

Buchwald, Achim; Thorwarth, Susanne

**Working Paper**

## Outside directors on the board, competition and innovation

DICE Discussion Paper, No. 173

**Provided in Cooperation with:**

Düsseldorf Institute for Competition Economics (DICE), Heinrich Heine University Düsseldorf

*Suggested Citation:* Buchwald, Achim; Thorwarth, Susanne (2015) : Outside directors on the board, competition and innovation, DICE Discussion Paper, No. 173, ISBN 978-3-86304-172-4, Heinrich Heine University Düsseldorf, Düsseldorf Institute for Competition Economics (DICE), Düsseldorf

This Version is available at:

<https://hdl.handle.net/10419/107067>

**Standard-Nutzungsbedingungen:**

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

**Terms of use:**

*Documents in EconStor may be saved and copied for your personal and scholarly purposes.*

*You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.*

*If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.*

# DISCUSSION PAPER

No 173

## Outside Directors on the Board, Competition and Innovation

Achim Buchwald,  
Susanne Thorwarth

February 2015

## IMPRINT

### DICE DISCUSSION PAPER

Published by

düsseldorf university press (dup) on behalf of  
Heinrich-Heine-Universität Düsseldorf, Faculty of Economics,  
Düsseldorf Institute for Competition Economics (DICE), Universitätsstraße 1,  
40225 Düsseldorf, Germany  
[www.dice.hhu.de](http://www.dice.hhu.de)

### Editor:

Prof. Dr. Hans-Theo Normann  
Düsseldorf Institute for Competition Economics (DICE)  
Phone: +49(0) 211-81-15125, e-mail: [normann@dice.hhu.de](mailto:normann@dice.hhu.de)

### DICE DISCUSSION PAPER

All rights reserved. Düsseldorf, Germany, 2015

ISSN 2190-9938 (online) – ISBN 978-3-86304-172-4

The working papers published in the Series constitute work in progress circulated to stimulate discussion and critical comments. Views expressed represent exclusively the authors' own opinions and do not necessarily reflect those of the editor.

# Outside Directors on the Board, Competition and Innovation

Achim Buchwald<sup>a,b</sup> and Susanne Thorwarth<sup>b,c,d,e</sup>

*a) Monopolies Commission, Bonn, Germany*

*b) Düsseldorf Institute for Competition Economics, Düsseldorf, Germany*

*c) DICE Consult GmbH, Düsseldorf, Germany*

*d) Centre for European Economic Research (ZEW), Germany*

*e) KU Leuven, Dept. of Managerial Economics, Strategy and Innovation, Belgium*

February 2015

## Abstract

We investigate the influence of non-executive outside directors on firms' innovative performance for a sample of 1,393 listed firms in the EU-15 member states plus Norway and Switzerland in the period 2005 to 2010. Our results show that the fraction of non-executive outside directors on the board is associated with a significant decrease in the number of patent applications if competition in the market is low. This may indicate that restrictive monitoring and lower advising competences of outside directors mitigate executives' incentives to innovate. In industries with effective competition, the negative influence of outsiders is offset by the pressure to focus on innovation strategies.

**JEL-Classification:** G34, L14, L25, M21, O31

**Keywords:** Competition, Corporate Governance, Innovation, Patents, Board Composition, Outside Directors

## Contact Details:

*Achim Buchwald*

Monopolies Commission

Heilsbachstraße 16, 53123 Bonn, Germany

Phone: +49-228/338882-39, e-mail: [achim.buchwald@monopolkommission.bund.de](mailto:achim.buchwald@monopolkommission.bund.de)

*Susanne Thorwarth*

DICE Consult GmbH

Merowinger Platz 1, 40225 Düsseldorf, Germany

Phone: +49- 211/43635780, e-mail: [thorwarth@dice-consult.de](mailto:thorwarth@dice-consult.de)

## 1. Introduction

In this paper we investigate the influence of non-executive outside directors on the board on the innovative activities of European listed firms and the mediating role of competition in this process. Innovation has been identified as an essential determinant for growth and the competitive position of a firm in the market. An increasing number of recent studies have focused on factors influencing innovation strategies in publicly traded firms. In these typically manager-led firms, the separation of management and control goes along with a discretionary scope for decision-making which enables the management to pursue private objectives. Since investments in R&D projects are complex, and future outcomes are relatively uncertain and hardly to predict, managers may have incentives to focus on short-term financial performance at the cost of sustainable innovation strategies with a longer time horizon to avoid the risk of dismissal or to maximize short-term remuneration (Aghion et al., 2013; Manso, 2011).

Consequently, previous research has studied the role of certain corporate governance indicators in the innovation process, for instance regarding the ownership structure (Aghion et al., 2013; Czarnitzki and Kraft, 2009; Ughetto, 2010) or national institutional differences (Miozzo and Dewick, 2002; Munari et al., 2010). Another branch of research examines certain management characteristics and abilities (Barker III and Mueller, 2002; Galasso and Simcoe, 2011; Talke et al., 2010) whilst others address the influence of non-executive outside directors on innovation. While firm interlocks via multiple directorships have been widely explored in the finance and governance literature (e.g. Adams et al., 2010; Bebchuk et al., 2009), first empirical studies highlight their relevance in the context of innovation (e.g. Balsmeier et al., 2014). From a theoretical perspective one might argue that non-executive outsiders either enhance the monitoring and advising intensity of the board increasing executives' efforts to innovate or that outside directors reduce executives' incentives to innovate if they lack firm- or

technology-specific knowledge and experience. It is further argued that outside directors with multiple directorships may face time constraints that prevent them from sufficiently exercising their supervisory function in the appointing firm (Fich and Shivdasani, 2006).

In this study, we contribute to the existing literature in several ways. First, using comprehensive panel data, we were able to trace a complete network of interlocking directorates among all listed firms in 17 European countries for the period 2005 to 2011. In addition, this cross-country research design allows us to examine the relationship between outside directors and innovation activities from a broader perspective compared to a single country design. Second, the empirical results provide further insights to evaluate the outcomes of outside directors on the board for the appointing firms. While the effect of non-executive outside directors on the board on the number of patent applications as a proxy for innovation is insignificant for the total sample and in industries with fierce competition, we find a significant negative influence if competition in the market is low suggesting that competition compensates for the negative influence of outside directors in terms of innovation.

The rest of the paper is organized as follows. In section 2 we develop our hypotheses based on the literature. In section 3 we discuss the legal and institutional framework, describe the compilation of the sample and the chosen methodology. In section 4 we present the empirical results regarding the influence of outside directors on the board on innovation. Section 5 concludes and illustrates the relevance for subsequent research in the field of firm networks and innovation.

## **2. Theoretical Framework and Literature Review**

Traditionally, economists use agency theory to explain managerial behavior. As large modern companies are characterized by the separation of ownership and control, managers have certain discretionary to pursue personal interests that may deviate from

shareholders' interests (Jensen and Meckling, 1976; Williamson, 1964). This conflict of interest gains particular importance regarding long-term oriented innovation strategies with risky and unpredictable outcomes that require reasonable investments in R&D activities (Aghion and Tirole, 1994).

Investments in innovative long-term oriented projects might be reduced because of short-term maximization of profits that improve a manager's valuation by the board at the cost of lower returns to long-term projects (Hirshleifer, 1993). Further, due to the rather unpredictable outcomes of innovation projects, risk-averse managers may reduce spending on innovative projects to avoid the risk of failure (Manso, 2011). On the contrary, managers may have incentives for a higher rate of innovative activities, since director remuneration is often strongly related to firm size rather than to profitability (Czarnitzki and Kraft, 2009). As a consequence, the level and kind of innovative activities a modern company pursues will depend on the preferences and characteristics of the CEO (Barker III and Mueller, 2002 or Green, 1995).

Among other factors executives' incentives to innovate are likely to be influenced by the structure of the board, in particular by the representation of non-executive outside directors. Regarding the influence of these outsiders one might argue, on the one hand, that their participation might increase the monitoring and advising intensity in the boardroom. It is found that independent outside directors who hold additional mandates are more independent (Hermalin and Weisbach, 1998) and experienced (Ferris et al., 2003; Fich, 2005). In this case, outside directors are valuable to support the management in strategic decision-making as they diffuse scarce and specific information and knowledge (e.g. Coles et al., 2012; Faleye et al., 2011; Kor, 2003; Kor and Sundaramurthy, 2009). Further, outsiders can contribute to realize long-term oriented growth strategies in protecting the management from dismissal in the case of short-term income risks (Aghion et al., 2013; Manso, 2011).

A negative impact has to be assumed if non-executive outsiders on the board lack detailed knowledge on firm-specific processes or innovation-related tasks or for the case that outsiders face time restrictions (Core et al., 1999; Fich and Shivdasani, 2006). If outside directors are limited in evaluating whether the failure of an innovative project is random or due to wrong management decisions, the presence of outsiders should further mitigate executives' incentives to innovate (Aghion et al., 2013). Balsmeier et al. (2014) provide evidence that outside directors on the board who are not experienced with similar innovative activities at their home firms reduce the number of patents of the appointing firms.

Given that outside directors harm managers' incentives to innovative, the question arises about the moderating role of competition. One might argue that managers are particularly discouraged from investing in innovation by the monitoring directors if they serve on the board of firms in industries with relative low competition. On a highly competitive market, however, this negative relationship should be mitigated as the manager is disciplined by the pressure to focus on innovation (Aghion et al., 2013 or similar Giroud and Mueller, 2011).

### **3. Data and Methodology**

#### **3.1. Institutional and Legal Framework**

While previous studies usually monitor the relationship between corporate governance characteristics and innovation on the country level, the use of a transnational dataset enables us to account for institutional and legal differences between countries (e.g. Davis et al., 2012; Ferraro et al., 2012; Munari et al., 2010). This aspect is particularly relevant when boards of directors, with technical differences in their composition, role and characteristics on the country level are examined.

For instance, while in Anglo-Saxon countries boards are typically characterized by



a monistic structure, other countries, like Germany or the Netherlands, permit a formal separation of the management and supervisory board. Some other countries, for example Belgium or France, exhibit mixed board structures (Heidrick & Struggles, 2009). While executive directors are responsible for the management of operations, non-executive directors primarily advise the management in strategic decisions, monitor its actions, decide about management remuneration and appoint or recall executive directors. The specific structure of the board influences the coordination between executive and non-executive directors. It is probable that information asymmetries between executive and non-executive directors are more pronounced in two-tiered boards (Adams and Ferreira, 2007). At the same time, two-tiered boards tend to be characterized by a more independent position of non-executive directors. These differences may result in a higher demand for independent outside directors on one-tiered boards and stronger cooperation between executive and non-executive directors in firms with two-tiered board structures, respectively (Ringleb et al., 2010).

In addition, the importance of a transnational perspective is motivated by further converging processes in the European Union, for instance the emergence of a unified European patent system, the introduction of the European Company (“Societas Europea”, SE) or the publication of a corporate governance framework by the European Commission in the year 2011 (European Commission, 2001, 2011).

### **3.2. Data and Econometric Set-Up**

Our data was obtained from different sources which were linked together. The sample base of our analysis was provided by the Monopolies Commission (2014) and stems from the “Officers & Directors” database of Thomson Reuters which contains detailed information regarding executive and non-executive directors on the boards of stock-market listed firms. Our analysis focuses on the EU 15 member states as well as

Norway and Switzerland. In a next step the identified firms were merged to the Bureau van Dijk's ORBIS database via their ISIN number which served as the unique identifier. ORBIS provides detailed balance sheet, ownership and also patent data on European firms and businesses which enables us to supplement director information with performance indicators, sector codes and the number of patent applications on the firm-level. To eliminate relations within corporate groups, all majority-owned subsidiaries were removed from the sample. Furthermore, firms operating in the sector of financial intermediation were also dropped. Finally, director linkages between firms were calculated on a basis of 5.370 firms with 28.158 firm-year observations and 69.568 mandate holders for the time period from 2005 to 2011.

For our further analysis on the effects of outside directors on firms' innovation performance we only take those firms into account which showed at least one patent application at the European Patent Office (EPO) between 2000 and 2010. After elimination of data with missing values in the variables of interest our final sample consists of 1.393 firms in an unbalanced panel with 5.574 firm-year observations between 2005 and 2010. The corresponding summary statistics are displayed in Table I. The definitions of the variables and sources are described in Table A1 in the Appendix.

We use the number of a firm's patent applications (*PAT*) in a current year as a proxy for innovation performance. Our central explanatory variable of interest is the fraction of non-executive outside directors on the board (*SH\_OUT*). Additionally, we use a number of further firm-specific control variables, such as capital intensity (*CAPINT*), number of employees (*EMPL*), firm age (*AGE*), number of executive directors (*EXD*), number of non-executive directors (*NONEXD*), R&D expenditures (*RD*) and a dummy variable *BLOCK* which equals 1 if there is at least one shareholder who holds more than 25 percent of a firm's equity.

**(Table I: Summary Statistics)**

Based on the available information for around 730.000 firms in the entire ORBIS database for the countries of interest, we also calculated a competition measure (*CONC*), such as proposed by Aghion et al. (2005) which enables us to label industries as less or more competitive. That is, “high/low competition” is the subsample where the competition measure is above/below the sample median. Table I illustrates that the firms in the sample submit on average 19 patents per annum to the EPO. The mean difference t-test in Table II shows weak structural differences between firms in less competitive industries compared to firms in fiercely competitive markets with regard to patent applications. Further, the average fraction of outside directors on the board is about 30 percent in both subsamples.

***(Table II: Mean Comparison t-Test)***

Since the number of patent applications is restricted to non-negative integer values and also characterized by many zeros, we estimate count data models as the following:

$$E[PAT_{it+1}|Z_{it}, X_{it}, c_i] = \exp(\alpha Z_{it} + X_{it}'\beta + c_i)$$

where  $PAT_{it+1}$  denotes the future patent applications of firm  $i$ ,  $Z_{it}$  accounts for the share of non-executive outside directors on board of the respective firm and  $X_{it}$  represents the set of our additional control variables. Furthermore, year, country and industry dummies were included in the regression model. To control for unobserved heterogeneity, we introduce fixed effects into the model by using the pre-sample mean method proposed by Blundell et al. (1999). We estimate Poisson models as well as zero-inflated hurdle models as a robustness check. Since the presence of outside directors may be influenced by time-varying factors that cannot be observed, our regression model may suffer from an endogeneity bias. By using the yearly mean share of outside directors on the regional level (NUTS 3) and the number of firms in the region

accordingly as instruments we perform the control function approach (see e.g. Wooldridge, 2010). This procedure did not provide evidence of endogeneity in the regression model.

#### **4. Empirical Results**

In line with previous research our results presented in column (a) of Table III show that an increasing share of outside directors on the board has no significant effect on firms' patent activities (Balsmeier et al., 2014). When we split the sample in the group of firms in a low (column (b)) and high (column (c)) competitive environment, we find that a one percent increase in the fraction of outside directors leads to a reduction of firms' patent activity by 0.44 percent in a less competitive environment. For firms in the high competition subsample no significant effect is found.

#### ***(Table III: Regression Results)***

A limitation of the empirical findings might be that we neglected investments in research and development (R&D) which have been identified to be essential for a firm's innovative performance (Czarnitzki et al., 2009; Griliches, 1990; Pakes and Griliches, 1980). To address this concern, we repeated the estimations including information on R&D as an additional explanatory variable. Since a large number of European firms in the sample are exempted from the obligation to publish data on R&D, the sample is reduced to 3,648 firm-year-observations. The estimation results displayed in Table A1 in the Appendix remain qualitatively unchanged. If competition is low, the number of patent applications is reduced by 0.41 percent if the fraction of outside directors rises by one percent. With regard to R&D we find that a doubling on R&D investments significantly increases the patent activity by about a fifth in the full sample while the relationship is stronger in industries with higher competition intensity.

The empirical results remain robust when zero inflated hurdle models are applied as well as when the control function approach is implemented. Further, we tested the possibility of time constraints of outside directors but found no evidence that firms with and without a majority of busy outside directors differ in their monitoring activities.

## **5. Discussion**

The empirical findings suggest a critical appraisal of outside directorships with respect to innovation. Outside non-executive outside directors on the board have a negative and significant influence on the number of patent applications of the firms they monitor when competition in the market is low. The negative relation may be due to the fact that outside directors are associated with generally restrictive monitoring and lower advising competences. One might argue that outsiders on the board face a lack of firm-specific knowledge and experiences mitigating their capability to evaluate long-term oriented innovation strategies. This should in turn reduce executives' incentives to innovate.

However, if competition intensity is comparatively high, the market pressure obliges the management to innovate. Effective competition in an industry would thus offset managers' incentives for a restrictive innovation policy. Further, van Reenen (2011) argues and finds evidence that competition has a positive influence on management quality what might in turn mitigate the need for advising and monitoring by outsiders. Overall, the results indicate that competition compensates for the negative influence of outside directors in terms of innovation.

The empirical results also exhibit implications for competition policy. First, the results do not provide evidence that outside directorships are a mechanism for informal agreements or intensified collusion in terms of technology strategies given that firm networks via multiple directorships have a negative influence on the number of patent

applications, particularly if product market competition is low. Second, our results may reflect that sending firms try to exploit the target firm in order to reduce innovative activities of the latter in markets with low competition. To analyze this possible explanation in more detail, further research should consider different types of firm linkages in more detail. In particular, it is essential to further examine the direction of director firm linkages, e.g. to separate the specific effects for sending and receiving firms or to consider horizontal or vertical firm linkages along the supply chain and simultaneous minority shareholdings. Further, the inclusion of individual characteristics of multiple directors is a promising approach to increase the knowledge on the causes and effects of firm linkages via multiple directorships in the context of innovation.

## Tables and Figures

**Table I: Summary Statistics**

Variable	No. Obs.	Mean	Std. Dev.	Min	Max
PAT	5,574	19.05	99.76	0	2,047
SH_OUT	5,574	0.31	-	0	1
CAPINT	5,574	792.02	9,333.35	5	365,294
EMPL	5,574	14,565.33	47,029.93	10	592,964
AGE	5,574	46.72	51.16	1	491
EXD	5,574	6.71	4.60	0	28
NONEXD	5,574	6.36	3.85	1	31
BLOCK	5,574	0.31	-	0	1
PATMEAN	5,574	9.13	55.40	0	1,041
d(PATMEAN=0)	5,574	0.11	-	0	1
CONC	5,574	0.96	0.03	0.71	1.00
RD	3,648	128,447.60	531,522.70	0	6,651,224
d(RD=0)	3,648	0.06	-	0	1

**Table II: Mean Comparison t-Test**

Variable	Total	Low Competition	High	Mean Comparison t-Test
PAT	19.05	21.26	16.70	1.725*
SH_OUT	0.31	0.30	0.31	-1.102
CAPINT	792.02	863.20	716.31	0.596
EMPL	14,565.33	12,173.22	17,109.77	-3.895***
AGE	46.72	42.09	51.64	-6.957***
EXD	6.71	6.78	6.64	1.099
NONEXD	6.36	6.17	6.56	-3.762***
BLOCK	0.31	0.30	0.32	-1.859
PATMEAN	9.13	10.77	7.38	2.311**
d(PATMEAN=0)	0.11	0.11	0.11	-0.189
No. Observations	5,574	2,873	2,701	
RD	128,447.60	129,468.10	127,191.30	0.130
d(RD=0)	0.06	0.04	0.08	-4.162***
No. Observations	3,648	2,013	1,635	

Note: Significance levels: \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .



**Table III: Regression Results**

Variable	Total (a)	Low Competition (b)	High Competition (c)
SH_OUT	-0.213 (0.176)	-0.442*** (0.171)	0.119 (0.250)
log(CAPINT)	0.142** (0.064)	0.251*** (0.069)	0.105 (0.089)
log(EMPL)	0.172*** (0.037)	0.219*** (0.038)	0.132*** (0.043)
log(AGE)	0.031 (0.056)	0.009 (0.059)	0.028 (0.073)
EXD	-0.005 (0.009)	-0.009 (0.010)	0.000 (0.011)
NONEXD	-0.003 (0.012)	-0.003 (0.014)	0.012 (0.014)
BLOCK	0.022 (0.101)	0.025 (0.089)	-0.063 (0.131)
log(PATMEAN)	0.754*** (0.035)	0.735*** (0.041)	0.755*** (0.039)
d(PATMEAN=0)	-1.610*** (0.169)	-1.430*** (0.227)	-1.762*** (0.179)
Constant	-1.020 (0.755)	-1.509* (0.799)	-1.476* (0.818)
Joint significance of industry dummies $\chi^2(16)$	50.27***	108.17***	53.65***
Joint significance of country dummies $\chi^2(16)$	62.93***	76.62***	80.87***
Joint significance of year dummies $\chi^2(4)$	13.03**	6.39	9.39**
No. Observations	5,574	2,873	2,701
Pseudo Log-likelihood	-24,414.62	-11,928.79	-11,229.66

Note: Poisson estimations with pre-sample mean, dependent variable  $PAT_{t+1}$ , clustered standard errors in brackets.

Significance levels: \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

## References

- Adams, R.B., Hermalin, B.E., Weisbach, M.S., 2010. The Role of Boards of Directors in Corporate Governance: A Conceptual Framework & Survey. *Journal of Economic Literature* 48 (1), 58–107.
- Adams, R.B., Ferreira, D., 2007. A Theory of Friendly Boards. *Journal of Finance* 62 (1), 217–250.
- Aghion, P., van Reenen, J.M., Zingales, L., 2013. Innovation and Institutional Ownership. *American Economic Review* 103 (1), 277–304.
- Aghion, P., Tirole, J., 1994. The Management of Innovation. *Quarterly Journal of Economics* 109, 1185–1209.
- Aghion, P., Bloom, N., Blundell, R., Griffith, R., Howitt, P., 2005. Competition and Innovation: an Inverted-U Relationship. *The Quarterly Journal of Economics* 120 (2), 701–728.
- Balsmeier, B., Buchwald, A., Stiebale, J., 2014. Outside Directors on the Board and Innovative Firm Performance. *Research Policy* 43 (10), 1800–1815.
- Barker III, V.L., Mueller, G.C., 2002. CEO Characteristics and Firm R&D Spending. *Management Science* 48 (6), 782–801.
- Bebchuk, L.A., Cohen, A., Ferrell, A., 2009. What Matters in Corporate Governance? *Review of Financial Studies* 22 (2), 783–827.
- Blundell, R., Griffith, R., van Reenen, J., 1999. Market Share, Market Value and Innovation in a Panel of British Manufacturing Firms. *Review of Economic Studies* 66 (3), 529–54.
- Coles, J.L., Daniel, N.D., Naveen, L., 2012. Board Advising. SSRN Working Paper [http://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=2002250](http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2002250).
- Core, J.E., Holthausen, R.W., Larcker, D.F., 1999. Corporate Governance, Chief Executive Officer Compensation, and Firm Performance. *Journal of Financial Economics* 51 (3), 371–406.
- Czarnitzki, D., Kraft, K., Thorwarth, S., 2009. The Knowledge Production of ‘R’ and ‘D’. *Economics Letters* 105 (1), 141–143.
- Czarnitzki, D., Kraft, K., 2009. Capital Control, Debt Financing and Innovative Activity. *Journal of Economic Behavior & Organization* 71 (2), 372–383.
- Davis, G.F., Gordon Walker, G., Kogut, B.M., 2012. Governance Networks, Small Worlds, and Acquisitions in Germany and the United States, 2000–2005, in: Kogut, B.M. (Ed), *The Small Worlds of Corporate Governance*. MIT Press, Cambridge, Mass, pp. 203–235.
- European Commission, 2001. Council Regulation on the Statute for a European Company (SE) Council Regulation (EC) No 2157/2001.

- European Commission, 2011. Green Paper: The EU Corporate Governance Framework. COM(2011) 164 final.
- Faleye, O., Hoitash, R., Hoitash, U., 2011. The Costs of Intense Board Monitoring. *Journal of Financial Economics* 101 (1), 160–181.
- Ferraro, F., Corrado, R., Schnyder, G., Heemskerk, E.M., Del Vecchio, N., 2012. Structural Breaks and Governance Networks in Western Europe, in: Kogut, B.M. (Ed), *The Small Worlds of Corporate Governance*. MIT Press, Cambridge, Mass, pp. 151–182.
- Ferris, S.P., Jagannathan, M., Pritchard, A.C., 2003. Too Busy to Mind the Business? Monitoring by Directors with Multiple Board Appointments. *Journal of Finance* 58 (3), 1087–1112.
- Fich, E.M., 2005. Are Some Outside Directors Better than Others? Evidence from Director Appointments by Fortune 1000 Firms. *Journal of Business* 78 (5), 1943–1971.
- Fich, E.M., Shivdasani, A., 2006. Are Busy Boards Effective Monitors? *Journal of Finance* 61 (2), 689–724.
- Galasso, A., Simcoe, T.S., 2011. CEO Overconfidence and Innovation. *Management Science* 57 (8), 1469–1484.
- Giroud, X., Mueller, H.M., 2011. Corporate Governance, Product Market Competition, and Equity Prices. *Journal of Finance* 66 (2), 563–600.
- Green, S.G., 1995. Top Management Support of R&D Projects: A Strategic Leadership Perspective. *IEEE Transactions on Engineering Management* 42 (3), 223–232.
- Griliches, Z., 1990. Patent Statistics as Economic Indicators: a Survey. *Journal of Economic Literature* 28 (4), 1661–1707.
- Heidrick & Struggles, 2009. Corporate Governance Report 2009: Boards in Turbulent Times (downloaded on 24 June 2010 from <http://www.heidrick.com/NR/rdonlyres/A03A8F3A-A676-43FC-BBBA-06105F43B034/0/CorporateGovernance2009Europe.pdf>).
- Hermalin, B.E., Weisbach, M.S., 1998. Endogenously Chosen Boards of Directors and Their Monitoring of the CEO. *American Economic Review* 88 (1), 96–118.
- Hirshleifer, D., 1993. Managerial Reputation and Corporate Investment Decisions. *Financial Management* 22 (2), 145–160.
- Jensen, M.C., Meckling, W.H., 1976. Theory of the Firm: Managerial Behavior, Agency Costs and Ownership Structure. *Journal of Financial Economics* 3 (4), 305–360.
- Kor, Y.Y., 2003. Experience-Based Top Management Team Competence and Sustained Growth. *Organization Science* 14 (6), 707–719.
- Kor, Y.Y., Sundaramurthy, C., 2009. Experience-Based Human Capital and Social Capital of Outside Directors. *Journal of Management* 35 (4), 981–1006.
- Manso, G., 2011. Motivating Innovation. *Journal of Finance* 66 (5), 1823–1860.

- Miozzo, M., Dewick, P., 2002. Building Competitive Advantage: Innovation and Corporate Governance in European Construction. *Research Policy* 31 (6), 989–1008.
- Monopolies Commission, 2014. Eine Wettbewerbsordnung für die Finanzmärkte: Hauptgutachten 2012/2013.
- Munari, F., Oriani, R., Sobrero, M., 2010. The Effects of Owner Identity and External Governance Systems on R&D Investments: A Study of Western European Firms. *Research Policy* 39 (8), 1093–1104.
- Pakes, A., Griliches, Z., 1980. Patents and R&D at the Firm Level: A First Report. *Economics Letters* 5 (4), 377–381.
- Ringleb, H.-M., Kremer, T., Lutter, M., Werder, A. von, 2010. Kommentar zum Deutschen Corporate Governance Kodex: Kodex-Kommentar (4<sup>th</sup> Ed.). Beck, München.
- Talke, K., Salomo, S., Rost, K., 2010. How Top Management Team Diversity Affects Innovativeness and Performance via the Strategic Choice to Focus on Innovation Fields. *Research Policy* 39 (7), 907–918.
- Ughetto, E., 2010. Assessing the Contribution to Innovation of Private Equity Investors: A Study on European Buyouts. *Research Policy* 39 (1), 126–140.
- van Reenen, J.M., 2011. Does Competition Raise Productivity Through Improving Management Quality? *International Journal of Industrial Organization* 29 (3), 306–316.
- Williamson, O.E., 1964. *The Economics of Discretionary Behavior: Managerial Objectives in a Theory of the Firm*. Prentice Hall, Upper Saddle River, New Jersey.
- Wooldridge, J.M., 2010. *Econometric Analysis of Cross Section and Panel Data* (2nd ed.). MIT Press, Cambridge, Mass.

## Appendix

**Table A1: Definition of Variables**

Variable	Definition	Source
PAT	Number of patent applications	Bureau van Dijk
SH_OUT	Fraction of outside (non-executive) directors on the board	Thomson Reuters
CAPINT	Capital intensity =Total Assets/Employees	Bureau van Dijk
EMPL	Number of Employees	
AGE	Firm age in years	
EXD	Number of executive directors on the board	
NONEXD	Number of non-executive directors on the board	
BLOCK	Dummy variable =1 if at least on shareholder owns 25 percent or a higher share of a firm's equity	
PATMEAN	Average number of patent applications in the pre-sample period 1978 to 2004	
d(PATMEAN=0)	Dummy indicating zero pre-sample (1978 to 2004) patent applications	
CONC	Competition measure on the industry-level, following (Aghion et al., 2005)	
RD	Expenditures on research & development (R&D), thousand EUR	
d(RD=0)	Dummy indicating zero R&D expenditures	

**Table A2: Regression Results (Poisson Estimation with Pre-Sample Mean)**

Variable	Total (a)	Low Competition (b)	High Competition (c)
SH_OUT	-0.178 (0.168)	-0.406** (0.167)	0.163 (0.246)
log(CAPINT)	0.032 (0.068)	0.157** (0.065)	-0.015 (0.086)
log(EMPL)	0.058 (0.048)	0.107** (0.052)	-0.003 (0.056)
log(AGE)	0.052 (0.059)	0.03 (0.064)	0.053 (0.072)
EXD	-0.010 (0.009)	-0.010 (0.010)	-0.008 (0.010)
NONEXD	-0.007 (0.011)	-0.003 (0.014)	0.006 (0.014)
BLOCK	-0.002 (0.099)	0.000 (0.092)	-0.083 (0.132)
log(PATMEAN)	0.647*** (0.042)	0.630*** (0.042)	0.632*** (0.048)
d(PATMEAN=0)	-1.370*** (0.230)	-1.088*** (0.292)	-1.626*** (0.253)
log(RD)	0.214*** (0.045)	0.211*** (0.047)	0.252*** (0.055)
d(RD=0)	2.114*** (0.481)	2.004*** (0.504)	2.493*** (0.636)
Constant	-1.246 (0.774)	-1.945** (0.789)	-1.894** (0.790)
Joint significance of industry dummies $\chi^2(16)$	354.99***	406.20***	166.22***
Joint significance of country dummies $\chi^2(16)$	53.19***	63.75***	130.91***
Joint significance of year dummies $\chi^2(4)$	15.82***	7.45**	9.74**
No. Observations	3,648	2,013	1,635
Pseudo Log-likelihood	-20,679.07	-10,277.67	-9,141.97

Note: dependent variable  $PAT_{i+j}$ , clustered standard errors in brackets. Significance levels: \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ ; since R&D expenditures are not available for all firms, regressions are performed for a sub-sample of 3,648 firm-year observations.

## PREVIOUS DISCUSSION PAPERS

- 173 Buchwald, Achim and Thorwarth, Susanne, Outside Directors on the Board, Competition and Innovation, February 2015.
- 172 Dewenter, Ralf and Giessing, Leonie, The Effects of Elite Sports Participation on Later Job Success, February 2015.
- 171 Haucap, Justus, Heimeshoff, Ulrich and Siekmann, Manuel, Price Dispersion and Station Heterogeneity on German Retail Gasoline Markets, January 2015.
- 170 Schweinberger, Albert G. and Suedekum, Jens, De-Industrialisation and Entrepreneurship under Monopolistic Competition, January 2015.
- 169 Nowak, Verena, Organizational Decisions in Multistage Production Processes, December 2014.
- 168 Benndorf, Volker, Kübler, Dorothea and Normann, Hans-Theo, Privacy Concerns, Voluntary Disclosure of Information, and Unraveling: An Experiment, November 2014. Forthcoming in: European Economic Review.
- 167 Rasch, Alexander and Wenzel, Tobias, The Impact of Piracy on Prominent and Non-prominent Software Developers, November 2014. Forthcoming in: Telecommunications Policy.
- 166 Jeitschko, Thomas D. and Tremblay, Mark J., Homogeneous Platform Competition with Endogenous Homing, November 2014.
- 165 Gu, Yiquan, Rasch, Alexander and Wenzel, Tobias, Price-sensitive Demand and Market Entry, November 2014. Forthcoming in: Papers in Regional Science.
- 164 Caprice, Stéphane, von Schlippenbach, Vanessa and Wey, Christian, Supplier Fixed Costs and Retail Market Monopolization, October 2014.
- 163 Klein, Gordon J. and Wendel, Julia, The Impact of Local Loop and Retail Unbundling Revisited, October 2014.
- 162 Dertwinkel-Kalt, Markus, Haucap, Justus and Wey, Christian, Raising Rivals' Costs Through Buyer Power, October 2014. Published in: Economics Letters, 126 (2015), pp.181-184.
- 161 Dertwinkel-Kalt, Markus and Köhler, Katrin, Exchange Asymmetries for Bads? Experimental Evidence, October 2014.
- 160 Behrens, Kristian, Mion, Giordano, Murata, Yasusada and Suedekum, Jens, Spatial Frictions, September 2014.
- 159 Fonseca, Miguel A. and Normann, Hans-Theo, Endogenous Cartel Formation: Experimental Evidence, August 2014. Published in: Economics Letters, 125 (2014), pp. 223-225.
- 158 Stiebale, Joel, Cross-Border M&As and Innovative Activity of Acquiring and Target Firms, August 2014.
- 157 Haucap, Justus and Heimeshoff, Ulrich, The Happiness of Economists: Estimating the Causal Effect of Studying Economics on Subjective Well-Being, August 2014. Published in: International Review of Economics Education, 17 (2014), pp. 85-97.

- 156 Haucap, Justus, Heimeshoff, Ulrich and Lange, Mirjam R. J., The Impact of Tariff Diversity on Broadband Diffusion – An Empirical Analysis, August 2014.
- 155 Baumann, Florian and Friehe, Tim, On Discovery, Restricting Lawyers, and the Settlement Rate, August 2014.
- 154 Hottenrott, Hanna and Lopes-Bento, Cindy, R&D Partnerships and Innovation Performance: Can There be too Much of a Good Thing?, July 2014.
- 153 Hottenrott, Hanna and Lawson, Cornelia, Flying the Nest: How the Home Department Shapes Researchers' Career Paths, July 2014.
- 152 Hottenrott, Hanna, Lopes-Bento, Cindy and Veugelers, Reinhilde, Direct and Cross-Scheme Effects in a Research and Development Subsidy Program, July 2014.
- 151 Dewenter, Ralf and Heimeshoff, Ulrich, Do Expert Reviews Really Drive Demand? Evidence from a German Car Magazine, July 2014.  
Forthcoming in: Applied Economics Letters.
- 150 Bataille, Marc, Steinmetz, Alexander and Thorwarth, Susanne, Screening Instruments for Monitoring Market Power in Wholesale Electricity Markets – Lessons from Applications in Germany, July 2014.
- 149 Kholodilin, Konstantin A., Thomas, Tobias and Ulbricht, Dirk, Do Media Data Help to Predict German Industrial Production?, July 2014.
- 148 Hogrefe, Jan and Wrona, Jens, Trade, Tasks, and Trading: The Effect of Offshoring on Individual Skill Upgrading, June 2014.  
Forthcoming in: Canadian Journal of Economics.
- 147 Gaudin, Germain and White, Alexander, On the Antitrust Economics of the Electronic Books Industry, September 2014 (Previous Version May 2014).
- 146 Alipranti, Maria, Milliou, Chrysovalantou and Petrakis, Emmanuel, Price vs. Quantity Competition in a Vertically Related Market, May 2014.  
Published in: Economics Letters, 124 (2014), pp. 122-126.
- 145 Blanco, Mariana, Engelmann, Dirk, Koch, Alexander K. and Normann, Hans-Theo, Preferences and Beliefs in a Sequential Social Dilemma: A Within-Subjects Analysis, May 2014.  
Published in: Games and Economic Behavior, 87 (2014), pp. 122-135.
- 144 Jeitschko, Thomas D., Jung, Yeonjei and Kim, Jaesoo, Bundling and Joint Marketing by Rival Firms, May 2014.
- 143 Benndorf, Volker and Normann, Hans-Theo, The Willingness to Sell Personal Data, April 2014.
- 142 Dauth, Wolfgang and Suedekum, Jens, Globalization and Local Profiles of Economic Growth and Industrial Change, April 2014.
- 141 Nowak, Verena, Schwarz, Christian and Suedekum, Jens, Asymmetric Spiders: Supplier Heterogeneity and the Organization of Firms, April 2014.
- 140 Hasnas, Irina, A Note on Consumer Flexibility, Data Quality and Collusion, April 2014.
- 139 Baye, Irina and Hasnas, Irina, Consumer Flexibility, Data Quality and Location Choice, April 2014.



- 138 Aghadadashli, Hamid and Wey, Christian, Multi-Union Bargaining: Tariff Plurality and Tariff Competition, April 2014.
- 137 Duso, Tomaso, Herr, Annika and Suppliet, Moritz, The Welfare Impact of Parallel Imports: A Structural Approach Applied to the German Market for Oral Anti-diabetics, April 2014.  
Published in: Health Economics, 23 (2014), pp. 1036-1057.
- 136 Haucap, Justus and Müller, Andrea, Why are Economists so Different? Nature, Nurture and Gender Effects in a Simple Trust Game, March 2014.
- 135 Normann, Hans-Theo and Rau, Holger A., Simultaneous and Sequential Contributions to Step-Level Public Goods: One vs. Two Provision Levels, March 2014.  
Forthcoming in: Journal of Conflict Resolution.
- 134 Bucher, Monika, Hauck, Achim and Neyer, Ulrike, Frictions in the Interbank Market and Uncertain Liquidity Needs: Implications for Monetary Policy Implementation, July 2014 (First Version March 2014).
- 133 Czarnitzki, Dirk, Hall, Bronwyn, H. and Hottenrott, Hanna, Patents as Quality Signals? The Implications for Financing Constraints on R&D?, February 2014.
- 132 Dewenter, Ralf and Heimeshoff, Ulrich, Media Bias and Advertising: Evidence from a German Car Magazine, February 2014.  
Published in: Review of Economics, 65 (2014), pp. 77-94.
- 131 Baye, Irina and Sapi, Geza, Targeted Pricing, Consumer Myopia and Investment in Customer-Tracking Technology, February 2014.
- 130 Clemens, Georg and Rau, Holger A., Do Leniency Policies Facilitate Collusion? Experimental Evidence, January 2014.
- 129 Hottenrott, Hanna and Lawson, Cornelia, Fishing for Complementarities: Competitive Research Funding and Research Productivity, December 2013.
- 128 Hottenrott, Hanna and Rexhäuser, Sascha, Policy-Induced Environmental Technology and Inventive Efforts: Is There a Crowding Out?, December 2013.
- 127 Dauth, Wolfgang, Findeisen, Sebastian and Suedekum, Jens, The Rise of the East and the Far East: German Labor Markets and Trade Integration, December 2013.  
Published in: Journal of the European Economic Association, 12 (2014), pp. 1643-1675.
- 126 Wenzel, Tobias, Consumer Myopia, Competition and the Incentives to Unshroud Add-on Information, December 2013.  
Published in: Journal of Economic Behavior and Organization, 98 (2014), pp. 89-96.
- 125 Schwarz, Christian and Suedekum, Jens, Global Sourcing of Complex Production Processes, December 2013.  
Published in: Journal of International Economics, 93 (2014), pp. 123-139.
- 124 Defever, Fabrice and Suedekum, Jens, Financial Liberalization and the Relationship-Specificity of Exports, December 2013.  
Published in: Economics Letters, 122 (2014), pp. 375-379.
- 123 Bauernschuster, Stefan, Falck, Oliver, Heblich, Stephan and Suedekum, Jens, Why Are Educated and Risk-Loving Persons More Mobile Across Regions?, December 2013.  
Published in: Journal of Economic Behavior and Organization, 98 (2014), pp. 56-69.

- 122 Hottenrott, Hanna and Lopes-Bento, Cindy, Quantity or Quality? Knowledge Alliances and their Effects on Patenting, December 2013.  
Forthcoming in: Industrial and Corporate Change.
- 121 Hottenrott, Hanna and Lopes-Bento, Cindy, (International) R&D Collaboration and SMEs: The Effectiveness of Targeted Public R&D Support Schemes, December 2013.  
Published in: Research Policy, 43 (2014), pp.1055-1066.
- 120 Giesen, Kristian and Suedekum, Jens, City Age and City Size, November 2013.  
Published in: European Economic Review, 71 (2014), pp. 193-208.
- 119 Trax, Michaela, Brunow, Stephan and Suedekum, Jens, Cultural Diversity and Plant-Level Productivity, November 2013.
- 118 Manasakis, Constantine and Vlassis, Minas, Downstream Mode of Competition with Upstream Market Power, November 2013.  
Published in: Research in Economics, 68 (2014), pp. 84-93.
- 117 Sapi, Geza and Suleymanova, Irina, Consumer Flexibility, Data Quality and Targeted Pricing, November 2013.
- 116 Hinloopen, Jeroen, Müller, Wieland and Normann, Hans-Theo, Output Commitment Through Product Bundling: Experimental Evidence, November 2013.  
Published in: European Economic Review, 65 (2014), pp. 164-180.
- 115 Baumann, Florian, Denter, Philipp and Friehe Tim, Hide or Show? Endogenous Observability of Private Precautions Against Crime When Property Value is Private Information, November 2013.
- 114 Fan, Ying, Kühn, Kai-Uwe and Lafontaine, Francine, Financial Constraints and Moral Hazard: The Case of Franchising, November 2013.
- 113 Aguzzoni, Luca, Argentesi, Elena, Buccirossi, Paolo, Ciari, Lorenzo, Duso, Tomaso, Tognoni, Massimo and Vitale, Cristiana, They Played the Merger Game: A Retrospective Analysis in the UK Videogames Market, October 2013.  
Published in: Journal of Competition Law and Economics under the title: "A Retrospective Merger Analysis in the UK Videogame Market", (10) (2014), pp. 933-958.
- 112 Myrseth, Kristian Ove R., Riener, Gerhard and Wollbrant, Conny, Tangible Temptation in the Social Dilemma: Cash, Cooperation, and Self-Control, October 2013.
- 111 Hasnas, Irina, Lambertini, Luca and Palestini, Arsen, Open Innovation in a Dynamic Cournot Duopoly, October 2013.  
Published in: Economic Modelling, 36 (2014), pp. 79-87.
- 110 Baumann, Florian and Friehe, Tim, Competitive Pressure and Corporate Crime, September 2013.
- 109 Böckers, Veit, Haucap, Justus and Heimeshoff, Ulrich, Benefits of an Integrated European Electricity Market, September 2013.
- 108 Normann, Hans-Theo and Tan, Elaine S., Effects of Different Cartel Policies: Evidence from the German Power-Cable Industry, September 2013.  
Published in: Industrial and Corporate Change, 23 (2014), pp. 1037-1057.
- 107 Haucap, Justus, Heimeshoff, Ulrich, Klein, Gordon J., Rickert, Dennis and Wey, Christian, Bargaining Power in Manufacturer-Retailer Relationships, September 2013.

- 106 Baumann, Florian and Friehe, Tim, Design Standards and Technology Adoption: Welfare Effects of Increasing Environmental Fines when the Number of Firms is Endogenous, September 2013.
- 105 Jeitschko, Thomas D., NYSE Changing Hands: Antitrust and Attempted Acquisitions of an Erstwhile Monopoly, August 2013.  
Published in: Journal of Stock and Forex Trading, 2 (2) (2013), pp. 1-6.
- 104 Böckers, Veit, Giessing, Leonie and Rösch, Jürgen, The Green Game Changer: An Empirical Assessment of the Effects of Wind and Solar Power on the Merit Order, August 2013.
- 103 Haucap, Justus and Muck, Johannes, What Drives the Relevance and Reputation of Economics Journals? An Update from a Survey among Economists, August 2013.
- 102 Jovanovic, Dragan and Wey, Christian, Passive Partial Ownership, Sneaky Takeovers, and Merger Control, August 2013.  
Published in: Economics Letters, 125 (2014), pp. 32-35.
- 101 Haucap, Justus, Heimeshoff, Ulrich, Klein, Gordon J., Rickert, Dennis and Wey, Christian, Inter-Format Competition Among Retailers – The Role of Private Label Products in Market Delineation, August 2013.
- 100 Normann, Hans-Theo, Requate, Till and Waichman, Israel, Do Short-Term Laboratory Experiments Provide Valid Descriptions of Long-Term Economic Interactions? A Study of Cournot Markets, July 2013.  
Published in: Experimental Economics, 17 (2014), pp. 371-390.
- 99 Dertwinkel-Kalt, Markus, Haucap, Justus and Wey, Christian, Input Price Discrimination (Bans), Entry and Welfare, June 2013.
- 98 Aguzzoni, Luca, Argentesi, Elena, Ciari, Lorenzo, Duso, Tomaso and Tognoni, Massimo, Ex-post Merger Evaluation in the UK Retail Market for Books, June 2013.  
Forthcoming in: Journal of Industrial Economics.
- 97 Caprice, Stéphane and von Schlippenbach, Vanessa, One-Stop Shopping as a Cause of Slotting Fees: A Rent-Shifting Mechanism, May 2012.  
Published in: Journal of Economics and Management Strategy, 22 (2013), pp. 468-487.
- 96 Wenzel, Tobias, Independent Service Operators in ATM Markets, June 2013.  
Published in: Scottish Journal of Political Economy, 61 (2014), pp. 26-47.
- 95 Coublucq, Daniel, Econometric Analysis of Productivity with Measurement Error: Empirical Application to the US Railroad Industry, June 2013.
- 94 Coublucq, Daniel, Demand Estimation with Selection Bias: A Dynamic Game Approach with an Application to the US Railroad Industry, June 2013.
- 93 Baumann, Florian and Friehe, Tim, Status Concerns as a Motive for Crime?, April 2013.
- 92 Jeitschko, Thomas D. and Zhang, Nanyun, Adverse Effects of Patent Pooling on Product Development and Commercialization, April 2013.  
Published in: The B. E. Journal of Theoretical Economics, 14 (1) (2014), Art. No. 2013-0038.
- 91 Baumann, Florian and Friehe, Tim, Private Protection Against Crime when Property Value is Private Information, April 2013.  
Published in: International Review of Law and Economics, 35 (2013), pp. 73-79.

- 90 Baumann, Florian and Friehe, Tim, Cheap Talk About the Detection Probability, April 2013.  
Published in: International Game Theory Review, 15 (2013), Art. No. 1350003.
- 89 Pagel, Beatrice and Wey, Christian, How to Counter Union Power? Equilibrium Mergers in International Oligopoly, April 2013.
- 88 Jovanovic, Dragan, Mergers, Managerial Incentives, and Efficiencies, April 2014 (First Version April 2013).
- 87 Heimeshoff, Ulrich and Klein Gordon J., Bargaining Power and Local Heroes, March 2013.
- 86 Bertschek, Irene, Cerquera, Daniel and Klein, Gordon J., More Bits – More Bucks? Measuring the Impact of Broadband Internet on Firm Performance, February 2013.  
Published in: Information Economics and Policy, 25 (2013), pp. 190-203.
- 85 Rasch, Alexander and Wenzel, Tobias, Piracy in a Two-Sided Software Market, February 2013.  
Published in: Journal of Economic Behavior & Organization, 88 (2013), pp. 78-89.
- 84 Bataille, Marc and Steinmetz, Alexander, Intermodal Competition on Some Routes in Transportation Networks: The Case of Inter Urban Buses and Railways, January 2013.
- 83 Haucap, Justus and Heimeshoff, Ulrich, Google, Facebook, Amazon, eBay: Is the Internet Driving Competition or Market Monopolization?, January 2013.  
Published in: International Economics and Economic Policy, 11 (2014), pp. 49-61.

Older discussion papers can be found online at:  
<http://ideas.repec.org/s/zbw/dicedp.html>

**Heinrich-Heine-University of Düsseldorf**

**Düsseldorf Institute for  
Competition Economics (DICE)**

Universitätsstraße 1 \_ 40225 Düsseldorf  
[www.dice.hhu.de](http://www.dice.hhu.de)