

Supplementary Material for
“Corporate Innovation: Do Diverse Boards Help?”

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Supplemental Appendix A. Construction of the Board Diversity Index

The composite board diversity index consists of six subindexes: i) a demographic diversity index, ii) an educational diversity index, iii) a professional diversity index, iv) a director experience index, v) a managerial trait index, and vi) a cultural diversity index.

A. Step 1: Development of Sub-Index Components

1. Sub-Index I: Demographic Diversity

Age Diversity

We measure the board age diversity by the coefficient of variance (CV) of directors' age across the board. A higher CV indicates a greater degree of age diversity:

$$(A-1) \quad \text{AGE_DIVERSITY} = \frac{\text{Standard Deviation of Age}}{\text{Mean of Age}}.$$

Gender Diversity

We measure gender diversity with the Teachman (1980) entropy-based index:

$$(A-2) \quad \text{GENDER_DIVERSITY} = \sum(-p_i) \times \ln(p_i),$$

where p_1 (p_2) is the proportion of male (female) board directors.

Nationality Diversity

We measure nationality diversity using the total number of directors' nationalities scaled by the board size (i.e., the total number of directors) whereas NATIONALITY refers to a director's nationality:

$$(A-3) \quad \text{NATIONALITY_DIVERSITY} = \frac{\text{Total Number of Nationalities}}{\text{Total Number of Directors}}$$

We count dual nationalities as two nationalities.

2. Sub-Index II: Educational Diversity

Educational Degree Diversity

We classify all directors' educational degrees into six categories: i) bachelor's, ii) juris doctor (JD), iii) masters of business administration (MBA), iv) master's, v) PhD/MD, and vi) other degrees (including no college degrees). We measure educational degree diversity using the HHI, which is the sum of the squares of the percentage of directors holding each degree across the board:

$$(A-4) \quad \text{EDU_DEGREE_DIVERSITY} = \sum \left(\frac{\text{NumberofDirectorsHoldingCertainDegree}}{\text{TotalNumberofDirectors}} \right)^2 .$$

Different from the coefficient of variance, the HHI is an inverse measure. Therefore, a higher HHI indicates a lower degree of diversity.

Educational Background Diversity

We classify directors' educational background into five categories: i) business, ii) art, iii) STEM, iv) law, v) medicine, and vi) others. Educational background diversity is also measured by the HHI, which is the sum of the squares of the percentage of directors with certain educational background across the board:

$$(A-5) \quad \text{EDU_BACKGROUND_DIVERSITY} = \sum \left(\frac{\text{NumberofDirectorswithCertainBackground}}{\text{TotalNumberofDirectors}} \right)^2$$

3. Sub-Index III: Professional Diversity

Expertise Diversity

We classify all directors' expertise or professional backgrounds into five categories: i) industry, ii) finance, iii) consulting, iv) law, and v) academia, and measure expertise diversity by the HHI:

$$(A-6) \quad \text{EXPERTISE_DIVERSITY} = \sum \left(\frac{\text{Number of Directors with Certain Expertise}}{\text{Total Number of Directors}} \right)^2 .$$

Business-Founding Experience Diversity

We first calculate the percentage of directors who have experience founding a business with any firm and then measure business-founding experience diversity by the Teachman (1980) entropy-based index:

$$(A-7) \quad \text{FOUNDING_EXP_DIVERSITY} = \sum (-p_i) \times \ln(p_i),$$

where p_1 (p_2) is the proportion of board directors with (without) business-founding experience.

Executive Position Diversity

We classify all directors' highest executive positions as belonging to one of four categories: i) CEO, ii) chair, iii) other executive positions (including chief financial officer, chief operating officer, chief technology officer, vice chair, president, vice president, managing director, and managing partner), and iv) other positions (including treasurer, secretary, and controller).

Executive position diversity is also measured using the HHI:

$$(A-8) \quad \text{EXECUTIVE_POSITION_DIVERSITY} = \sum \left(\frac{\text{NumberofDirectorswithCertainPosition}}{\text{TotalNumberofDirectors}} \right)^2$$

4. Sub-Index IV: Director Experience Diversity

Tenure Diversity

We measure directors' tenure diversity by the CV of the number of years the directors have been serving on the board.

$$(A-9) \quad \text{TENURE_DIVERSITY} = \frac{\text{Standard Deviation of Director Tenure}}{\text{Mean of Director Tenure}}.$$

We measure tenure by the number of years that a director has been serving on the board. Our main results hold if we measure tenure by directorship at any firm(s).

External Board Seat Diversity

We measure external board seat diversity using the CV of the number of board seats the directors hold in other firms:

$$(A-10) \quad \text{EXTERNAL_SEATS_DIVERSITY} = \frac{\text{Standard Deviation of External Board Seats}}{\text{Mean of External Board Seats}}.$$

Independence Diversity

We first calculate the percentage of independent directors on a board and then measure independence diversity by the Teachman (1980) entropy-based index:

$$(A-11) \quad \text{INDEPENDENCE_DIVERSITY} = \sum(-p_i) \times \ln(p_i),$$

where p_1 (p_2) is the proportion of independent (nonindependent) directors.

Board Size Diversity

We measure board size diversity as the total number of directors on the board (larger boards tend to be more diverse).

$$(A-12) \quad \text{BOARDSIZE_DIVERSITY} = \text{Total Number of Directors on a Board}.$$

Political Connection Diversity

We follow Goldman, Rocholl, and So (2009) and classify a director as politically connected if the director has held at least one of the following former positions: president, presidential (vice-presidential) candidate, member of the U.S. Congress, (assistant) secretary, deputy secretary, deputy assistant secretary, undersecretary, governor, director (CIA, FEMA), deputy director (CIA, OMB), associate director, commissioner (IRS, NRC, SSA, CRC, FDA, SEC), representative to the United Nations, ambassador, mayor, staff (White House, president, presidential campaign), chair of the party caucus, chair or staff of the presidential election campaign, and chair or member of one of the president's committees/councils. We first calculate the percentage of directors who have political connections and then measure political connection diversity using the Teachman (1980) entropy-based index:

$$(A-13) \quad \text{POLITICAL_CONNECTION}_{\text{diversity}} = \sum(-p_i) \times \ln(p_i),$$

where p_1 (p_2) is the proportion of politically connected (unconnected) directors.

5. Sub-Index V: Managerial Trait Diversity

Military Experience Diversity

We first calculate the percentage of directors who have military experience and then measure the military experience diversity by the Teachman (1980) entropy-based index:

$$(A-14) \quad \text{MILITARY_EXP_DIVERSITY} = \sum(-p_i) \times \ln(p_i),$$

where p_1 (p_2) is the proportion of board directors with (without) military experience.

Depression Baby Diversity

Following Malmendier, Tate, and Yan (2011), we classify a director as a Depression baby if the director was born before 1931 (the Great Depression period). We first calculate the percentage of Depression babies across the board and then measure Depression baby diversity using the Teachman (1980) entropy-based index:

$$(A-15) \quad \text{DEPRESSION_BABY_DIVERSITY} = \sum(-p_i) \times \ln(p_i),$$

where p_1 (p_2) is the proportion of board directors who are (are not) Depression babies.

6. Sub-Index VI: Cultural Diversity

Based on directors' nationalities, we consider five dimensions of cultural diversity (power distance, individualism, uncertainty avoidance, masculinity, and long-term orientation) and estimate the CV of each dimension.

Power Distance Diversity

Power distance measures the extent to which the less powerful accept that power is distributed unequally. The higher the power distance score in a country, the more that people in that country accept that power is distributed unequally. For example, Arab countries have higher power distance scores than Western European countries.

$$(A-16) \quad \text{POWER_DISTANCE_DIVERSITY} = \frac{\text{Standard Deviation of Power Distance Score}}{\text{Mean of Power Distance Score}}.$$

Individualism Diversity

Individualism measures the degree of preference for a loosely knit social framework in which individuals are expected to take care of only themselves.

$$(A-17) \quad \text{INDIVIDUALISM_DIVERSITY} = \frac{\text{Standard Deviation of Individualism Score}}{\text{Mean of Individualism Score}}.$$

Uncertainty Avoidance Diversity

Uncertainty avoidance measures the degree to which people in a country feel uncomfortable with uncertainty and ambiguity.

$$(A-18) \quad \text{UNCERTAINTY_AVOIDANCE} = \frac{\text{Standard Deviation of Uncertainty Avoidance Score}}{\text{Mean of Uncertainty Avoidance Score}}.$$

Masculinity Diversity

Masculinity measures the degree of preference in society for achievement, heroism, assertiveness, and material rewards for success.

$$(A-19) \quad \text{MASCULINITY_DIVERSITY} = \frac{\text{Standard Deviation of Masculinity}}{\text{Mean of Masculinity}}.$$

Long-Term Orientation Diversity

Long-term orientation reflects the fostering in a society of pragmatic virtues oriented toward future rewards, in particular perseverance and thrift.

$$(A-20) \quad \text{LONG-TERM ORIENTATION_DIVERSITY} = \frac{\text{Standard Deviation of Long-Term Orientation}}{\text{Mean of Long-Term Orientation}}$$

B. Step 2: Constructing the Six Subindexes

After we calculate the 20 components, we rank each firm component based on sample quintiles of all firms in the year. For example, because the age component is measured by the CV of all directors' ages across the board, a higher value of this component indicates a higher level of diversity. A firm would earn a rank of 5 on age diversity if the value of its age component falls in the fifth quintile of all firms in that year. Similarly, we assign the first quintile a rank of 1, the second quintile a rank of 2, and so forth for the following components: gender, nationality, founding experience, tenure, number of external board seats, independence, board size, political connections, military experience, Depression baby, and the five cultural components.

A higher value indicates a *lower* degree of diversity for the remaining components: educational degree and background, director expertise, and executive positions. A lower (higher) rank indicates a higher (lower) degree of diversity, since they are measured by HHI. Therefore, we assign the first quintile a rank of 5, the second quintile a rank of 4, and so forth.

To construct a subindex, we sum the rank numbers of its corresponding components and then scale the sum by 100:

$$(A-21) \quad \text{Subindex} = \sum \text{Rank}_i / 100.$$

As explained in the data and variable section, we scale the indexes by 100 to make the composite diversity index range between 0 and 1.

C. Step 3: Constructing the Composite Board Diversity Index

The board diversity index is the sum of the six subindex scores:

$$(A-22) \quad \text{BRD_DIVERSITY} = \sum \text{Subindex}_i.$$