much attention from scholars and politicians around the world. We provide new insights to this ongoing debate by employing power indices from game theory to examine the 'real' power of employees on boards and its effect on firm performance. Based on unique panel data of the largest listed companies in Germany, we find an inversely U-shaped relationship between labour power and Tobin's Q with a value-maximising labour power of approximately 43 %. Our results are robust to different game theoretical calculations of labour power, as well as various econometric models.

JEL-Codes: C71, D72, J53, K22, K31, L21, L25, M21, M54

Corporate Governance und Arbeitnehmermacht im Aufsichtsrat

Eine angewandt spieltheoretische Analyse

Zusammenfassung

Die Diskussion über Arbeitnehmermitbestimmung in Aufsichtsräten hat erhebliche Aufmerksamkeit von Wissenschaftlern und Politiker in vielen Ländern erfahren. Wir tragen neue Einsichten zu dieser fortdauernden Debatte bei, indem wir spieltheoretische Machtindices verwenden, um die Macht von Beschäftigten und deren Beitrag zum Unternehmenserfolg zu bestimmen. Mit originären Paneldaten der größten deutschen gelisteten Unternehmen finden wir eine umgekehrt U-förmige Beziehung zwischen Arbeitnehmermacht und Tobin's Q, wobei die wertmaximierende Arbeitnehmermacht bei rund 43 % liegt. Unsere Ergebnisse sind robust sowohl hinsichtlich unterschiedlicher spieltheoretischer Berechnungen der Arbeitnehmermacht als auch verschiedener ökonometrischer Modellierungen.

Im Internet unter:

http://www.wiwi.uni-muenster.de/io/forschen/downloads/DP-IO_09_2011.pdf

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1. Introduction

The role of the board has been one the most analysed topics in the field of corporate governance for decades. Among many experts, it is widely believed that the board is the key instrument for minimising agency costs, due to the separation of ownership and control in publicly traded companies. Thus far, researchers have investigated various board characteristics, such as board size, independence of directors, bankers on boards, and simultaneous outside directorships (see Adams et al. 2010 for an overview). The focus of most studies on boards is generally aimed at identifying the optimal board structure by investigating how certain board characteristics affect board actions and corporate performance. Nonetheless, both empirical and theoretical studies have provided ambiguous results with regard to the effectiveness of certain board characteristics on corporate governance. One of the most controversial debates between academics, politicians, and practitioners about optimal board composition concerns (mandatory) employee participation.

Employee representation on boards is a common feature of the continental European corporate governance system that differs notably, in some regards, from the intensely analysed Anglo-Saxon shareholder system (Shleifer and Vishny 1997). Several countries with some of the most productive economies in the world, including France, Germany and Japan, emphasise the role of the stakeholders in a company within their corporate governance system (Hoshi 1998, Schmidt and Tyrell 1997). Against the background of the recent financial crisis and the subsequent worldwide economic downturn, it has been widely recognised that a stakeholder system of corporate governance that relies on cooperation between managers and employees may help to overcome negative effects of an economic slump and enhance firm performance in the long run. The latest discussion of this perception further motivates us to thoroughly analyse how employee representation on boards affects corporate performance. We examine the case of Germany, where employees on boards are commonly observable, to carry out a comprehensive theoretical and empirical investigation of this topic.

Germany is an ideal case to analyse firm monitoring by employees on boards, so-called co-determined boards, because employee directors are granted by law the same voting and decision rights as every other regularly elected supervisory board member. According to the German stock company act (*Aktiengesetz*), all supervisory board members are responsible for

reviewing firm performance, selecting the chief executive, determining executives' compensation and shaping long-term strategic objectives. Operative leadership is exclusively assigned to the management board, which is strictly separated from the supervisory board. Therefore, no executive is allowed to simultaneously serve as a monitoring director on the supervisory board of the same company or vice versa (see Prigge 1998 for a survey of German company regulation). Supervisory board members have similar tasks and duties as monitoring directors on a US or British board of directors.

The largest obstacle for a reliable empirical identification of the impact of co-determination on any corporate outcome variable is the fact that German co-determination laws (*Mitbestimmungsgesetz*, *Drittelbeteiligungsgesetz* and *Betriebsverfassungsgesetz*) constrain firms to realise one out of merely three different quotas of labour on the supervisory board. These quotas are determined primarily by the legal form of the company and the number of employees and partly by the sector in which the company operates. All private companies, limited liability companies (GmbHs), public stock companies (AGs and KGaAs) comprising fewer than 500 employees and companies pursuing mainly ideological objectives, such as media or religious companies ("Tendenzbetriebe"), are exempt from co-determination.[1] Such companies usually do not have a supervisory board, or if so, their workers' quota therein is zero. Limited liability companies with more than 500 employees, as well as AGs and KGaAs with more than 500 but fewer than 2,001 employees, are obliged to grant a third of their supervisory board seats to their employee representatives. In larger public stock companies, including KGaAs, half of the seats of the supervisory board are assigned to worker representatives. It is important to note that the chairman of the supervisory board is always elected by the owners of the company and holds a double voting right in case of a deadlock, thereby resulting in quasi-parity instead of pure parity. A neutral chairman only exists for companies of the coal and steel industry.

Given this low variance of employee representation, which is also closely linked to other characteristics of companies and is hardly separable from them, estimation strategies have often focussed on the analysis of status changers or the effects of changes of the relevant laws (see Gerum and Wagner 1998 for an overview). More recent studies have aimed to exploit factual deviations from the legal thresholds. For example, some companies with more than 500 workers have no supervisory board and, therefore, no employee representation, even

[1] An exemption from this rule applies to publicly traded corporations (AGs) with fewer than 500 employees that were founded before 1994 and are not related to ideological businesses or run by a family. These companies are required to have one-third of the supervisory board seats assigned to employee representatives.

though such a board is mandatory (see Boneberg 2009, Troch 2009, and Wagner 2009). All of these estimation strategies suffer from very similar problems, as typically only two outcomes – having employee representation or not having employee representation – are compared; therefore, unobserved time constant variables, such as management skills, are not controlled for, and possible self-selection into the considered groups is not addressed. Hence, identifying the pure employee co-determination effect is not feasible.

To date, Fauver and Fuerst 2006 have presented the most compelling analysis based on a cross-section of 786 listed German firms in 2003. These researchers used employee representative data from Bloomberg and found variations from the mandatory seat allocation due to retirement, resignation or death of some supervisors. Although not directly identified, as the analysis relies on three categories of employee representation, their results point to an inverted U-shaped relation of firm value and employee representation, with a turning point located between that points at which one-third and less than one-half of the board are comprised of employees.

The present investigation is related to the work of Fauver and Fuerst as it builds on the hypothesis that the judicious use of labour representation on boards can improve corporate governance, while employees with excessive power reduce firm performance, at least from a shareholder perspective. Our main extension of the existing literature on co-determination is our precise assessment of the influence of employees on the board, which is achieved by the application of power indices from cooperative game theory. For example, one-third of a supervisory board's members elected by employees exercise a different influence if they are faced by a heterogeneous group of directors representing diverse shareholders, rather than being confronted with one owner holding the other two-thirds of the seats. The resulting variance of the impact of the worker representatives can, in turn, be used to estimate its influence on the company's performance. As the 'real' impact of employee representation varies significantly between companies and over time, we are able to precisely identify the non-linear effects of employee representation. In contrast to former studies, the within variation in our data allows us to control effectively for unobserved firm heterogeneity by estimation of firm fixed-effects regressions.

While we apply this powerful approach to the case of employees on the board, this approach can be quite easily transferred to other groups of interests, such as bankers, politicians, former executives or family members. This topic may be relevant to future studies of board composition, as it shows that the fraction of seats held by a certain group of directors, which

is currently taken as the main explanatory variable in most studies of board composition, is by no means suitable for assessment of the real influence that one party can execute on corporate decision-making. We show that some large groups may have no real power to shape corporate strategy, whereas in other cases, one seat might be sufficient to give the holder of this mandate significant power over board actions and corporate strategy. Our findings have implications not only for co-determination but also for numerous future studies of board or committee structure.

The second section of this article reviews the existing theoretical arguments and empirical results regarding the effects of co-determination on corporate governance. The third section introduces the game theoretic concept of power indices and its application to boards. The fourth section contains a description of the utilised data set, including descriptive statistics. The fifth section presents the main results of our empirical investigations, whereas the sixth section presents further results, including data relevant to labour union representatives. The seventh and final section presents the conclusions.

2. Theoretical Background and Literature Review

The German legislator regulates the composition of the board of directors of a corporate entity with at least 501 but not more than 2,000 employees under the “Drittelbeteiligungsgesetz” (since 2004, until then the “Betriebsverfassungsgesetz” from 1952). A board of directors of limited and stock corporations of this size must reserve one-third of its seats to representatives of the employees. Co-determination with an equal number of seats for employees and shareholders is mandatory for stock corporations with more than 2,000 employees according to the “Mitbestimmungsgesetz” from 1976.

Usually, two quite simple arguments are presented against the existence of any real advantages of employee representation on supervisory boards. The first argument, generally designed by Alchian and Demsetz (1972), uses basic assumptions about efficient decision making and was explicitly transferred to the case of co-determination by Furubotn (1988). In general, the employees earn their wages quite independent from the performance of the company, while the shareholders bear the costs of a company’s decision on their own. Accordingly, the shareholders should have total control such that efficient decision making is in their power as well as in their interest. The second argument against co-determination was formulated by Jensen and Meckling (1979) and holds that co-determination of employees is advantageous neither for the overall economy nor the shareholders because otherwise it would

be introduced voluntarily. Because one cannot observe co-determination in free markets without regulation by the state, it can be advantageous at most, if at all, only for the employees at higher costs to the owners.

Other economic arguments favour co-determination and its prescription by law, postulating some advantages of co-determination for either all stakeholders, including the shareholders or, at least, for the overall efficiency according to the compensation criterion such that the shareholders may lose, but the employees win more. The most important argument is that co-determination enables a more efficient and effective use of information (Freeman and Lazear 1995). Employees on the board improve communication quality between the lower and the higher levels of a firm. The top managers receive access to detailed information and first-hand operational knowledge, while at the same time, the acceptance of board decisions among normal employees rises as the employees are informed in a timely manner. This scenario helps to prevent conflicts between employees and managers and, in economically critical times, makes it easier to achieve necessary compromises. Another positive effect of co-determination is the credible protection of long-term investments in firm-specific human capital by the employees in which they participate in the risks of the company (Furubotn and Wiggins 1984). Because exploitation of specific investments by hold-up of the owners becomes less probable, underinvestment in firm-specific human capital is effectively reduced.

To the counter-argument that efficient co-determination with that many advantages would be introduced voluntarily, potential market failure is an answer, especially with respect to adverse selection (Levine 1989 and 1995, as well as Dilger 2002 with additional arguments). In spite of the described advantages, the market does not bring about co-determination by itself, as every company that establishes some kind of co-determination independent from its competitors has to fear attracting less capable employees who benefit from the higher protection of employees' rights to a higher degree than more able employees. In this way, the more able employees may take advantage of the wage differential in companies without co-determination. This association results in a lower level of human capital and productivity in companies with voluntary co-determination, which could undermine the advantages for every given employee. In the end, no company establishes co-determination voluntarily. If one follows this line of argumentation, enforcing co-determination by law (at least for companies of a certain size, because co-determination seems less necessary for small companies where owners and employees can directly interact) is a solution to this dilemma and can be advantageous for all employees and shareholders.

A justified decision between these theoretical arguments for and against co-determination needs an empirical examination. However, previous empirical studies of workers' participation do not provide a uniform conclusion, or even find contradictory results. On this basis, one is not able to make a founded decision in support of any one of the theoretical explanations introduced previously (Baums and Frick 1998 came to the same conclusion based on the literature available at that time).

A negative view of co-determination, at least of quasi-parity, compared to one-third of supervisory board members being employee representatives, is supported by the results of Schmid and Seger (1998), Gorton and Schmid (2000), and Gorton and Schmid (2004). The authors' regression analyses based on different samples of (listed) German corporations point to a 15 % to 31 % lower market valuation of corporations with half of the supervisory board representing workers compared to those with only one-third (for a basic critique of this finding and the method, see Frick et al. 1999). This result is complemented by a recent study by Petry (2009), who analyses the market's reaction on a change of status from non-co-determined to co-determined supervisory boards and vice versa. He observes, on average, abnormal negative returns on the share price in the event of the first nomination of employee representatives on a supervisory board, whereas there are abnormal positive returns in the case of a complete removal of these representatives from a supervisory board. This result can be seen as an indicator for a negative impact of worker participation, at least for shareholders.

A positive evaluation of having a moderate degree of employee representation on supervisory boards can be deduced from the results of Fauver and Fuerst (2006). These authors found an inversely U-shaped relationship between the proportion of employee representatives on supervisory boards and the market valuation of the respective companies. The optimal employee participation on supervisory boards, as measured by the proportion of the aggregated mandates, is slightly under 50 %. Employee representation was found to be particularly advantageous in industries with a high need for coordination. The results of Kraft and Stank (2004) also indicate a positive effect of employee representation on supervisory boards. Between 1971 and 1990, corporations that were affected by the introduction of the Co-Determination Act in 1976 filed significantly more patents. The authors interpret their result as evidence for a positive impact of employee participation on innovation. Moreover, FitzRoy and Kraft (2005) found with comparable data on 179 corporations and observation periods from 1972 to 1976 and from 1981 to 1985 that the introduction of worker participation is associated with a positive growth of sales. This growth of sales is highest in

corporations with parity. These findings indicate a linear positive correlation between employee representation and corporate performance (see Kraft et al. 2009 for somewhat different results). Vitols (2006) analyses 504 German stock corporations from 2002 to 2004 and finds a significantly higher valuation of corporations with the parity form of co-determination. The results of Renaud (2007) support this finding. Although there does not seem to be any increase of productivity caused by employee representation between 1970 and 2000, Renaud identifies short-term positive effects on productivity and performance by an increase of this representation from one-third to one-half. Finally, the results of Vulcheva (2008), based on data from 672 German companies between 1998 and 2006, suggest a disciplining impact of employee participation on management, as corporations exercise significantly less discretion to smooth the performance in accounting values if their degree of co-determination is higher.

No significant correlation between employee representation and corporate performance is found by Wagner (2009) or Baums and Frick (1998). The negative and positive results discussed above could be caused by company size, rather than co-determination.

3. Power Indices to Measure Employee Influence

A general obstacle for the empirical analysis of employee participation is the linking of their representatives with the number of employees and, therefore, with the size of the firm. Because in almost all cases the exact legal minimum of employee representatives is realised, the observable variance of participation between companies and over time is quite small, at least when using the usual measure of the proportion of representatives on the supervisory board. This limitation makes it difficult to control for unobservable heterogeneity without a substantial loss of explanatory power and necessitates an adept and complicated detachment of the effects from firm-size and the effects from co-determination. The small variance of the proportion of employee representatives also hinders the estimation of an inversely U-shaped relationship between co-determination and relevant characteristics, including the performance of companies. The literature, to date, often compares only companies with one-half and one-third of their supervisory board members representing employees and labour unions.

Furthermore, the measurement of employee participation by the proportion of their representatives on the supervisory board ignores the employees' potential opponents who have a key role in advancing or hindering employee interests. Opponents of the employees are often the owners, at least if their interests are negatively affected. However, particularly for

listed firms with a high fraction of free floating shares, the actual power of shareholders is questionable. A common policy of all shareholders and their representatives by which the employee representatives could lose all power and be overruled is by no means guaranteed, at least if a significant number of different shareholder representatives are present on the board. Conversely, one dominant owner could reduce the same formal control and decision rights of the employee representatives to information rights.

This example indicates that the real influence of employees on corporate decision making cannot be assessed only formally by the legally mandated number of employee representatives on the supervisory board. Employee power is also highly influenced by the composition and coordination of the representatives of equity. To assess the factual power of the employees, or at least their representatives, we use power indices, which are common in cooperative game theory, to analyse the distribution of political power. By this method, it is possible to define the power of each coalition in a continuum between zero and one, given the number of votes for each coalition. The application to the supervisory board is straightforward. This approach enables us to define the influence of the employee representatives under explicit consideration of different allocations of the votes of the owners' side, including representatives from banks. It is possible that the power of the employees has a value of zero, even though there is mandatory employee representation as the representatives of a dominant shareholder might always vote as one and win accordingly. Conversely, the influence of the employees, measured with a power index, can be higher than the mandatory quota of their representatives if there are many dispersed shareholders.

This new approach has two key advantages compared to empirical analyses of co-determination at the corporate level as used to date. First, power indices indicate the real influence of employee representatives better than their mandatory proportion on the supervisory board, which enables us to analyse their influence more precisely and to test for non-linear relations. Second, the variation of power measured this way is much higher between units and across time. Therefore, methods that use non-observable heterogeneity can be applied more efficiently, and the problematic correlation between co-determination and company size is reduced in a simple manner.

In the following, two common power indices are used to measure the influence of the employee representatives within the supervisory board. Both the power index from Shapley and Shubik (1954) and the index from Banzhaf (1965) can express the relative influence of each group of board members. Influence, in this sense, means that a group is able to change a

losing coalition into a winning one by entering the coalition (Leech 2002, p. 2) and is, therefore, pivotal for this coalition.

Power indices as a measure of voting power have been used for more than 50 years and were originally deployed to compute voting power of parties and coalitions in parliaments and political committees. For an overview of previous studies concerning power indices, see, for example, Felsenthal and Machover (1998) or Straffin (1994). As coalitions with equal or similar interests also exist on supervisory boards, which can be understood as a special form of (political) committee, transferring power indices into the analysis of weighting power in these boards is straightforward. Recently, Kirstein (2010) presented a detailed case study of the application of the power index concept to the supervisory board of one company. Although power index analysis has been established, computational difficulties have hindered its wide application. Leech (2003) describes methods that can be used to deal with the computational complexity that arises from application of power index analysis.

As a first step in measuring the power of different groups on a supervisory board, the number of seats for every group must be determined. We take the seats of employees, as well as the seats of bankers, as published by each company in their annual reports. Every shareholder owning at least 5 % of the shares is known and treated as a blockholder. Additionally, the remaining fraction of widely held shares is divided in a way that the power on the side of the equity representatives is maximally dispersed. This action implies the assumption that the small shareholders do not coordinate themselves in director elections such that either large shareholders can capture more seats or remaining mandates are assigned quasi-randomly to unknown directors.

The rule of D'Hondt (1882) is used to determine the number of representatives for each blockholder. D'Hondt's rule is a famous seat allocation rule for parties in parliaments in several states around the world. In our case, it effectively solves the possible problem that the fraction of shares held by major shareholders cannot be exactly replicated by according numbers of supervisory board seats. The elementary algorithm works as follows:

Let s_j be the shares of all blockholders $j = 1,...,n$ with potential board membership(s) and m be the total number of seats of shareholder representatives on the board. Initially, D'Hondt's algorithm computes $r_{ij} = \frac{s_j}{i}$ for all $i = 1,...,m;\ j = 1,...,n$ and searches for the m greatest

numbers in $R = \{r_{11}, r_{12}, ..., r_{1n}, r_{21}, ..., r_{mn}\}$. Thus, every member *j* is given as many seats on the board of directors as often r_{ij}, $i = 1, ..., m$ occurs within the *m* greatest numbers of *R*.

D'Hondt's rule usually leads to an allocation of supervisory board seats that approximates the fraction of shares. However, it favours large blocks and can lead to significant abbreviations if one large blockholder is confronted with small shareholders or free-floating shares.

A specific example may best illustrate the impact of the application of D'Hondt's algorithm on supervisory board seat allocation. Let 51 % of the shares of a company belong to one single blockholder and the remaining 49 % of shares to widely distributed shareholders, each holding less than 5 % of the shares. Considering 10 available supervisory board seats, an application of the D'Hondt rule would then assign all of the seats to the only existing blockholder. We argue that this case is the most realistic as the blockholder has the majority of voting rights at the annual shareholders' meeting, where the supervisory board members are usually elected. Therefore, it is unlikely that one significant blockholder would allow for unknown directors to be elected to the board. Only another significant blockholder could act to have its own representatives on the board in such a case. The D'Hondt rule assures that this scenario takes place. Nevertheless, we will relax this assumption in section 5 to prove that our results are robust to the selection of the seat allocation mechanism.

In a subsequent step, all seats for representatives of the shareholders (blockholders), as well as the set seats of representatives of the employees and banks, must be divided by the total number of seats. The resulting proportions are the voting weights $v_1, ..., v_m$ for every member of the board.

After this preliminary work, the Shapley-Shubik index (S_j) can be calculated. For this calculation, every possible permutation of the groups of board members (employees, banks and every blockholder with at least one directorship) is computed. For every permutation, the numbers of directors of every group in order of their appearance are summed, and the one group that changes a losing coalition into a winning one is identified. We implemented the assumption that the largest blockholder is the chairman of the board, who always has a decisive vote in stand-offs.[2] Afterward, the number of pivotal roles for every group is counted. Finally, the Shapley-Shubik index of every group is expressed as the number of times a group is pivotal divided by the number of all permutations (p):

[2] An exemption applies only to 7 observations of firms from the coal and steel industry, where pure parity co-determination is mandatory.

$$S_k = \sum_{C_k} \frac{c!(p-c-1)!}{p!},\ k = 1,\ldots, p,$$

where C_k is the number of coalitions for which k is pivotal and c is the number of groups in C_k.

Measuring voting power using the Shapley-Shubik index has been criticised because the order of appearance in the permutations plays an important role. This might indeed be a problem as, by computing the power of a group, the order of entering a coalition should be less important than the actual strength of the group (Leech, 2002, p. 4). Therefore, we alternatively calculate the Banzhaf index, thereby relaxing the implicit assumption of Shapley-Shubik.

In contrast to Shapley-Shubik, the Banzhaf index does not compute every possible permutation but only those coalitions that change from a losing to a winning coalition if the relevant group enters the coalition:

$$B_k = \frac{c_k}{2^{n-1}}.$$

For a comparison of both indices, the Banzhaf index must be normalised, as the sum of all non-normalised Banzhaf indices for all groups does not need to equal one. Accordingly, the index is normalised in the following form:

$$B_k^{norm} = \frac{B_k}{\sum_k B_k}.$$

4. Sample Composition and Descriptive Statistics

The empirical investigation is based on non-financial German firms that were listed for at least two years among one of the three largest German stock indices DAX, MDAX or SDAX during the period from 1998 to 2007. These data include 1,968 identified observations of 240 companies. Detailed ownership structure information that is needed to calculate the employee power indices was obtained for 1,545 observations from *AMADEUS*. Accounting data come from *Worldscope* and market data from *Datastream*. All data on supervisory board composition were collected from annual company reports and *Hoppenstedt Jahrbuch der Großunternehmen*. After removing observations with missing or inconclusive values of the variables of interest, 1,499 observations on 222 stock corporations remain in the sample. As

we estimate fixed effects regressions with covariates lagged by one year, we report descriptive statistics only for those 1,179 firm-year observations that contribute to the econometric analysis. Table I summarises the variables used in the study.

Our main explanatory variable is the voting power of the employee representatives on the supervisory board. Due to slight conceptual advantages of the Banzhaf power index over the Shapley-Shubik power index, as explained in section 3, all further presentations and interpretations refer to employee power calculated according to Banzhaf. This approach seems to be justified by the high correlation of both indices (r = 0.85), thus confirming the theoretical reasoning that both indices measure roughly the same. In fact, all estimations presented below are robust regarding changes in the method of calculating the power index.

Table I: Summary of Variables

Variable	Description	Source
Employee Power Shapley-Shubik (EPS)	Power index of the employee representatives on the supervisory board according to Shapley-Shubik, see section 3 for calculation details	Own calculation on basis of AMADEUS
Employee Power Banzhaf (EPB)	Power index of the employee representatives on the supervisory board according to Banzhaf, see section 3 for calculation details	Own calculation on basis of AMADEUS
Board Size	Number of supervisory board members	Annual reports
ROA	Return on assets: operating income/[(total assets$_t$+total assets$_{t-1}$)/2] *100	Worldscope
Tobin's Q	(Market value of equity + total assets - equity)/total assets	Worldscope/Datastream
Market-to-Book	Market-to-book value = market value of equity/total assets	Worldscope/Datastream
Total Assets	Total assets (in € 1,000)	Worldscope
Leverage	(Short term debt + long term debt)/total assets	Worldscope
R&D	Research and development expenditures/total assets * 100, set to 0 if no R&D expenditures were reported in the annual report	Worldscope
Age	Years since company was founded	Worldscope
Industrially Diversified	Dummy indicating whether less than 90 % of sales are in one SIC segment	Worldscope
Geographically Diversified	Dummy indicating whether less than 90 % of sales are in one geographic region	Worldscope
Freefloat25+/50+/75+	Dummy indicating whether the fraction of widely held shares is higher than 25 %/50 %/75 %	AMADEUS

Table II describes the distribution of employee power over the entire sample. This table shows that employees have no voting power in 41 % of all firm-year observations. Out of these 482 observations, 39 % have at least one employee representative on the board, while the remaining 61 % have no co-determined supervisory board (not reported in Table II). The second and third most frequent voting power values are clustered at 33 % (n=193), which is

the median employee power, and 50 % (n=112). Interestingly, the employee representatives constitute the strongest group on the supervisory board according to their voting power in 59 % of all observations.

Table II: Employee Power Distribution

Employee Power	Frequency	Percent	Cumulative
0.00	482	40.88	40.88
16.67	6	0.51	41.39
20.00	33	2.8	44.19
28.57	1	0.08	44.27
33.33	193	16.37	60.64
37.04	1	0.08	60.73
38.46	28	2.37	63.1
39.29	5	0.42	63.53
45.45	12	1.02	64.55
50.00	112	9.5	74.05
63.64	89	7.55	81.59
75.00	65	5.51	87.11
83.78	68	5.77	92.88
86.11	3	0.25	93.13
90.00	26	2.21	95.34
91.30	5	0.42	95.76
94.07	24	2.04	97.79
96.59	12	1.02	98.81
98.08	14	1.19	100
Sum	1,179	100	

With firm fixed effects regressions in mind, it is worth mentioning that the within-firm variation of employee voting power has a standard deviation of $s_w = 16$, which is much higher than the within-firm variation of the fraction of employees on the board, which amounts only to $s_w = 0.04$. This finding may explain why former studies of co-determination that relied on the fraction of employees on the board as the main explanatory variable found only minimal significant or robust evidence when controlling for unobserved firm heterogeneity.

Table III presents descriptive statistics of the various employee power indices and all other variables used in the study.

Table III: Descriptive Statistics

Variable	Obs.	Mean	Std. Dev.	Min	Max
EPS	1,179	30.49	28.23	0	85.71
EPB	1,179	32.87	32.55	0	98.08
Board Size	1,179	10.76	5.65	3	21
ROA	1,179	1.08	2.56	-12.64	16.12
Tobin's Q	1,179	1.41	0.93	0.20	11.50
Market-to-Book	1,179	0.75	1.00	0.01	11.24
Total Assets	1,179	8,505,817	27,800,000	8,816	235,000,000
Leverage	1,179	25.39	17.23	0	97.53
R&D	1,179	1.94	3.64	0	44.56
Age	1,179	73.63	50.17	2	259
Industrially Diversified	1,179	0.41	0.49	0	1
Geographically Diversified	1,179	0.74	0.44	0	1
Freefloat25+	1,179	0.73	0.45	0	1
Freefloat50+	1,179	0.40	0.49	0	1
Freefloat75+	1,179	0.20	0.40	0	1

Dependent Variables

Firm performance is measured by market-based as well as by accounting-based performance indices. To enhance the comparability of our estimations with the existing corporate governance literature, our preferred market-based performance measure is *Tobin's Q*. Alternatively, we use the *Market-to-Book* value that was used as a performance proxy in other studies of co-determination. Operative performance is measured by the return on assets (*ROA*). While the average Tobin's Q is 1.41, the market-to-book value is 0.75 on average. All firms in the sample realised on average 1 % return on assets over the covered period.

Explanatory Variables

In addition, we employ several control variables that may affect firm performance other than employee power in the boardroom. First, we control for firm size and age, as larger and older firms often have lower performance and growth potentials than smaller or younger firms, due to a higher fraction of already identified and realised growth opportunities. Therefore, the logarithms of *Total Assets* and *Age* enter the regressions as right-hand side variables.

Jensen (1986) argues that debt can have a disciplining effect on managerial perquisite consumption. Thus, we control for the ratio of total debt to total assets (*Leverage*) in our regressions. On average, we observe a debt ratio of 25 %.

It is known that research and development (*R&D*) expenditures often have a positive impact on firm performance and growth (Stiglitz 1969, Griliches 1980, and Schankerman 1981). To account for the size of the company, we divide R&D expenditures by total assets. We set R&D expenditures to zero if the firm did not report any expenditure in their annual report. Note that this variable underestimates the real values in some cases, as German firms are not required to publish annual R&D expenditures by law.

Other studies have found significant effects of firm diversification on corporate performance (Ang et al. 2000 or Lang and Stulz 1994). Therefore, and to enhance comparability with prior research, especially with respect to Fauver and Fuerst (2006), we include two measures of diversification (*Industrially Diversified* and *Geographically Diversified*) in our regression framework.

Finally, it is essential to control for ownership concentration, as many prior studies have found significant effects of ownership concentration on firm performance and growth (Gorton and Schmid 2000, Lins and Servaes 2002, Morck et al. 1988). Ownership concentration is, in general, positively related to the monitoring-intensity of the top-management, as a larger fraction of equity owned by one shareholder is associated with higher benefits for this shareholder from active monitoring and vice versa. Although large block holdings ensure effective monitoring, they may reduce firm value if blockholders try to enhance private benefits of control at the expense of minority shareholders. Therefore, we allow for a non-linear relationship between ownership concentration and our preferred outcome variables by employing three dummy variables. The variables *Freefloat25+/50+/75+* respectively indicate whether more than 25 %, 50 % or 75 % of the firm's shares cumulate to no blocks of 5 % or more of the firm's equity. The threshold values are chosen due to the different shareholder rights with which they are usually associated. A minority shareholding of at least 25 %, a blocking minority, often allows vetoing amendments of the corporate charter, for example. More than 50 % of the shares are generally sufficient to decide the firm's strategy, and more than 75 % of the shares usually provide unrestricted control rights. Alternatively, we used the same variables as Fauver and Fuerst (2006), as well as the linear and square term of free-floating shares, as ownership variables. We found primarily the same results in these regressions as reported below. Thus, we do not report these results.

To assess possible structural differences between companies with positive employee power on the board and those firms facing no voting rights of employees, we present mean difference t-tests of all explanatory variables in Table IV.

Table IV: Mean Comparisons

Variable	Mean of firm-year observations with positive employee power (n=697)	Mean of firm-year observations without employee power (n=482)	Differences in means t-values for H0: mean(no power)-mean(power)=0
Board Size	13.407	6.942	-24.226***
ROA	1.035	1.144	0.714
Tobin's Q	1.360	1.486	2.187**
Market-to-Book	0.682	0.847	2.674***
Total Assets	13,600,000	1,110,216	-9.348***
Leverage	24.450	26.741	2.167**
R&D	2.102	1.695	-1.839*
Age	83.458	59.415	-8.539***
Industrially Diversified	0.524	0.247	-10.141***
Geographically Div.	0.815	0.627	-7.104***
Freefloat25+	0.756	0.683	-2.749***
Freefloat50+	0.491	0.276	-7.717***
Freefloat75+	0.277	0.098	-8.269***

Notes: *, ** and *** denote significance at the 10 %, 5 % and 1 % levels, respectively.

Referring to our performance measures, we observe the expected signs of differences. Corporate performance of firms without employee power is slightly higher according to ROA, Tobin's Q and the market-to-book value compared to firms having positive employee power, while only the differences of the market-based performance measures are statistically significant at the 5 % and 1 % levels. Moreover, firms with employee power on the board have significantly larger boards, are larger according to total assets, are older, have less leverage, are more diversified in terms of industry segments and geography, and have a higher fraction of free-floating shares (52 %, not reported) compared to firms without employee power on the board (37 %).

5. Empirical Results

5.1 Employee Power and Corporate Performance

To estimate the impact of employee power in the boardroom on corporate performance, we use OLS regressions with ROA, Tobin's Q and the market-to-book value as dependent variables. Because of the theoretical background explained in section 2 and the results of Fauver and Fuerst (2006), we expect to find an inverted U-shaped relation between employee power and firm performance. Hence, the linear and the squared term of employee power enter the regressions.

All models are estimated, including the full set of explanatory variables described above, as well as firm and time fixed effects to control for unobserved heterogeneity between firms and business-cycle effects. Moreover, two dummies indicating different accounting standards (IFRS, US-GAAP) control for unobserved differences in the measurement of accounting-based variables. Finally, we lagged all explanatory variables by one year to limit possible simultaneity biases and feedback effects of firm performance on employee power and certain other covariates. Moreover, it seems reasonable to assume a considerable time lag until actions taken by employee representatives on the board are detected through measures of firm performance. Table V shows the results.

Table V: Effect of Employee Power on Corporate Performance

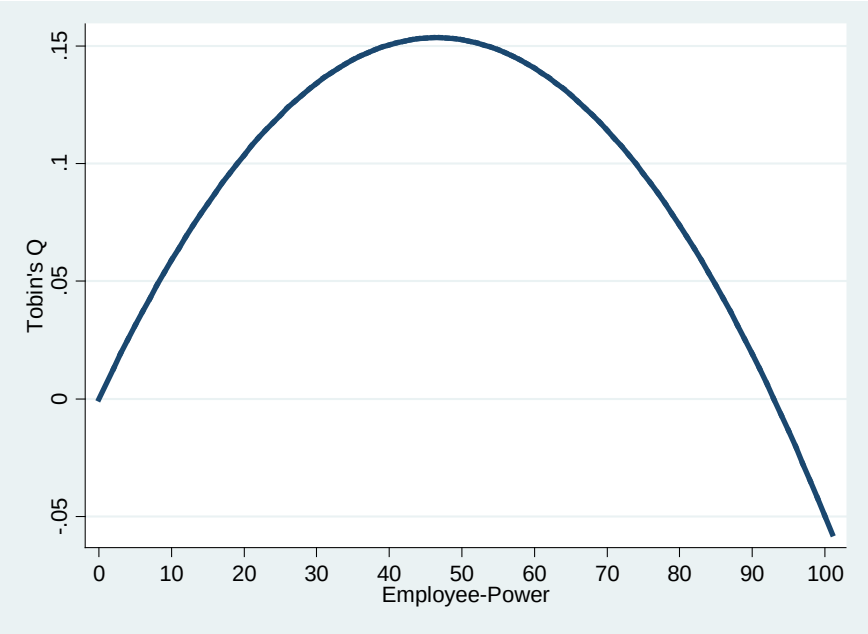
	a	**b**	**C**
Dependent Variable	**ROA**	**Tobin's Q**	**Market-to-Book**
Employee Power	0.015*	0.007**	0.006**
	(1.83)	(2.16)	(2.14)
Employee Power^2	-0.000	-0.000**	-0.000**
	(-1.23)	(-2.14)	(-2.13)
log(Total Assets)	0.019	-0.005	-0.033
	(0.07)	(-0.03)	(-0.21)
Leverage	-0.005	-0.006**	-0.009***
	(-0.51)	(-2.51)	(-3.46)
R&D	-0.051	0.005	0.004
	(-1.40)	(0.44)	(0.31)
log(Age)	0.907**	-0.095	-0.130
	(2.17)	(-0.75)	(-0.95)
Industrially Diversified	-0.179	0.022	0.007
	(-1.02)	(0.36)	(0.12)
Geographically Diversified	0.275	-0.175	-0.165
	(0.75)	(-1.39)	(-1.28)
Freefloat25+	-0.008	-0.039	-0.043
	(-0.05)	(-0.83)	(-0.88)
Freefloat50+	0.243	0.046	0.062
	(1.22)	(0.80)	(1.04)
Freefloat75+	-0.081	0.065	0.050
	(-0.46)	(0.96)	(0.76)
Year and Firm fixed effects	✓	✓	✓
N	1,179	1,179	1,179
Firms	189	189	189
R^2	0.102	0.095	0.121

Notes: All regressions use heteroskedasticity-robust standard errors. Explanatory variables are lagged by one year. *t*-values are given in parentheses. *, **, *** denote significance at the 10 %, 5 % and 1 % levels, respectively.

All models of Table V were alternatively estimated with employee power calculated by Shapley-Shubik, rather than Banzhaf (see section 3 for details). As expected, all coefficients are similar to the reported coefficients with respect to economic magnitude and statistical significance. To save space, we do not report these results here.

The market-based performance regressions reveal a significant (5 %) inverted U-shaped relation between employee power and Tobin's Q (model b) or market-to-book value (model c), respectively, which is also confirmed by Sasabuchi-tests (see Lind and Mehlum 2010 for details on this test). Figure I illustrates the relationship graphically.

Figure I: Employee Power and Tobin's Q



Corporate performance increases as employee power increases until the voting power of the employees reaches 46 % (models b and c) and declines thereafter.

Regressing ROA on employee power, employee power squared and the other covariates does not confirm this relation (model a). Accounting-based performance measures may react with a longer time lag than one year on employee influence. We tested this assumption but did not find any significant results using longer lags of employee power. Alternatively, ROA may suffer from earnings management or other subjective appraisals of assets that are uncovered by the market. This perception is supported by regressions of ROA on employee power and the other covariates, excluding the squared term of employee power. In this model, we find a significant linear positive effect of employee power, suggesting that employee power is

always positively related to firm performance over the whole range of voting power. However, given the results of models b and c, we do not trust this result. Rather, we conclude that the market either uncovers overestimations of accounting performance or anticipates value reducing effects of very high employee power in the future.

Interestingly, we find statistically weak but robust evidence indicating that firms with positive employee power outperform firms without influential employees on the board (not reported). Even if negative effects of high employee power exist, the performance estimations suggest positive effects of weak and moderate employee participation on the board.

Only a few of the remaining explanatory variables are significantly different from zero. Older companies show higher accounting-based performance, and higher leverage has a negative effect on market-based performance. The latter result indicates that the market negatively assesses higher risks implied with higher debt ratios.

5.2 Robustness Check I: Seat Allocation According to Sainte-Laguë

In section 3, we introduced the D'Hondt rule as an appropriate mechanism for the allocation of supervisory board seats to each blockholder. It was necessary to apply the D'Hondt rule in all cases in which the fraction of the shares of each observed blockholder could not be related to an according fraction of supervisory board seats. It is essential to apply such a rule in those cases where the rounding of fractions to the next highest or smallest number does not, in sum, result in the actual available number of seats.

The D'Hondt algorithm assures that each blockholder is assigned an integer number of supervisory board seats. The algorithm favours large blocks compared to small ones, meaning that a large blockholder may be allocated a fraction of supervisory board seats that is above the fraction of his or her shares. We argue that this assumption is the most realistic, as the largest blockholder has, by definition, the greatest voting rights. Among all blockholders, the largest one is most capable of winning the game for the last seat, if there is any seat left to be assigned.

Nevertheless, one might argue that preferential treatment of large blockholders is a far-reaching assumption. To examine whether our results are driven by the allocation rule, we alternatively apply the Sainte-Laguë rule as a first robustness check of our results (in the U.S.,

this technique is also known as the Webster method). The Sainte-Laguë rule is a variation of the D'Hondt rule that avoids favouritism of large blockholders against small ones.

Let s_j be the shares of all blockholders $j = 1,...,n$ with potential board membership(s) and m be the total number of seats of shareholder representatives on the board. A slight variation of D'Hondt's algorithm computes $r_{ij} = \frac{s_j}{i}$ for all $i = 0.5;\ 1.5;\ ...; m - 0.5;\ j = 1,\ ..., n$ and searches for the m greatest numbers in $R = \{r_{0.51}, r_{0.52}, ..., r_{0.5n}, r_{1.51}, ..., r_{m-0.5n}\}$. Afterward, every member j receives as many seats on the board of directors as often $r_{ij},\ i = 0.5,\ ..., m - 0.5$ occurs within the m greatest numbers of R.

After allocating all supervisory board seats to each blockholder according to Sainte-Laguë, the power of the employee representatives on the board is recalculated, exactly as described in section 3. The Banzhaf power-indices of the employees calculated after seat allocation, according to D'Hondt and Sainte-Laguë, are highly correlated with $r = 0.95$. As the application of the Sainte-Laguë algorithm tends to assign large blockholders fewer seats, employee power is, on average, higher in the present case compared to the initially calculated values ($\bar{x}_{DrHondt} = 32.9, \bar{x}_{SainteL} = 38.6$).

In a next step, we test whether the application of the new seat allocation rule changes our previously presented results concerning the effect of employee power on firm performance. Hence, we rerun all regressions presented in Table V but take employee power and its squared term calculated with the seat allocation according to Sainte-Laguë instead of D'Hondt.

Table VI: Robustness Check I – Seat Allocation According to Sainte-Laguë

	a	b	C
Dependent Variable	**ROA**	**Tobin's Q**	**Market-to-Book**
Employee Power	0.015	0.008**	0.008**
	(1.33)	(2.37)	(2.36)
Employee Power^2	-0.000	-0.000***	-0.000***
	(-1.09)	(-2.61)	(-2.61)
log(Total Assets)	0.040	0.003	-0.025
	(0.14)	(0.02)	(-0.17)
Leverage	-0.005	-0.006**	-0.008***
	(-0.49)	(-2.51)	(-3.48)
R&D	-0.053	0.005	0.003
	(-1.44)	(0.39)	(0.24)
log(Age)	0.965**	-0.075	-0.111
	(2.27)	(-0.59)	(-0.80)
Industrially Diversified	-0.181	0.023	0.008
	(-1.02)	(0.37)	(0.13)
Geographically Diversified	0.288	-0.170	-0.160
	(0.79)	(-1.35)	(-1.25)
Freefloat25+	-0.022	-0.043	-0.046
	(-0.14)	(-0.90)	(-0.94)
Freefloat50+	0.273	0.073	0.090
	(1.28)	(1.28)	(1.52)
Freefloat75+	-0.031	0.076	0.063
	(-0.19)	(1.28)	(1.06)
Year and Firm fixed effects	✓	✓	✓
N	1,179	1,179	1,179
Firms	189	189	189
R^2	0.100	0.098	0.124

Notes: All regressions use heteroskedasticity-robust standard errors. Explanatory variables are lagged by one year. *t*-values are given in parentheses. *, **, *** denote significance at the 10 %, 5 % and 1 % levels, respectively.

From Table VI, it follows that all former results remain qualitatively the same. The effect of employee power on firm performance is inversely U-shaped at a significance level below 5 %. The value maximising turning points vary slightly between the reported specifications, that is, 42 % when Tobin's Q is considered (model b) and 41 % when the market-to-book value is considered (model c) as a performance proxy. The identified lower value maximising employee power in the present models compared to the previous estimates (46 %) stresses the negative association of high employee power in the boardroom with firm performance.

In keeping with the findings presented in the previous subsection, employee power does not affect accounting performance in a statistically significant U-shaped manner.

5.3 Robustness Check II: Summing Up All Blocks of Shareholdings

The next robustness check relaxes the implicit assumption that the probability to form a coalition between each party on the board is equal. It might be interesting to analyse a modification of the presumption that the probability of a coalition between employee representatives and a blockholder is treated to be as likely as a coalition between two blockholders. As all residual rights are with the shareholder representatives on the board, it might be more realistic to assume that all blockholders cooperate and will, therefore, always vote as one block.

We implement this idea in our analysis by recalculating the power indices of the employee representatives after summing all blocks of shares above 5 % to one block and allocating an according fraction of supervisory board seats to this one block. Any remaining supervisory seats are assigned to the free-floating shares, thereby treating every free-floating representative as an individual party. Equivalent to the initially introduced procedure in section 3, bankers and employees are taken as observed from the annual company reports. As we only have two blocks of shares in this case, there is no need to apply a formal seat allocation mechanism, such as was employed by D'Hondt or Sainte-Laguë. We simply assign to the blockholders the next highest computational possible fraction of seats that corresponds to their fraction of shares and treat them as one party.

This strategy leads to a mean value of employee power, calculated according to Banzhaf, of 44.5 % compared to 33.9 % with the initially introduced procedure. The reason for the increase of employee power in the context of increased share concentration is the abandonment of any assignment rules. Both the D'Hondt and the Sainte-Laguë algorithm tend to favour blockholders against very small shareholders, particularly those who fall under the free-floating proportion. In the present case, all blockholders receive the fraction of seats that generally matches their sum of shares, while the remaining available seats are quasi-randomly assigned to unnamed parties. Note that both measures of employee power are highly correlated ($r = 0.79$).

Table VII shows the results of our performance regressions from the previous subsections including employee power measured as described above.

Table VII: Robustness Check II – Summing Up All Blocks of Shareholdings

	a	b	C
Dependent Variable	**ROA**	**Tobin's Q**	**Market-to-Book**
Employee Power	-0.001	0.009**	0.009**
	(-0.11)	(2.21)	(1.98)
Employee Power^2	0.000	-0.000***	-0.000**
	(0.31)	(-2.72)	(-2.55)
log(Total Assets)	0.030	-0.013	-0.039
	(0.10)	(-0.08)	(-0.24)
Leverage	-0.005	-0.006**	-0.009***
	(-0.51)	(-2.51)	(-3.48)
R&D	-0.050	0.006	0.004
	(-1.40)	(0.52)	(0.38)
log(Age)	0.984**	-0.078	-0.112
	(2.31)	(-0.58)	(-0.76)
Industrially Diversified	-0.164	0.033	0.018
	(-0.93)	(0.55)	(0.30)
Geographically Diversified	0.282	-0.181	-0.171
	(0.77)	(-1.43)	(-1.32)
Freefloat25+	-0.050	-0.077	-0.076
	(-0.34)	(-1.48)	(-1.44)
Freefloat50+	0.251	0.098	0.115*
	(1.09)	(1.59)	(1.79)
Freefloat75+	-0.072	0.075	0.061
	(-0.46)	(1.23)	(1.01)
Year and Firm fixed effects	✓	✓	✓
N	1,179	1,179	1,179
Firms	189	189	189
R^2	0.097	0.098	0.124

Notes: All regressions use heteroskedasticity-robust standard errors. Explanatory variables are lagged by one year. *t*-values are given in parentheses. *, **, *** denote significance at the 10 %, 5 % and 1 % levels, respectively.

Again we find a significant inverted U-shaped relation between employee power and firm performance, as measured by Tobin's Q (model b) and the market-to-book value (model c). The value maximising values of employee power lay within the range of the previous findings (46 % by model b, 44 % by model c). The return on assets is again unaffected by the power of the employee representatives on the supervisory board.

5.4 Robustness Check III: Considering Only Co-determined Firms

As explained in section 2, employee representation on the supervisory board is mandatory only for those firms that fulfil certain criteria with regard to the legal form and firm size, as measured by the number of employees and industry affiliation. All firms in our sample that are not forced to have employees on the board did not voluntarily appoint any employee. Thus, employee power is, by definition, zero in these cases, and the power of the corresponding observations for the identification of an effect of employee power on firm performance is limited.

Therefore, as a further robustness check, we repeat our estimations presented in subsection 5.1 on a restricted subsample consisting only of those firms that are subject to co-determination and have at least three employees on the board.[3] This condition leads to the results shown in Table VIII.

The subsample estimations reveal results similar to those found in the full sample. That is, the effects of employee power on corporate performance are inversely U-shaped. The value-maximising power levels are close to those found in former model estimations (44 % by model b, 43 % by model c). Interestingly, employee power is also significantly hump-shaped, as related to ROA, our accounting based measure of firm performance (model a). According to this specification, the value maximising employee power is at 58 %. This finding must be interpreted with caution, though, as the squared term coefficient is statistically significant at the rather low level of 10 %, and we did not find similar results in model estimations based on the full sample.

All subsample estimations confirm the previous findings and sustain the perception that employee power on the board is a relevant determinant of firm performance.

[3] Note that all other previously presented results also hold when estimations are based on this subsample of observations.

Table VIII: Robustness Check III – Subsample of Co-Determined Firms

	a	b	C
Dependent Variable	**ROA**	**Tobin's Q**	**Market-to-Book**
Employee Power	0.018**	0.007**	0.007**
	(2.22)	(2.32)	(2.38)
Employee Power^2	-0.000*	-0.000**	-0.000**
	(-1.70)	(-2.42)	(-2.53)
log(Total Assets)	0.098	0.119	0.088
	(0.24)	(0.78)	(0.56)
Leverage	-0.002	-0.005*	-0.008***
	(-0.15)	(-1.81)	(-2.72)
R&D	-0.065	0.011	0.008
	(-1.58)	(0.88)	(0.71)
log(Age)	0.834*	-0.083	-0.114
	(1.81)	(-0.58)	(-0.74)
Industrially Diversified	-0.128	-0.015	-0.021
	(-0.76)	(-0.28)	(-0.39)
Geographically Diversified	0.293	-0.085	-0.081
	(0.70)	(-0.65)	(-0.62)
Freefloat25+	-0.113	-0.022	-0.021
	(-0.62)	(-0.48)	(-0.44)
Freefloat50+	0.167	0.010	0.019
	(0.87)	(0.16)	(0.31)
Freefloat75+	0.011	0.099	0.086
	(0.06)	(1.25)	(1.11)
Year and Firm fixed effects	✓	✓	✓
N	930	930	930
Firms	142	142	142
R^2	0.112	0.105	0.131

Notes: All regressions use heteroskedasticity-robust standard errors. Explanatory variables are lagged by one year. *t*-values are given in parentheses. *, **, *** denote significance at the 10 %, 5 % and 1 % levels, respectively.

5.5 Robustness Check IV: Testing for Endogeneity of Employee Power

Although all explanatory variables in our estimations are lagged by one year to avoid simultaneity biases in the first place, one might be concerned whether employee power is, nonetheless, endogenous in our regression models. Endogeneity could indirectly stem from feedback effects of firm performance on ownership concentration as, for instance, bad firm performance induces blockholders to sell their stakes, which would affect the power of the employees.

While we do not believe that this concern is a severe problem in our regression framework, as the number of employees on the supervisory board is mandatory, and blocks of shares are usually not bought or sold because of certain measures of Tobin's Q or ROA, we address this potential caveat of our study by applying formal tests of possible endogeneity of employee power.

Endogeneity tests in regression analysis have been independently derived by Durbin (1954), Wu (1973) and Hausman (1978) and are, therefore, known as the Durbin-Wu-Hausman (DWH) tests (see Wooldridge 2010, pp. 129 et seq.). Carrying out a DWH test requires instruments for the potentially endogenous variables. If employee power is endogenous, its squared term is likely to be endogenous, as well. Thus, we need two instruments. Our first instrument for employee power is the size of the supervisory board. The notion behind this approach is that the minimum size of the supervisory board is mandatory for large German firms, as for those in our sample. German law requires that the minimum number of supervisory members increases with certain threshold values of the number of employees. As the mandatory fraction of employee representatives on the board also increases with the workforce, it is likely that employee power increases with the size of the supervisory board, while the affected companies have almost no option to deviate from the required employee participation. Firms may attempt to remain below a certain threshold value of staff, but there is little evidence in favour of such behaviour. As almost all companies in our sample realise the minimum compulsory board size, we conclude that the supervisory board size is exogenous in our regression framework.

As a second instrument for employee power, we use the average employee power at the 2-digit SIC industry level per year. Industry level instruments have been introduced by Jaffe (1986). The argument for the validity of these instruments is that firms orient their behaviour to their industry peers, while a firm is individually not able to affect the whole industry significantly.

In order to perform the DWH test, we estimate two models where the dependent variables, employee power and its squared term, are regressed on all explanatory variables from the performance regressions already shown plus the instruments. Table IX reports the results.

Table IX: First Stage of the DWH Test

	a	b
Dependent Variable	**Employee-Power**	**Employee-Power^2**
log(Total Assets)	-1.414	-125.863
	(-0.61)	(-0.68)
Leverage	0.063	6.952
	(0.98)	(1.12)
R&D	0.267	20.356
	(0.92)	(0.82)
log(Age)	6.352	368.279
	(1.29)	(0.88)
Industrially Diversified	-1.513	-259.721*
	(-0.97)	(-1.97)
Geographically Diversified	3.274	354.488
	(1.18)	(1.47)
Freefloat25+	-1.695	25.536
	(-0.93)	(0.19)
Freefloat50+	3.929*	105.656
	(1.97)	(0.63)
Freefloat75+	21.313***	2371.726***
	(6.94)	(7.70)
Board Size	4.710***	371.985***
	(7.22)	(6.62)
Employee Power Industrial Average	0.434***	38.168***
	(3.73)	(4.06)
Year and Firm fixed effects	✓	✓
N	1,179	1,179
Firms	189	189
R^2	0.332	0.372
F-value of joint significance of instruments	32.19***	29.94***

Notes: All regressions use heteroskedasticity-robust standard errors. Explanatory variables are lagged by one year. *t*-values are given in parentheses. *, **, *** denote significance at the 10 %, 5 % and 1 % levels, respectively.

Both instruments are individually highly significant in both specifications. This finding confirms their relevance as predictors of employee power. Staiger and Stock (1997) emphasise that endogeneity tests can be misleading if the utilised instruments are weak. These authors propose performing an F-test of joint significance on the utilised instruments. As a rule of thumb, the F-value should exceed 10 to avoid a weak instrument bias. As indicated in the last column in Table IX, the F-value is far above 10 in both specifications; therefore, we are not concerned with weak instrument bias.

In the second stage, the residuals of both specifications are calculated and included in the original models as additional regressors. Thus, the F-test of joint significance of these residuals serves as the test statistic for the null hypothesis of exogeneity of employee power and its squared term. We find F-values between 0.84 (p-value = 0.43, model a) and 1.99 (p-value = 0.14, model b), meaning that exogeneity of employee power is not rejected in our performance regressions. Note that the test results do not diverge when we perform the endogeneity test within the previously presented robustness check frameworks.

5.6 Robustness Check V: Employee Power or Ownership Structure

As a final short robustness check, we address the supposition that we might identify effects of ownership concentration rather than of employee power. The argument is that the power of worker representatives varies, due to differences in the ownership structure, which itself could be responsible for the found variations in corporate performance if a medium level of shareholder concentration is related to higher firm performance than both widely held stock and one dominant shareholder. To assess how sensitive employee power reacts to ownership concentration and whether we observe a different effect with our employee power variable, we report the correlation coefficients between the fraction of free-floating shares and employee power, as well as the correlation between the power of the largest blockholder and employee power. Not surprisingly, employee power is positively correlated with the fraction of widely held shares (r = 0.35), while it is negatively correlated with power of the largest blockholder (r = -0.54). The low correlations suggest against any severe measurement problems. Nonetheless, we re-estimated all regression models presented previously with the power of the largest blockholder instead of the employee power as the main explanatory variable. As expected, we found no significant results. The same (missing) result is revealed when the fraction of widely held shares is taken. Against this background and the results of the reported robustness checks, we conclude that employee power drives our results.

6. The Role of Union Representatives on the Board

Employee representatives on supervisory boards consist of regular workers who are elected for representation by the entire workforce, as well as union representatives who are, in almost all cases, sent to the board by worker unions from outside the firm that they are monitor. Within the group of employee representatives, union representatives amount to a maximum proportion of one-third or three people. As the union representatives are supposed to monitor

the firm on behalf of the interests of the employees of the firm to which they are appointed, it is reasonable to treat all employee representatives as one party.

However, one might argue that union representatives follow their own agenda and that the interests within the group of employee representatives are not always fully aligned. A reason for such differences could be that union representatives, as they are not employees of the firm that they monitor, are not directly affected by the decisions that they make. These representatives usually hold no residual rights. Furthermore, as unions may send a supervisor to two or more firms simultaneously, conflicts of interest may arise if, for instance, one firm's strategic investment has a negative impact on the growth prospects of another competing firm being supervised by the same union representative.

Considering the potentially positive effects of employee representation on the board due to enhanced information flows from low levels of the hierarchy to the top level of the firm, as well as higher acceptance rates of decisions that affect workers negatively, one might argue that the advantages of employee representation only apply to the elected workers and not to the union representatives on the board. If the union representatives are sent from outside of the firm, it is difficult to understand how these directors could provide first-hand operational knowledge to the board or influence higher acceptance rates of unpopular managerial decisions among workers.

We address potentially different influences of worker and union representatives on corporate decision-making by calculating the power of each group of employee representatives separately. We apply exactly the same procedure as initially described in section 3 with seat allocation among the shareholder representatives according to D'Hondt and voting power measured according to Banzhaf, but we treat union representatives and workers among the employees on the board as separate parties.[4]

6.1 Empirical Results

Descriptive statistics of the power of both groups of employee representatives on the board show, not surprisingly, lower voting power compared to the case when all employees belong to one group. The average power of the workers representatives is 12.7 % with a median of 10 %. The power of this group ranges between zero (499 cases) and a maximum of 64 %.

[4] We also calculated the power index of each group according to Shapley-Shubik. As already shown in section 4, both measures lead to only slightly different values compared to Banzhaf, such that we do not report these results separately. All estimations presented below are robust to an exchange of both indices.

Union representatives have even less power, amounting to an average of 4 % with a median value of 0 %, indicating a high fraction of cases in which union representatives have no power in the boardroom (658 cases). The maximum observed union power approaches 17 %.

Including both measures of employee power into a regression of firm performance yields the following results as reported in Table X. In addition to the linear term of worker and employee power, all control variables that were used in the previous performance regressions enter into our models. We take only the linear terms of employee power to test the hypothesis that workers have a continuously positive influence on boards monitoring quality, while the effect of union representatives is zero or negative.

According to Table X, worker power has a robust positive effect on firm performance at a weak significance level of 10 % regardless of whether performance is measured by Tobin's Q, the market-to-book value or ROA. As shown in specifications b and c, an increase of worker power in the boardroom of one percentage point leads to an average increase of market valuation between 0.005 (Tobin's Q) and 0.006 (market-to-book), while ROA increases, on average, by 0.01 %. Firm performance is descriptively lower with a greater power of the union representatives on the board, but this difference is not significantly different from zero.

We also tested an inverted U-shaped influence of worker and union power on firm performance but found no statistically significant results. To incorporate the ideas that low levels of employee power have an especially positive effect on firm performance and that this effect declines with increasing power, we estimated models with the logarithm of employee power instead of its linear term. We find a positive relation of worker representative power and firm performance with an even higher significance level of 5 %, which can be interpreted as a confirmation of this perception. The influence of the union representatives remains insignificant.

One reason for the identified continuously positive effect of employee power on firm performance might be that the workers on the board rarely reach a firm value-reducing power level. Given that the analysis presented in section 5 yielded value maximising employee power levels between 41 % and 46 % when we considered all employee representatives voting together, a split of the two groups of employees ensures that worker power remains, in most cases, below the value-reducing levels. This finding is consistent with the descriptive statistics indicating that worker representatives' power was above 41 % (46 %) in less than 5 % (2 %) of the observations. From this finding, it follows that workers on boards may

actually reduce firm performance if they receive power above 41 % to 46 %, but the present sample does not allow us to test this hypothesis.

Table X: Worker and Union Power on the Board

	a	B	C
Dependent Variable	**ROA**	**Tobin's Q**	**Market-to-Book**
Worker Power *(only firm representatives)*	0.013*	0.006*	0.005*
	(1.77)	(1.85)	(1.81)
Union Power	-0.005	-0.001	-0.002
	(-0.31)	(-0.24)	(-0.54)
log(Total Assets)	0.025	-0.009	-0.036
	(0.08)	(-0.06)	(-0.23)
Leverage	-0.005	-0.006**	-0.009***
	(-0.52)	(-2.53)	(-3.48)
R&D	-0.051	0.005	0.003
	(-1.42)	(0.42)	(0.28)
log(Age)	0.942**	-0.102	-0.137
	(2.27)	(-0.78)	(-0.97)
Industrially Diversified	-0.161	0.032	0.018
	(-0.91)	(0.54)	(0.30)
Geographically Diversified	0.290	-0.176	-0.165
	(0.80)	(-1.40)	(-1.28)
Freefloat25+	-0.025	-0.046	-0.050
	(-0.16)	(-1.00)	(-1.06)
Freefloat50+	0.254	0.051	0.067
	(1.25)	(0.88)	(1.13)
Freefloat75+	-0.154	-0.018	-0.032
	(-0.95)	(-0.35)	(-0.62)
Year and Firm fixed effects	✓	✓	✓
N	1,179	1,179	1,179
Firms	189	189	189
R^2	0.100	0.094	0.120

Notes: All regressions use heteroskedasticity-robust standard errors. Explanatory variables are lagged by one year. *t*-values are given in parentheses. *, **, *** denote significance at the 10 %, 5 % and 1 % levels, respectively.

Interestingly, estimations of models a through c of Table X, without the firm fixed effects, yield a highly significant negative influence of union representatives power on firm performance, even when we control for unobserved industry sector effects and all other explanatory variables that were used as controls beforehand (see Table A1 in the appendix). Although our explanatory variables correlate with some unobserved time-constant firm

characteristics, leading to inconsistent estimations of coefficients in the standard OLS framework, we interpret this finding as weak evidence for a negative effect of the power of the union representatives on firm performance. The relatively high standard errors of the union power coefficient in the fixed effects model are, at least partly, determined by the low within variation of union power (s_w = 0.02). Even though the fixed effects estimator is consistent, it might not be appropriate to identify the union power effect in our sample.[5] Note that the reported positive worker representatives' effect indicated in Table X is even more pronounced in terms of economic magnitude and statistical significance in the standard OLS framework.

6.2 Interaction of Union and Firm Representatives

While union representatives seem to affect firm performance negatively, the robust evidence of a positive effect of the power of worker representatives on firm performance may explain the inversely U-shaped relation of employee power and firm performance analysed in section 5. When employee power exceeds a certain threshold value between 41 % and 46 %, the downward-pointing right side of the inverted U might be mainly driven by the influence of union representatives.

We investigate this perception empirically by adding two dummy variables to our regressions, indicating whether union representatives have any positive power themselves, as well as their interaction with employee power. Table XI reports the results.

The estimations shown in Table XI reveal two main results. The already-identified positive influence of the workers power on firm performance is more pronounced in terms of magnitude and significance in those firms in which union representatives are not present or where they themselves have no power. Considering ROA as a performance proxy, the effect is insignificant. The interaction term shows that the positive power of union representatives on the board significantly reduces the positive effect of the workers to almost zero (0.001). Union representatives' power seems to have no direct significant influence. This evidence supports the perception that union representatives could be responsible for the sometimes negative effect of employee representation on boards in general. The analyses is, however, limited, as it does not discriminate between whether union representatives have a direct negative effect on monitoring quality by the employee representatives on the board or whether

[5] Note that the coefficient of log (union power +1) is, at the 10 % level, significantly negative related to market-based firm performance measures in the fixed effects model, if we consider only the subsample of firms that have mandatory co-determined boards (see subsection 5.4).

they indirectly affect board decisions negatively by pushing the power of the employee representatives beyond a performance-enhancing level. Regardless of which explanation holds true, the power of union representatives on the board has no positive effect on firm performance.

Table XI: Interaction of Worker Power with Union Power

	a	B	c
Dependent Variable	**ROA**	**Tobin's Q**	**Market-to-Book**
Worker Power *(only firm representatives)*	0.018	0.012**	0.011**
	(1.31)	(2.19)	(2.11)
Worker Power x Union Power, dummy	-0.011	-0.011*	-0.010*
	(-0.84)	(-1.97)	(-1.88)
Union Power, dummy	0.187	0.092	0.075
	(0.93)	(1.30)	(1.08)
log(Total Assets)	0.013	-0.011	-0.038
	(0.04)	(-0.07)	(-0.25)
Leverage	-0.005	-0.006**	-0.009***
	(-0.50)	(-2.45)	(-3.41)
R&D	-0.051	0.005	0.003
	(-1.41)	(0.43)	(0.29)
log(Age)	0.931**	-0.103	-0.138
	(2.24)	(-0.80)	(-0.99)
Industrially Diversified	-0.176	0.025	0.011
	(-1.00)	(0.42)	(0.19)
Geographically Diversified	0.296	-0.165	-0.156
	(0.81)	(-1.36)	(-1.25)
Freefloat25+	-0.009	-0.030	-0.035
	(-0.05)	(-0.61)	(-0.70)
Freefloat50+	0.246	0.042	0.058
	(1.24)	(0.73)	(0.98)
Freefloat75+	-0.130	0.001	-0.014
	(-0.80)	(0.03)	(-0.27)
Year and Firm fixed effects	✓	✓	✓
N	1,179	1,179	1,179
Firms	189	189	189
R^2	0.101	0.101	0.125

Notes: All regressions use heteroskedasticity-robust standard errors. Explanatory variables are lagged by one year. *t*-values are given in parentheses. *, **, *** denote significance at the 10 %, 5 % and 1 % levels, respectively.

7. Conclusion

For decades, practitioners and researchers in many fields of social sciences have discussed whether corporate governance benefits from employee representation on the board. Previous theoretical and empirical studies have provided ambiguous results on this topic. We introduced the concept of power indices from cooperative game theory to board-composition analysis so as to assess, for the first time, the 'real' influence of employees on corporate decision-making. This approach, combined with a rich panel data set, enabled us to overcome two major obstacles of all former studies on co-determination. First, employee power is much more precisely measured, and second, unobserved firm heterogeneity is effectively controlled for in multivariate empirical analyses.

Regression models show an inversely U-shaped relationship between labour power and Tobin's Q, as well as the market-to-book value of large listed companies in Germany. Labour power seems to be optimal between 41 % and 46 % from a shareholders perspective. Therefore, an increase of employee power is advantageous for the owners, provided that this power does not become too great. Because the optimal figure is approximately 43 %, depending on the measure of firm performance, most publicly owned corporations could still benefit from an increase in employee power. However, any increase of employee power should be made on the side of the workers, rather than the union representatives, because only enhancements of the former group are associated with a robust improvement of firm valuation. In terms of policy recommendations, our analysis suggests a limitation of union representatives on supervisory boards, while higher levels of worker representation might be economically advantageous.

Before firm strategies are changed or general politics are altered based on our findings, it is noteworthy to indicate one restriction. Effective representation of the owners on the board of directors cannot be quantified exactly. It is concluded from the distribution of shares, what might lead to a small bias in the identification of optimal employee power. While mistakes in this regard weaken our empirical results, the robust significance of our results substantiates the importance of employee power. The same is true for the fact that different owners and their representatives also have common interests with regard to the workers and their representatives. In practice, managers should carry out a thorough investigation of their specific situation in which all board members and possible coalitions are known exactly.

Being confronted with co-determination, the shareholders must cooperate, which might improve the performance of the company. Therefore, future studies may focus on different outcome variables that are primarily in the interest of the employees, such as employment growth and stability, mergers and acquisitions and investments in the research and development of new products.

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Appendix

Table A1: Worker and Unions' Power on the Board – OLS

	a	b	c
Dependent Variable	**ROA**	**Tobin's Q**	**Market to Book**
Workers-Power *(only firm representatives)*	0.031***	0.007***	0.009***
	(3.72)	(2.70)	(3.20)
Union-Power	-0.130***	-0.019***	-0.026***
	(-7.51)	(-3.62)	(-4.51)
log(Total Assets)	-0.018	-0.028	-0.045**
	(-0.35)	(-1.63)	(-2.51)
Leverage	-0.022***	-0.012***	-0.018***
	(-5.00)	(-7.29)	(-10.21)
R&D	0.054**	0.061***	0.066***
	(2.26)	(4.44)	(4.60)
log(Age)	-0.091	-0.104***	-0.123***
	(-1.30)	(-4.65)	(-5.26)
Industrially Diversified	-0.492***	-0.002	-0.040
	(-3.29)	(-0.04)	(-0.73)
Geographically Diversified	1.235***	0.030	0.056
	(6.60)	(0.54)	(0.99)
Freefloat25+	0.019	0.153**	0.151**
	(0.10)	(2.19)	(2.08)
Freefloat50+	0.178	-0.111	-0.106
	(0.83)	(-1.43)	(-1.32)
Freefloat75+	-0.376	-0.158*	-0.190**
	(-1.64)	(-1.96)	(-2.25)
Year and Industry fixed effects	✓	✓	✓
N	1179	1179	1179
Firms	189	189	189
R^2	0.202	0.219	0.280

Notes: All regressions use heteroskedasticity-robust standard errors. Explanatory variables are lagged by one year. *t*-values are given in parentheses. *, **, *** denote significance at the 10 %, 5 % and 1 % levels respectively.

Table AII: Interaction of Worker Power with Union Power – OLS

	a	b	c
Dependent Variable	**ROA**	**Tobin's Q**	**Market to Book**
Workers-Power *(only firm representatives)*	0.048***	0.013***	0.015***
	(4.00)	(3.00)	(3.42)
Employee-Power x Union Power, dummy	-0.020	-0.010**	-0.010**
	(-1.46)	(-2.13)	(-2.12)
Union Power, dummy	-1.310***	-0.118	-0.183**
	(-4.96)	(-1.57)	(-2.28)
log(Total Assets)	0.028	-0.017	-0.032*
	(0.54)	(-0.97)	(-1.79)
Leverage	-0.021***	-0.012***	-0.018***
	(-4.95)	(-7.32)	(-10.27)
R&D	0.066***	0.063***	0.069***
	(2.74)	(4.62)	(4.80)
log(Age)	-0.088	-0.105***	-0.124***
	(-1.26)	(-4.68)	(-5.28)
Industrially diversified	-0.411***	0.008	-0.027
	(-2.74)	(0.14)	(-0.48)
Geographically diversified	1.138***	0.009	0.031
	(6.11)	(0.16)	(0.56)
Freefloat25+	0.087	0.170**	0.170**
	(0.45)	(2.41)	(2.33)
Freefloat50+	0.166	-0.114	-0.110
	(0.78)	(-1.49)	(-1.39)
Freefloat75+	-0.405*	-0.146*	-0.180**
	(-1.79)	(-1.85)	(-2.18)
Year and Industry fixed effects	✓	✓	✓
N	1,179	1,179	1,179
Firms	189	189	189
R^2	0.205	0.223	0.283

Notes: All regressions use heteroskedasticity-robust standard errors. Explanatory variables are lagged by one year. *t*-values are given in parentheses. *, **, *** denote significance at the 10 %, 5 % and 1 % levels respectively.

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