Innovation Incentives under Tariffs
Evidence from Germany

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Abstract

The question of how unions affect innovation has been receiving more attention in recent years. In most cases, a negative influence is assumed. However, the various levels of wage setting have yet been neglected. Is there also a consistently negative impact and is it true that in fact the largest wage flexibility guarantees the largest innovation incentives? In this paper, we try to answer these questions.

Using a theoretical framework, we distinguish between centralized, decentralized and coordinated wage setting. Centralized negotiations take place at industry level, whereas decentralized collective bargaining implies no tariff wages. In coordinated wage settings at company level, the wage is set according to the productivity of the company. Due to a hold-up problem, the union is not able to credibly communicate the reason for not raising wages after a successful innovation. Under this policy, the company has minimal innovation incentives. In contrast, companies with centralized wage setting have the strongest incentives to innovate. Using an empirical approach, we can confirm the negative effects of coordinated wage setting for German industries. Impacts of contracts designed for a specific industry are not clear and appear to have a negative influence on innovation as well. This can be attributed to possible exceptions in German wage agreements.

Keywords: Collective bargaining, centralization, R&D, innovation

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1 Introduction

Innovations are regarded as crucial conditions for growth and a long-term increase of efficiency as well as of employment. The EU Lisbon Strategy of 2000 emphasizes the importance of research and development (R&D) as a crucial requirement for innovation. Thus, one of the goals of this strategy is to increase R&D spending to 3% of GDP by 2010.[1] Given the current economic situation after the crisis and its impact on the labor market, the issue has gained significance again. Therefore, it is essential to know potential factors that influence R&D and the generation of innovations. This knowledge can be used for innovation strategies of companies as well as for public policy decisions.

Unions as a labor market institution are considered as one of these influential factors. How unions affect the productivity of companies has been a controversial topic for a long time. Following the rent-seeking model, unions act as a tax on quasi-rents of intangible capital investments. Thus, an increase in regulation of the labor market measured by union power can lead to a decrease in research activities, resulting in less innovation.[2] But on the other hand, unions are valued as a constructive part of a country's labor market regime. They simplify industrial interactions, which enhances labor productivity and can thus reduce average total costs.[3] Numerous empirical studies have analyzed the effects of union power on the innovation incentives in different countries and industries. In most cases, negative impacts were found. Additionally, the results depend heavily on the measurement of union variables.[4]

However, it is not only the mere existence of unions, which is crucial for the innovation behavior of a company. Also the specific type of labor market organization plays a role, for example the level of wage setting centralization. The dimension of wage negotiations can range from decentralized, inside the company only, to maximally centralized, exclusively at the national level.[5] Currently, inflexibilities according to centralized wage settings attract considerable public criticism. Labor market rigidities are broadly viewed as bad for economic efficiency.[6] Decreased centralization and more flexibility are supposedly beneficial for employment and economic welfare.[7] Therefore, the OECD supports more flexible wage setting and employment conditions. Cutting restrictions related to these dimensions leads to more adaptability to local conditions of a country or an industry.[8] Accordingly, an increase in hybrid

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1 See e.g. BMBF (Ed.)(2008).

2 See Connolly et al. (1986) or Hirsch (1991).

3 For details, see Haucap and Wey (2004): p. C149 or Freeman and Medoff (1984).

4 Overviews of previous and recent studies can be found in Flanagan (1999); Menezes-Filho et al. (1998); Betts et al. (2001); Menezes-Filho and Van Reenen (2003); Hirsch (1991, 2004) or Schnabel and Wagner (1994).

5 E.g. parts of Scandinavia or Austria. See Wagner and Jahn (2004): p. 201.

6 For details, see e.g. Burda and Wyplosz (2003): pp. 98ff. or pp. 542f.; Franz and Pfeiffer (2003).

7 See Bellmann et al. (1999), Wey (2004) or Brenke (2004).

8 See OECD (2006).

structures between the two extremes is observable. This, in turn, allows for adjustments of local conditions at a company level. In Germany, such exceptions in tariff agreements are gaining more and more prominence.[9] This leads to a questioning of the optimal centralization level. However, studies about the influence of centralization levels of tariff negotiation systems on further indicators of economic productivity are lacking.[10]

Motivated by the current trends of more flexible wage settings, we try to analyze to what extent the level of centralization influences incentives for innovation. We question if the impacts of unions on innovations are linear or if direct agreements on company level are better than bargaining with the entire industry. The rest of this paper is structured as follows. Chapter 2 introduces a theoretical model by Haucap and Wey proposed in 2004, which presents possible effects of wage bargaining levels on innovation incentives. A description of the data and the empirical method to examine these effects in practice are given in chapter 3. The results are summarized in chapter 4. Finally, chapter 5 discusses some implications.

2 Theoretical Framework

The theoretical model by Haucap and Wey (2004) establishes the relation between different unionization structures and innovation incentives. Three levels of union centralization ρ can be distinguished. Decentralized wage setting D is defined as wage negotiations between a company and its individual employees. It represents the minimum level of centralization. At the coordinated level C, a trade union negotiates on behalf of all employees of a single company. Thus, the union coordinates the employees wage demands according to the labor productivity of the company. The third level is centralized wage setting U. In this case, a union determines uniform wages for all employees of an industry or region.

The model examines a Cournot market for a homogenous good with two competing companies and constant returns to scale. Labor A constitutes the only factor of production. A patent race establishes which of the two companies executes the innovation. Only non-radical process innovations are examined to avoid crowding out. That means the decline of the production costs after the innovation is not strong enough to allow monopoly prices. Productivity growth is thus limited to $\Delta \leq 1/3$. Both companies $i = \{1, 2\}$ have a reaction function depending on the quantity of supply q_i, wages w_i, and productivity Δ

$$q_i\left(w_i, w_j, \Delta\right) = \frac{A - 2w_i\left(1 - \Delta\right) + w_j}{3},$$

[9] See Bispinck (2008).

[10] Wagner and Jahn (2004): p. 201. Only studies with a focus on macro-economic impacts, see Flanagan (1999).

with i as the innovating and j as the non-innovating firm. The extent to which the way of wage determination has an influence on investment decisions can be seen from the company's expenses for wages, which are derived from the unions' wage demands. The unions will try to maximize these according to their level of centralization. The utility functions U of the unions depend on the level of centralization ρ, labor demand l_i resulting from the reaction function, and current wages w_i.

$$U_i^D = l_i\left(w_i - w_o\right) \qquad U_i^C = \sum_{i=1}^{2} l_i\left(w_i - w_o\right) \qquad U_i^U = \sum_{i=1}^{2} l_i\left(w - w_o\right)$$

According to $w^C{}_i > w^U{}_i > w^D{}_i$, wages for the innovating company are highest in coordinated wage setting and lowest in decentralized structures, because of the union's reaction to productivity gains. With coordinated wage-setting, the wage level corresponds to the productivity of each firm. An increase of the productivity after an innovation will increase the wage to the same extent. For the non-innovating company, $w^U{}_i > w^C{}_i > w^D{}_i$ holds. It pays the highest wages in centralized wage setting. Here, the wage is set according to the average industry productivity. After the innovation of the other company, the average productivity increases and as a consequence also the wages will rise. Due to differences in productivity, the wage discrepancy between the two companies is highest in decentralized wage setting. With centralized wage-setting, the industry union ignores productivity differences. Here, the wages are the same for both companies and the wage discrepancy is $\Delta\ w^U{}_1 = 0.$

The level of wage setting centralization ρ also influences the decision to invest in innovation. A process innovation increases the productivity of a company, creating a competitive advantage. The union, whose wage demands are determined by productivity, gains an advantage from successful innovation. At the same time, the company runs the risk of losing all gains from innovation due to equivalent wage increases. This hold-up problem can cause a lack of necessary investments in innovation. Incentives for investments are positive as long as gains from innovation $\Pi(\Delta)$ are higher than the costs of innovation $I(\Delta)$

$$\Psi(\Delta) := \Pi_i(\Delta) - \Pi_j(\Delta) > I(\Delta)$$

with $i \neq j$. $\Pi_i(\Delta)$ is the gain for the innovating firm, whereas $\Pi_j(\Delta)$ for the non-innovating firm. Hence, $\Psi(\Delta)$ can be interpreted as the maximum amount a company is willing to spend on innovation. Because of the hold-up problem, the three wage setting levels ρ have different impacts on the innovation incentive. The problem can most easily be reduced in centralized wage setting. In this case, the wages rise only to the average productivity of the industry and the innovating firm does not lose all the innovation gains. Thus, innovation incentives can most easily be shielded from increased wage demands.[11] Employees profit from unified tariffs as well. Although they obtain a minor fraction of the innovation earnings, this increases with innovation.

[11] See Wey (2004): p. 150 for more detail.

Following the results of the theoretical model, two hypotheses can be deduced.

Hypothesis 1: In centralized wage setting *U*, companies have the highest incentives to invest in productivity enhancing innovations.

Hypothesis 2: Incentives are lowest in cooperative wage setting *C*. The relationship between the level of centralization of wage negotiation and innovation incentives established in hypothesis 1 is nonlinear.

3 Data and empirical methodology

To find out how the various bargaining levels impact in practice, we test the theoretical hypotheses in different empirical models. The Mannheimer Innovation Panel (MIP), the German part of the Community Innovation Survey (CIS) of the European Commission, serves as database. It has been compiled yearly for Germany since 1993 by the Centre for European Economic Research (ZEW) on behalf of the Federal Ministry. The MIP is concerned with information about new products, services and technologies, as well as the factors, which promote and also hinder innovation activities of enterprises. The EU Oslo Manual can be used to define these terms.[12] The multistage sampling procedure is grouped by industry, size and region. The sample is representative for the manufacturing sector as well as distributive and business services.

Information about the method of wage setting as an indicator for the level of centralization is taken from the establishment survey from the Institute for Employment Research (IABB).[13] The data set, covering 16,000 companies, is a yearly survey of employment policy related subjects. Since 1996 it has been considered as representative for all industries and for all sizes of companies in Germany. The data span a variety of topics and serve as the foundation of the study on demand by the labor markets. The integration of the indicators was carried out through random sampling by industry and region.[14] For simplicity's sake, we merge some industries by matching content and similar tariff structures to minimize falsification of the original data.[15]

We examine data from 2000 to 2004 and exclude new, merged or partly sold companies from the analysis. Companies with a revenue gain of over 10 percent are not considered.

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[12] See Europäische Kommission (Ed.)(2005).

[13] The data basis of this paper is the IAB establishment panel, wave 2000 – 2004. The data access was carried out by controlled remote data processing at the Research Data Centre (FDZ) of the German Federal Employment Agency (BA). Further informations see Herrlinger et al. (2005).

[14] That is why these both variables are not used again in the regression models.

[15] Summary of included industries can be found in table 1.

Descriptive Statistics

First we take a look at the two variables that we have used to match the two data sets. In figure 1, we can see large industry differences in innovation frequency.

- Figure 1 here -

Differences caused by technology-specific characteristics reconfirm influences of industry type on innovation behavior. The distribution of tariff indicators in figure 2 clearly shows the differences between eastern and western Germany. In the eastern region, wage setting was rather decentralized during the observation period.

- Figure 2 here -

Overall, the fraction of unionized companies declined between 2000 and 2004. This distribution seems to have an impact on R&D activity as well. A company's R&D activity is also influenced by the number of employees, as can be seen in figure 3. The scatter plot in figure 4 indicates differences in innovation intensity according to the level of centralization. This descriptive assessment seems to confirm our second hypothesis.

- Figures 3 and 4 here -

To study the influences of these variables, we conduct the following regressions.

Regression Approaches

Our first estimation model uses the binary coded values of executed process innovations *Pc* as dependent variable. They are defined as new or significantly improved technologies or processes. The level of novelty is solely judged by the company. Diffusion and imitation of innovations are thus included. Innovators are all companies with successful innovation over the last three years.

Explanatory variables are company size, frequency of R&D activity and the tariff indicators.[16] Based on the descriptive statistics, we expect a positive coefficient for company size and R&D activities. As we have already noted in Chapter 2 in Hypothesis 2, we expect a negative impact of company tariffs. In contrast, the effects of industry-level bargaining, according to the Hypothesis 1, are expected to be positive.

$$P(Pc = 1 \mid X) = \Phi(\beta_0 + \beta_1 \cdot size + \beta_2 \cdot research + \delta \cdot tariff\ indicators) \quad (1)$$

The sample is further limited for a detailed fitting of the estimation to the theoretical model. The hypotheses only apply to non-radical innovations that have an increase in productivity of less than one third. Accordingly, we limit our analysis to new technologies with cost reductions of less than 30 percent in equation (2).

$$P(Pc = 1 \mid X) = \Phi(\beta_0 + \beta_1 \cdot size + \beta_2 \cdot research + \delta \cdot tariff\ indicators)\ if\ cost\ reduction_t \leq 30\% \quad (2)$$

[16] Codification: company size: 1 = less than 50 employees, 2 = 50-250 employees, 3 = more than 250 employees; R&D activity: 1 = never, 2 = occasional, 3 = continuous. Tariff indicators are binary.

The domestic wage system affects the stronger, the less a company is active in foreign markets with different wage structures. Therefore, we exclude exporting firms from the analysis. We expect that equation (3) will enhance the effects of the tariff indicators.

$$P(Pc = 1 | X) = \Phi(\beta_0 + \beta_1 \cdot size + \beta_2 \cdot research + \delta \cdot tariff\ indicators)\ if\ cost\ reduction_t \leq 30\%\ \&\ exports{=}0 \qquad (3)$$

In equation (1) to (3) only companies with successful innovation are examined. Additionally, tariff wages may already influence the efforts to achieve an innovation through research. For this reason, we estimate an additional calculation. Research intensity *Fues* serves as a possible regressand in this equation, which is defined as research costs relative to the revenue. This also allows us to compare our findings to existing innovation studies.[17] For reasons of anonymity, the values are truncated according to 0.15.

$$Research\ intensity = \beta_0 + \beta_1 \cdot size + \beta_2 \cdot research + \delta \cdot tariff\ indicators\ if\ research\ intensity \leq 0.15 \qquad (4)$$

Even here, in a further step exporting companies are excluded.

$$Research\ intensity = \beta_0 + \beta_1 \cdot size + \beta_2 \cdot research + \delta \cdot tariff\ indicators$$
$$if\ research\ intensity \leq 0.15\ \&\ exports{=}0 \qquad (5)$$

4 Empirical results

Using the presented data and empirical methods, we obtained the following results. Table 2 summarizes the regression coefficients of equations (1) to (3) for the year 2000 with different reference categories.

- Table 2 here -

Calculating equation (1) gives us the expected positive characteristics about large companies that conduct research regularly.[18] Compared to decentralized negotiations, wage bargaining at industry and at company level have a slightly negative but not significant influence. Estimating the limited equation (2) increases the regression coefficients of all included variables. In particular, the impact of collective bargaining on company level rises clearly. Additionally, the value of significance rises. However, dependence on an industry union remains slightly negative and non-significant in the restricted model. Replicating the calculation with company tariffs as reference category yields similar results. It shows that decentralized and centralized wage setting have a clearly positive impact compared to coordinated wage setting. As before, coefficients rise and become significant after limiting only. These results remain robust when the model is adjusted to the repeatedly discussed possibility of reverse

[17] See e.g. Menzes-Filho et al. (1998) or Schnabel and Wagner (1994)

[18] In order to test non-linearity, regressions with binary coded values of company size and level of research were calculated. We find positive, significant relations in all years

causality.[19] We can conclude that non-drastic process innovations are most likely in big and research-active companies without tariffs wages. The likelihood decreases significantly if the wage is set by a company union. This contradicts the first hypothesis, while hypothesis 2 can be confirmed. This direction of impact is observable from 2000 to 2004. However, the results are not at the same level of significance in every year.

Since we do not know whether cost reductions are achievable in the same year as the innovation is implemented, we have also tested cost variables of the following year or of the same and the following years. However, the results are ambiguous. Thus, the question of the right time to measure the cost savings cannot be answered.

According to equation (1) and (2), hypothesis 2 is already confirmed. The additional exclusion of exporting companies in equation (3) can also confirm hypothesis 1. While the coefficients of firm size and research easily fall, the influence of the collective bargaining variables greatly increases. Additionally, industry tariffs have a positive impact on innovation, as assumed in hypothesis 1. However, this coefficient is not significant in any year.

The coefficients of the Tobit regressions are shown in table 3 for 2000.

- Tables 3 here -

Although the binary regression returns more innovations from large companies, small companies seem to invest larger fractions of their revenue into research activities. One reason might be the improved development opportunities of large companies. In addition, synergy effects in large companies can reduce the costs of development. The positive impact of research activity holds throughout the years. Both, industry and company union decreases innovation incentives of a company compared to wage setting without tariffs, although the results are not constant over time with respect to direction and significance. However, they are constant with the results from the Probit regression (1) and (2) in their tendency. The generally smaller effects and the lower level in significance of these results can be attributed to the lack of limitations of the equation. In contrast to previous results, the exclusion of exporting companies does not change the coefficients or the level of significance.

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[19] The decision for a given bargaining level with trade unions may also be influenced by the innovation tilt of a company. This possible endogeneity of union indicators has been discussed many times. The solution using instrumental variables cannot be used due to the lack of appropriate variables in the database. Nevertheless, to exclude a possible bias the different bargaining levels are regressed on generated process innovations in the same or the previous year with or without control for other variables. We cannot find significant evidence for reverse causality. Similar results were found by Lu et al. (2010). In a two-step regression, as it has done e.g. by Hirsch (1992), the effects remain the same with slightly rising standard errors. Also previous studies did not reveal a reversed causality. See e.g. FitzRoy and Kraft (1990), Audretsch and Schulenburg (1990) or Addison and Chilton (1990).

This corresponds to the results of prior studies. Menezes-Filho et al. (1998) found this relation when no control variables were included. The negative coefficients found in the Tobit model are also consistent with the interaction of unions within an industry and costs of research in Betts et al. (2001).

5 Conclusions

The hypotheses derived from the theoretical model on the role of tariff agreements for innovation can, at least partially, be confirmed using the binary Probit model. As assumed in Hypothesis 2, company tariffs have a negative impact on the incentive to innovate. However, we obtain significant results from non-radical process innovation only. The effect increases particularly after exclusion of internationally active companies. Additionally, the time of measurement seems to play a crucial part. But it is difficult to find the optimal time to observe innovation gains. The positive impacts of centralized wage setting on innovation incentives stated in hypothesis 1 cannot be confirmed clearly using the present data. Only when studying non-radical innovations, a positive and slightly significant coefficient compared to coordinated wage setting can be observed. After the additional exclusion of exporting firms, centralized wage setting shows a positive influence in comparison to no tariffs. However, this result is not always significant. These ambiguities can be attributed to the operationalization of the indicator. The numerous exceptions in industry agreements allow company specific modifications, resulting in lower innovation incentives. But in any case, the results prove the assumption of a non-linearity. So far, it cannot be confirmed that increased flexibility inevitably leads to more innovations.

Based on our empirical results, impacts on the development of new technologies can be derived. From a managerial and political point of view, wage setting at company level should be avoided. This is confirmed by the negative influence of cooperative wage setting methods in all presented regression models. The results for centralized wage-setting are less clear. In the Probit model, we have found a positive effect on the generation of innovation. However, this only applies under restrictions. The results of the Tobit model show a negative effect on research intensity. But this ambiguity should not result in rejecting the system of tariffs currently in use in Germany. It still offers the necessary representation of employees. Apart from wages, tariff negotiations offer the opportunity to negotiate lay-off protection, work schedules or contract lengths. A strong competitive pressure between companies would be possible without conditions determined by tariffs. Unbalanced working conditions would not be controllable. A minimum wage, as discussed recently among German policymakers and in parliament, might be the reaction. Numerous exceptions already allow for non-tariff wages. This results in an erosion of industry agreements. In addition, strikes and wage demands that are judged to be excessive, accelerate the downward trend of tariffs. On the other hand, non-tariff regulation, no-strike clauses and universal validity of industry tariffs reduce incentives for companies to drop tariffs. For this reason, a stabilizing policy for confining wage differences and company specific modifications is recommended.

From a labor market perspective, we can also derive conclusions.[20] In general, process innovations are considered as labor-saving innovations. New technologies lead to increased productivity and a more efficient production, which – under constant output – leads to reductions in the workforce. Hence, labor market policy should more focus on the development of new and radically improved products and the opening of new markets instead of subsidizing process innovation. However, a simple transfer of the model assumptions about process innovation onto the more complex interdependencies of product innovations is not possible. Therefore, an extended theoretical model for product innovations should be developed and empirical tested.

[20] See e.g. Matzner et al. (1990) or Chennells and Van Reenen (2002) for more details.

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Figures

Figure 1: Share of innovators according to industry for 2000 with data from MIP and IABB.

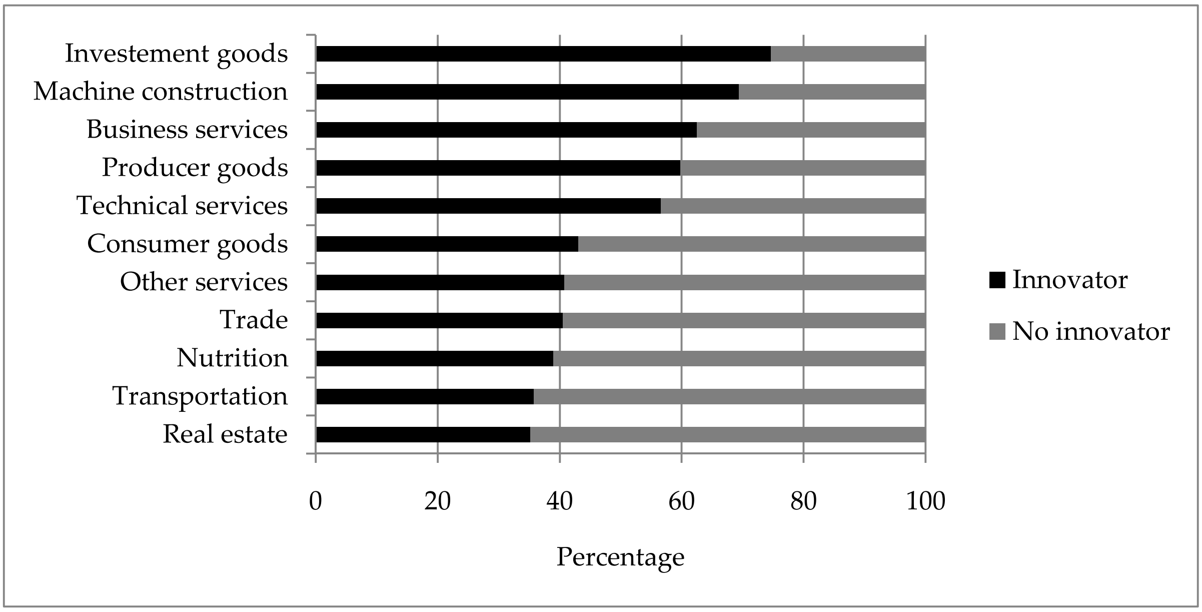


Figure 2: Share of wage centralization according to region for 2000 and 2004 with data from MIP and IABB.

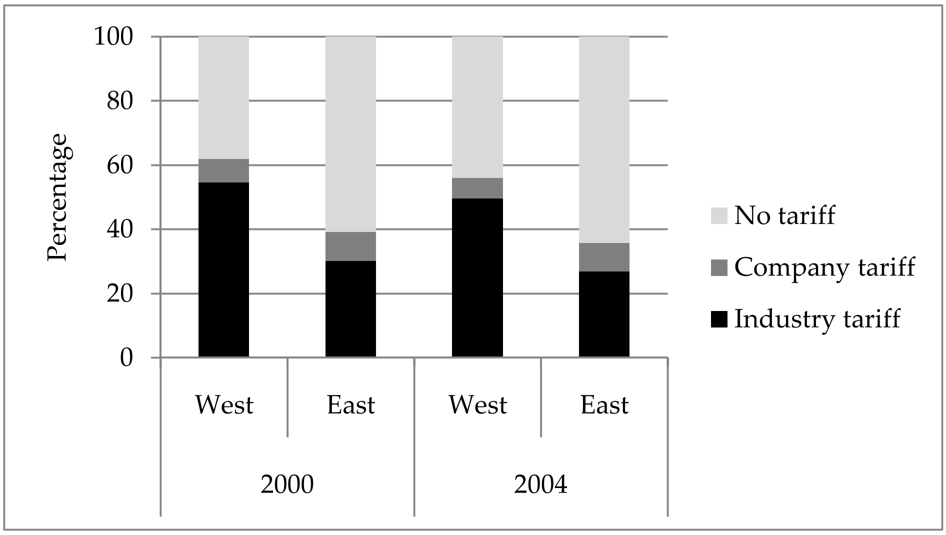


Figure 3: Share of innovators according to company size for 2000 with data from MIP and IABB.

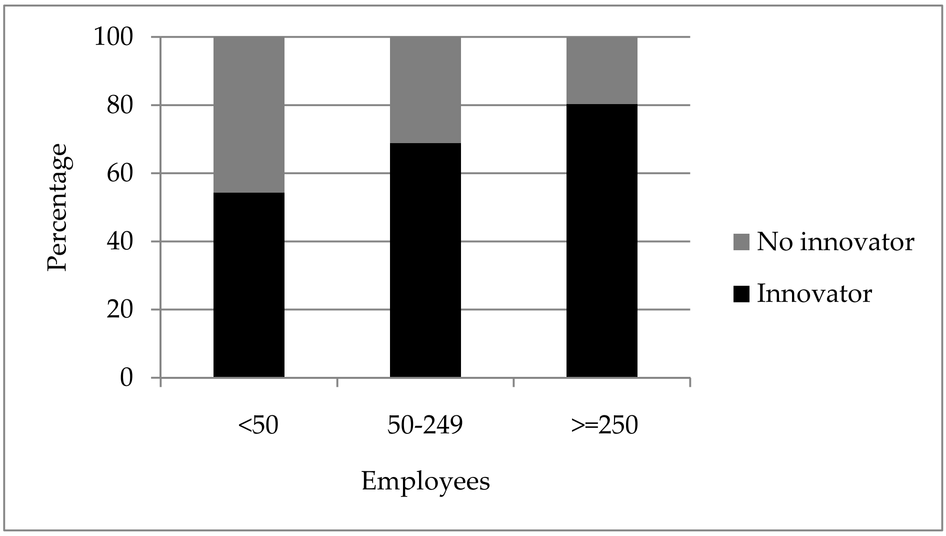
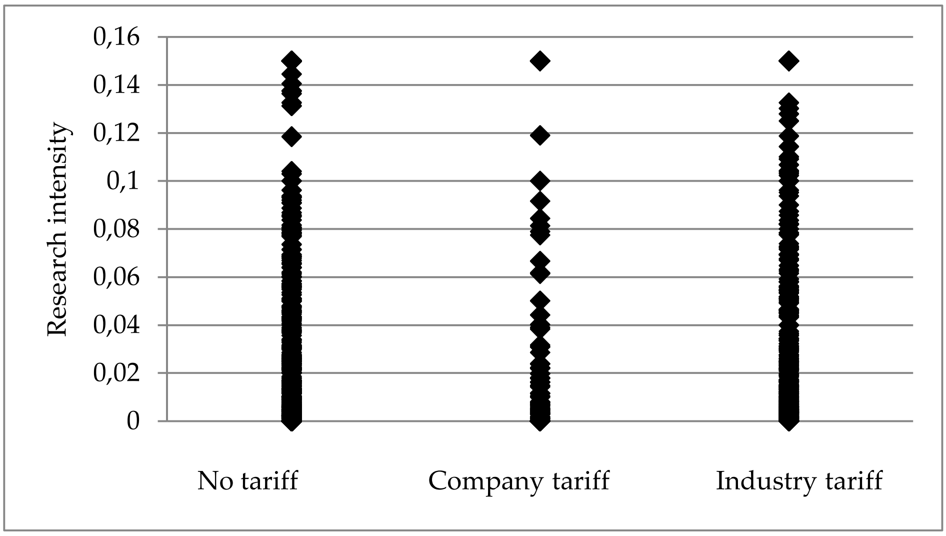


Figure 4: Scatter plot of research intensity and tariff type for 2000 with data from MIP and IABB. Variable research intensity is truncated to 0.15.



Tables

Table 1: Industry classification. Based on the NACE Rev. 1 systematic.

	Industry notation	Contents
1	Consumer goods	Textiles, furniture, energy
2	Nutrition	foodstuffs, drinks, tobacco
3	Producer goods	Basic materials: synthetics, glass, ceramics, metal, chemistry
4	Machine construction	Engineering
5	Investment goods	Electrical engineering, vehicle construction
6	Trade	Retail, wholesale
7	Transportation	Traffic, mailing
8	Business services	Consulting, advertising, research
9	Technical services	Data handling, constructions
10	Other services	Recycling, disposal
11	Real estate	Dwelling, renting

Table 2: Results of the Probit regression *Pc* for 2000 with the different reference categories `No tariff´ and `Company tariff´.

2000	(1)		(2)		(3)	
Size	.2705***	.2705***	.3350***	.3350***	.2852***	.2852***
	(.0379)	(.0379)	(.0525)	(.0525)	(.0856)	(.0856)
Research	.5341***	.5341***	1.4385***	1.4385***	1.2668***	1.2668***
	(.0325)	(.0325)	(.0759)	(.0758)	(.0876)	(.0876)
Industry tariff	-.0036	.0926	-.0757	.3196**	.0741	.5877**
	(.0567)	(.1014)	(.0731)	(.1436)	(.1315)	(.2319)
Company tariff	-.0963		-.3953***		-.5136**	
	(.1016)		(.1438)		(.2378)	
No tariff		.0963		.3953***		.5136**
		(.1016)		(.1438)		(.2378)
Constant	-1.2213***	-1.3177***	-1.2642***	-1.6595***	-1.1420***	-1.6556***
	(.0705)	(.1121)	(.0926)	(.1578)	(.1774)	(.2670)
N	2627	2627	1932	1932	671	671
Corr. Predict	73.96%	73.96%	83.95%	83.95%	83.76%	83.76%
Likelihood	-1418.16	-1418.16	-811.47	-811.50	-270.84	-270.84
Pseudo-R^2	0.1287	0.1287	0.3562	0.3562	0.4154	0.4154

Explanatory variable is process innovation generated. (1) Unlimited, (2) limited regression excluding drastic innovations, (3) additionally excluding exporting companies. ***/**/* significant at 0.01/0.05/0.1 level. Standard error in parenthesis. Own calculations with data from MIP and IABB.

Table 3: Results of the Tobit regression *Fues* for 2000 with the different reference categories `No tariff´ and `Company tariff´.

2000	(4)		(5)	
Size	-.0068***	-.0068***	-.0120***	-.0120***
	(.0007)	(.0007)	(.0014)	(.0014)
Research	.0274***	.0274***	.0275***	.0275***
	(.0006)	(.0006)	(.0012)	(.0012)
Industry tariff	-.0019*	-.0009	-.0032	-.0017
	(.0010)	(.0017)	(.0023)	(.0036)
Company tariff	-.0010		-.0015	
	(.0018)		(.0037)	
No tariff		.0009		.0015
		(.0017)		(.0037)
Constant	.0103***	.0093***	.0215***	.0200***
	(.0012)	(.0019)	(.0030)	(.0042)
N	2517	2517	949	949
Likelihood	5526.66	5526.66	1731.53	1731.53
Pseudo-R^2	-0.1500	-0.1500	-0.1516	-0.1516
$\hat{\sigma}$	.0238	.0238	.0324	.0324

Explanatory variable is research intensity. (4) Unlimited, (5) excluding exporting companies. ***/**/* significant at 0.01/0.05/0.1 level. Standard error in parenthesis. Own calculations with data from MIP and IABB.