

A brokerage-based measure of organizational diversity and exploratory analysis of regulatory violations among Fortune 100 corporations

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Abstract

In this paper, we introduce a straightforward method to measure organizational diversity that utilizes the importance of social ties. In developing our single-mode brokerage-based measure of diversity, two themes are central. The first stems from the work that has emphasized the benefits of increased diversity for organizational decision-making, while the second draws on the insights from social network analyses to consider the roles that individuals play in connecting individuals not already affiliated. The paper is organized into three sections: the first contextualizes our measure within the work that has theorized the importance of brokerage, homophily, and organizational diversity; the second describes and outlines the steps for deconstructing brokerage roles that is necessary to generate our measure of organizational diversity; and the third contributes to the literature by applying our brokerage-based measures of diversity to an exploration of whether increased levels of demographic diversity is related to greater corporate responsibility in 2005 as indicated by lower numbers of regulatory violations among the Fortune 100.

Keywords

Brokerage roles, Organizational diversity, Corporate social responsibility, Interlocking directorates, Regulatory violations.

One of the pioneers of social network theory is Mark Granovetter, whose 1973 article in the *American Journal of Sociology*, "The strength of weak ties," challenged much of the existing discourse that exalted the value of strong ties in social networks. Instead, Granovetter noted that strong ties could lead to overall social fragmentation based on how they encouraged local level cohesion, and that weak ties were advantageous for increasing cohesion within communities comprised of different groups or greater integration across communities. As a result, weak ties can lead to social mobility and opportunity (Granovetter, 1974). Similarly, the principle of homophily has prominence in much of the theory surrounding social network scholarship (McPherson and Smith-Lovin, 1987; McPherson et al., 2001).

However, recent scholarship has highlighted the strength of cognitively diverse teams for problem solving and decision making (Page, 2007). Through a diversity of perspectives, interpretations, heuristics and predictive models, Page shows how cognitive diversity leads to better decisions. Furthermore, Page extends the concept to identity diversity. Understandably, social identities impact the lived experiences of individuals, and those heterogeneous experiences, when "well-managed," are also associated with cognitive diversity (Page, 2007, p. 314). In this paper, we combine Granovetter's and Page's insights to develop and apply a brokerage-based measure of organizational diversity. And while the main contribution of the paper is methodological, it is important to contextualize our approach within extant

scholarship that addresses the positive effects of diversity on organizational performance.

We readily acknowledge that identity diversity can take a variety of forms as there are potentially numerous social identities that any one individual carries. As complex human beings with multiple intersecting and coexisting identities, no person is simply one category or another (Collins, 1999; Crenshaw, 1991). Nonetheless, two areas of identity diversity that have received significant scholarly attention are racial diversity and sex diversity. Several studies have explored the impact of the racial diversity of a group on the quality of decision-making. Phillips et al. (2005) found that racially diverse groups outperformed racially homogeneous groups in decision-making, whether or not they learned about deep-level similarities between group members. In their study, surface-level homogeneous groups performed slightly better when learning about deep-level similarities, but learning about deep-level similarities had no discernable impact on the performance of surface-level diverse groups, which consistently outperformed the homogeneous groups (Phillips et al., 2005). In another study, Antonio et al. (2004) found that the presence of racial and opinion minorities in small groups had a positive impact on their integrative complexity – that is how one's cognitive process and style integrates, differentiates, and reconciles varying dimensions and perspectives – thereby providing more insight into decision-making processes and how they may differ in diverse groups. The effect of racial diversity on decision-making also has been applied to mock jury deliberations where racially diverse juries exchanged a wider range of information than racially homogeneous (all-white) juries (Sommers, 2006). Equally significant, this difference was not simply due to the performance of the specific Black jurors, but rather underscored the importance of Page's cognitive diversity. Finally, regarding decision-making on corporate boards, Richard et al. (2003) underscore that racial diversity is a knowledge-based resource that is contingent on the type of task and innovation strategy.

Much like with racial diversity, sex diversity also produces benefits in terms of the quality of decision-making. This area of scholarship has been particularly prominent in corporate governance with the extant literature presenting mixed results. Early work by Erhardt et al. (2003) showed that the average percent of nonwhites and white females in 1997 and 1998 significantly increased return on assets and return on investment for 112 US corporations. From a comparative perspective, similar findings were found in Spain where Campbell and Mínguez-Vera (2008)

and Reguera-Alvarado et al. (2017) both concluded that the percentage of women on the board, as well as measures for “variety” and “balance,” were all significantly related to financial performance as measured by Tobin's Q. Yet, Bennis et al. (2018) reported mixed results on this question; though the accounting measures of performance were positively associated with diversity, the association with Tobin's Q disappeared when controlling for endogenous effects. Similarly, Pletzer et al. (2015) meta-analysis of 20 studies identified in the spring of 2014 and covering 3,000 companies, revealed no correlation between the percentage of women on corporate boards and firm performance as measured by one of the following: return on assets, return on equity, or Tobin's Q. However, when one expands our assessment beyond accounting measures, the research results become more nuanced. For example, greater sex diversity was associated with positive financial performance for those firms who pursued growth or innovation strategies (Dezsö and Ross, 2012) that undoubtedly benefitted from the enhanced decision-making processes generated from cognitive diversity.

As a closing note, it is important to bear in mind that corporate boards of directors are unlike other social groups in so far as these governance bodies wield immense power and resources. And even if people of color and women remain underrepresented on corporate boards, they nonetheless can be considered part of the economic elite (Domhoff and Zweigenhaft, 2006). In Sweden for example, research has shown that women who occupy these positions, while not numerically on parity with men, maintain the same structural status as elite men in those positions (Edling et al., 2013). Furthermore, diversifying corporate boards does not necessarily come easily, as the patterns of elites on corporate boards opening up their ranks to women often involve outside pressure as a catalyst (Heemskerk and Fennema, 2014).

Deconstructing brokerage roles

There have been significant developments in how network scientists have conceptualized brokerage roles. Beginning with a clear definition of brokerage, a brokerage role exists when an actor serves as an intermediary between two other unconnected actors. Depending upon the attributes of the actors, Gould and Fernandez (1989) identified five types of brokers in networks of directed ties. A coordinator emerges when an actor connects two other actors and all three of these individuals are members that share the same attribute or are members of the same group.

When a broker belonging to one group connects two other individuals who are members of a different group, an itinerant broker role emerges. If one of the unconnected actors shares the same attribute as the broker, but they both differ from the third actor, two types of brokerage roles can occur depending on the direction of the ties. A representative brokerage role occurs if the broker is in the middle of the path between actor who shares the same attribute as the broker and the third individual who possesses a different attribute. On the other hand, if direction of the path is reversed, then the broker serves as a gatekeeper. Finally, if all three actors possess a different attribute or belong to different groups, then a liaison brokerage role is formed. Figure 1 illustrates these brokerage roles with the shading of the vertices indicating group membership or different values of an attribute. In a network of undirected ties, there is no difference between representative and gatekeeper brokerage roles. Given that our analyses of corporate interlocking directorates utilize undirected ties, there are only four distinct brokerage ties in our analyses.

Network scholarship on brokerage ties has extended Gould and Fernandez's conceptualization of brokerage to two-mode networks. Two-mode, or affiliation, networks operate on distinct levels of analyses and consequently, can bring to bear data on these different units of analyses. Jasny and Lubell (2015) have developed a two-dimensional typology of organizational diversity utilizing differences in the institutions (M_1) and organizations (M_2). Their typology ranges from "More Homogeneous" to "More Heterogeneous" which is an important conceptual advance over Fernandez and Gould (1994) measure of "inside" versus "outside" brokerage. With the same motivation to extend the Gould and Fernandez typology of brokerage to first, retain greater information from the configuration of network ties and second, to operate at both the individual and organization levels of analysis, we propose a

two-step approach in developing our brokerage-based measure of organizational diversity. The first begins at the individual level and calculates brokerage roles applying Gould and Fernandez's methodology for a one-mode projection of directors linked through shared board memberships. This approach offers several advantages. First, by constructing our measure of organizational diversity using a one-mode projection of directors, we are able to decompose the number of various brokerage roles using standard network software such as Pajek or UCINET (we used the former). The second advantage to this more simplified approach is that we are able to add greater conceptual sensitivity to the calculation of the brokerage roles beyond Fernandez and Gould (1994) "inside" versus "outside" and Jasney and Lubell's scale of homogeneous to heterogeneous. As we will show, by decomposing the total number of brokerage roles each vertex possesses, we are able to capture the *type* of diversity. Finally, by conducting the brokerage analyses on one level of analyses (directors) and then using these results to develop a measure of organizational diversity (corporations), our method utilizes data on both levels of analyses.

Our deconstruction begins by creating an affiliation network of directors and their membership on the boards of directors across the Fortune 100 corporations in 2005. The occurrence of multiple board memberships by a single individual generates the phenomena of interlocking directorates. While there is an extensive literature on interlocking directorates, suffice it to say that interlocking directorates create inter-organizational networks of corporations linked through shared board members; or interpersonal networks of directors tied together through their mutual affiliations on corporate boards. Our affiliation network based on the Fortune 100 corporations yields 1,248 affiliations across 1,064 unique directors. Of these directors, 142 sat on the

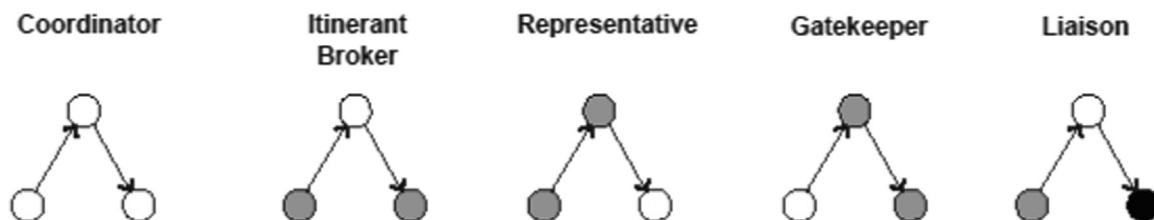


Figure 1: Five types of brokerage roles.

boards of two corporations, 42 served on three boards of directors, and two individuals were board members of four corporations. Given the centrality of the race and sex of our directors, it is also important to note the demographic characteristics of the directors in this study. The literature on corporate board diversity has consistently reported an over-representation of white men and under-representation of women and directors of color. Therefore, it should not be surprising that for our 1,064 directors, 776 or 72.9 percent of the directors were white males, 111 were nonwhite males (10.4 percent). In all, 13.6 percent were white females ($n=145$) and only 32 (3.0 percent) were nonwhite females. While the relatively small number of nonwhite females might raise questions about the utility of a brokerage-based measure of organizational diversity, we illustrate below how even a small number of, for example, white females generate (relatively speaking) a much greater number of brokerage roles involving sex-based diversity, or race- and sex-based diversity.

Next, we constructed a one-mode projection of the network of directors connected through undirected ties formed through their corporate board affiliations. We also created an attribute file with the directors' race-sex code: 1=white male, 2=nonwhite male, 3=white female, and 4=nonwhite female.¹ Both Pajek and UCINET produce a census of the five brokerage roles identified by Gould and Fernandez for each vertex and for the network as a whole. However, because these programs are more concerned with the structural properties of the brokerage roles, these tools do not distinguish between the different, "types," of a given brokerage role. Given the focus of our analyses, it is vitally important to distinguish if a specific director has brokerage roles that involve race, sex, or both types of demographic diversity. Figure 2 specifies the various brokerage roles formed through undirected ties for white males and classifies these brokerage roles according to the type of demographic diversity they represent.

Beginning with coordinators, these brokerage roles (by definition) do not involve any diversity on the dimensions of race and sex. Utilizing our four-category race-sex variable, the next row of Figure 2

shows how a white male can serve as an itinerant broker between two nonwhite males, two white females, or two nonwhite females. This means that such a director can serve in an itinerant broker role that produces, respectively, race diversity (orange box), sex diversity (blue box), or both (green box). While it is true that a white male itinerant broker situated between two nonwhite females represents the "most" diversity, it is also meaningful to think of types of diversity, as opposed to the level of diversity. It is also important to emphasize that under the Gould and Fernandez methodology, all three itinerant broker roles we be treated the same. However, by being mindful of the type of diversity represented, our more nuanced view of brokerage adds conceptual clarity. Working our way down Figure 2, the brokerage roles of representatives or gatekeepers also can be classified as to whether these brokerage roles involve race, sex or both types of diversity. Finally, since liaisons require differences for the attribute in question for all three vertices, all three types of liaison roles for white males involve both types of demographic diversity.

Figure 3 provides an example from a small portion of the network of interlocking directorates from the Fortune 100 in 2005. Each of the seventy vertices has been color-coded to indicate the directors' race and sex according to the colors in Figure 1. Green vertices represent white males, blue indicate nonwhite males, orange signify white females, and yellow vertices indicate that the director is a nonwhite female. This sociogram has been constructed with the directors for Abbott Laboratories residing in the center and the corporations that are interlocked with Abbott Laboratories through shared board members surround our focal corporation. Finally, the directors that form bridges to the other corporations are positioned so that the various types of brokerage ties can be more easily identified. As Figure 3 illustrates, there are six directors serving on the board of Abbott Laboratories that are structurally positioned to serve as a broker: Roxanne S. Austin (white female), and five white males: William M. Daley, W. James Farrell, H. Laurance Fuller, Jack M. Greenberg, and John R. Walter.

Limiting our narrative to a few of the brokerage roles evident in this sociogram, it is easy to "see" that Roxanne Austin serves as a coordinator between Ann Reynolds (Abbott) and Mary Minnick and Anne-Marie Mulcahy (Target). As noted above, serving as a coordinator does not involve any race or sex-based diversity. Roxanne Austin also is an itinerant broker between Robert Ulrich (Target) and Jack Greenberg (Abbott), both white males. This

¹We acknowledge the negative implications of using a binary male-female code for our attribute variable. Nonetheless, we have decided to use a binary code for gender as we suspect that the incidence of nonbinary or gender-nonconforming board directors on Fortune 100 companies is extremely small.

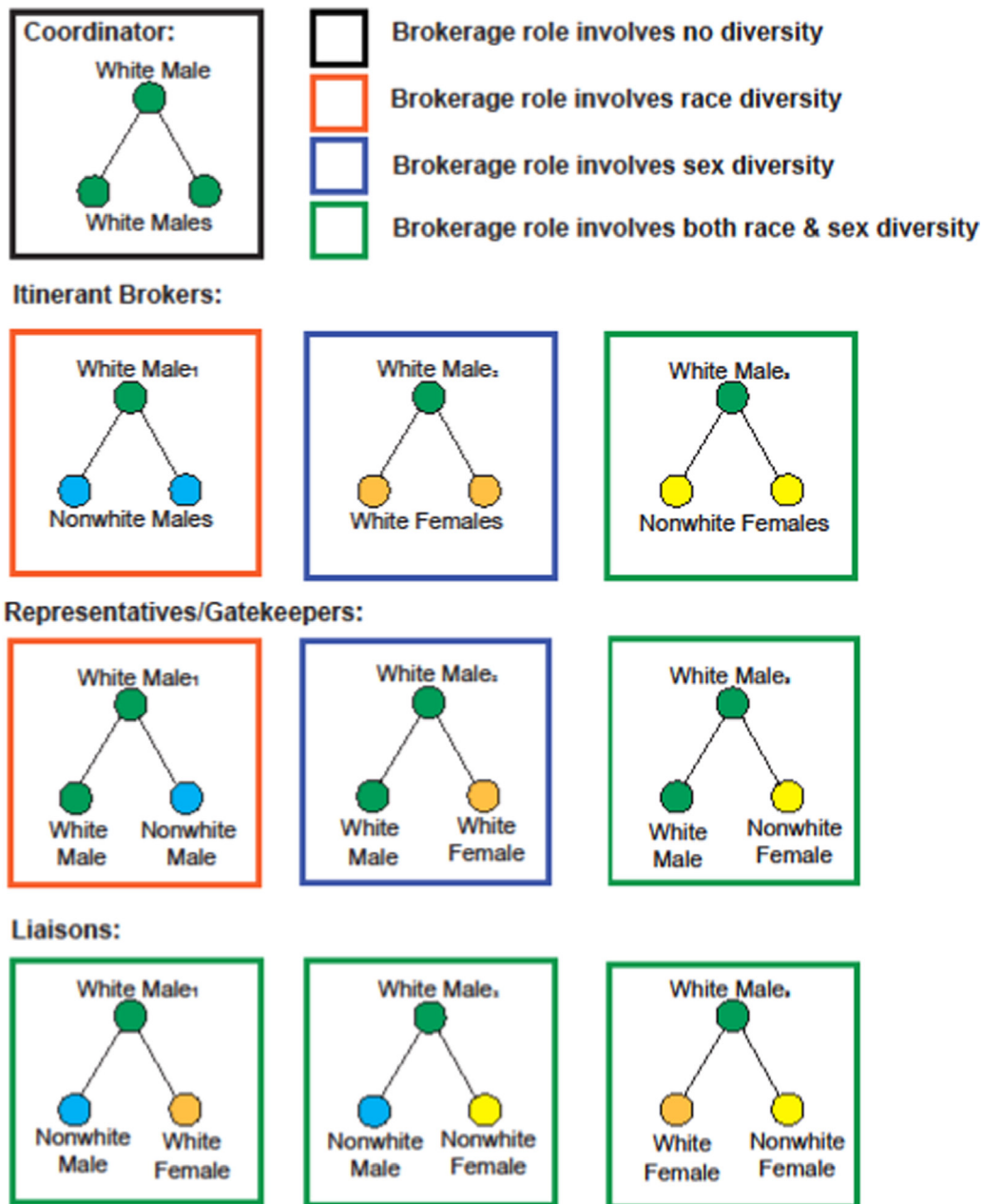


Figure 2: Decomposition of brokerage roles and classification of type of race-sex diversity.

means that this specific brokerage role involves sex-based diversity. Situated on the only path between Ann Reynolds (white female director at Abbott) and James Johnson (white male director from Target), Roxanne Austin also is also both a representative or a gatekeeper between these two corporate directors. These complementary brokerage roles also involve only sex-based diversity. Finally, the vertices on the upper right side of Figure 3

illustrate how Roxanne Austin is a liaison between H. Laurance Fuller (Abbott) and Solomon Trujillo (Target). This brokerage role involves both race and sex-based diversity since Roxanne Austin serves as a broker between a white male director from Abbott and a nonwhite male from Target.

While these individual examples are illustrative, one cannot visually identify all the brokerage roles in this small example, let alone a network of all

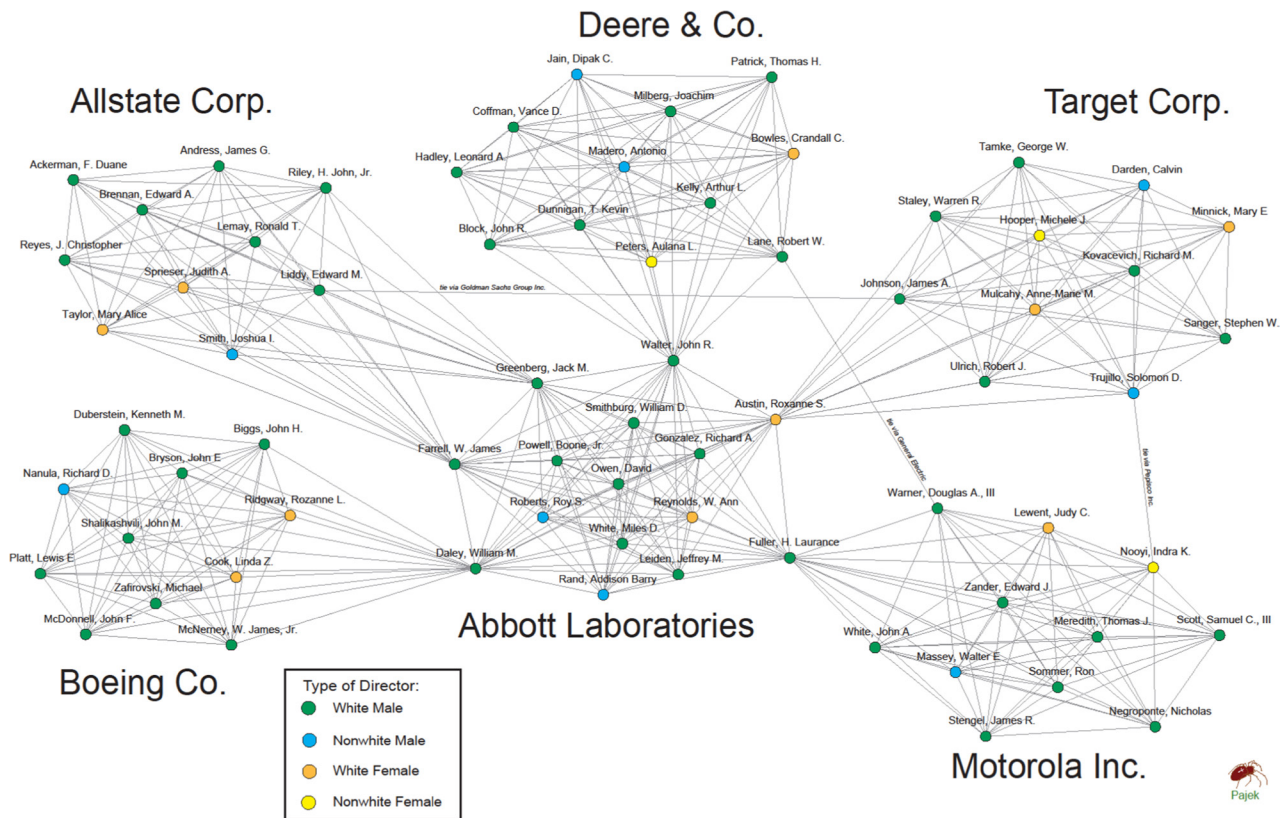


Figure 3: Network of directors from Abbott Laboratories and Neighbors, 2005.

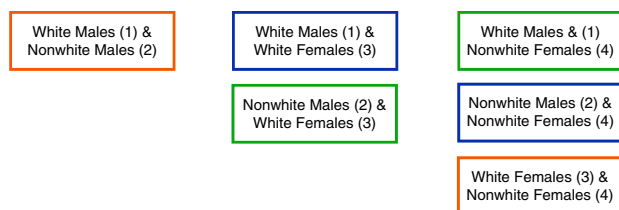
1,064 directors serving on the boards of our one hundred corporations in 2005. To ascertain the numbers of brokerage roles and to deconstruct these brokerage roles based on whether they involve racial diversity, sex diversity, or both, we need to utilize the computational power of our software. To generate the frequencies of the different types of diversity captured

by the different brokerage roles, it is necessary to extract a series of subsamples based on the race and sex of the directors and run the brokerage analysis on each of the subsamples.²

Such a procedure requires that we conduct brokerage analyses for each of the following pairs of types of directors in the network:

²To deconstruct the brokerage roles by race and sex in Pajek, one needs to start with a director network of interlocks and a partition indicating the race and sex of each vertex. Once one loads the network and partition into Pajek, the next step is to select a subsample (white males=1 and nonwhite males=2) using the following sequence: Operations > Network and Partition > Extract > SubNetwork Induced by Union of Selected Clusters, enter 1,2. Making sure you are working with the newly extracted subnetwork of white males and nonwhite males, you can calculate the Gould and Fernandez brokerage roles with these commands: Operations > Network and Partition > Brokerage Roles. Finally, to export the numbers of brokerage roles for each vertex in the subnetwork, we followed these steps: Tools > Excel > Send to Excel > All Vectors. These steps of extracting subsamples, calculating

brokerage roles, and exporting the results to Excel is repeated for all subsamples noted on pages 11 and 12. Once one has extracted all of the brokerage roles for all of the subsamples, we returned to our file of corporate affiliations that lists the vertices for each corporation, the race and sex of each vertex, and the corporate affiliation. Using the VLOOKUP function in Excel, we added data for the number of brokerage roles generated across subsamples for all of the directors. Depending on the race and sex of the director, we calculated the number of brokerage roles representing no diversity, race diversity only, sex diversity, and both forms of diversity. Finally, these values for all directors were aggregated by corporation to obtain the total number of brokerages roles for the corporations capturing race only diversity, sex only diversity and both forms of diversity.



We have also identified, for each of these six subsamples, the type of diversity they capture. In the upper left and bottom right, subsamples of white males and nonwhite males, as well as white females and nonwhite females, allow us to identify the brokerage roles involving race diversity only. At the top middle and the middle row of the right column, selecting for white males and white females and for nonwhite males and nonwhite females captures brokerage roles involving sex diversity only. Finally, the subsamples of white males and nonwhite females, as well as nonwhite males and white females generates the occurrences of brokerage roles involving both race and sex diversity.

We also selected the following four combinations of the three types of directors within the network of interlocking directorates. Given that liaison brokerage roles require that each of the three vertices have a different value for the attribute of interest, each of the four subsamples of directors produces brokerage roles involving both race and sex-based diversity.



The results of these multiple brokerage analyses for the six interlocking directors sitting on the board of directors for Abbott Laboratories are displayed in Table 1. The top section of the table reports the numbers of brokerage roles on a director by director basis that correspond to the results generated from Pajek or UCINET. Most of the table, however, reports the numbers of brokerage roles for each of the subsamples noted above, results that are not directly obtainable from the algorithm. The table also uses the same color coding in Figure 2 to partition the results according to whether the brokerage roles involve race-based diversity, sex-based diversity, or both.

The top of the second section of Table 1 reports the number of coordinator roles for each of these directors. As noted earlier, these brokerage roles involve no race-sex diversity and hence the frequencies appear in black boxes. The more interesting portions of Table 1 display the frequencies for the remaining brokerage roles. The number of itinerant brokers,

representatives, and gatekeepers are partitioned by each of the six subsamples. Focusing on the number of itinerant brokerage roles for Roxanne Austin, we see that of the total 140 roles, 132 (blue box) were between two white males and consequently involved sex-based diversity. In the remaining eight itinerant broker roles however, Roxanne Austin served as a broker between two nonwhite males and thus, involved both race and sex-based diversity (green box). By contrast, William Daley only has a dozen itinerant broker roles and one third (four of twelve) are between two nonwhite males (racial diversity only, frequency in an orange box) and the remaining eight itinerant broker roles for William Daley were between two white females, thus representing sex-based diversity (blue box).

Moving to the complementary roles of representatives and gatekeepers, Roxanne Austin has thirty-five representative and gatekeeper brokerage roles. Given the predominance white males on the boards of our 100 corporations, it is not surprising that twenty-eight of the total roles involve sex diversity only (blue boxes). Six of the representative and gatekeeper roles linked a white female with a nonwhite male and hence, involved both race and sex diversity (green boxes). Finally, Roxanne Austin had one representative and one gatekeeper role involving two white females and one nonwhite females – the path being, Ann Reynolds → Roxanne Austin → Michele Hooper, Figure 3. These brokerage roles involve sex-based diversity that are identified by the orange boxes.

The decomposition of the representative and gatekeeper brokerage roles is followed by the four subsamples used to generate the number of liaison roles across these six interlocking directorates. Given that all liaison roles produce brokerage roles with both race and sex diversity, there is little utility of running these separate samples over what is obtained through Pajek or UCINET. However, should there be more than four categories for the attribute of interest, or had there been a theoretical reason to focus on different dimensions of diversity, it could very well be that the subsamples of liaison roles would yield meaningful results. Nonetheless, this section of Table 1 does show how the total number of liaison roles is constituted.

Finally, the bottom section of Table 1 reports the number of brokerage roles that involve only race-based diversity, sex-based diversity, or both race and sex diversity for each of these interlocking directors. This represents the analytic payoff of this decomposition. Not only can we report on a director by director basis the number of brokerage roles involving the different types of diversity, these director-based values can

Table 1. Decomposition of brokerage roles for interlocking directors, Abbott Laboratories, 2005.

Decomposition of Brokerage Roles	Interlocking Directors					
	Austin, Roxanne (white female)	Daley, William (white male)	Farrell, W. James (white male)	Fuller, H. Laurance (white male)	Greenberg, Jack M. (white male)	Walter, John R. (white male)
From Software						
Coordinators	4	160	126	160	126	160
Itinerant Brokers	140	12	12	8	12	12
Representatives	35	62	55	62	55	72
Gatekeepers	35	62	55	62	55	72
Liaisons	94	12	12	16	12	20
Brokerage Role and Subsamples (Based on Attribute Codes)						
Coordinators:						
White Males (1)	--	160	126	160	126	160
Nonwhite Males (2)	--	--	--	--	--	--
White Females (3)	4	--	--	--	--	--
Nonwhite Females (4)	--	--	--	--	--	--
Total	4	160	126	160	126	160
Itinerant Brokers:						
White Males (1) & Nonwhite Males (2)	--	4	4	4	4	8
White Males (1) & White Females (3)	132	8	8	4	8	4
White Males (1) & Nonwhite Females (4)	--	--	--	--	--	--
Nonwhite Males (2) & White Females (3)	8	--	--	--	--	--
Nonwhite Males (2) & Nonwhite Females (4)	--	--	--	--	--	--
White Females (3) & Nonwhite Females (4)	--	--	--	--	--	--
Total	140	12	12	8	12	12
Representatives:						
White Males (1) & Nonwhite Males (2)	--	26	23	26	23	36
White Males (1) & White Females (3)	28	36	32	26	32	26
White Males (1) & Nonwhite Females (4)	--	--	--	10	--	10
Nonwhite Males (2) & White Females (3)	6	--	--	--	--	--
Nonwhite Males (2) & Nonwhite Females (4)	--	--	--	--	--	--
White Females (3) & Nonwhite Females (4)	1	--	--	--	--	--
Total	35	62	55	62	55	72
Gatekeepers:						
White Males (1) & Nonwhite Males (2)	--	26	23	26	23	36
White Males (1) & White Females (3)	28	36	32	26	32	26
White Males (1) & Nonwhite Females (4)	--	--	--	10	--	10
Nonwhite Males (2) & White Females (3)	6	--	--	--	--	--
Nonwhite Males (2) & Nonwhite Females (4)	--	--	--	--	--	--
White Females (3) & Nonwhite Females (4)	1	--	--	--	--	--
Total	35	62	55	62	55	72
Liaisons:						
White Males (1), Nonwhite Males (2) & White Females (3)	68	12	12	8	12	12
White Males (1), Nonwhite Males (2) & Nonwhite Females (4)	--	--	--	4	--	4
White Males (1), White Females (3) & Nonwhite Females (4)	22	--	--	4	--	4
Nonwhite Males (2) White Females (3) & Nonwhite Females (4)	4	--	--	--	--	--
Total	94	12	12	16	12	20
Distribution of Types of Diversity Roles:						
No Diversity	4	160	126	160	126	160
Race Diversity Only	2	56	50	56	50	80
Sex Diversity Only	188	80	72	56	72	56
Both Race and Sex Diversity	114	12	12	36	12	40
Total	308	308	260	308	260	336

be also be aggregated at the organizational level to create a measure of the diversity of brokerage roles for a given corporation. As argued in our introduction, this measure of organizational diversity recognizes that it is not just the percent of males or females, or the proportions of white versus directors of color that is important; it is also the connections formed by directors of varying identities with other diverse directors that has the potential to influence the organization's decision making. Accordingly, summing the number of brokerage roles for Abbott Laboratories yields the following: 736 that involve no diversity, 294 constituting race diversity, 524 representing sex diversity, and 226 that contain both race- and sex-based diversity. So, while only one of the six interlocking directors on Abbott's board was a white female (and the remaining five were white males), nearly 30 percent of the brokerage roles involving sex diversity and another 12.7 percent involving both race and sex diversity can be attributed to Roxanne Austin. This result is due in part to the composition Abbott's board of directors and the composition of the boards of directors with which Abbott is connected. Having calculated the number of brokerage roles involving these types of diversity for all one hundred of our corporations in 2005, the final portion of this paper explores whether our measure of diversity yields "better" decisions as reflected by lower numbers of regulatory violations.

Corporate diversity and regulatory violations: an exploratory analysis

While the literature cited in our introduction emphasizes the impact of board diversity (both race and sex) on firm performance, there is also a growing body of literature that has shifted the focus to examine broader outcomes under the heading of corporate social responsibility. Galbreath (2018) concluded that the association between board diversity and financial performance is an indirect relationship with diversity's effect operating through corporate social performance or responsibility. Similarly, Macaulay et al. (2018) not only showed that a firm's centrality within its alliance network is positively associated with a firm's level of corporate social performance, it is also the case that the percentage of female representation on the board was positively correlated with corporate social performance. Shifting the frame of reference from social responsibility and performance to a *modus operandi* with more negative societal consequences, Saona et al. (2019) reported that higher levels of female directors led to lower levels of earnings "management" (i.e., manipulation), and that the presence of gender

quotas (statutory or recommended) strengthened this effect among non-financial companies of the major European Union countries. Similar results have recently been reported for the United States. Wahid (2019) analyzed 6,132 unique firms between 2000 and 2010 and demonstrated that gender diverse boards had lower incidences of restatements and irregularity-type restatements (indicators of financial misconduct) – even when controlling for the effects of board members' qualifications or effort. Regarding racial diversity (Boulouta, 2013) reports that the decision-making within gender and racially diverse boards is improved as indicated by a significant decrease in negative social practices. Most relevant to our study on regulatory violations, Liu (2018) found that among S&P 1500 firms between 2000 and 2015, greater gender diversity within the boards of directors was related to fewer instances of being sued for environmental infringements. Finally, Lu and Herremans (2019) concluded that greater gender diversity was tied to higher environmental performance scores and that this relationship was stronger among more environmentally impactful industries in the resource extraction sector. So, what are the results on our brokerage-based measures of board diversity and corporate regulatory violations?

Data and variables

We extend the line of research on board diversity and greater social responsibility by applying our brokerage based measures of organizational diversity to our network of F100 corporations and a unique dataset of regulatory violations.³ While the basic parameters of the network of directors formed through shared board memberships among the F100 corporations is noted in the discussion of our brokerage-based measure of diversity, it will be useful to provide a brief summary of the network of corporations upon which this exploratory analysis is based. Beginning with the F100 corporations, Table 2 provides an overview of the number of corporations in each of the SIC Divisions, as well as the average, maximum and minimum values for revenue in billions of dollars. Regarding the network of interlocked corporations, the main component encompasses 88 corporations with a dozen isolate

³An earlier data set of regulatory violations was constructed through a collaboration with Amanda Kahl Smith and presented at the International Network of Social Network Analysis Sunbelt Conference, Utrecht, the Netherlands (Smith and Barnes, 2018).

Table 2. Profile of the F100 corporations.

SIC division	N	2005 revenue, in \$ billions		
		Ave.	Max	Min
Finance, insurance, and real estate	27	46.3	131.0	21.3
Manufacturing	39	65.1	339.9	21.3
Mining	1	59.0	59.0	59.0
Retail trade	15	62.4	315.7	23.3
Services	4	31.1	39.8	24.5
Transportation, communications, electric, gas, and sanitary services	9	38.5	75.1	22.3
Wholesale trade	5	53.8	80.5	28.8

corporations. Within the main component, 11.4 percent of the corporations were linked to just one other corporation, 18.2 percent were linked to two other corporations, 12.5 percent were linked to three other corporations, and another 12.5 percent were tied to four other corporations. The remaining 40 corporations in the main component were linked to five or more other corporations with Citigroup being linked to eleven other corporations, and JP Morgan Case being connected to a dozen other corporations through interlocking directorates.

Dependent variable

Our dependent variable, the number of regulatory violations is based on the data in a public database entitled "Violation Tracker," that is compiled by the organization, "Good Jobs First." According to the website (Good Jobs First, 2021), this resource compiles "enforcement data obtained from more than 250 federal, state and local regulatory agencies with responsibility for banking, consumer protection, environmental, wage & hour, unfair labor practice, health and safety, workplace discrimination and other matters." In our dataset, we identified violations across fifty-four federal regulatory bodies that include such agencies as the Environmental Protection Agency (EPA), the National Labor Relations Board (NLRB) and the SEC (Securities and Exchange Commission). Using the number of regulatory violations as an indicator of corporate social responsibility and ethical behavior – or more appropriately, corporate social irresponsibility and

unethical behavior – raises the possibility that corporations may not *really* be more ethical or more responsible; but rather, these corporations either have institutional measures to prevent regulatory violations or are more effective in avoiding detection. While we believe that establishing internal policies and procedures to increase compliance with federal regulations is consistent with greater social responsibility, the issue of being better at hiding violations is potentially more problematic. To address this possibility, recall that the theoretical motivation for this paper is Page's insight that cognitively diverse organizations arrive at better decisions. In this paper, we have operationalized "better decisions" as those that result in fewer regulatory violations since violations harm consumers, employees, and the environment. Yet, in a perverse example of "better decision making," corporations may decide that hiding violations is the desired course of action since, if sufficiently thought-through and successful, such a decision avoids the negative financial consequences of being caught. Consequently, in this alternative view of corporate decision making, the "better" decision was to preserve a return on investment, albeit through socially irresponsible or unethical means and decisions. While this alternative explanation for lower regulatory violations is possible, we will maintain our view that fewer violations are an indicator of greater corporate social responsibility.

There are a couple of considerations in utilizing the data obtained from the Violation Tracker database. To begin, it is important to appreciate that the data are reported according to both the "parent"

company and all subsidiary companies at time the data are accessed. This means that to accurately attribute violations to the corporations in our study, one needs to parse the violations according to the time-period of interest and the chronology of merger and acquisition activity related to the corporations. The periodization of the data is straight forward as we measure corporate responsibility for the year 2005 by including all violations that are encompassed within a five-year window from 2003 through 2007. The reason for including years after 2005 is that the implications from decisions often take time to manifest themselves and so the data take into consideration this lag. The countless mergers and acquisitions that have occurred since the Violation Tacker database was established in 2000 represents a second and more formidable temporal consideration when attributing regulatory violations to our Fortune 100 corporations. Consider the following recent example within the aerospace and defense industries. On October 11, 2019, the shareholders of United Technologies and Raytheon approved the merger of the two corporations with it becoming final on April 3, 2020. Given that we compiled the data on regulatory violations in August 2020, United Technologies appears on the list of regulatory violations, *in its own right* as a company, and also as a current subsidiary of Raytheon. While this recent example makes clear that the violations occurring between 2003 and 2007 should be separately listed for United Technologies and not included in those violations committed by Raytheon, this conclusion is based on knowing the timing of the merger. Now, there are thousands of such mergers and acquisitions over the past two decades, and it is not possible to make similarly nuanced coding decisions for all subsidies listed in the search results from Violation Tracker. Therefore, in addition to limiting the records to the five-year window of 2003–2007, we also only include subsidiary corporations that are founding or root corporations of the “parent”, such as Sears Roebuck & Co. for Sears Holding Corporation, and exclude K-mart.

This more conservative approach has a several additional advantages that help us deal with the complexities of the data. First, it prevents double counting regulatory violations for Fortune 100 corporations that are also subsidiaries of another corporation in our sample. For example, by the end of December 2006, the Federal Communications Commission had approved the acquisition of Bellsouth by AT&T. Since Bellsouth and AT&T are both listed in the top 100 of the Fortune 100 for 2005, the violations for Bellsouth could mistakenly be double-counted for

AT&T if we did not exclude Bellsouth as a subsidiary of AT&T. A second benefit from adopting this more restrictive criteria of only including the data for the founding or root corporations of the “parent” is seen when considering holding corporations. Berkshire Hathaway currently lists sixty-three different subsidiary corporations ranging from Burlington Northern Santa Fe Railroad to See’s Candies. Yet, the governing boards (our unit of analysis) of any subsidiary corporation is not the same as the board of directors for Berkshire Hathaway. Therefore, our method only includes violations attributed to the corporation Berkshire Hathaway, and not the subsidiaries of this “parent” corporation. The final payoff from this simplified method of inclusion is that one does not need to be concerned with when a subsidiary was purchased by a “parent” company. We acknowledge that this approach greatly reduces the number of regulatory violations attributed to each of our Fortune 100 corporations, but a consistent application of these rules of inclusion and exclusion will generate a relative measure of corporate responsibility/irresponsibility between corporations that is easier to replicate.

Competing measures of diversity

Since our exploratory analyses are interested in determining the utility of our brokerage-based measures of diversity, our analyses also consider the potential explanatory value of four alternative measures. The first is simply the percent of the board of directors that are white males. Here, the higher the percentage, the lower the diversity. We also calculated an index of qualitative variation (IQV) for each of the boards of directors using the four different demographic groups discussed above. The algorithm for the IQV is as follows:

$$IQV = \frac{k(N^2 - \sum f^2)}{N^2(k-1)}$$

Where k is the number of groups (four in this case) and f is the frequency of each group.

We have argued that the primary advantage of our brokerage-based measure of diversity is that it incorporates the diversity of the corporate boards that are interlocked with the focal corporation. More precisely, the concept of brokerage is based on occurrence of an intermediate linking two unconnected directors – that is, the other board members of the focal corporation and the directors connected to them from the other board(s) through the interlocking directorate. As we have shown above, the creation

of our brokerage-based measures of diversity has many steps, though straightforward in its calculation. Is it possible that a measure of overall demographic diversity of the interlocked boards would yield an indicator of organizational diversity that has greater explanatory power and is easier to calculate than our brokerage-based measure of diversity? To answer this question, we also consider two competing measures of diversity rooted in the demographics of the interlocked corporations. The first calculates the proportion of directors that are female that includes the focal board and the other alternative measure excludes the directors of the focal corporation in the calculation of the proportion of female directors.

Control variables

As noted above in the discussion of our brokerage-based measure of diversity, the formation of the five brokerage roles depends on the existence of interlocking directorates. Therefore, to make sure that the number of brokerage roles that involve no diversity, racial diversity only, gender diversity only, or both dimensions of diversity, are not primarily the result of the number of interlocking directorates, we also control for board size and corporate degree. The rationale is that the larger the board, the greater the opportunities for sharing a director with another corporation. The measure of corporate degree is a simple measure of the number of other corporations

interlocked with the focal corporation. The descriptive statistics and correlation matrix of all our variables appear in Appendices A and B respectively.

Descriptive results

We hypothesize that greater board diversity will produce higher levels of corporate responsibility (i.e., lower average number of violations). Therefore, we begin our analyses with a brief comparison of the average number of regulatory violations by levels of diversity according to our four brokerage-based measures. If our hypothesis is correct, then for the quartiles of “Brokerage Roles with No Diversity,” we would expect to see steady increases in the average number of regulatory violations as boards become increasingly less diverse or become more homogeneous. On the other hand, we would anticipate the opposite trend for the three sets of quartiles for race, sex and both forms of brokerage-based diversity. Specifically, as the levels of brokerage-based diversity increases, we predict that the average number of regulatory violations would decrease. As Figure 4 makes clear, our expectations are not realized in these findings. As noted above, the first brokerage measure of board diversity is best interpreted as a measure of homogeneity, since increasing numbers of brokerage roles with no diversity means mostly brokerage roles among white males. Although we predicted increasing levels of regulatory violations with increasing homogeneity,

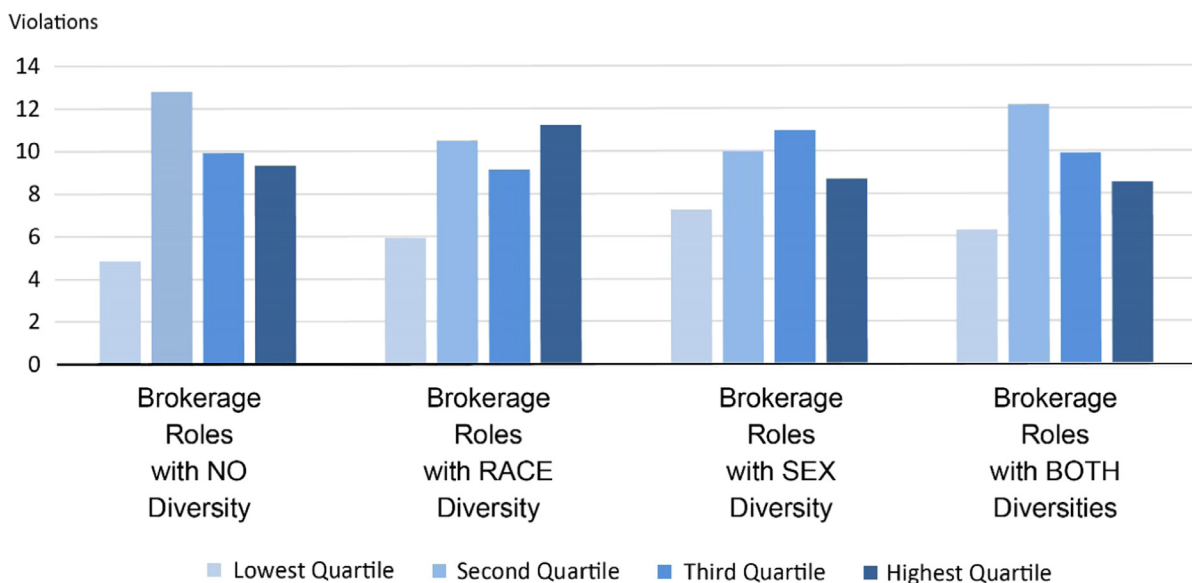


Figure 4: Average brokerage roles and classification of type of race-sex diversity, 2005.

the opposite appears to be the case as the pattern across the second through fourth quartiles is one of decreasing average violations. For the measures of brokerage roles involving race diversity and then sex diversity, the data display patterns of increasing regulatory violations as the levels of brokerage-based diversity increases – again, this is opposite of what we anticipated. The measure of the number of brokerage-based roles involving both race and sex diversity does show a decrease in the average number of regulatory violations for Q_2 through Q_4 . In sum, these descriptive findings are not only inconsistent with our expectations, in some cases, they are antithetical to our working hypothesis that greater diversity will be associated with lower levels of corporate regulatory violations.

Predicting regulatory violations

Since brokerage roles require interlocks between corporations through the presence of a shared director, the descriptive results may be confounded by the network of ties itself. Therefore, to better assess

the potential effects of our brokerage-based measures of corporate diversity on the number of regulatory violations, the second phase of our exploratory analyses utilizes multiple regression techniques to control for the effects of both board size and the number of ties to other corporations (Corporation Degree). Although the descriptive statistics above utilized the number of regulatory violations to compare means across quartiles of our diversity measures, this dependent variable possesses a strong positive skew. There are also a fair number of corporations without any violations for the time-period between 2003 through 2007. Consequently, we conducted a simple log transformation so that our dependent variable is the natural log of the number of regulatory violations plus 0.01. The six models in Table 3 are designed to compare the effects of our brokerage-based measures of corporate diversity, the potential impact of the alternative measures of corporate diversity, and the role of the two network control variables – the size of the board of directors and the degree of the corporation in the network

Table 3. Linear regression results: predicting 2005 (ln) total regulatory violations with brokerage-based measures of diversity.

	Standardized beta coefficients					
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
	<i>B</i>	<i>B</i>	<i>B</i>	<i>B</i>	<i>B</i>	<i>B</i>
N brokerage roles, No diversity	0.177			0.012		0.044
N brokerage roles, race diversity	–0.053			–0.122		–0.167
N brokerage roles, sex diversity	–0.247 [†]			–0.328*		–0.381*
N brokerage roles, both diversity	0.164			0.023		–0.032
Percent white males (on the board)		–0.065			–0.130	–0.232
Index of qualitative variation (IQV)		0.058			–0.029	–0.114
Proportion of women on interlocked boards		–0.117			–0.100	–0.008
Proportion of women on interlocked boards, (excluding focal corporation)		0.078			0.063	–0.013
Board size			–0.019	0.077	0.021	0.150
Corporate degree			0.093	0.341	0.067	0.397
R^2	0.041	0.010	0.007	0.051	0.015	0.077
F ratio	1.009	0.200	0.359	0.839	0.204	0.643

Notes: [†]Sig. < 0.10. *Sig. < 0.05.

formed by interlocking directors.⁴ One final note on our interpretation of the results is that we are focusing primarily on the *relative effects and direction* of the measures of diversity on our dependent variable and are not overly concerned with the variation explained or the statistical significance of the models, as we have defined our “population” to be the F100 corporations and consequently, explicit statistical inferences are not warranted.

Model 1 in Table 3 shows the effects of our four brokerage-based measures of corporate diversity on our dependent variable. The first thing to note is that all but the brokerage roles based on both race and sex diversity display the expected direction. As the number of brokerage roles that involve no diversity increases, so too does the number of regulatory violations. The race-based diversity measure shows the expected, albeit relatively small, negative effect on regulatory violations. In contrast, the brokerage-based measure of corporate board diversity based on the sex of the directors is both the strongest predictor of regulatory violations and has the anticipated negative effect.

Model 2 reports the effects of each of the four competing measures of diversity on regulatory violations. In this model, as the percent of the board of directors becomes increasingly composed of white males, the number of regulatory violations decreases; but the effect is relatively small. For the IQV variable, increases in variation lead to greater numbers of

regulatory violations; but again, this effect is quite weak. While the proportion of women on interlocked boards is negative and is in the anticipated direction – i.e., as the relative presence of women on the boards increases, regulatory violations decrease – the effect does not approach statistical significance. Finally, when we exclude the focal board, the effect reverses and is now in the opposite direction. Given the magnitude of each of these standardized coefficients, one can conclude that these four alternative measures of diversity have relatively little effect on the number of regulatory violations.

The number of brokerage roles any given corporation possesses is structurally dependent on the number of ties a corporation has with other corporations. Therefore, the size of the board of directors, as well as the number of other corporations that it is connected through interlocking directorates, should both influence our brokerage-based measures of diversity. Consequently, Model 3 displays the effects of these two variables on the dependent variable and Model 4 controls for the effects of both board size and corporate degree when evaluating the effects of our brokerage-based measures of diversity. The striking feature of model 4 in Table 3 is that both the race and the sex-based brokerage measures of diversity increase in the strength of their effects when we introduce these control variables. And while Model 4 shows a sizable positive effect for corporate degree, the direction of these effects for our two brokerage-based measures of diversity maintains their hypothesized direction – as diversity increases, the number of regulatory violations goes down.

Models 5 reports the effects of the competing measures of diversity while controlling for the network effects of board size and corporate degree. For this model, the introduction of the control variables has very little impact on the original effects reported in Model 2. Finally, Model 6 compares the relative effects of the four brokerage-based measures of diversity, the four competing measures of corporate diversity, and the two control variables. Again, the effects of both the number of brokerage roles based on race diversity and on sex diversity exhibit modest increases in their negative effects on the number of regulatory violations – even beyond those of Model 4. The effect of corporate degree remains relatively strong in Model 6 – though this coefficient is still far from being statistically significant – and the competing measures of corporate diversity continue to demonstrate relatively little effect on our dependent variable. Taken together, these results demonstrate a consistent negative effect of the number of brokerage roles based on sex as a measure of corporate diversity.

⁴Empirically, it is not surprising that there is a high correlation between two of our measures of diversity and the frequency of G&F brokerage roles. Indeed, as we note in describing how we calculated our various measures of race-sex diversity, our “no diversity” measure is the same as the number of coordinator roles as this is the only configuration where the race and sex of the directors must be the same, $r=1.000$. Similarly, the G&F liaison roles must have both race and sex diversity, but as we point out in Table 1, there are other ways to have brokerage roles that represent both types of diversity, $r=0.965$. A linear Regression model with just G&F brokerage roles and the natural log of total violations shows that the number of itinerant brokerage roles has a marginally negative impact on the number of regulatory violations ($B=-0.372$, sig. = 0.069) and the number of liaison roles has marginally positive impact ($B=0.465$, sig. = 0.092). However, the point of this paper is to argue that G&F brokerage roles do not distinguish between the type of demographic differences between directors in, say, an itinerant broker role. Our approach allows for these distinctions and therefore, we have gained additional conceptual clarity as to the nature of the brokerage roles and the type of diversity they encompass.

Conclusions and discussion

The purpose of this paper is two-fold. First, we introduce a straight-forward measure of organizational diversity that can be readily obtained using widely available software. Secondly, we illustrate the utility of this measure by addressing an empirical question regarding corporate board diversity and the occurrence of regulatory violations. While the results for our multivariate analyses have shown that our brokerage-based measure of sex-based diversity is indeed associated with lower levels of regulatory violations, the race-based measure and the measure of demographic diversity based on both race and sex differences did not prove to be as useful in explaining the number of corporate violations. In short, our results provide encouraging results that we believe invite a number of further investigations utilizing our extension of the Gould and Fernandez conceptualization of brokerage. First, it would be interesting to apply the same methodology to a much larger data set of corporations across a broad spectrum of industries. The corporations in this study encompass the one hundred largest (by revenue) and consequently, the population of companies are dominated by large retail, oil, and financial institutions. Second, this methodology should be applied to a more recent time-period, or better yet, to a longitudinal analysis that could capture differences in how the George W. Bush administration approached corporate regulation relative to, for example, the Obama administration. A third avenue of further work would be to squarely address the question of board diversity and financial performance. As noted in the introduction, much of the existing literature on board diversity is concerned with its positive effects on financial performance. Although this is beyond the scope of this current paper, such analyses are being contemplated; and future research could address the question, “do our brokerage-based indicators of board diversity lead to higher return on shareholder equity; and what, if any, could be the intervening role of regulatory violations on this hypothesized relationship?” Finally, as a potentially rich complement to these analyses that utilize the race and sex of the members of the boards of directors, a more in-depth analysis into the biographical and genealogical backgrounds of our thousand plus directors could be pursued. While such analyses are not possible for this paper, this qualitative approach to the analysis of interlocking directorates certainly has precedence in the research on board interlocks (Comet, 2018, 2019). Therefore, while the exploratory analysis did not

produce exceptionally strong results, the results are suggestive of richer and more extensive work in the future.

Methodologically, the exploratory analysis underscores the value of using our brokerage-based measure of corporate board diversity over that of a simple percent of white males (measure of homogeneity), a qualitative measure of variation, and more sophisticated measures of board diversity that considers the composition of the boards tied to the focal corporation through interlocking directorates. These results are important because not only does it show that our brokerage-based measure yields substantive findings; it is also the case that our measure of diversity incorporates the pivotal concept of brokerage within social network analyses. As such, our approach utilizes the relationships between corporations and the composition of the various boards to capture the complexity of relationships (and the insights generated through those relations and interactions) that exist within, and move through, interlocking corporate boards of directors.

Finally, we believe that the method of deconstructing the five brokerage roles according to the dimensions of race and sex to yield “types” of diversity, represents a contribution that can be extended beyond this simple example. Within the same conceptual framework of examining the diversity of corporate boards, one could categorize directors along three dimensions – race, sex and age cohort. While the number of different types of diversity would increase dramatically, the same process of extracting subsamples and running the brokerage analyses would apply to create a three-dimensional measure of organizational diversity. Alternatively, we believe this approach can be used in any circumstance in which one desires to use the network information at lower level of analysis (e.g. individual directors) to create an aggregated variable at the organizational level for subsequent analysis. Our approach allows researchers to capture different types of diversity according to their theoretical framework and moves beyond the level or degree of diversity.

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Appendix

Table A1. Descriptive statistics for F100 corporations.

	<i>N</i>	Min	Max	Mean	SD
Dependent:					
Natural log of total number of regulatory violations	100	−4.605	4.234	1.095	2.265
Brokerage-based measures of diversity:					
Number of brokerage roles, no diversity	100	0	1950	456.40	427.72
Number of brokerage roles, race diversity	100	0	1768	328.68	423.26
Number of brokerage roles, sex diversity	100	0	1244	330.28	305.52
Number of brokerage roles, both diversity	100	0	1686	304.82	348.86
Competing measures of diversity:					
Proportion white males	100	0.400	0.929	0.724	0.107
Index of qualitative variation	100	0.177	0.889	0.558	0.157
Proportion of women on interlocked boards	88	0.042	0.342	0.170	0.049
Proportion of women on interlocked board (excluding focal corporation)	88	0.000	0.300	0.167	0.054
Network controls:					
Board size	100	7	20	12.48	2.26
Corporation degree	100	0	12	3.86	2.81

Table A2. Correlation matrix of dependent, independent and control variables.

Var. Label	Variable										
	1	2	3	4	5	6	7	8	9	10	11
1 In Total Regulatory Violations	1.000	0.077	0.061	-0.079	0.067	-0.074	0.081	-0.017	0.014	0.023	0.084
2 N Brokerage Roles, no diversity		1.000	0.607 **	0.552 **	0.420 **	0.150	-0.120	-0.184	0.038	0.419 **	0.815 **
3 N Brokerage Roles, race diversity			1.000	0.391 **	0.632 **	-0.153	0.169	-0.171	0.029	0.302 **	0.781 **
4 N Brokerage Roles,sex diversity				1.000	0.558 **	-0.219 *	0.245 *	0.202	-0.052	0.570 **	0.685 **
5 N Brokerage Roles, both diversity					1.000	-0.316 **	0.351 **	0.104	0.003	0.406 **	0.785 **
6 P White Males						1.000	-0.973 **	-0.538 **	0.075	-0.114	-0.151
7 IQV							1.000	0.503 **	-0.097	0.178	0.188
8 P Women Interlocked Boards								1.000	0.464 **	-0.055	-0.006
9 P Women Interlocked Boards (excl Focal)									1.000	-0.046	0.071
10 Board Size										1.000	0.455 **
11 Corporation Degree											1.000

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).