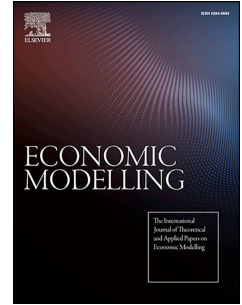


Journal Pre-proof

Does board diversity in industry-experience boost firm value? The role of corporate innovation

Peng Huang, Yue Lu, Ji Wu



PII: S0264-9993(23)00316-4

DOI: <https://doi.org/10.1016/j.econmod.2023.106504>

Reference: ECMODE 106504

To appear in: *Economic Modelling*

Received Date: 5 May 2022

Revised Date: 27 August 2023

Accepted Date: 27 August 2023

Please cite this article as: Huang, P., Lu, Y., Wu, J., Does board diversity in industry-experience boost firm value? The role of corporate innovation, *Economic Modelling* (2023), doi: <https://doi.org/10.1016/j.econmod.2023.106504>.

This is a PDF file of an article that has undergone enhancements after acceptance, such as the addition of a cover page and metadata, and formatting for readability, but it is not yet the definitive version of record. This version will undergo additional copyediting, typesetting and review before it is published in its final form, but we are providing this version to give early visibility of the article. Please note that, during the production process, errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

© 2023 Published by Elsevier B.V.

Does Board Diversity in Industry-experience Boost Firm Value?

The Role of Corporate Innovation [◇]

Peng Huang, Yue Lu, and Ji Wu^{*}

Abstract

Previous studies examining board diversity disproportionately focus on directors' demographic features. In this paper, we construct a sophisticated measure of board diversity based on directors' industry-experience diversity (BIED) and examine its effect on firm value. Using a sample of S&P1500 firms, we find that higher BIED leads to higher firm value. This result survives both firm fixed effects and an instrumental variable approach, at least partially suggesting a causal relationship. We argue that a more diverse board brings more perspectives, viewpoints, knowledge and information to the firm, enhances directors' capability of advising, and thus creates higher firm value. We further find one possible underlying economic mechanism through which BIED facilitates value creation. That is, BIED creates value by promoting corporate innovation. Overall, BIED constitutes a valuable corporate governance mechanism.

Keywords: Corporate Boards of Directors; Industry-experience Diversity; Firm Value; Corporate Innovation

[◇] This paper is based on Yue Lu's PhD thesis from The University of New South Wales (UNSW Sydney). She would like to acknowledge the supervision of Dr. Lixiong Guo and constructive feedback from Prof. Fei Xie (University of Delaware) and A/Prof. Ye Cai (Santa Clara University). The authors would like to thank the editor Prof. Sushanta K. Mallick and two anonymous reviewers for their very helpful comments. In particular, Prof. Mallick provided very constructive and detailed comments in the five rounds of revisions, which have helped us significantly improve the quality of the paper. All remaining errors are our own.

^{*} Peng Huang is from the School of Accounting, Finance and Economics at The University of Waikato, New Zealand. Yue Lu is from the School of Economics, Finance and Marketing at the RMIT University, Australia. Ji Wu is from Massey University Business School, New Zealand. Corresponding author (Yue Lu): susanna.lu@rmit.edu.au.

Does Board Diversity in Industry-experience Boost Firm Value? The Role of Corporate Innovation

Abstract

Previous studies examining board diversity disproportionately focus on directors' demographic features. In this paper, we construct a sophisticated measure of board diversity based on directors' industry-experience diversity (BIED) and examine its effect on firm value. Using a sample of S&P1500 firms, we find that higher BIED leads to higher firm value. This result survives both firm fixed effects and an instrumental variable approach, at least partially suggesting a causal relationship. We argue that a more diverse board brings more perspectives, viewpoints, knowledge and information to the firm, enhances directors' capability of advising, and thus creates higher firm value. We further find one possible underlying economic mechanism through which BIED facilitates value creation. That is, BIED creates value by promoting corporate innovation. Overall, BIED constitutes a valuable corporate governance mechanism.

Keywords: Corporate Boards of Directors; Industry-experience Diversity; Firm Value; Corporate Innovation

1 Introduction

Diversity of boards of directors has obtained substantial attention from the regulators, investors, and the media. By far, a few European countries either have already adopted gender quotas on boards of directors or are considering similar legislation (Smith, 2014). In the U.S., regulators¹ and institutional investors² have long been calling for more diversity on boards. The traditional definition of board diversity disproportionately focuses on demographic features such as gender and ethnicity³, and the existing literature only provides mixed evidence on the impact of board diversity on corporate performance (see Adams et al. (2015) for a review). Inspired by a newly emerged concept centered on experiential or cognitive differences (Geletkanycz et al., 2018)⁴ and the call of Adams et al. (2015) for research on “different forms of board diversity”, we focus on a specific aspect of board diversity, that is, the board industry-experience diversity (hereafter, BIED), and examine its effect on firm value.

Board diversity is associated with both benefits and costs (Anderson et al., 2011; Erhardt et al., 2003; Giannetti and Zhao, 2019). On the one hand, firms could potentially benefit from a more diverse board. Diversity on corporate boards can bring unique perspectives, which helps develop new products and strategies, making the business

¹ For example, on 16 Dec 2009, the U.S. Securities and Exchange Commission (SEC) approved new rules related to enhanced disclosure about corporate governance, risk and compensation. One of the rules specifically requires disclosures in proxy and financial statements about “the consideration of diversity in the process by which candidates for director are considered for nomination”.

² For example, CalPERS (California Public Employees’ Retirement System), the largest public pension fund in the U.S., requires that “The board should facilitate a process that ensures a thorough understanding of the diverse characteristics necessary to effectively oversee management’s execution of a long-term business strategy. Board diversity should be thought of in terms of skill sets, gender, age, nationality, race, and historically under-represented groups”. See <http://www.calpers-governance.org/>.

³ See, for example, Adams and Ferreria (2009); Ahern and Dittmar (2012); Campbell and Minguez-Vera (2008); Carter et al. (2003); Chapple and Humphery (2014); Erhardt et al. (2003); Giannetti and Zhao (2019); Gul et al. (2011); Nielsen and Huse (2010); Post and Byron (2015); Terjesen et al. (2009); Torchia et al. (2011).

⁴ For example, consulting experts in Deloitte note that “Up to now, diversity initiatives have focused primarily on fairness for legally protected populations. But the smartest organizations are embracing and harnessing a more powerful and nuanced type of diversity: diversity of thought” (Parker et al., 2017). In a similar way, a global management consulting firm named Korn Ferry urges corporations to re-direct their recruiting schemes in order to emphasize “diverse perspectives, experiences, and contributions”. See: <https://www.kornferry.com/challenges/diversity-and-inclusion>.

more profitable (Anderson et al., 2011). Adams and Ferreira (2009) argue that diversity enhances a board's independence of thought. As a result, the board can improve its monitoring function. With regard to industry-experience diversity, we expect that directors with experience from different industries can bring varied perspectives, viewpoints, information and knowledge to the corporation, facilitate more rigorous, far-reaching and thought-provoking discussions, increase the effectiveness of the firm's strategies, and thus be value-increasing. On the other hand, however, it can be costly to have a diverse board due to higher coordination and communication issues. While a diversified knowledge background of the board can enhance strategic planning and corporate governance, coordination and communication problems might overwhelm the advantages and thus result in lower board effectiveness (Jensen, 1993). Board diversity may increase decision-making costs on board, resulting in more conflicts and factions in teams (Adams et al., 2015). As such, we expect that a board with more diversified director industry experience may be associated with increased coordination and communication costs, exacerbated conflicts, reduced board effectiveness, and thus lower firm value. Given the two competing theories, which effect would dominate the other is unclear and remains an empirical question.

In a sample of S&P1500 firms from 2000 to 2012, we first examine the impact of BIED on firm value. We define the primary industry of a director as the one in which she has the longest working experience during her employment history. We then construct two measures of BIED. The first one measures the number of unique primary industries of directors relative to the board size. The second one is a Blau diversity measure of directors' industry experience. We show a robust result that BIED is value-enhancing. This result survives firm fixed effects and the instrumental variable (hereafter, IV) approach, at least partially suggesting a causal relationship. In the

robustness check, our key finding remains valid after controlling for other dimensions of board diversity, such as gender, age, nationality, and education.

We further examine the role of corporate innovation as a potential channel through which BIED enhances firm value, because corporate innovation is generally viewed as an important engine for value creation. We find a significant mediating effect of corporate innovation. Specifically, using patenting activities and patent citations as measures for corporate innovation, we find consistent evidence that innovation is an important economic mechanism for BIED to affect firm value. Moreover, the interaction analysis suggests that the effect of BIED is even stronger and more pronounced when firms have lower levels of innovation.

This paper contributes to the literature on corporate boards in general and board diversity in particular. A large number of studies explore the implication of board structure and director characteristics for firm performance.⁵ The quality of decisions made by the board depends on both director characteristics and the interaction among them (Giannetti and Zhao, 2019). We emphasize that board diversity arising from industry experience has a significant impact on corporate decision making. Most existing studies on board diversity disproportionately focus on the demographic features of board members (e.g. Adams and Ferreira, 2009; Giannetti and Zhao, 2019; Gu et al., 2011). We turn our attention to a more sophisticated, task-related, functional diversity which arises because of directors' different industry experience and examine how this specific aspect of diversity affects firm value. A few prior studies also examine board diversity using composite indexes⁶ (Anderson et al., 2011; Bernile et al., 2018;

⁵ See, for example, Adams and Ferreira (2007); Đăng et al. (2020); Field et al. (2013); Gattai et al. (2023); Guner et al. (2008); Kim et al. (2014); Knyazeva et al. (2013); Masulis et al. (2012).

⁶ A composite index of board diversity refers to a multidimensional index which usually includes the following dimensions: gender, age, ethnicity, education, professional expertise, and breadth of board experience. See Bernile et al. (2018) for example.

Gompers et al., 2016) but find mixed results on the impact of diversity on corporate performance. By focusing on BIED, we are able to pinpoint a specific dimension of board diversity which has a significant impact on firm value. Our results suggest that it is necessary to separate different types of diversity rather than using simple composite indexes (Giannetti and Zhao, 2019). We also address the question of “when and which concept of diversity may be important” (Adams et al., 2015). Furthermore, our results complement several studies that examine industry expertise of directors.⁷ Those studies collectively show that industry expertise of directors adds value to the firm. Our study extends the prior literature by showing that board members’ industry-experience diversity is also a valuable source to enhance directors’ capabilities in performing their duties.

We structure this paper as follows. Section 2 discusses relevant literature and hypotheses development. Section 3 describes the data and sample construction, and reports summary statistics for the sample. In Section 4, we show the empirical results on the relation between BIED and firm value. In Section 5, we explore the role of corporate innovation in mediating the effect of BIED on firm value. We conclude in Section 6.

2 Literature Review and Hypotheses Development

2.1 Existing Literature on Board Diversity

Most existing research on board diversity disproportionately focuses on directors’ demographic features, such as gender and ethnicity. While researchers well acknowledge that board diversity is related to both benefits and costs, in examining the impact of board diversity on firm performance, prior studies provide mixed findings. For instance, Adams and Ferreira (2009) find a negative impact of gender diversity on

⁷ See, for example, Drobetz et al. (2018); Faleye et al. (2018); Wang et al. (2015).

firm performance, although a gender-diverse board allocates more effort to monitoring. Using the mandated gender quota as a quasi-natural experiment, Ahern and Dittmar (2012) show that the mandated female representation in Norway significantly reduces stock prices at the announcement of the law and Tobin's Q in the following years. However, Carter et al. (2003) report a significantly positive effect of the fraction of women or minorities on the board on firm value. Similarly, Erhardt et al. (2003) document that a higher percentage of women and minorities on boards leads to better financial performance. Gul et al. (2011) show that gender diversity on boards improves the informativeness of stock prices. Thus, a gender-diverse board can act as a substitute mechanism for corporate governance which could be otherwise weak. More recently, Giannetti and Zhao (2019) examine board ancestral diversity and find that it leads to high volatility of firm performance. To reconcile these conflicting results, Post and Byron (2015) combine the outcomes from 140 studies in a meta-analysis and examine whether they are affected by legal, regulatory and socio-cultural factors of firms. They find that higher percentage of female directors enhances accounting returns and this result is stronger in countries with more advanced shareholder protection. They further show that, although the effect of board gender diversity on market returns is near zero, this effect is positive if the country has greater gender parity.

While a lot of prior research focuses on a single dimension of board diversity (e.g. gender diversity), Anderson et al. (2009) construct a composite index with six dimensions to measure director heterogeneity and show that there is a valuation premium (discount) on more (less) heterogeneous boards. More recently, Bernile et al. (2018) propose a similar index for board diversity with six dimensions and show that firms with a higher diversity index have lower volatility but better performance.

Overall, existing studies offer conflicting evidence on the effect of board diversity on financial outcomes and their findings are mostly derived from directors' demographic diversity. In a literature review, Adams et al. (2015) argue that one possible reason for the mixed evidence on board diversity is that "it is not clear when and which concept of diversity may be important". To shed more light on this question, we propose a new dimension of board diversity which arises from directors' industry experience and examine its effect on firm value. Another reason why it is difficult to obtain clear-cut conclusions might be the endogenous nature of general corporate governance issues (Adams et al. 2010; Hermalin and Weisbach, 1998; 2003). In this paper, we deal with the endogeneity problem by using firm fixed effects and an IV approach to establish a plausibly causal effect of board diversity on corporate outcomes.

2.2 The Possible Links between BIED and Firm Value

In theory, it is not clear whether BIED has a positive influence on firm value or not. The existing literature provides two conflicting perspectives. On the one hand, greater diversity in directors' industry experience could be a competitive advantage, as it leads to a greater knowledge base and more creativity. Directors with diverse industry experience could bring different perspectives, viewpoints, knowledge, and information to the boardroom, which increases the effectiveness of corporate decision making (Pfeffer and Salancik, 1978). If individual skills and expertise are treated as additive intermediate production inputs, then greater BIED could result in greater flexibility and information, particularly under uncertainty (Alesina et al., 2000; Hamilton et al., 2003). When each individual on board possesses valuable private information which is not fully correlated one another, then collectively the board can possess more information with the potential to make better decisions (Adams et al., 2015). Overall, BIED is likely

to lead to better decision making on boards and is thus value-enhancing. Based on the above discussions, we propose our first hypothesis as follows:

Hypothesis 1a: Board industry-experience diversity increases firm value.

On the other hand, however, BIED can be a disadvantage and thus value-decreasing. According to Putnam (2007), heterogeneity among individuals brings obstacles to collaboration, introduces frictions to communication and may result in social loafing. With regard to board functioning, while breadth of knowledge is beneficial for strategic planning and corporate governance, coordination and communication issues can overweight the benefits and therefore impair board effectiveness (Jensen, 1993). Greater BIED might be associated with interactional difficulties and increased conflicts among board members, and thus reduced levels of board performance and behavioral integration (Treichler, 1995). Board members with diverse industry experience are more likely to disagree with each other, which can weaken the consensus of the team and reduce the ability of the board to achieve efficient strategies (Baranchuk and Dybvig, 2009). They may also be slower in their actions and responses, which limits the ability of the board to take timely strategic actions (Goodstein et al., 1994). As noted by Sterman (1989), strategic decisions involve a great amount of uncertainty and people who make decisions need to adjust promptly by incorporating performance feedback. While prompt decision-making and swift performance feedback can better balance long-term and short-term decisions, delayed decision-making slows down the cycle of performance feedback, leading to less sound decisions. Based on the above discussions, we propose an alternative hypothesis to H1a as follows:

Hypothesis 1b: Board industry-experience diversity decreases firm value.

3 Data and Sample

Our initial sample comes from the BoardEx database. Company ISIN codes and company names are used to identify S&P 1500 firms from 2000 to 2012. Financial firms (SIC code 60–69) and utility firms (SIC code 49) are excluded, because they are subject to different regulation. As described in detail below, we construct the BIED measures using director employment history from BoardEx. Directors with same industry experience and directors from related industries are also identified based on this information.

Our sample period starts from the year of 2000, given that BoardEx starts to provide information on corporate boards of directors for S&P 1500 firms from 2000 and the coverage increases gradually over time. Information collected for pre-2000 period is very incomplete and limited. This is also consistent with prior studies using BoardEx (Fracassi and Tate, 2012; Engelberg et al., 2013; Wang et al., 2015).

We also obtain data on board characteristics from BoardEx, including busy directors, board size and independence, and CEO-Chairman duality. Variables on accounting items are obtained from Compustat. These variables are winsorized at 0.5% at both extremes. Innovation variables, including patent, citation and patent value, are obtained from Kogan et al. (2017). This new database provides better coverage than NBER patent database and is more up to date. Also, the new patent value variable is directly relevant to our study. The final sample consists of firms with required variables available in these databases, resulting in 15,925 firm-year observations for 1,734 unique firms.

3.1 Variable Construction

3.1.1 Board Industry-experience Diversity (BIED)

To measure the key variable of interest, BIED, we examine the employment record of each director in the sample based on BoardEx information. We identify the 2-digit SIC code (SIC2) for each public firm where the director was employed or is currently employed. For each director, the number of years worked in each SIC2 is calculated and we define the SIC2 with the longest working years as the primary industry of a director. If there are more than one SIC2 with the longest experience, we consider the most recent one as the primary SIC2 for a director. There are a couple of reasons why our focus is on the primary industry experience rather than all industry experience of directors. Firstly, it is plausible that the experience obtained from the primary industry has the most significant influence on the formation of a director's perspectives. Secondly, directors may have worked in many other industries than their primary industry. However, it is likely that it is their expertise in their primary industry that matters when they are appointed as a director in a new industry. Thirdly, individual directors tend to affect the decision-making process if they possess expertise in a particular industry than if they have only limited understanding in that industry. By focusing on the primary industry experience, we can reduce the noise in the diversity measure⁸.

We have two variables to measure the extent of BIED in the boardroom. The first one is the number of unique primary industries of board members, scaled by the board size. We denote it as BIED_%. This measure captures the extent to which a board has unique experience from various industries. A smaller BIED_% implies a less diversified board that is dominated by directors with the same primary industry experience. When BIED_% is 1, it means that the board is fully diversified and every

⁸ We thank an anonymous reviewer for suggesting a possible alternative measure: the proportion of directors with previous work experience in an industry different from the focal firm's primary industry. However, after examining the data, we find that most directors (>90%) are in this category. As a result, there is a lack of cross-sectional and time variation for this variable, and we still focus on our original measure of BIED.

director on the board has different primary industry experience from each other. This measure is easy to calculate and intuitive to understand yet it does not consider the concentration of a particular SIC2 in a board.

The second measure is a Blau diversity measure which is commonly used in the literature (Bernile et al., 2018; Giannetti and Zhao, 2019). It is defined as $1 - \sum x_i^2$, where x_i is the number of directors whose primary industry is i , scaled by the board size. We denote this measure as BIED_Blau. A higher value of BIED_Blau indicates greater diversity of industry experience. Below we illustrate how this measure is constructed using a hypothetical firm that has five directors.

Directors	Primary Industry (SIC2)
Director A	01
Director B	01
Director C	01
Director D	15
Director E	72

To calculate BIED_Blau, we need to know the size of the board as well as the number of directors who have experience in the same primary industry. In this example, the board size of the hypothetical firm is 5 and there are three directors in primary SIC2 01, one director in primary SIC2 15 and one director in primary SIC2 72. We summarize the information as:

Primary Industry (SIC2)	01	15	72
# of directors	3	1	1

Finally, BIED_Blau is calculated as:

$$1 - \sum x_i^2 = 1 - \left[\left(\frac{3}{5}\right)^2 + \left(\frac{1}{5}\right)^2 + \left(\frac{1}{5}\right)^2 \right] = 1 - 0.44 = 0.56$$

3.1.2 Corporate Innovation

We follow the literature (Bena and Li, 2014) and use several performance-oriented measures for corporate innovation. These measures are related to patent counts and patent citations.

First, the number of successful patent applications during the year is used to measure the quantity of innovation output.⁹ Second, as Hall et al. (2005) prove that patent citations are a significant contributor to firm value, we use the number of citations received by successful patents in a year¹⁰ and the total value of these patents to proxy for the quality of innovation output. Last, we use the number of patent subclasses, the standard deviation of citation counts, and the standard deviation of patent values to measure the dispersion of the impact of innovation output. We expect that diversified perspectives may enhance the innovation output but may lead to more extreme situations in terms of importance.

3.1.3 Control Variables

We include additional variables to control for other board- and firm-level characteristics, including: board size, board independence, CEO-Chairman duality (Chen et al., 2017), percentage of busy directors (Fich and Shivdasani, 2006), percentage of independent directors with work experience in the same industry (Wang et al., 2015), percentage of directors from related industries (Dass et al., 2013), firm size, leverage, ROA, and investment opportunities. Detailed variable definitions are shown in the Appendix.

⁹ We note that there is a time lag between the application time of a patent and the time when a patent is finally granted. In our study, a successful patent is recorded if it is granted by the end of the sample period (Kogan, et al., 2017). For example, a patent applied in 2007 may be granted in 2010. As long as this is a successful patent application, we record it in 2007. Therefore, a successful patent recorded in 2007 actually captures innovation efficiency in the same year.

¹⁰ We acknowledge the truncation bias of patent citation data as discussed in Hall et al. (2001, 2005). However, due to the fact that Hall's adjustment factors are only for the sample before 2000, we are unable to use them to make adjustments to our data. Nevertheless, as discussed by Dass et al. (2017), we follow Hall et al. (2002) to control for year fixed effects in the regression, which should capture some of the time effects and partially alleviate the concern.

3.2 Summary Statistics

We report summary statistics for all dependent and independent variables in Table 1. For our key variables of interest, BIED, as explained earlier, we have a percentage measure (BIED_%) and a Blau measure (BIED_Blau). The percentage and Blau measures have a mean value of 0.48 and 0.54 respectively, indicating that an average board just falls in between a board with all directors having the same primary industry experience and a board with directors having totally different primary industry experience one another. The sample mean and median of these two measures are similar.

[Insert Table 1 here]

Firm characteristics and board characteristics are largely consistent with studies in the literature. An average sample firm has a Tobin's Q of 2.10, with a median of 1.64. An average (median) firm has total assets of \$6821 (\$1190) billion, suggesting that we have large firms in our sample. The average ROA is 9%; the average book leverage is 21%; and the average capital expenditure is 5%. An average firm operates in 1.67 business segments and has 8.92 directors among whom 74% are independent. 25% of directors on board are busy directors with more than three directorships in a given year. 48% directors have related industry experience to the focal firm, comparable to the number in Dass et al. (2013). 22% independent directors have the same industry experience, which is similar to that in Wang et al. (2015).

The average R&D expenditure is about 4% of total assets in the full sample. For firms with available information from Kogan et al. (2017) patent database, the average number of successful patent applications, the average number of citations received by a patent, and the mean market value of the patents are 15.445, 254.43 and \$984.567, respectively. For an average firm, the number of patent subclasses is 33.67. We also notice a large variation in the standard deviation of citations and market values of patents across firms.

To depict a more complete picture on our BIED measures, we report more statistics on the year trend and industry distributions in Table 2.¹¹ As shown in Panel A, through our sample period, there is a steadily increasing trend for both measures. The average value of BIED_% (BIED_Blau) starts from 0.44 (0.51) in 2000 and gradually increases to 0.48 (0.54) in 2006. It then keeps increasing steadily to 0.53 (0.60) in 2012. In Panel B, we report the statistics on both measures according to 2-digit SIC code. We can see some variations across industries. Take the BIED_Blau measure for example. Industries such as Agricultural Production – Crops (SIC2: 01), Tobacco Products (SIC2: 21), and Railroad Transportation (SIC2: 40) have a high value of 0.70 and above. Industries such as Agricultural Production – Livestock (SIC2: 02) and Agricultural Services (SIC2: 07) have a low value which is below 0.20. Most industries have a value between 0.50 and 0.60, which is consistent with an average value of 0.54 for all industries.

[Insert Table 2 here]

4 BIED and Firm Value

4.1 Baseline Results

We first examine the impact of BIED on firm value. We use ordinary least squares (OLS) regressions to estimate the following model:

$$\text{Firm value}_{i,t} = \alpha + \beta \text{BIED}_{i,t-1} + \gamma' X_{i,t-1} + \varphi_i + \omega_t + \varepsilon_{i,t}$$

where i and t denote the firm and year, respectively. We use Tobin's Q to proxy for firm value. BIED is our key variable of interest which is measured by BIED_% and BIED_Blau. X denotes other determinants of firm value identified in the prior studies. In particular, as recent studies document that CEO-Chairman duality (Chen et al., 2017), busy directors (Fich and Shivdasani, 2006), directors with same-industry experience

¹¹ We note that there is a sudden decrease in the sample size for 2012. This is mainly due to the unavailability of data for many firms when we first collected them in 2011. When we drop 2012 observations, our results do not change materially.

(Drobetz et al., 2018; Wang et al., 2015) and directors with related-industry experience (Dass et al., 2013) can all affect corporate policies and outcomes, we control for CEO-Chairman duality, the percentage of busy directors, the percentage of directors with same-industry experience and the percentage of directors with related-industry experience. All independent variables are measured in year $t - 1$. We also use both firm fixed effects (φ) and year fixed effects (ω). In all regressions, we cluster robust standard errors at the firm level and report them in parentheses below the estimates.

[Insert Table 3 here]

Table 3 reports the results. The estimated coefficients on BIED are significantly positive at the 5% level in both columns, indicating a positive impact of BIED on firm value. Regarding the economic significance, take the BIED_% measure for example. Its coefficient is 0.292, which means that one standard deviation increase in BIED leads to an increase of 5.55% in firm value. Given that the sample average of Tobin's Q is 2.1, this translates into an increase of 2.64% in firm value for an average firm, which is economically significant. Similarly, for the BIED_Blau measure, the estimated coefficient is 0.242, which means that one standard deviation increase in this measure leads to an increase of 5.57% in Tobin's Q, which translates into an increase of 2.65% in firm value for a typical firm.

Regarding board-related control variables, we show that board size has a negative effect on firm value, consistent with Yermack (1996). Board independence has a positive effect on firm value, lending support to the call of Sarbanes-Oxley Act for greater board independence and recent empirical findings (Knyazeva et al., 2013; Masulis and Zhang, 2019). Interestingly, we find that busy directors, directors with same-industry experience, and directors with related-industry experience have insignificant impact on firm value. A plausible explanation for this result is that the

previous studies that find a significant role of these directors largely use industry rather than firm fixed effects in their regressions (Dass et al., 2013; Drobetz et al., 2018). Once firm fixed effects or time-invariant unobservable firm characteristics that could potentially affect both board structure and firm value, are controlled for, the impacts of such directors tend to diminish. However, our key variable of interest, BIED, survives firm fixed effects, suggesting that our main result is not likely to be driven by those unobservable firm characteristics.

Coefficient estimates of other control variables are mostly consistent with those in prior studies. For instance, R&D intensity, operating profitability (as proxied by ROA), and investment opportunities (as proxied by CAPEX) have positive impacts on firm value, while leverage and corporate diversification (as proxied by Segments) have negative impacts on firm value.¹²

4.2 Endogeneity Correction

A concern with our inferences is endogeneity. For the potential unobserved heterogeneity, we have included firm fixed effects in the baseline regressions and thus largely addressed this problem. Yet, the other two sources of endogeneity still remain: reverse causality and omitted variable bias. On the one hand, a reverse causality may exist in the relation between board structure and firm value. For instance, our previous result that BIED positively affects firm value might simply be due to the fact that firms with good performance can easily attract directors with greater industry-experience diversity, rather than that such directors contribute to value creation. On the other hand, our results could be driven by unobservable factors which affect BIED and firm value

¹² We also use alternative dependent variables such as ROE and stock returns. We failed to find any significant impact of BIED on either ROE or stock returns. We argue that, while ROE and stock returns are common measures of corporate financial performance, the main focus of our paper is on firm value, which is commonly proxied by Tobin's Q in the literature. Evidence shows that while BIED has a significantly positive impact on firm value, it doesn't have any significant impact on corporate financial performance.

simultaneously. Thus, we apply the IV approach to alleviate such concerns and ensure the validity of the results.

We follow the spirit of prior studies (e.g. Carter et al., 2017; Huang and Kisgen, 2013; Knyazeva et al., 2013) and use a local labor supply-based measure as our instrument. Specifically, our instrument for BIED is the average BIED for firms located in the area which shares the same first two-digit ZIP code with the focal firm. We exclude the focal firm's BIED in the calculation. The idea is that, if local firms can attract directors with diverse industry experience, then the firm itself is also exposed to this potential supply of directors and thus more likely to hire these directors. As in Bernile et al. (2018), the average board diversity may be affected by differences in infrastructures that provide some locations with easier access to a more diversified director pool. Thus, there are concerns that the development of a city may directly affect corporate activities and outcomes. Our IV measure, however, is less suffered from such concerns because it is based on ZIP code introduced in 1963 that aims to make the mail system more efficient and therefore it is unlikely to be dominated by a particular city or industry.

[Insert Table 4 here]

Table 4 reports the results from the IV regressions. In the first stage, we regress the BIED measures on the IV. In columns 1 and 3, we find that our instrument strongly relates to our BIED measures. The F-statistics on the instrument in our first stage are above the critical value from the Cragg-Donald Wald weak identification test. The F-statistic for BIED_% is 18 and for BIED_Blau is 24.18, suggesting relevance of the instrument. Furthermore, the first stage R-squared is large (22.2% for BIED_% and 31.0% for BIED_Blau), indicating that our estimation is efficient. Because it seems less likely that the local average BIED (excluding the focal firm's contribution) will have

any direct impact on firm value of the focal firm, it is plausible that our instrument meets exclusion requirements. We conclude that our IV is valid.

Results of the second stage model is reported in columns 2 and 4. The dependent variable is firm value and the key independent variable is the fitted value of BIED obtained from the first stage regressions. We find that, for both measures of BIED, they are still significantly positive, confirming that BIED has a positive impact on firm value.¹³

4.3 Robustness Checks

In this section, we conduct a few robustness tests to rule out the possibility that our BIED variable is simply a consequence of other aspects of board diversity, including age, education, gender and nationality. If this is the case, then the previously documented impact of BIED on firm value should not exist if we add other measures of board diversity into our model. We therefore add the following diversity measures: Female %, which measures gender diversity, is the percentage of female directors on a board; Foreign %, which measures nationality diversity, is the percentage of foreign directors on a board; Std. Age, which measures age diversity, is the standard deviation of director age; Std. Qualification, which measures education diversity, is calculated as the standard deviation of the number of a director's qualifications. We further include # Nationality as an alternative nationality diversity measure, which is the number of unique nationalities on a board¹⁴. We report the results in Table 5.

¹³ We also use an alternative IV, which is defined as the log of the number of 2-digit SIC code industries within the local area, to capture the potential supply of local directors with diverse industry experience. In unreported tables, we still find that the instrumented BIED measures are significantly positive.

¹⁴ We note that *Foreign %* and *# Nationalities* capture different aspects of nationality diversity. Suppose we have two U.S. boards (A and B) of the same size of 10, both with 3 foreign directors. For A, all foreign directors are from the same country (e.g. U.K.), but for B, they are from three distinct countries (U.K., Mexico, and Australia). In this case, for both A and B, their *Foreign %* measure is the same: 30%. But their *# Nationalities* measures are different: A for 2 (U.S.+U.K.) but B for 4 (U.S.+U.K.+Mexico+Australia).

As shown, our main finding, BIED significantly improves firm value, does not change. The inclusion of the additional board diversity measures does not attenuate the impact of BIED. We argue that, while age, gender, education, and nationality also contribute to the general diversity of the board, they may not be directly relevant to the industry experience of a board. Thus, our findings here highlight the importance of investigating different dimensions of board diversity, especially those arising from directors' experiential or cognitive differences¹⁵.

5 The Role of Corporate Innovation

In this section, we examine the role of corporate innovation in linking BIED and firm value. We focus on corporate innovation because it is normally recognized as a primary alternative for firms to achieve long-term success (Ahamed et al., 2023). We expect that BIED encourages corporate innovation, which, in turn, creates firm value. The reasons why we take this position are as follows. First, innovation, which usually explores new and untested ideas, involves high risk and unpredictability and requires long-term investment. Thus, in every step of the process, managers and board members have to deliberate. As a source of external perspective, the board is helpful in providing timely feedback on the strategic plans for the next stage of development (Griffin et al., 2021). Second, as discussed above, BIED brings different knowledge, perspectives, and information to the boardroom problem solving and decision making, which is valuable especially in uncertain situations such as innovation. Directors with diverse industry experience acquire knowledge beyond the firm's existing expertise and are more likely to cultivate a culture of creativity and innovation. Thus, a higher BIED is likely to be associated with better corporate innovation outcomes, which help drive up firm value.

¹⁵ We also perform several subsample analyses: large and small firms; before and after 2009 SEC rule; BIED intensive and non-intensive industries; firms with and without international businesses. Results do not show any significance in these subsamples, which suggests that the impact of BIED does not vary with these factors.

To empirically test our conjectures, we adopt two methods. First, we follow Baron and Kenny (1986) to test the mediating effect of corporate innovation on the impact of BIED on firm value. Second, we conduct the interaction analysis to check in which scenarios BIED plays a more significant role.

5.1 The Mediating Effect

We follow the method used by Baron and Kenny (1986) to test the mediating effect of corporate innovation. We classify corporate innovation into two categories: patenting activities and patent citations.

5.1.1 Patenting Activities

Table 6 reports the results for patenting activities, with Panel A for BIED_% and Panel B for BIED_Blau¹⁶. For comparison, column (1) presents the baseline results where the dependent variable is firm value and the key independent variable is BIED only. In column (2) of Panel A, we first regress the number of patents on BIED, along with the full array of control variables. Consistent with our conjectures, we find a positive and highly significant coefficient on BIED, which indicates that BIED could significantly increase the number of patents. Furthermore, we regress firm value on both BIED and the number of patents. We find that, BIED is still significantly and positively associated with firm value, but the magnitude of the coefficient is somewhat reduced. At the same time, the number of patents is significantly and positively associated with firm value, demonstrating that innovation is a critical driver of firm value.

In column (2) of Panel B, the mediating effect of corporate innovation is even stronger. First, we continue to find a significantly positive effect of BIED on the number of patents, confirming our conjecture that BIED enhances corporate innovation.

¹⁶ We note that the number of observations in this table differs from that in the previous tables. The reason is that in our dataset of patents obtained from Kogan et al. (2017), there is a significant drop of observations after 2008. To avoid any sample selection bias, we have thus dropped observations for 2009-2012.

However, when both BIED and the number of patents are included in the model, the coefficient on BIED becomes insignificant but the coefficient on the number of patents is highly significant and positive, indicating that the effect of BIED on firm value comes mainly through the channel of corporate innovation.

Overall, the results in column (2) of both panels indicate that corporate innovation, as measured by the number of patents, plays a significant mediating role between BIED and firm value. Corporate innovation is thus one of the important channels through which BIED increases firm value.

[Insert Table 6 here]

We repeat our analysis in column (2) by using different measures of patenting activities: in column (3), we use the number of patent classes, which reflects the diversity of a firm's patents; in column (4), we use the sum of patent values, which reflects the value of all patents in a firm; in column (5), we use the standard deviation of patent values, which captures the distribution of patent values in a firm. Results are consistent with those in column (2) of both panels.

Taken together, we find consistent evidence in Table 6 that BIED enhances firm value through the channel of corporate innovation. Greater BIED results in more patent counts, more diverse patents, and more valuable patents, which, in turn, translate into higher firm value.

5.1.2 Patent Citations

While patent counts represent the *quantity* of innovation, it couldn't separate groundbreaking innovations from incremental technologies. Considering the impact and significance of patents, we now measure the *quality* of corporate innovation using

patent citations. Given that BIED leads to more diverse and valuable patents, we expect that firms with such a diverse board will receive more citations on their patents.

[Insert Table 7 here]

We conduct a similar analysis as in Table 6. We use two measures of patent citations: $\log(1 + \text{the number of patent citations})$, and the standard deviation of citation counts a patent receives. Results are reported in columns 1 and 2 of Table 7 for BIED_% (columns 3 and 4 for BIED_Blau). We find qualitatively unchanged results as in Table 6: BIED is associated with more patent citations and more widely distributed citations; its enhancing impact on firm value goes mainly through the channel of corporate innovation.

Taken together, results in section 5.1 show consistent evidence that 1) BIED enhances firm value; 2) BIED encourages corporate innovation; 3) corporate innovation is an important underlying channel through which BIED enhances firm value.

5.2 Interaction Analysis

To provide more insights on the role played by corporate innovation in linking BIED and firm value, we further conduct an interaction analysis by creating an interaction term between BIED and corporate innovation measures. Results are reported in Table 8 with Panel A for BIED_% and Panel B for BIED_Blau.

[Insert Table 8 here]

Results in Table 8 are largely consistent across the panels with the following findings worth noting. First, we find strong evidence that BIED is significantly and positively associated with firm value. All the coefficients of BIED are positive and highly significant across different columns in both panels. Second, all the innovation measures are also positive and highly significant, confirming their role as value drivers. Last and most important, the interaction term is consistently negative in both panels

with most of them highly significant in Panel B. This finding suggests that BIED has a more pronounced effect on firm value in firms with a lower level of corporate innovation. While BIED has a positive effect on firm value in general, this effect is even stronger when firms have lower levels of innovation. This piece of evidence further confirms our previous finding that corporate innovation is a possible channel through which BIED enhances firm value.

6 Conclusion

Corporate board diversity is a topic of significant interest to policy makers, investors and academics. A large number of academic studies have evaluated how board diversity affects corporate policies and outcomes, and much of their investigation focuses on directors' demographic features, such as gender and ethnicity (Adams and Ferreira, 2009; Ahern and Dittmar, 2012; Giannetti and Zhao, 2019; Gul et al., 2011). Yet, there is little attention paid to the functional diversity of directors which might affect their capability to play their roles. In this paper, we answer the call of Adams et al. (2015) for research on "different forms of diversity that affect decisions and behavior in the boardroom". In particular, we fill the gap in the literature by looking at directors' industry-experience diversity.

In a sample of S&P1500 firms during the period of 2000-2012, we find a significantly positive impact of BIED on firm value. In order to alleviate endogeneity concerns, we apply both firm fixed effects and an IV approach. Our results suggest that the positive impact of BIED is causal. We further examine the mediating effect of corporate innovation and find that BIED promotes firm value through the channel of corporate innovation. Moreover, the effect of BIED on firm value is more pronounced when firms have lower levels of corporate innovation.

Overall, our results highlight the important role played by BIED in shaping firm decision making. We conclude that industry-experience diversity within corporate boards constitutes a valuable corporate governance mechanism. However, we also recognize that our estimates only represent the average effect of BIED and thus in some cases the costs of diversity may outweigh the associated benefits (Bernile et al., 2018; Wang et al., 2015). Therefore, any decision to increase BIED should carefully consider the firm's specific characteristics and needs, and only be made based on the analysis of costs and benefits.

We recognize a potential limitation of this research which arises from an outdated sample period of 2000-2012. We choose this sample period due to the lack of legal access to the BoardEx database afterwards. Future studies can update the sample to the most recent period and verify the validity of our results.

References

- Adams, R.B., and D. Ferreira, 2007, A theory of friendly boards, *Journal of Finance* 62, 217-250.
- Adams, R.B., and D. Ferreira, 2009, Women in the boardroom and their impact on governance and performance, *Journal of Financial Economics* 94, 291-309.
- Adams, R.B., J. de Haan, S. Terjesen, and H. van Ees, 2015, Board diversity: Moving the field forward, *Corporate Governance: An International Review* 23, 77-82.
- Adams, R.B., B. Hermalin, and M. Weisbach, 2010, The role of boards of directors in corporate governance: A conceptual framework and survey, *Journal of Economic Literature* 48, 58-107.
- Ahamed, M. M., K. B. Luintel, S. K. Mallick, 2023, Does local knowledge spillover matter for firm productivity? The role of financial access and corporate governance, *Research Policy* 52, 104837.
- Ahern, K., and A. Dittmar, 2012, The changing of the boards: The impact on firm valuation of mandated female board representation, *Quarterly Journal of Economics* 127, 137-197.
- Alesina, A., E. Spolaore, and R. Wacziarg, 2000, Economic integration and political disintegration, *American Economic Review* 90, 1276-1296.
- Anderson, R., D. Reeb, A. Upadhyay, and W. Zhao, 2011, The economics of director heterogeneity, *Financial Management* 40, 5-38.
- Balsmeier, B., L. Fleming, and G. Manso, 2017, Independent boards and innovation, *Journal of Financial Economics* 123, 536-557.
- Baranchuk, N., and P.H. Dybvig, 2009, Consensus in diverse corporate boards, *Review of Financial Studies* 22, 715-747.
- Bardos, K.S., M. Ertugrul, and L.S., Gao, 2020, Corporate social responsibility, product market perception, and firm value, *Journal of Corporate Finance* 62, 101588.
- Baron, R.M., and D.A. Kenny, 1986, The moderator-mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology* 51, 1173-1182.
- Bena, J., and K. Li, 2014, Corporate innovations and mergers and acquisitions, *Journal of Finance* 69, 1923-1960.
- Bernile, G., V. Bhagwat, and S. Yonker, 2018, Board diversity, firm risk, and corporate policies, *Journal of Financial Economics* 127, 588-612.

Campbell, K., and A. Minguez-Vera, 2008, Gender diversity in the boardroom and firm financial performance, *Journal of Business Ethics* 83, 435-451.

Carter, D.A., B.J. Simkins, and W.G. Simpson, 2003, Corporate governance, board diversity, and firm value, *Financial Review* 38, 33-53.

Carter, M.E., F. Franco, and M. Gine, 2017, Executive gender pay gaps: The roles of female risk aversion and board representation, *Contemporary Accounting Research* 34, 1232-1264.

Chapple, C., and J.E. Humphery, 2014, Does board gender diversity have a financial impact? Evidence using stock portfolio performance, *Journal of Business Ethics* 122, 709-723.

Chen, J., W.S. Leung, and M. Goergen, 2017, The impact of board gender composition on dividend payouts, *Journal of Corporate Finance* 43, 86-105.

Custodio, C., M. Ferreira, and P. Matos, 2019, Do general managerial skills spur innovation? *Management Science* 65, 459-476.

Đặng, R., L. Houanti, K. Reddy, and M. Simioni, 2020, Does board gender diversity influence firm profitability? A control function approach, *Economic Modelling* 90, 168-181.

Dass, N., O. Kini, V. Nanda, B. Onal, and J. Wang, 2014, Board expertise: do directors from related industries help bridge the information gap? *Review of Financial Studies* 27, 1533-1592.

Dass, N., V. Nanda, and S.C. Xiao, 2017, Truncation bias corrections in patent data: Implications for recent research on innovation, *Journal of Corporate Finance* 44, 353-374.

Drobetz, W., F. von Meyerinck, D. Oesch, and M. Schmid, 2018, Industry expert directors, *Journal of Banking and Finance* 92, 195-215..

Engelberg, J., P. Gao, and C. Parsons, 2013, The value of a rolodex: CEO pay and personal network, *The Review of Financial Studies* 26, 79-114.

Erhardt, N. L., J. D. Werbel, and C. B. Shrader, 2003, Board of director diversity and firm financial performance, *Corporate Governance: An International Review* 11, 102-111.

Faleye, O., R. Hoitash, and U. Hoitash, 2018, Industry expertise on corporate boards, *Review of Quantitative Finance and Accounting* 50, 441-479.

Faleye, O., T. Kovacs, and A. Venkateswaran, 2014, Do better-connected CEOs innovate more? *Journal of Financial and Quantitative Analysis* 49, 1201-1225.

- Fich E., and A. Shivdasani, 2006, Are busy boards effective monitors? *Journal of Finance* 61, 689-724.
- Field, L., M. Lowry, and A. Mkrtchyan, 2013, Are busy boards detrimental? *Journal of Financial Economics* 109, 63-82.
- Fracassi, C., and G. Tate, 2012, External networking and internal firm governance, *Journal of Finance* 67, 153-194.
- Gattai, V., P. Natale and F. Rossi, 2023, Board diversity and outward FDI: Evidence from Europe, *Economic Modelling* 120, 106156.
- Geletkanycz, M., C.E. Clark, and P. Gabaldon, 2018, When boards broaden their definition of diversity, women and people of color lose out, *Harvard Business Review*, 3 October 2018.
- Giannetti, M., and M. Zhao, 2019, Board ancestral diversity and firm performance volatility, *Journal of Financial and Quantitative Analysis* 54, 1117-1155.
- Gompers, P.A., V. Mukharlyamov, and Y. Xuan, 2016, The cost of friendship, *Journal of Financial Economics* 119, 626-644.
- Goodstein, J., K. Gautam, and W. Boeker, 1994, The effects of board size and diversity on strategic change, *Strategic Management Journal* 15, 241-250.
- Griffin, D., K. Li, and T. Xu, 2021, Board gender diversity and corporate innovation: International evidence, *Journal of Financial and Quantitative Analysis* 56, 123-154.
- Gul, F., B. Srinidhi, A. Ng, 2011, Does board gender diversity improve the informativeness of stock prices? *Journal of Accounting and Economics* 51, 314-338.
- Guner, A.B., U. Malmendier, and G. Tate, 2008, Financial expertise of directors, *Journal of Financial Economics* 88, 323-354.
- Hall, B., A. Jaffe, and M. Trajtenberg, 2001, The NBER Patent Citation Data File: Lessons, Insights and Methodological Tools, National Bureau of Economic Research Working Paper.
- Hall, B., A. Jaffe, and M. Trajtenberg, 2005, Market value and patent citations, *RAND Journal of Economics* 36, 16-38.
- Hamilton, B., J. Nickerson, and H. Owan, 2003, Team incentives and worker heterogeneity: An empirical analysis of the impact of teams on productivity and participation, *Journal of Political Economy* 111, 465-497.
- Hermalin, B.E., and M. Weisbach, 1998, Endogenously chosen boards of directors and their monitoring of the CEO, *American Economic Review* 88, 96-118.

Hermalin, B.E., and M. Weisbach, 2003, Boards of directors as an endogenously-determined institution: A survey of the economic literature, *Economic Policy Review* 9, 7-26.

Hirshleifer, D., A. Low, and S. Teoh, 2012, Are overconfident CEOs better innovators? *Journal of Finance* 67, 1457-1498.

Hsu, P., X. Tian, and Y. Xu, 2014, Financial development and innovation: Cross-country evidence, *Journal of Financial Economics* 112, 116-135.

Huang, J., and D.J. Kisgen, 2013, Gender and corporate finance: Are male executives overconfident relative to female executives? *Journal of Financial Economics* 108, 822-839.

Islam, M., and J. Zein, 2020, Inventor CEOs, *Journal of Financial Economics* 135, 505-527.

Jensen, M., 1993, The modern industrial revolution, exit, and the failure of the internal control system, *Journal of Finance* 48, 831-880.

Jia, N., 2017, Should directors have term limits? Evidence from corporate innovation, *European Accounting Review* 26, 755-785.

Kang, H., M. Cheng, and S.J. Gray, 2007, Corporate governance and board composition: Diversity and independence of Australian boards, *Corporate Governance: An International Review* 15, 194-207.

Kim, K., E. Mauldin, and S. Patro, 2014, Outside directors and board advising and monitoring performance, *Journal of Accounting and Economics* 57, 110-131.

Knight, D., C.L. Pearce, K.G. Smith, J.D. Olian, H.P. Sims, K.A. Smith, and P. Flood, 1999, Top management team diversity, group process, and strategic consensus, *Strategic Management Journal* 20, 445-465.

Knyazeva, A., D. Knyazeva, and R. Masulis, 2013, The supply of corporate directors and board independence, *Review of Financial Studies* 26, 1561-1605.

Kogan, L., D. Papanikolaou, A. Seru, and N. Stoffman, 2017, Technological innovation, resource allocation, and growth, *Quarterly Journal of Economics* 132, 665-712.

Martynova, M., and L. Renneboog, 2008, A century of corporate takeovers: What have we learned and where do we stand? *Journal of Banking and Finance* 32, 2148-2177.

Masulis, R., C. Wang, and F. Xie, 2012, Globalizing the boardroom – The effects of foreign directors on corporate governance and firm performance, *Journal of Accounting and Economics* 53, 1-28.

Masulis, R. and E. Zhang, 2019, How valuable are independent directors? Evidence from external distractions, *Journal of Financial Economics* 132, 226-256.

Nielsen, S., and M. Huse, 2010, The contribution of women on boards of directors: Going beyond the surface, *Corporate Governance: An International Review* 18, 136-148.

Parker, A., C. Medina, and E. Schill, 2017, Diversity's new frontier: Diversity of thought, *Rotman Management Magazine*, 1 September 2017.

Pfeffer, J., and G. Salancik, 1978, *The External control of organizations - A resource dependence perspective*, New York: Harper & Row.

Post, C., and K. Byron, 2015, Women on boards and firm financial performance: A meta-analysis, *Academy of Management Journal* 58, 1546-1571.

Putnam, R., 2007, E Pluribus Unum: Heterogeneity and community in the twenty-first century the 2006 Johan Skytte Prize Lecture, *Scandinavian Political Studies* 30, 137-174.

Smith, N., 2014, Gender quotas on boards of directors, IZA World of Labor, May.

Sterman, J.D., 1989, Modeling managerial behavior: Misperceptions of feedback in a dynamic decision making experience, *Management Science* 35, 321-339.

Sunder, J., S.V. Sunder, and J. Zhang, 2017, Pilot CEOs and corporate innovation, *Journal of Financial Economics* 123, 209-224.

Terjesen, S., R. Sealy, and V. Singh, 2009, Women directors on corporate boards: A review and research agenda, *Corporate Governance: An International Review* 17, 320-337.

Torchia, M., A. Calabro, and M. Huse, 2011, Women directors on corporate boards: From tokenism to critical mass, *Journal of Business Ethics* 102, 299-317.

Treichler, C.M., 1995, Diversity of board members and organizational performance: An integrative perspective, *Corporate Governance: An International Review* 3, 189-200.

Wang, C., F. Xie, and M. Zhu, 2015, Industry expertise of independent directors and board monitoring, *Journal of Financial and Quantitative Analysis* 50, 929-962.

Yermack, D., 1996, Higher market valuation of companies with a small board of directors, *Journal of Financial Economics* 40, 185-211.

Appendix: Variable Definitions

<i>Variable</i>	<i>Definition and Data Source</i>
<i>Diversity Measures</i>	
<i>BIED_%</i>	The number of unique primary industries divided by the board size. The primary industry of each director is defined as the one in which the director has the longest working years in her employment history. (BoardEx)
<i>BIED_Blau</i>	Defined as $1 - \sum x_i^2$, where x_i is the number of directors whose primary industry is i , scaled by the board size. (BoardEx)
<i>Firm Characteristics</i>	
<i>Tobin's Q</i>	The book value of assets minus the book value of equity, plus the market value of equity, divided by the book value of assets. (Compustat)
<i>Size</i>	Book value of total assets in millions of dollars. Natural log is applied to this variable in regressions. (Compustat)
<i>ROA</i>	The firm's annual return on assets, calculated as income before interest and taxes (EBIT) divided by the book value of assets at the beginning of the fiscal year. (Compustat)
<i>Leverage</i>	Book value of long-term and short-term debts divided by total assets. (Compustat)
<i>CAPEX</i>	The firm's capital expenditures scaled by total assets. (Compustat)
<i>Segments</i>	The number of business segments. (Compustat Segment)
<i>Board Characteristics</i>	
<i>Board Size</i>	The total number of directors on board. (BoardEx)
<i>Board Independence</i>	The number of independent directors divided by the total number of directors on board. (BoardEx)
<i>Duality</i>	A dummy variable which equals one if the CEO also holds the title of the Chairman of the board. (BoardEx)
<i>Busy %</i>	The number of directors with more than three directorships in a given year divided by the total number of directors on board. (BoardEx)
<i>Related Industry %</i>	The number of directors with related industry experience, scaled by board size. A director is defined as having related industry experience if her prior or current employment is from related industries (SIC2) in which the focal firm operates, following Dass et al. (2013). (BoardEx and Compustat).
<i>Industry Experts %</i>	The percentage of directors who have prior or current employment from the same industries (SIC2) in which the focal firm operates. (BoardEx and Compustat)
<i>Female %</i>	The number of female directors scaled by board size. (BoardEx)
<i>Foreign %</i>	The number of foreign directors scaled by board size. (BoardEx)
<i>Std. Age</i>	The standard deviation of directors' ages. (BoardEx)
<i>Std. Qualifications</i>	The standard deviation of the number of directors' qualifications. (BoardEx)

<i># Nationalities</i>	The number of unique nationalities on boards. (BoardEx)
<i>Innovation Measures</i>	
<i>R&D</i>	The firm's R&D expenditures scaled by total assets, which is set to zero if Compustat reports R&D as missing. (Compustat)
<i># Patents</i>	The number of successful patent applications during the year, which is set to zero in regressions if missing. The variable is transformed into natural log. (Kogan et al. 2017)
<i># Citations</i>	The number of citations received by successful patents, which is set to zero in regressions if missing. (Kogan et al. 2017)
<i># Subclass</i>	The number of unique subclasses of successful patents in a year, which is set to zero in regressions if missing. The variable is transformed into natural log. (Kogan et al. 2017)
<i>Patent Value</i>	Estimated patent value based on stock market reactions to patent grants, which is set to zero in regressions if missing. The variable is transformed into natural log. (Kogan et al. 2017)
<i>Std. Citation</i>	Standard deviation of citations received by successful patents, which is set to zero in regressions if missing. The variable is transformed into natural log. (Kogan et al. 2017)
<i>Std. Value</i>	Standard deviation of estimated patent value of successful patents, which is set to zero in regressions if missing. The variable is transformed into natural log. (Kogan et al. 2017)

Table 1 Summary Statistics

This table reports summary statistics for variables used in this paper. Our sample consists of 1,734 firms from the S&P 1500 index excluding those from financial and utility industries over the period 2000-2012. Data on board characteristics are from BoardEx database, financial and accounting data are from Compustat, and patent data are from Kogan et al. (2017) patent database. All variables are defined in Appendix.

	Obs	Mean	Min	Median	Max	Std
BIED_%	15,925	0.48	0.00	0.45	1.00	0.19
BIED_Blau	15,925	0.54	0.00	0.58	0.94	0.23
Tobin's Q	15,925	2.10	0.66	1.64	10.59	1.43
R&D	15,925	0.04	0.00	0.01	0.35	0.06
ROA	15,925	0.09	-0.49	0.09	0.45	0.11
Size (\$mil)	15,925	7.22	-2.43	7.08	13.59	1.66
Leverage	15,925	0.21	0.00	0.19	1.00	0.20
CAPEX	15,925	0.05	0.00	0.03	0.35	0.05
Segments	15,925	1.67	1.00	1.00	11.00	1.13
Duality	15,925	0.69	0.00	1.00	2.00	0.46
Board Size	15,925	8.92	3.00	9.00	25.00	2.34
Board Independence	15,925	0.74	0.07	0.77	1.00	0.15
Busy %	15,925	0.25	0.00	0.23	1.00	0.18
Related Industry %	15,925	0.48	0.00	0.00	1.00	0.49
Industry Experts %	15,925	0.22	0.00	0.17	1.65	0.24
# Patent	11,564	0.91	0.00	0.00	8.39	1.52
# Subclass	11,564	0.81	0.00	0.00	6.90	1.38
Patent Value	11,564	1.47	0.00	0.00	10.90	2.43
Std. Value	11,564	0.45	0.00	0.00	5.40	0.92
# Citations	11,564	1.00	0.00	0.00	10.80	1.89
Std. Citation	11,564	0.37	0.00	0.00	4.49	0.73
Female %	15,708	0.09	0.00	0.07	0.64	0.10
Foreign %	15,708	0.04	0.00	0.00	0.95	0.09
Std. Age	15,708	7.99	0.58	7.63	25.37	2.75
Std. Qualification	15,708	1.04	0.00	0.99	4.42	0.39
# Nationalities	15,708	1.35	1.00	1.00	8.00	0.69

Table 2 Year Trend and Industry Distribution of BIED Measures

This table reports the year trend (Panel A) and industry distribution (Panel B) of our BIED measures. Our sample consists of 1,734 firms from the S&P 1500 index excluding those from financial and utility industries over the period 2000-2012. Data are from BoardEx database. Industries are defined according to the 2-digit SIC classification. All variables are defined in Appendix.

Panel A

Year	Obs	BIED_%			BIED_Blau		
		Mean	Median	Std	Mean	Median	Std
2000	1024	0.44	0.43	0.19	0.51	0.56	0.24
2001	1030	0.46	0.43	0.19	0.52	0.56	0.24
2002	1087	0.46	0.44	0.19	0.53	0.56	0.24
2003	1428	0.46	0.44	0.19	0.52	0.56	0.24
2004	1431	0.46	0.44	0.19	0.52	0.56	0.24
2005	1434	0.47	0.44	0.20	0.53	0.56	0.24
2006	1420	0.48	0.45	0.19	0.54	0.58	0.24
2007	1380	0.48	0.45	0.19	0.54	0.58	0.23
2008	1355	0.49	0.50	0.19	0.55	0.60	0.23
2009	1259	0.50	0.50	0.19	0.56	0.61	0.22
2010	1204	0.51	0.50	0.19	0.57	0.61	0.23
2011	1202	0.52	0.50	0.19	0.58	0.64	0.22
2012	671	0.53	0.50	0.19	0.60	0.64	0.21

Panel B

2-Digit Industry Classification	Obs	BIED_%			BIED_Blau		
		Mean	Median	Std	Mean	Median	Std
01 Agricultural Production – Crops	32	0.66	0.67	0.09	0.76	0.79	0.06
02 Agricultural Production – Livestock	7	0.24	0.29	0.08	0.17	0.24	0.12
07 Agricultural Services	12	0.26	0.20	0.11	0.11	0.00	0.21
10 Metal, Mining	85	0.47	0.47	0.13	0.63	0.66	0.18
12 Coal Mining	64	0.60	0.60	0.15	0.69	0.72	0.10
13 Oil & Gas Extraction	701	0.43	0.42	0.18	0.47	0.48	0.25
14 Nonmetallic Minerals, Except Fuels	52	0.39	0.35	0.14	0.51	0.56	0.20
15 General Building Contractors	155	0.40	0.38	0.16	0.43	0.41	0.21
16 Heavy Construction, Except Building	95	0.49	0.50	0.21	0.55	0.62	0.24
17 Special Trade Contractors	32	0.49	0.50	0.11	0.54	0.59	0.14
20 Food & Kindred Products	500	0.49	0.44	0.21	0.57	0.61	0.24
21 Tobacco Products	39	0.62	0.56	0.16	0.70	0.67	0.11
22 Textile Mill Products	55	0.47	0.50	0.12	0.58	0.61	0.15
23 Apparel & Other Textile Products	131	0.50	0.44	0.20	0.55	0.61	0.23
24 Lumber & Wood Products	114	0.56	0.59	0.18	0.63	0.70	0.19
25 Furniture & Fixtures	132	0.52	0.55	0.17	0.61	0.67	0.19
26 Paper & Allied Products	254	0.54	0.55	0.16	0.64	0.69	0.18
27 Printing & Publishing	196	0.48	0.48	0.17	0.58	0.64	0.21
28 Chemical & Allied Products	1520	0.46	0.45	0.18	0.53	0.58	0.23
29 Petroleum & Coal Products	130	0.54	0.57	0.20	0.63	0.73	0.23
30 Rubber & Miscellaneous Plastics Products	151	0.57	0.56	0.20	0.65	0.70	0.18
31 Leather & Leather Products	70	0.42	0.38	0.22	0.40	0.41	0.28
32 Stone, Clay, & Glass Products	119	0.46	0.43	0.17	0.52	0.56	0.21
33 Primary Metal Industries	311	0.50	0.50	0.18	0.57	0.64	0.20
34 Fabricated Metal Products	267	0.56	0.57	0.20	0.62	0.64	0.19
35 Industrial Machinery & Equipment	1270	0.52	0.50	0.19	0.60	0.64	0.20
36 Electronic & Other Electric Equipment	1496	0.46	0.43	0.19	0.49	0.53	0.24
37 Transportation Equipment	532	0.50	0.50	0.18	0.59	0.66	0.22
38 Instruments & Related Products	1177	0.48	0.46	0.19	0.55	0.59	0.22
39 Miscellaneous Manufacturing Industries	176	0.49	0.50	0.23	0.50	0.53	0.28
40 Railroad Transportation	71	0.60	0.58	0.21	0.70	0.74	0.18
41 Local & Interurban Passenger Transit	20	0.52	0.40	0.27	0.51	0.45	0.24
42 Trucking & Warehousing	171	0.38	0.36	0.19	0.38	0.32	0.27
43 U.S. Postal Service	77	0.45	0.43	0.13	0.54	0.53	0.16
45 Transportation by Air	178	0.50	0.54	0.20	0.58	0.64	0.26
47 Transportation Services	90	0.50	0.50	0.19	0.55	0.60	0.22

48 Communications	501	0.52	0.55	0.22	0.58	0.64	0.26
49 Electric, Gas, & Sanitary Services	114	0.59	0.57	0.17	0.66	0.73	0.18
50 Wholesale Trade – Durable Goods	389	0.46	0.43	0.19	0.51	0.52	0.24
51 Wholesale Trade – Nondurable Goods	225	0.47	0.43	0.17	0.54	0.56	0.19
52 Building Materials & Gardening Supplies	39	0.41	0.40	0.25	0.45	0.49	0.33
53 General Merchandise Stores	53	0.47	0.50	0.20	0.55	0.61	0.28
54 Food Stores	88	0.40	0.44	0.15	0.45	0.50	0.21
55 Automotive Dealers & Service Stations	110	0.47	0.45	0.18	0.52	0.54	0.22
56 Apparel & Accessory Stores	40	0.39	0.43	0.14	0.41	0.45	0.19
57 Furniture & Homefurnishings Stores	70	0.56	0.62	0.22	0.66	0.79	0.25
58 Eating & Drinking Places	308	0.48	0.45	0.16	0.56	0.59	0.20
59 Miscellaneous Retail	191	0.53	0.55	0.17	0.58	0.64	0.21
70 Hotels & Other Lodging Places	25	0.51	0.50	0.09	0.65	0.62	0.13
72 Personal Services	75	0.39	0.33	0.20	0.45	0.41	0.25
73 Business Services	2104	0.45	0.43	0.20	0.49	0.52	0.25
75 Auto Repair, Services, & Parking	45	0.52	0.50	0.17	0.61	0.72	0.21
78 Motion Pictures	67	0.46	0.44	0.14	0.53	0.53	0.20
79 Amusement & Recreation Services	106	0.37	0.36	0.15	0.46	0.50	0.24
80 Health Services	380	0.46	0.50	0.18	0.51	0.56	0.23
82 Educational Services	114	0.50	0.50	0.14	0.60	0.63	0.15
83 Social Services	15	0.53	0.56	0.11	0.64	0.69	0.18
87 Engineering & Management Services	316	0.54	0.50	0.21	0.59	0.61	0.21
99 Non-Classifiable Establishments	68	0.61	0.63	0.16	0.69	0.73	0.16

Table 3 BIED and Firm Value: Baseline Results

This table reports OLS regression results for the effect of BIED on firm value as proxied by Tobin's Q. Our sample consists of 1,734 firms from the S&P 1500 index excluding those from financial and utility industries over the period 2000–2012. All variable definitions are in the Appendix. All models include both year and firm fixed effects. All standard errors are clustered at the firm level and reported in parentheses. *, **, and *** denote the 10%, 5%, and 1% significance levels, respectively.

	(1)	(2)
	Tobin's Q	Tobin's Q
BIED_%	0.292**	
	(0.121)	
BIED_Blau		0.242**
		(0.118)
R&D	3.478***	3.441***
	(0.886)	(0.885)
ROA	3.540***	3.547***
	(0.269)	(0.270)
Size	-0.511***	-0.517***
	(0.046)	(0.046)
Leverage	-0.295**	-0.290**
	(0.137)	(0.137)
CAPEX	1.727***	1.757***
	(0.425)	(0.425)
Segments	-0.041***	-0.041***
	(0.013)	(0.013)
Duality	0.077**	0.080**
	(0.037)	(0.037)
Board size	-0.023**	-0.031***
	(0.012)	(0.012)
Board Independence	0.255*	0.247*
	(0.141)	(0.142)
Busy Director %	0.147	0.148
	(0.115)	(0.116)
Related Industry %	0.507	0.544
	(0.876)	(0.873)
Industry Experts %	-0.039	-0.036
	(0.126)	(0.126)
Constant	7.763***	7.831***
	(0.801)	(0.809)
Observations	15,925	15,925
R-squared	0.235	0.235

Table 4 BIED and Firm Value: Endogeneity Correction using an IV Approach

This table reports the first-stage and second-stage results from our IV regressions. Our sample consists of 1,734 firms from the S&P 1500 index excluding those from financial and utility industries over the period 2000–2012. All variable definitions are in the Appendix. All standard errors are clustered at the firm level and reported in parentheses. *, **, and *** denote the 10%, 5%, and 1% significance levels, respectively.

	(1)	(2)	(3)	(4)
	1 st Stage	2 nd Stage	1 st Stage	2 nd Stage
	BIED_%	Tobin's Q	BIED_Blau	Tobin's Q
IV: average local BIED excluding the focal firm	0.076*** (0.018)		0.101*** (0.021)	
BIED_%_instrumented		5.029** (1.989)		
BIED_Blau_instrumented				3.746*** (1.435)
R&D	-0.217*** (0.031)	10.637*** (0.574)	-0.148*** (0.039)	10.100*** (0.424)
ROA	-0.079*** (0.015)	5.758*** (0.246)	-0.090*** (0.017)	5.701*** (0.230)
Size	0.029*** (0.001)	-0.260*** (0.059)	0.030*** (0.001)	-0.227*** (0.044)
Leverage	0.010 (0.008)	-0.252*** (0.097)	0.028*** (0.009)	-0.303*** (0.101)
CAPEX	-0.052 (0.034)	2.254*** (0.350)	0.019 (0.040)	2.456*** (0.326)
Segments	0.002* (0.001)	-0.075*** (0.011)	0.000 (0.001)	-0.064*** (0.009)
Duality	-0.010*** (0.003)	0.101*** (0.034)	-0.019*** (0.004)	0.119*** (0.037)
Board size	-0.009*** (0.001)	0.035** (0.018)	0.018*** (0.001)	-0.074*** (0.026)
Board Independence	0.277*** (0.012)	-1.485*** (0.570)	0.308*** (0.013)	-1.244*** (0.460)
Busy Director %	0.226*** (0.009)	-0.722 (0.452)	0.258*** (0.010)	-0.552 (0.374)
Related Industry %	-0.006 (0.004)	0.138*** (0.034)	-0.023*** (0.005)	0.193*** (0.045)
Industry Experts %	-0.039*** (0.007)	0.118 (0.096)	-0.010 (0.008)	-0.041 (0.060)
Constant	0.345*** (0.029)	4.104*** (1.327)	0.255*** (0.026)	4.885*** (1.272)
Cragg-Donald Wald F statistic	18.00		24.18	
Observations	15,925	15,925	15,925	15,925
R-squared	0.222	0.036	0.310	0.124

Table 5 Robustness Checks: Controlling for Other Measures of Board Diversity

This table reports OLS regression results controlling for other measures of board diversity. Our sample consists of 1,734 firms from the S&P 1500 index excluding those from financial and utility industries over the period 2000–2012. Female % is the percentage of female directors on board and Foreign % is the percentage of foreign directors on board. All other variables are defined in the Appendix. All models include both year and firm fixed effects. All standard errors are clustered at the firm level and reported in parentheses. *, **, and *** denote the 10%, 5%, and 1% significance levels, respectively.

	(1) Tobin's Q	(2) Tobin's Q
BIED_%	0.281** (0.120)	
BIED_Blau		0.222* (0.119)
Female %	-0.275 (0.224)	-0.237 (0.224)
Foreign %	0.362 (0.379)	0.359 (0.379)
Std Age	0.006 (0.007)	0.006 (0.007)
Std Qualification	0.065 (0.049)	0.067 (0.049)
# Nationalities	-0.040 (0.043)	-0.040 (0.042)
R&D	3.433*** (0.883)	3.399*** (0.882)
ROA	3.538*** (0.270)	3.544*** (0.270)
Size	-0.490*** (0.044)	-0.496*** (0.044)
Leverage	-0.289** (0.136)	-0.284** (0.137)
CAPEX	1.708*** (0.427)	1.737*** (0.427)
Segments	-0.043*** (0.013)	-0.042*** (0.013)
Duality	0.068* (0.037)	0.071* (0.037)
Board size	-0.021* (0.012)	-0.028** (0.012)
Board Independence	0.281** (0.142)	0.273* (0.142)
Busy Director %	0.129 (0.114)	0.132 (0.115)
Related Industry %	0.499 (0.910)	0.534 (0.907)
Industry Experts %	-0.066 (0.127)	-0.061 (0.127)
Constant	4.672*** (0.550)	4.772*** (0.553)
Observations	15,715	15,708
R-squared	0.226	0.227

Table 6 The Mediating Effect of Patenting Activity

This table reports OLS regression results for the mediating effect of corporate innovation, based on patenting activities. Our sample consists of 1,734 firms from the S&P 1500 index excluding those from financial and utility industries over the period 2000–2012. All variable definitions are in the Appendix. All models include both year and firm fixed effects. All standard errors are clustered at the firm level and reported in parentheses. *, **, and *** denote the 10%, 5%, and 1% significance levels, respectively.

Panel A: BIED_% Measure

	(1)	(2)		(3)		(4)		(5)	
	Tobin's Q	# Patent	Tobin's Q	# Subclass	Tobin's Q	Patent Value	Tobin's Q	Std. Value	Tobin's Q
BIED	0.320** (0.141)	0.219** (0.100)	0.287** (0.139)	0.189** (0.095)	0.291** (0.139)	0.305* (0.160)	0.293** (0.139)	0.155** (0.069)	0.293** (0.139)
# Patent			0.146*** (0.021)						
# Subclass					0.150*** (0.023)				
Patent Value							0.088*** (0.013)		
Std. Value									0.173*** (0.028)
R&D	2.574*** (0.933)	-0.047 (0.411)	2.581*** (0.925)	-0.043 (0.402)	2.580*** (0.924)	-0.250 (0.640)	2.595*** (0.925)	-0.328 (0.281)	2.631*** (0.928)
ROA	3.785*** (0.319)	-0.170 (0.119)	3.810*** (0.316)	-0.187 (0.114)	3.813*** (0.316)	-0.442** (0.194)	3.824*** (0.315)	-0.160** (0.073)	3.813*** (0.317)
Size	-0.571*** (0.057)	0.145*** (0.028)	-0.592*** (0.057)	0.155*** (0.028)	-0.594*** (0.057)	0.172*** (0.048)	-0.586*** (0.057)	0.023 (0.019)	-0.575*** (0.057)
Leverage	-0.391*** (0.150)	0.009 (0.075)	-0.392*** (0.149)	-0.007 (0.073)	-0.390*** (0.149)	-0.076 (0.125)	-0.384*** (0.148)	-0.045 (0.053)	-0.383*** (0.149)
CAPEX	1.930*** (0.519)	1.033*** (0.242)	1.781*** (0.515)	0.983*** (0.224)	1.784*** (0.515)	1.615*** (0.381)	1.790*** (0.513)	0.453*** (0.146)	1.851*** (0.514)

Segments	-0.039** (0.018)	0.008 (0.021)	-0.040** (0.018)	0.009 (0.020)	-0.040** (0.018)	0.016 (0.033)	-0.040** (0.018)	0.001 (0.013)	-0.039** (0.018)
Duality	0.068 (0.042)	-0.026 (0.028)	0.072* (0.041)	-0.035 (0.027)	0.073* (0.041)	-0.037 (0.046)	0.071* (0.041)	-0.031 (0.021)	0.073* (0.041)
Board size	-0.020* (0.012)	0.003 (0.008)	-0.021* (0.012)	0.004 (0.008)	-0.021* (0.012)	0.005 (0.013)	-0.020* (0.012)	0.003 (0.007)	-0.021* (0.012)
Board Independence	0.215 (0.161)	0.229** (0.095)	0.182 (0.159)	0.208** (0.095)	0.184 (0.159)	0.326** (0.156)	0.186 (0.159)	0.084 (0.074)	0.200 (0.159)
Busy Director %	0.203 (0.135)	0.085 (0.089)	0.191 (0.134)	0.126 (0.086)	0.184 (0.134)	0.133 (0.144)	0.192 (0.134)	0.008 (0.063)	0.202 (0.133)
Related Industry %	-0.552 (0.980)	-0.092 (0.287)	-0.538 (0.982)	-0.126 (0.424)	-0.533 (0.968)	-0.460 (0.724)	-0.511 (0.961)	-0.224 (0.259)	-0.513 (0.966)
Industry Experts %	-0.084 (0.149)	-0.028 (0.096)	-0.080 (0.148)	-0.035 (0.088)	-0.079 (0.148)	-0.081 (0.142)	-0.077 (0.148)	-0.047 (0.060)	-0.076 (0.148)
Constant	8.378*** (0.785)	0.007 (0.306)	8.376*** (0.774)	-0.221 (0.323)	8.410*** (0.772)	1.103 (0.794)	8.281*** (0.756)	0.969* (0.518)	8.209*** (0.753)
Observations	11,564	11,564	11,564	11,564	11,564	11,564	11,564	11,564	11,564
R-squared	0.232	0.260	0.238	0.258	0.238	0.230	0.239	0.128	0.237

Panel B: BIED_Blau Measure

	(1)	(2)		(3)		(4)		(5)	
	Tobin's Q	# Patent	Tobin's Q	# Subclass	Tobin's Q	Patent Value	Tobin's Q	Std. Value	Tobin's Q
BIED	0.231*	0.244***	0.196	0.221***	0.198	0.340***	0.202	0.143***	0.207
	(0.131)	(0.083)	(0.129)	(0.077)	(0.129)	(0.130)	(0.129)	(0.052)	(0.129)
# Patent			0.145***						
			(0.021)						
# Subclass				0.149***					
				(0.023)					
Patent Value							0.088***		
							(0.013)		
Std. Value									0.173***
									(0.028)
R&D	2.551***	-0.052	2.559***	-0.047	2.558***	-0.259	2.573***	-0.332	2.609***
	(0.932)	(0.409)	(0.924)	(0.400)	(0.924)	(0.638)	(0.924)	(0.280)	(0.928)
ROA	3.789***	-0.163	3.812***	-0.180	3.815***	-0.432**	3.827***	-0.157**	3.815***
	(0.318)	(0.118)	(0.316)	(0.114)	(0.315)	(0.193)	(0.315)	(0.073)	(0.317)
Size	-0.575***	0.142***	-0.596***	0.153***	-0.598***	0.168***	-0.590***	0.022	-0.579***
	(0.057)	(0.028)	(0.057)	(0.028)	(0.057)	(0.048)	(0.057)	(0.019)	(0.057)
Leverage	-0.383**	0.012	-0.385**	-0.004	-0.383**	-0.070	-0.377**	-0.042	-0.376**
	(0.151)	(0.075)	(0.150)	(0.073)	(0.149)	(0.125)	(0.149)	(0.053)	(0.149)
CAPEX	1.959***	1.034***	1.809***	0.983***	1.813***	1.617***	1.819***	0.455***	1.880***
	(0.520)	(0.242)	(0.516)	(0.224)	(0.516)	(0.381)	(0.514)	(0.146)	(0.515)
Segments	-0.039**	0.008	-0.040**	0.009	-0.040**	0.015	-0.040**	0.001	-0.039**
	(0.018)	(0.021)	(0.018)	(0.020)	(0.018)	(0.033)	(0.018)	(0.013)	(0.018)
Duality	0.070*	-0.024	0.074*	-0.033	0.075*	-0.033	0.073*	-0.029	0.075*
	(0.042)	(0.028)	(0.041)	(0.027)	(0.041)	(0.046)	(0.041)	(0.021)	(0.041)
Board size	-0.028**	-0.003	-0.027**	-0.002	-0.028**	-0.004	-0.027**	-0.001	-0.028**

	(0.013)	(0.008)	(0.012)	(0.008)	(0.012)	(0.014)	(0.012)	(0.007)	(0.012)
Board Independence	0.214	0.217**	0.183	0.196**	0.185	0.309**	0.187	0.079	0.201
	(0.161)	(0.094)	(0.159)	(0.095)	(0.160)	(0.156)	(0.159)	(0.074)	(0.160)
Busy Director %	0.214	0.078	0.203	0.118	0.197	0.124	0.204	0.008	0.213
	(0.136)	(0.089)	(0.135)	(0.086)	(0.135)	(0.144)	(0.135)	(0.063)	(0.134)
Related Industry %	-0.510	-0.070	-0.500	-0.108	-0.494	-0.430	-0.472	-0.207	-0.474
	(0.978)	(0.284)	(0.981)	(0.419)	(0.967)	(0.716)	(0.960)	(0.256)	(0.965)
Industry Experts %	-0.084	-0.029	-0.080	-0.036	-0.079	-0.083	-0.078	-0.047	-0.076
	(0.149)	(0.096)	(0.148)	(0.088)	(0.148)	(0.142)	(0.148)	(0.060)	(0.148)
Constant	8.451***	0.034	8.445***	-0.200	8.480***	1.144	8.351***	0.994*	8.278***
	(0.790)	(0.305)	(0.779)	(0.323)	(0.776)	(0.795)	(0.760)	(0.519)	(0.756)
Observations	11,564	11,564	11,564	11,564	11,564	11,564	11,564	11,564	11,564
R-squared	0.232	0.260	0.238	0.259	0.238	0.231	0.239	0.128	0.237

Table 7 The Mediating Effect of Patent Citations

This table reports OLS regression results for the mediating effect of corporate innovation, based on patent citations. Our sample consists of 1,734 firms from the S&P 1500 index excluding those from financial and utility industries over the period 2000–2012. All variable definitions are in the Appendix. All models include both year and firm fixed effects. All standard errors are clustered at the firm level and reported in parentheses. *, **, and *** denote the 10%, 5%, and 1% significance levels, respectively.

	(1)		(2)		(3)		(4)	
	BIED_%		BIED_Blau		BIED_Blau		BIED_Blau	
	# Citation	Tobin's Q	Std. Citation	Tobin's Q	# Citation	Tobin's Q	Std. Citation	Tobin's Q
BIED	0.352*	0.277**	0.130	0.296**	0.341**	0.190	0.134*	0.203
	(0.188)	(0.137)	(0.111)	(0.138)	(0.157)	(0.128)	(0.074)	(0.128)
# Citation		0.121***						
		(0.016)						
Std. Citation				0.180***				
				(0.026)				
# Citation					0.120***			
					(0.016)			
Std. Citation								0.211***
								(0.035)
R&D	0.556	2.507***	0.640	2.459***	0.545	2.486***	0.448	2.457***
	(0.724)	(0.919)	(0.425)	(0.925)	(0.722)	(0.918)	(0.338)	(0.921)
ROA	-0.527**	3.849***	-0.315***	3.842***	-0.520**	3.851***	-0.198*	3.830***
	(0.215)	(0.315)	(0.119)	(0.317)	(0.214)	(0.315)	(0.101)	(0.317)
Size	0.258***	-0.602***	0.105***	-0.590***	0.255***	-0.606***	0.084***	-0.593***
	(0.054)	(0.057)	(0.031)	(0.057)	(0.054)	(0.057)	(0.025)	(0.057)
Leverage	-0.067	-0.383***	-0.057	-0.380**	-0.055	-0.377**	-0.014	-0.380**
	(0.142)	(0.148)	(0.083)	(0.148)	(0.142)	(0.148)	(0.067)	(0.149)
CAPEX	1.907***	1.701***	0.805***	1.787***	1.908***	1.730***	0.859***	1.779***
	(0.462)	(0.505)	(0.290)	(0.505)	(0.463)	(0.506)	(0.240)	(0.510)
Segments	-0.005	-0.038**	-0.012	-0.037**	-0.005	-0.038**	-0.009	-0.037**

	(0.037)	(0.018)	(0.019)	(0.018)	(0.037)	(0.018)	(0.014)	(0.018)
Duality	-0.048	0.074*	-0.016	0.071*	-0.044	0.076*	-0.018	0.074*
	(0.053)	(0.041)	(0.031)	(0.041)	(0.053)	(0.041)	(0.025)	(0.041)
Board size	0.011	-0.021*	0.006	-0.021*	0.001	-0.028**	-0.007	-0.026**
	(0.015)	(0.012)	(0.009)	(0.012)	(0.015)	(0.012)	(0.007)	(0.012)
Board Independence	0.527***	0.153	0.291**	0.164	0.514***	0.154	0.204**	0.172
	(0.192)	(0.159)	(0.116)	(0.160)	(0.191)	(0.159)	(0.092)	(0.160)
Busy Director %	0.299*	0.167	0.185*	0.170	0.297*	0.178	0.144*	0.184
	(0.166)	(0.133)	(0.097)	(0.133)	(0.167)	(0.134)	(0.076)	(0.134)
Related Industry %	-0.697	-0.467	-0.387	-0.482	-0.661	-0.430	-0.232	-0.461
	(0.694)	(0.962)	(0.408)	(0.961)	(0.687)	(0.961)	(0.269)	(0.971)
Industry Experts %	-0.159	-0.065	-0.114	-0.063	-0.162	-0.065	-0.014	-0.081
	(0.189)	(0.147)	(0.109)	(0.147)	(0.188)	(0.147)	(0.087)	(0.147)
Constant	0.313	8.338***	0.294	8.323***	0.372	8.404***	0.471	8.350***
	(0.968)	(0.745)	(0.714)	(0.743)	(0.969)	(0.748)	(0.506)	(0.755)
Observations	11,564	11,564	11,564	11,564	11,564	11,564	11,564	11,564
R-squared	0.321	0.244	0.273	0.242	0.322	0.245	0.276	0.241

Table 8 The Interaction Effect of BIED and Innovation Measure

This table reports OLS regression results for the interaction analysis. Our sample consists of 1,734 firms from the S&P 1500 index excluding those from financial and utility industries over the period 2000–2012. All variable definitions are in the Appendix. All models include both year and firm fixed effects. All standard errors are clustered at the firm level and reported in parentheses. *, **, and *** denote the 10%, 5%, and 1% significance levels, respectively.

Panel A: BIED_% Measure

	(1) Tobin's Q	(2) Tobin's Q	(3) Tobin's Q	(4) Tobin's Q	(5) Tobin's Q	(6) Tobin's Q
BIED	0.399*** (0.141)	0.419*** (0.139)	0.406*** (0.139)	0.415*** (0.138)	0.340** (0.135)	0.321** (0.132)
# Patent	0.203*** (0.041)					
BIED*# Patent	-0.120 (0.075)					
# Subclass		0.226*** (0.045)				
BIED*# Subclass		-0.155** (0.078)				
Value			0.126*** (0.027)			
BIED*Value			-0.076 (0.048)			
Std. Value				0.321*** (0.075)		
BIED*Std. Value				-0.281** (0.129)		
# Citation					0.150*** (0.033)	
BIED*# Citation					-0.060 (0.061)	
Std. Citation						0.258*** (0.078)
BIED*Std. Citation						-0.100

						(0.152)
R&D	2.571*** (0.924)	2.573*** (0.924)	2.588*** (0.925)	2.617*** (0.928)	2.498*** (0.919)	2.469*** (0.922)
ROA	3.810*** (0.316)	3.814*** (0.315)	3.827*** (0.315)	3.815*** (0.316)	3.848*** (0.315)	3.825*** (0.317)
Size	-0.591*** (0.057)	-0.592*** (0.057)	-0.585*** (0.057)	-0.574*** (0.057)	-0.601*** (0.057)	-0.588*** (0.057)
Leverage	-0.389*** (0.149)	-0.387*** (0.148)	-0.382** (0.148)	-0.378** (0.148)	-0.382*** (0.147)	-0.386*** (0.148)
CAPEX	1.763*** (0.514)	1.764*** (0.515)	1.769*** (0.512)	1.823*** (0.514)	1.686*** (0.504)	1.737*** (0.509)
Segments	-0.038** (0.018)	-0.038** (0.018)	-0.038** (0.018)	-0.037** (0.018)	-0.036** (0.018)	-0.036** (0.018)
Duality	0.073* (0.041)	0.074* (0.041)	0.072* (0.041)	0.075* (0.041)	0.074* (0.041)	0.072* (0.041)
Board size	-0.021* (0.012)	-0.022* (0.012)	-0.021* (0.012)	-0.021* (0.012)	-0.022* (0.012)	-0.020* (0.012)
Board Independence	0.176 (0.159)	0.174 (0.159)	0.179 (0.159)	0.194 (0.159)	0.145 (0.159)	0.167 (0.160)
Busy Director %	0.191 (0.134)	0.186 (0.134)	0.195 (0.133)	0.213 (0.133)	0.170 (0.132)	0.178 (0.132)
Related Industry %	-0.563 (0.983)	-0.566 (0.969)	-0.532 (0.961)	-0.543 (0.966)	-0.483 (0.963)	-0.510 (0.973)
Industry Experts %	-0.083 (0.148)	-0.082 (0.148)	-0.081 (0.148)	-0.077 (0.148)	-0.065 (0.147)	-0.082 (0.147)
Constant	8.366*** (0.771)	8.395*** (0.768)	8.263*** (0.753)	8.191*** (0.750)	8.326*** (0.744)	8.279*** (0.752)
Observations	11,564	11,564	11,564	11,564	11,564	11,564
R-squared	0.239	0.239	0.239	0.238	0.245	0.241

Panel B: BIED_Blau Measure

	(1) # Patent	(2) # Subclass	(3) Patent Value	(4) Std. Value	(5) # Citation	(6) Std. Citation
BIED	0.355*** (0.131)	0.374*** (0.131)	0.372*** (0.129)	0.358*** (0.127)	0.307** (0.127)	0.283** (0.125)
# Patent	0.257*** (0.046)					0.320*** (0.076)
BIED*# Patent	-0.195*** (0.070)					-0.204* (0.120)
# Subclass		0.289*** (0.051)				
BIED*# Subclass		-0.239*** (0.075)				
Value			0.164*** (0.029)			
BIED*Value			-0.130*** (0.043)			
Std. Value				0.429*** (0.080)		
BIED*Std. Value				-0.409*** (0.111)		
# Citation					0.188*** (0.035)	
BIED*# Citation					-0.118** (0.053)	
Std. Citation						0.320*** (0.076)
BIED*Std. Citation						-0.204* (0.120)
R&D	2.533*** (0.921)	2.532*** (0.922)	2.554*** (0.923)	2.586*** (0.926)	2.461*** (0.915)	2.437*** (0.919)

ROA	3.814*** (0.315)	3.817*** (0.315)	3.832*** (0.315)	3.820*** (0.316)	3.850*** (0.314)	3.825*** (0.317)
Size	-0.593*** (0.057)	-0.595*** (0.057)	-0.586*** (0.057)	-0.577*** (0.057)	-0.602*** (0.057)	-0.590*** (0.057)
Leverage	-0.384** (0.149)	-0.383** (0.148)	-0.377** (0.148)	-0.372** (0.148)	-0.377** (0.148)	-0.380** (0.148)
CAPEX	1.753*** (0.514)	1.751*** (0.514)	1.756*** (0.511)	1.807*** (0.512)	1.678*** (0.503)	1.736*** (0.508)
Segments	-0.037** (0.018)	-0.037** (0.018)	-0.037** (0.018)	-0.038** (0.018)	-0.035* (0.018)	-0.035* (0.018)
Duality	0.075* (0.041)	0.076* (0.041)	0.074* (0.041)	0.078* (0.041)	0.075* (0.041)	0.073* (0.041)
Board size	-0.028** (0.012)	-0.028** (0.012)	-0.028** (0.012)	-0.027** (0.012)	-0.028** (0.012)	-0.026** (0.012)
Board Independence	0.175 (0.159)	0.173 (0.160)	0.176 (0.159)	0.191 (0.160)	0.137 (0.159)	0.158 (0.160)
Busy Director %	0.204 (0.135)	0.199 (0.135)	0.210 (0.134)	0.230* (0.134)	0.184 (0.133)	0.192 (0.133)
Related Industry %	-0.533 (0.983)	-0.536 (0.970)	-0.506 (0.963)	-0.513 (0.969)	-0.467 (0.964)	-0.492 (0.973)
Industry Experts %	-0.081 (0.148)	-0.079 (0.149)	-0.080 (0.148)	-0.077 (0.148)	-0.064 (0.147)	-0.081 (0.147)
Constant	8.402*** (0.785)	8.426*** (0.784)	8.299*** (0.770)	8.251*** (0.768)	8.370*** (0.756)	8.338*** (0.762)
Observations	11,564	11,564	11,564	11,564	11,564	11,564
R-squared	0.240	0.240	0.240	0.240	0.246	0.241

Highlights

1. Does industry-experience diversity on corporate boards create firm value?
2. We construct a sophisticated measure “board industry-experience diversity (BIED)” to proxy for board diversity.
3. Higher BIED leads to higher firm value.
4. BIED enhances firm value through the channel of corporate innovation, as measured by patenting activities and patent citations.

Conflict of Interest

The authors declare that there is no identified conflict of interest.

Journal Pre-proof