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Political Ideologies and Moral Foundations of Engineering Professionals in the United States

Abstract

Scholars have argued that engineering practice should be understood in its societal context, including the political contexts in which engineers perform. However, very few research studies have systematically explored the political and moral backgrounds of engineering professionals, who would be the main agents in the political contexts. This paper reports our exploratory study of the political ideologies and moral foundations of engineers in the United States. Based on survey responses from 515 engineers, we conducted generalized ordinal logistic regression analyses and multiple linear regression analyses to examine how engineers' political ideologies are associated with their moral foundations and how engineers' political ideologies and moral foundations vary across their employment sectors, organizational positions, and demographic attributes. We found that engineers in the manufacturing sector are more politically conservative than engineers in the computer/electronics/IT sector. Additionally, engineers in higher positions in their organizations are more politically conservative than engineers in lower positions, and female engineers are more politically liberal than male engineers. We also found that engineers' endorsement of the five moral foundations differs by sector and demographic attributes. Moreover, engineers' moral foundations substantially explain engineers' political ideologies, consistent with previous studies using the Moral Foundations Theory.

Keywords: Political Ideology, Moral Foundations, Engineer, Professional Ethics, Employment Sector

Introduction

What should be the normative goals of engineering practice? Engineering professionals have collectively offered some general answers to such questions. For example, some specific norms and priorities for engineers can be found in professional codes of ethics (NSPE 2019; AIChE 2012; ASME 2006; IEEE 2004) and aspirational reports such as the Grand Challenges of the National Academy of Engineering (2008). However, individual engineers may have different answers to those questions depending on their values, beliefs, or worldviews, i.e., their general moral perspectives.

One's general moral commitments are linked to their vision of a good society, and the process of defining what constitutes a good society is "fundamentally ideological" (Spector 2008, 315). Thus, engineers' general moral commitments are closely related to their political ideologies. While engineers have often neglected the political and value-laden nature of their work (Karwat 2020; Cech 2012; Riley 2012), engineering can be a fundamentally political act. Holt (2001) argued that while engineers often draw boundaries between their technical work and the political contexts in which it is embedded, engineering practice is nonetheless "conditioned by the integration of technical knowledge within prevailing personal and social values and their institutional embodiments" (499). Because of the inherently political nature of engineering practice, engineering ethics scholars have argued that engineering ethics education needs to include concerns related to broader societal context, such as policy engagement (Mitcham 2009; Conlon 2008; Wulf 2004; Kim et al., 2023; Wang et al., 2015). Further, it has been argued that in evaluating technology and its broader societal impact, reflecting on political assumptions underlying the evaluation is also important (Coeckelbergh 2018); and it has been also argued that policies related to engineering and political dynamics that influence the policies should be more

explicitly discussed in academia (Cooper et al., 2023; Fox & Griffy-Brown, 2023). However, very few studies have systematically explored the political ideologies of engineering professionals, who would be the main agents of the technology development and evaluation – the main agents of the political and policy engagement.

Therefore, this paper reports on an exploratory study of political ideologies among practicing engineers. Specifically, we explore how engineers' political ideologies vary across their employment sectors, their positions in their workplace organizations, and their demographic attributes. Engineers work in various sectors including for-profit business organizations and government (National Science Board 2018). It has been argued that high-level ideological sorting across sectors can provide insights into the way they "coordinate, mobilize, and otherwise engage in the political process" (Bonica 2014, 383). Also, comparisons across positions and demographic groups could provide insights regarding how visions of what counts as a good society vary across subgroups of engineers. Moreover, we explore engineers' moral foundations, which have been suggested as strong predictors of one's political ideology (Graham et al. 2009). To sum up, in this paper, we answer the following research questions:

RQ1: How do practicing engineers' political ideologies vary across employment sectors, organizational positions, and demographic attributes?

RQ2 How do practicing engineers' moral foundations vary across employment sectors, organizational positions, and demographic attributes?

RQ3: How are practicing engineers' political ideologies related to their moral foundations?

Literature Review

Political Ideology

Political ideology is pervasive in everyday life (Jost 2006). While there is no consensus definition of political ideology, Ball et al. (2017) defined it as "a fairly coherent and comprehensive set of ideas that explains and evaluates social conditions, helps people understand their place in society, and provides a program for social and political action" (6). Ideologies are based on assumptions about human nature, and these assumptions about human nature - basic human motives, possibilities, and limitations – inform what goals people think are politically achievable.

For example, the political ideology of liberalism is based upon the belief that human beings are fundamentally rational beings. Liberalism attributes current social conditions to the choices and actions of rational individuals, favors social conditions that ensure individual freedom, orients society to ensure individuals live as they want and respect the rights of others who live freely, and suggests promoting individual liberty and opportunity. In contrast, conservatism is often called "the politics of imperfection" (Ball et al. 2017, 111), which means it is based upon the assumption that human beings are naturally imperfect and follow selfish motives. Conservatism explains that current social conditions result from the imperfections of human nature, favors social conditions that ensure stability and peace in a society, orients individuals to play their own part responsibly in a society, and suggests improving a society gradually and cautiously.

While the preceding passage describes some basic ideas of liberalism and conservatism, what it means to identify as liberal or conservative changes over time and place (Jost 2006). Such changes have also born multiple subdivisions in each ideology – e.g., welfare liberalism, neoclassical liberalism (or, libertarianism), and libertarian anarchism in contemporary liberalism; traditional conservatism, individualist conservatism, neoconservatism, and the religious right in

contemporary conservatism (Ball et al. 2017). Despite such complexities, ideological divisions in the U.S. have been traditionally discussed on a single liberal-conservative (or left-right) dimension. While other factors and dimensions have been introduced to reflect additional complexities (Caprara 2007; Caprara et al. 2017; Kitschelt and Hellemans 1990), the single dimension of liberal-conservative still serves an important organizing role in contemporary political thought (Caprara et al. 2017; Jost et al. 2009; Jost 2006; Bonica 2014).

Political Ideology in Occupations

While it is intuitive how political ideologies are pervasive in public policy issues, how they underlie other aspects of society, such as occupational activities, is more implicit and opaque. However, occupational activities are also embedded in political environments, and practitioners are influenced by that context. For example, the thoughts and actions of business managers are influenced by the ideologies of the political context at that time (Spector 2006).

To more directly examine possible patterns in political ideologies among individuals in different industry sectors, Bonica (2014) examined publicly available information about donations to political campaigns and causes during the 2004-2012 election cycles. He showed that donations from academics; entertainment; newspapers and print media; and online computer services were heavily skewed to the left, whereas donations from oil, gas, and coal; agriculture; building and construction; and mining industries were reliably conservative. He further suggested that ideological sorting across industries and occupations would provide a better understanding of how industries coordinate with the political context where they are embedded. Accordingly, Bonica et al. (2016) also examined distributions of political ideologies across various occupations and reported that American lawyers lean to the left on the ideological spectrum, while there is a slight

bimodality in the distribution. In that paper, they further compared lawyers to other well-educated professions, including academics and medical doctors, and found that lawyers and academics generally lean towards the left, while medical doctors lean to the right.

For some occupations, political ideologies not only predict professionals' voting behaviors as a citizen but also impact their practice as professionals. For example, Rosenwald and Hyde (2006) investigated the relationship between the political ideologies of social workers and their practice. They showed that the study participants with more liberal perspectives were more likely to bring their ideological views into their practice, while over 90% of the study participants self-reported that they could separate their practice from their political ideologies. Also, Norton and Tan (2019) reported that licensed mental health counselors' political ideologies predict their preferred counseling theories.

Few studies have explored the ideological spectrum of engineering professionals. A potential exception can be Bonica et al. (2016), which reported the ideological distribution of "technology workers" (293), which could include some engineering professionals. They suggested that technology workers were the most liberal among the occupations they examined. However, in their paper, they did not define what technology workers mean – in their paper, "technology workers" might have included many occupations besides engineering professionals. Except Bonica et al. (2016), Zussman (1985) investigated the political orientations of engineers who were working in two Massachusetts companies and reported that 53% of engineers (vs. 30% of general national survey participants) identified themselves as Republicans in 1972. To the best of our knowledge, this report based on almost half-a-century-old data was the only example that reported practicing engineering professionals' political orientation with empirical data. Also, the study was conducted

at only two employers, and there have been no large-scale, empirical, quantitative studies about the political ideologies of engineers across many workplaces.

Compared to other professions (e.g., lawyers), it is rather implicit how political ideology impacts the practice of the engineering profession. Supported by the value-neutrality thesis of technology (e.g., Patt 2014), the work of the engineering profession has been often argued as value-neutral. However, the argument, as well as the value-neutrality thesis, have been widely criticized (Morrow 2014; Miller 2012; Banks and Lachney 2017; Balabanian 2006; Karwat 2020; Riley 2008; Ihde 2002). Scholars have argued that political considerations are pervasive in engineering culture. For example, in one classic article, Winner (1980) argued that technologies in society are deeply interwoven with politics with some examples including the innovation of the pneumatic molding machine for enhanced efficiency in Cyrus McCormick's reaper manufacturing plant in the 1880s. He argued that technologies' development over history reflects the human motives towards having "dominion over others" (124).

There also have been studies that pointed out ideologies embedded in engineering culture, although the ideologies are not necessarily the same sort of political ideologies as already discussed. For example, Nieusma and Blue (2012) argued the pervasiveness of militarism in engineering culture, and Cech (2013) proposed the pervasiveness of meritocracy in engineering culture. While they did not directly connect their argument with political ideologies, some common characteristics of conservatism in contemporary politics include an emphasis on security and social order (Davis and Silver 2004; Schwart and Boehnke 2004; Jost et al. 2009) and belief in meritocracy (Hing et al. 2011; Napier and Jost 2008). Therefore, the arguments of embedded militarism and meritocracy in engineering culture may suggest a relatively conservative culture in engineering, which was also argued by Riley (2008).

Moral Foundations Theory

Since people tend to vote for political parties that they believe will protect and promote the values that they think are important, one's political ideology is closely related to their values (Carprara et al. 2017). For example, Piurko et al. (2011) showed that values more strongly predicted political ideology of study participants than sociodemographic variables in liberal countries like the U.S. They found that right-wing political ideology covaried positively with *tradition* (e.g., be humble, follow the customs), *power* (e.g., be rich, be respected by others), *conformity* (e.g., follow the rules even when no one is watching, behave properly), and *security* values (e.g., live in secure surroundings), whereas the right-wing political ideology negatively covaried with *universalism* values (e.g., treat people equally, care for the environment). Caprara et al. (2017) reported similar results, and Janoff-Bulman and Carnes (2016) empirically found that liberals emphasize social justice, whereas conservatives emphasize social order.

Although there are many social and moral values, Haidt (2012)'s Moral Foundations Theory provides a general classification of moral values across cultures. In this theory, there are five moral foundations: Care, Fairness, Loyalty, Authority, and Purity. Haidt explained that the degree to which a person endorses each moral foundation in making moral judgments varies by person. The importance of each moral foundation for each person depends on both genetic and environmental factors.

Further, Haidt and his colleagues found that the Moral Foundations Theory well explains the political behaviors of people in the U.S. For instance, Graham, Haidt, and Nosek (2009) reported that liberals endorsed the Care and Fairness foundations much more than the other three foundations, whereas conservatives endorsed all five moral foundations equally (also see Haidt

and Graham 2007). More precisely, conservatives value Loyalty, Authority, and Purity more than liberals, while they value Care and Fairness less than liberals. Graham et al. (2011) further reported that this pattern is robust across national and cultural contexts.

Given the potential explanatory power of Moral Foundations Theory, understanding engineers' moral foundations can provide unique insights to better understand engineers' political ideologies. However, to our best knowledge, there has been no empirical study that explored engineering professionals' moral foundations. As a few exceptions for engineering-related populations, Beever and Pinkert (2019) explored engineering students' moral foundations across engineering subdisciplines. Additionally, Clancy and Hohberger (2019) explored Chinese engineering students' moral foundations, and Clancy (2020) reported the relationship between Chinese engineering students' moral foundations and ethical reasoning skills.

Methods

Data Collection

Measures. We collected survey data using published instruments for measuring political ideology and moral foundations. For political ideology, we used a one-item 7-point Likert scale measure (1 = strongly liberal, 2 = moderately liberal, 3 = slightly liberal, 4 = neutral, 5 = slightly conservative, 6 = moderately conservative, 7 = strongly conservative). This is also often called a political self-placement item, as survey participants position themselves on the single-dimension bipolar liberal-conservative spectrum. The survey participants could also choose "Other" with a short description, but such answers were classified into the 7-point scale during the data cleaning process.

For moral foundations, we utilized the Moral Foundations Questionnaire (Graham et al. 2009), consisting of 32 items with five dimensions - Care, Fairness, Loyalty, Authority, and Purity. Half of the measure (16 items total) asks participants to rate to what extent each given consideration is relevant to their thinking when they decide whether something is right or wrong. For example, participants are given statements like "whether or not someone suffered emotionally" and asked to answer with a 6-point Likert item (0 = not at all relevant, 1 = not very relevant, 2 = slightly relevant, 3 = somewhat relevant, 4 = very relevant, 5= extremely relevant). The answer 0 (not at all relevant) indicates that the consideration has nothing to do with their judgments of right or wrong. The other half of the measure (16 items total) asks participants to rate to what extent they agree with each statement. For example, participants are given statements like "compassion for those who are suffering is the most crucial virtue" and asked to answer with a 6-point Likert item (0 = strongly disagree, 1 = moderately disagree, 2 = slightly disagree, 3 = slightly agree, 4 = moderately agree, 5 = strongly agree). Among the 32 items, two of them are attention check items. Therefore, among the remaining 30 items, 6 items measure each of the five moral foundations, and the total score for each foundation ranges from 0 to 30.

The survey also included extensive demographic questions for participants' age, gender, race/ethnicity, and work experience (e.g., current employer's industry sector).

Participants. In the fall of 2020, we distributed the survey to engineers working in various sectors (e.g., IT sector, oil and gas sector) through alumni associations of the authors' institutions and various social media platforms (e.g., LinkedIn, Twitter). We had four recruitment criteria for the survey: 1) holding at least one degree (BS or higher) in engineering, technology, or a related field, 2) received BS degree more than 3 years ago (graduated before September 2017), 3) currently working full time in industry as an engineer or other technical professional (including

management) or currently unemployed but worked full time in industry as an engineer or other technical professional recently, and 4) current country of residence is the United States. At the end of the survey, participants could optionally submit their contact information to be entered into a drawing for a $100 gift card (with a 1 in 20 odds of winning). A total of 651 practicing engineers at least partially completed the survey, with 518 of those engineers completed the survey to the end. Among the 518, three did not meet the inclusion criteria, so we excluded them from the dataset. Therefore, a total of 515 survey responses could be utilized for this study. Table 1 shows the demographic information of the 515 survey respondents.

[Insert Table 1 here]

Data Analysis

Among the 515 responses, four responses had one or two items of missing data. Since the amount of missing data was less than 1%, we decided to use listwise deletion (Bannett 2001). For our data, Cronbach's alpha for Care, Fairness, Loyalty, Authority, and Purity foundations were 0.63, 0.59, 0.67, 0.69, and 0.76 respectively, which suggests an acceptable level of internal consistency for each foundation. These values are generally consistent with the values reported in other studies that utilized the same measure (Graham et al. 2011), although some of the alpha values were somewhat low.

To answer RQ1, we first checked the descriptive statistics of the data. We obtained mean, standard deviation, and density plots of participants' political orientation by sectors, positions, and demographic attributes such as age, gender, and race. Then we conducted the Kruskal-Wallis test (Privitera 2017) to check for any statistically significant differences in political ideology across sectors, positions, and demographic attributes. Based on the Kruskal-Wallis test results, to identify

which pairs show significant differences, we conducted the Mann-Whitney U test for pairwise comparisons with Benjamini-Hochberg adjustment for *p*-value (Benjamini and Hochberg 1995). Finally, to examine each independent variable's own impact on the dependent variable after controlling the other variables, we conducted regression analyses. To conduct the regression analyses, we dummy-coded the categorical variables. Table 2 shows how the variables were dummy-coded. We combined sectors with similar characteristics (e.g., types of products or services) into larger categories to reduce the number of dummy variables that enter the regression models. We also combined entry-level, individual contributor, and project manager into the lower position category, and mid-level manager, top-level manager, and executive/c-level into the higher position category. The same coding scheme was used for all regression analyses we conducted for this paper.

[Insert Table 2 here]

We conducted generalized ordinal logistic regression analysis (Williams 2006; Williams 2016) because the dependent variable (political ideology) was an ordinal variable, thus we could not use multiple linear regression analysis. Ordinal logistic regression could have been an alternative, but according to the Brant test (Brant 1990), the parallel regressions assumption, which is the core assumption of ordinal logistic regression, was violated (χ^2=95.53, $p < .001$). Especially, we applied the partial proportional odds model, which relaxes the parallel regressions assumption only for the variables with the violated assumption (Williams 2006; Williams 2016) as a special case of generalized ordinal logistic regression. Table 3 shows the Brant test results, and according to the results, we can allow the coefficients of the independent variables to be fixed across the cumulative logits except for the age and race variables.

[Insert Table 3 here]

To answer RQ2, we created five sets of multiple linear regression models to identify what factors, including sectors, positions, and demographic attributes such as age, gender, and race, influence engineers' five moral foundations, respectively. Prior to running the regression analyses with those models, we checked four assumptions of linear regression analysis – linearity of the relationship between dependent and independent variables, independence of variables, normal distribution of residuals, and homoscedasticity. The results confirmed that our dataset meets the assumptions, so we proceeded with the data analysis.

To answer RQ3, we conducted generalized ordinal logistic regression analysis (Williams 2006; Williams 2016) again, because the dependent variable *political ideology* was an ordinal variable. Again, according to the Brant test (Brant 1990), the parallel regressions assumption was violated (χ^2=113.38, $p < .01$). Therefore, we conducted generalized ordinal logistic regression. Specifically, we applied the partial proportional odds model, because we could allow the coefficients of the independent variables to be fixed across the cumulative logits except for the age and race variables, as Table 4 shows the Brant test results.

[Insert Table 4 here]

We utilized R 4.0.3 for all statistical analyses in this paper, except the generalized ordinal logistic regression analysis, which we performed with Stata/SE 16.1.

Results

RQ1: How do practicing engineers' political ideologies vary across employment sectors, organizational positions, and demographic attributes?

Table 5 shows the mean and standard deviation of the political ideology of all participants and subgroups which were classified by sector, age, gender, race, and position at the participants' workplaces. Also, Figure 1 shows the density plot of political ideology by sector (a), age (b), gender (c), race (d), position (e), as well as combined sector (f). From top to bottom, the density plots by sector, age, position, and combined sector are in increasing order of the mean value.

[Insert Table 5 here]

[Insert Figure 1 here]

As discussed, before conducting regression analysis, we first conducted the Kruskal-Wallis test to check for any statistically significant differences in political ideology across sector, age, gender, race, and position. The test result for sector showed there is no statistically significant difference in engineers' political ideology across sectors (χ^2 =19.339, *df* = 14, *p* = .152).

However, the test result for age showed there is a statistically significant difference in engineers' political ideology across age groups (χ^2 =35.544, *df* = 2, *p* < .001). The pairwise differences were significant between the younger age group (less than 30) and middle age group (30-49) (*p* =.002, *r* = .15), between younger age group and older age group (50+) (*p* <.001, *r* =.33), and between middle age group and older age group (*p* < .001, *r* = .17). Here and in the following results, *p* denotes adjusted p-value and *r* denotes effect size (*r* = .10 is small effect size; *r* = .30 is medium effect size; *r* = .50 is large effect size; where $r = Z/\sqrt{N}$). The test result for gender also showed statistically significant difference across groups (χ^2 =27.652, *df* = 2, *p* < .001). The pairwise differences were significant between male and female (*p* < .001, *r* = .22). The test result for race also showed statistically significant difference (χ^2 =19.111, *df* = 2, *p* < .001). The pairwise differences were significant between White and Asian groups (*p* < .001, *r* = .18) and between

Asian and Others (p = .021, r =.10). Finally, the test result for the position also showed statistically significant difference ($\chi^2 = 23.06$, df = 5, p < .001). The pairwise differences were significant between entry-level and mid-level manager (p = .041, r = .17), between entry-level and top-level manager (p = .021, r = .21), between entry-level and executive/c-level (p = .020, r = .22), between individual contributor and mid-level manager (p =.020, r = .13), between individual contributor and top-level manager (p = .020, r = .13), between individual contributor and executive/c-level (p = .016, r = .14), between project manager and top-level manager (p = .041, r = .14), and between project manager and executive/c-level (p = .023, r = .16).

Table 6 shows the results of the partial proportional odds model. Model [1] estimates the odds of selecting the category 2 (moderately liberal), category 3 (slightly liberal), category 4 (moderate), category 5 (slightly conservative), category 6 (moderately conservative), and category 7 (strongly conservative) over the category 1 (strongly liberal). Models [2]-[6] can be interpreted similarly. For instance, Model [4] estimates the odds of selecting the category 5, category 6, and category 7 over the category 1, category 2, category 3, and category 4. Except for the Age and Race variables, the estimated odds ratios of all the other independent variables were same across the cumulative logits. For example, across the cumulative logits, working in the manufacturing sector (OR = 1.66, p < .05) and being higher position in the workplace (OR = 1.46, p < .05) were positively associated with political conservatism, and being female (OR = 0.41, p < .001) was negatively associated with political conservatism.

[Insert Table 6 here]

For Age and Race, the odds ratio differed across the cumulative logits. For example, the effect of being higher age (over 50) was not significant in Model [1] and Model [2] but significant in Model

[3] (OR = 1.82, $p < .05$), Model [4] (OR = 1.62, $p < .05$), and Model [6] (OR = 1.90, $p < .05$). For the Model [5], the result was not significant at .05 level, but the *p*-value was .051, which is very close to the borderline. Therefore, the result should be cautiously interpreted. The effect of being lower age (less than 30) was not significant in the Model [1], Model [2], Model [3], and Model [4] but significant in the Model [5] (OR = 0.38, $p < .05$) and Model [6] (OR = 0.18, $p < .05$).

The effect of being Asian was not significant in Model [1], Model [2], and Model [3] but significant in Model [4] (OR = 0.28, $p < .001$), Model [5] (OR = 0.32, $p < .01$), and Model [6] (OR = 0.34, $p < .05$). The effect of one identifying their race as Other instead of White or Asian was not significant in general, but significant in the Model [4] (OR = 0.32, $p < .001$). For further reference, the result of the multiple linear regression analysis is also attached in Appendix A.

RQ2: How do practicing engineers' moral foundations vary across employment sectors, organizational positions, and demographic attributes?

Table 7 shows the results of the multiple linear regression analyses each of which has Care, Fairness, Loyalty, Authority, and Purity as a dependent variable. *B* denotes unstandardized regression coefficients. Model 1 shows that sector, position, age, and identifying as a race/ethnicity other than White or Asian are not significantly associated with the Care foundation score. However, being female ($B = 2.026$, $p < .001$) and being Asian ($B = 1.751$, $p < .01$) are positively associated with higher score in the Care foundation. Model 2 shows that sector, position, and age are not significantly associated with the Fairness foundation score. However, being female ($B = 1.554$, $p < .001$), being Asian ($B = 1.664$, $p < .001$), and identifying with a race/ethnicity other than White or Asian ($B = 1.174$, $p < .05$) are positively associated with higher score in the Fairness foundation.

[Insert Table 7 here]

Model 3 shows that position, age, and identifying with a race/ethnicity other than White or Asian are not significantly associated with the Loyalty foundation score. However, working in the manufacturing sector (B = 1.561, p < .05) and being Asian (B = 1.636, p < .01) are positively associated with higher scores in the Loyalty foundation, and being female (B = -1.831, p < .01) is negatively associated with higher scores in the Loyalty foundation. Model 4 shows that position, being female, and identifying with a race other than White or Asian are not significantly associated with the Authority foundation score. However, working in the manufacturing sector (B = 1.577, p < .05), infrastructure sector (B = 1.686, p < .05), consumer sector (B = 1.677, p < .05), and others sector (B = 2.679, p < .01) as well as being in a higher age group (B = 1.804, p < .01) and being Asian (B = 1.617, p < .01) are positively associated with higher score in the Authority foundation. Model 5 shows that position and being female are not significantly associated with the Purity foundation score. However, working in others sector (B = 2.646, p < .05), being higher age group (B = 2.354, p < .001), being Asian (B = 2.345, p < .01), and being other race beyond White and Asian (B = 1.703, p < .05) are positively associated with higher score in the Purity foundation.

RQ3: How are practicing engineers' political ideologies related to their moral foundations?

Table 8 shows the results of the partial proportional odds model. Except for the Age and Race variables, the estimated odds ratios of all the other independent variables were same across the cumulative logits. For example, across the cumulative logits, higher scores in the Care foundation (OR = 0.89, p < .001) and Fairness foundation (OR = 0.89, p < .001) were negatively associated with political conservatism. Higher scores in the Loyalty foundation (OR = 1.08, p < .01), Authority foundation (OR = 1.10, p < .001), and Purity foundation (OR = 1.10, p < .001) were

positively associated with political conservatism. Also, being female (OR = 0.65, $p < .05$) was negatively associated with political conservatism.

[Insert Table 8 here]

However, the Age and Race variables showed difference in OR across the cumulative logits. For example, the effect of being lower age (less than 30) was not significant in the Model [2], Model [3], Model [4], and Model [6] but significant in the Model [1] (OR = 0.40, $p < .05$) and Model [5] (OR = 0.42, $p < .05$).

The effect of being Asian was not significant in the Model [1] and Model [3] but significant in the Model [2] (OR = 0.56, $p < .05$), Model [4] (OR = 0.20, $p < .001$), Model [5] (OR = 0.27, $p < .001$), and Model [6] (OR = 0.28, $p < .05$). The effect of identifying with a race/ethnicity other than White or Asian was not significant in general, but significant in the Model [4] (OR = 0.27, $p < .001$). We can also confirm that by adding the five moral foundations variables to the model, the pseudo R^2 increased from .078 (see Table 5) to .205 (see Table 9). For further reference, the result of the multiple linear regression analysis is also attached in Appendix A.

Discussion

In this section, we summarize our outcomes for each research question, and we compare our findings with the results of previous research.

To address RQ1, we examined descriptive statistics of the data, conducted Kruskal-Wallis tests, and conducted generalized ordinal logistic regression analyses. The results showed that for the political ideology across employment sectors, the contrast between the manufacturing sectors (including automotive, other manufacturing sectors, and oil and gas) and the

computer/electronics/IT sector was most evident. Except for the small retail sector, the computer/electronics/IT sector showed the most liberal political ideology on average (M = 3.40). By contrast, the automotive sector showed the most conservative political ideology on average (M = 4.39), followed by oil and gas/mining (M = 4.17), others (M = 4.17), military/defense/aerospace (M = 4.05), and manufacturing-other (M = 4.04). Further, according to the regression results, when other factors including position and demographic attributes are controlled, engineers who are working in the manufacturing sector are more likely to hold a conservative political ideology compared to engineers who are working in the computer/electronics/IT sector. This result comports with the prior research by Bonica (2014), who showed that the online computer-services industry, which includes Google and Facebook, tends to be left-leaning, while oil, gas, and coal and mining industries are right-leaning. Bonica did not specifically focus on engineers, however.

These results suggest that characteristics of various industrial sectors can be associated with the political ideology of employees in the industry. Since this study is correlational, however, we cannot determine the direction of causation: whether the industrial characteristics impact engineers' ideology or whether engineers self-select into the sectors whose ideology aligns with their own.

As discussed in the literature review, existing literature about the engineering profession and engineering culture have described engineering as a conservative profession (Riley 2008; Nieusma and Blue 2012; Cech 2013). However, as we have shown, engineers work in various sectors whose work environments are very different, and there are subgroups of engineers that more or less endorse conservative or liberal political ideologies, in part predicted by their employment sectors. While there can be some commonalities across engineers in different fields and sectors, it would be helpful to examine differences across engineers in different sectors for a deeper understanding of engineering practice. Explaining the reasons for the differences in political ideology across

sectors was out of the scope of this paper. A follow-up study could compare the most highly contrasting sectors.

Another interesting finding was the association between engineers' political ideology and their position in their workplace organizations. According to the regression results, after controlling the employment sector and demographic attributes, engineers with higher positions in their workplaces (at or above the mid-level manager level) are more likely to identify as conservative as compared to engineers in lower positions. Since the regression analysis controlled for age, the differences between positions cannot be attributed to age. This finding again raises an interesting chicken-and-egg problem: Are engineers with more conservative political ideology more likely to be promoted to higher positions, or do engineers become more conservative as they are promoted into higher positions? In their study about the political ideology of physicians, Bonica et al. (2014) raised similar questions regarding differences in partisanship across physicians' specialties. For example, surgeons contribute 48.1% more to the Republican Party than pediatricians do. Bonica et al. explain that while one possible explanation can be that this difference purely follows economic interests (therefore, surgeons become more conservative after they select their specialty), another explanation can be that students with Republican preferences select surgical specialties, as supported by Frank et al., (2007)'s study. A follow-up study could test whether endorsement of conservative political ideologies improves engineers' promotion in their workplaces, and how the fact varies across sectors with different ideological atmospheres.

To answer the RQ2, we conducted multiple regression analysis. According to the results, after controlling for position in the workplace and demographic attributes, engineers in the manufacturing sector showed higher endorsement of the Loyalty foundation than engineers in the computer/electronics/IT sector. Engineers in the manufacturing, infrastructure, consumer, and

others sectors all showed higher endorsement of the Authority foundation than engineers in the computer/electronics/IT sector. Also, engineers in the others sector showed higher endorsement of Purity foundation than the engineers in the computer/electronics/IT sector. However, there were no significant differences by sector in the Care and Fairness foundations. However, it is noteworthy that engineers from the manufacturing sectors showed significantly higher endorsement of Loyalty and Authority foundations than engineers from the computer/electronics/IT sector, and this may partially explain one of the findings from the RQ1 – engineers from manufacturing sectors are more conservative than engineers from computer/electronics/IT sector. This interpretation aligns with Graham et al. (2009), who showed that conservatives value Loyalty, Authority, and Purity more than liberals. Indeed, the impact of moral foundations in engineers' political ideology became more evident in RQ3, as we will discuss further below.

We found that Asian engineers showed higher endorsement of all five moral foundations as compared to White engineers, after controlling for sector, position, and other demographic attributes. The finding implies that, at least according to the figures, Asian engineers consider all five moral foundations as more important criteria for making moral judgments as compared to White engineers. First, we clarify that we use the race dimension as a cultural dimension, given the cultural construction of race. We believe the differences in the endorsement of each moral foundation across different races are due to the shared culture of each race group. In fact, the motivation behind the establishment of the Moral Foundations Theory was Haidt (2012)'s visit to India and his experience of cultural differences, which was inspired by Shweder et al. (1987)'s cultural study on morality. Shweder et al. (1987) argued that compared to the educated population in the United States, Indians have a broader moral domain. Therefore, it is not surprising that Asian

groups show higher endorsement of the other moral foundations of Loyalty, Authority, and Purity, especially considering that typically (and only) Care and Fairness are explicitly emphasized in WEIRD (Western, Educated, Industrialized, Rich, and Democratic) cultures when discussing morality. However, considering that Asian groups also showed higher endorsement of Care and Fairness foundations, it can be also possible that cultural differences caused different interpretations of the survey items. Future research may be needed to further explore these possibilities, such as by conducting a measurement invariant analysis to check whether the survey items are interpreted differently by the different demographic groups. We could not conduct such an analysis due to the limited sample size. A follow-up study would be necessary to identify the reasons for this difference.

To answer RQ3, we again conducted a generalized ordinal logistic regression. One noteworthy result was that while the manufacturing sectors showed more conservative-leaning tendencies as compared to the computer/electronics/IT sector in RQ1, after adding the five moral foundations as independent variables in the regression model, this difference disappeared. It means that moral foundations mostly explain the variance in political ideology among employment sectors. Based on the results, a follow-up study could examine what aspects of the industrial culture affect the differences in engineers' endorsement of the five moral foundations. Consistent with the findings from Graham et al. (2009), our results also showed that Care and Fairness foundations are positively associated with political liberalism, whereas Loyalty, Authority, and Purity foundations are positively associated with political conservatism.

Limitations and Future Work

The first limitation of this study lies in the sample. While we tried our best to collect data through various channels, the majority of the data was obtained through social media platforms, especially LinkedIn. Therefore, the majority of the study participants are active LinkedIn users, which may not accurately represent a more general population of engineers. Moreover, since the survey participation was completely voluntary, engineers who were interested in the topic and engineers who were more open to participating in this kind of research study were necessarily self-selected. Those issues raise questions about the representativeness of the study sample. However, even with the limitation, it is noteworthy that our sample covers diverse demographic groups and resembles the national-level demographics for the profession ("Engineer Statistics and Facts in the US" 2021; Roy 2019), although with a slight overrepresentation of Asian engineers.

Another limitation is the small number of respondents in some subgroups. Since one of the purposes of this study was to provide a broad overview of differences in political orientation and moral foundations among engineers across various sectors, we invited engineers from various sectors rather than limiting the number of the sectors for investigation. While this approach led to obtaining information from engineers in various sectors, this led to limiting the number of engineers representing each sector. For example, in the retail sector, there were only ten engineers. Since we later combined sectors into five broader sectors (computer/electronics/IT, manufacturing, infrastructure, consumer, and others), the regression results may be less biased. However, readers should cautiously interpret differences between small subgroups and other subgroups in Table 5 and Figure 1. Future studies with larger samples would be needed to check the accuracy of these differences.

The second limitation is our measure of political ideology. While the political self-placement item has been widely used with some validity evidence, some scholars have criticized the measure. For

example, Kitschelt and Hellemans (1990) reported that people's answers to the political self-placement item are often misaligned with their policy positions, while the answers are more accurate among political elites. Participants can misplace their position because there is a wide range of interpretations of the measure. While the political self-placement item benefits from its simplicity, future research could use a more sophisticated, reliable measure of political ideology.

While this study fulfilled its purpose of exploring political ideology and moral foundations of practicing engineers across the sector, position, and demographic attributes, we did not examine how such differences are reflected in their actual work practices and/or other types of activities they undertake in their professional or personal lives. Follow-up studies that delve into the reason and impact of such differences would be necessary.

Conclusion

In this paper, we reported the results of our exploratory study about engineering practitioners' political ideology and moral foundations. We highlighted the differences in political ideology and moral foundations across the subgroups of our study participants and showed that engineers working in the manufacturing sectors are more politically conservative than engineers working in the computer/electronics/IT sector. We found that engineers in higher positions in their workplaces were also more politically conservative than engineers in lower positions in their workplaces, and female engineers were more politically liberal than male engineers. We also showed that engineers' endorsements of the five moral foundations differ by sector and demographic attributes (age, gender, and race). Finally, we showed that engineers' moral foundations considerably explain their political ideology, consistent with previous studies involving Moral Foundations Theory.

Due to the inherently political nature of engineering practice, engineering ethics scholars have argued that engineering ethics education also needs to include concerns related to broader societal context, such as political engagement (Mitcham 2009; Conlon 2008). However, there have been few investigations regarding the main active agents of such political engagement – engineering practitioners. When emphasizing the importance of ideological analysis of the current corporate social responsibility movement in business settings, Spector (2008) said, "[…] doing well by doing good can lead to goals not shared by every advocate. Today's enthusiasm over doing well by doing good needs to be contained within a critical context—one that demands analysis and debate and makes transparent and debatable not just the goals of the agenda but also the process by which those goals are set" (333). Better understanding of political ideology and moral foundations of practicing engineers would establish a good starting point for finding common goals that many engineers can advocate together. In that sense, this study contributes to discussions around the normative goals of engineering practice, including currently predominant and future aspirational goals for the profession.

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Declaration of Generative AI and AI-assisted Technologies in the Writing Process

None

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Appendix A. Results of Multiple Linear Regression Analysis (for RQ1 and RQ3)

Variables	**Political Ideology**	
	Model 1	Model 2
	B	*B*
Intercept	3.653 ***	4.645 ***
Moral values		
Care		-.085 ***
Fairness		-.090 ***
Loyalty		.049 **
Authority		.074 ***
Purity		.074 ***
Combined sector		
Manufacturing	.466	.082
Infrastructure	.262	-.036
Consumer	.126	-.215
Others	.570	.047
Position		
Higher position	.385 *	.181
Age		
Older age	.474 *	.160
Younger age	-.282	-.194
Gender		
Female	-.889 ***	-.344 *
Race		
Asian	-.502 *	-.608 ***

Others	-.211	-.264
R^2	.146	.480
Adj. R^2	.128	.464

Table 1. Participant Demographic Information (n=515)

Demographic Variables	*n*	%	Demographic Variables	*n*	%
Age			**Employment Sector**		
Less than 30	130	25	Automotive	38	7
30 – 49	231	45	Computer/Electronics/IT	87	17
50+ (more than 50)	154	30	Construction	34	7
Gender			Food	15	3
Male	405	79	Government	16	3
Female	101	20	Healthcare	35	7
Others[1]	9	1	Manufacturing – Other[3]	76	15
Race			Military/Defense/Aerospace	40	8
White/Caucasian	312	61	Oil and Gas/Mining	35	7
Asian or Asian American	123	24	Retail	10	2
Others[2]	80	16	Transportation	20	4
Position			Utilities	29	6
Entry level	34	7	Consulting	14	3
Individual contributor	189	37	Consumer Products	25	5
Project manager	105	20	Others	41	8
Mid-level manager	76	15	**Academic Degrees Held**		
Top-level manager	58	11	Bachelor's degree	515	100
Executive/C-level	53	10	Master's degree	226	44
			PhD degree	59	11
			Other professional degrees[4]	76	15

[1]Including "Prefer not to answer" (7 responses = 1% of total)

[2]Including Hispanic or Latino/a (21 responses = 4% of total), Black or African American (18 responses = 3% of total), mixed race (24 responses = 5% of total), American Indian or Alaska Native (2 responses = 0% of total), and Prefer not to answer (15 responses = 3% of total)

[3]Manufacturing-Other means all the other manufacturing businesses including machinery and metal products manufacturing beyond the manufacturing of the other listed sectors in the table (e.g., automotive manufacturing, electronics manufacturing)

[4]Including MBA, JD, MD

Table 2. Dummy Codded Independent Variables

Independent variable	Reference group	Other group(s)
Combined sector	Computer/Electronics/IT	Manufacturing [a]
		Infrastructure [b]
		Consumer [c]
		Others
Position	Lower position [d]	Higher position [e]
Age	Middle age	Older age [f]
		Younger age [g]
Gender	Male	Female
Race	White	Asian
		Others

[a] Manufacturing: Automotive, Manufacturing-Other, Oil and Gas/Mining

[b] Infrastructure: Construction, Government, Military/Defense/Aerospace, Transportation, Utilities

[c] Consumer: Food, Healthcare, Retail, Consulting, Consumer Products

[d] Lower position: Entry Level, Individual Contributor, Project Manager

[e] Higher position: Mid-level Manager, Top-level Manager, Executive/C-Level

[f] Older age: 50+ years

[g] Younger age: Less than 30 years

Table 3. Results of Brant Test

Variables	χ^2	$p > \chi^2$
Overall model	95.53	<.001 ***
Combined sector (Referent: Computer/Electronics/IT)		
Manufacturing	3.78	.465
Infrastructure	1.83	.876
Consumer	2.80	.794
Others	6.93	.757
Position (Referent: Lower position)		
Higher position	4.01	.521
Age (Referent: Middle age)		
Older age	12.03	.033 *
Younger age	13.79	.018 *
Gender (Referent: Male)		
Female	2.40	.783
Race (Referent: White)		
Asian	19.41	.002 **
Others	21.24	<.001 ***

*$p < .05$. **$p < .01$. ***$p < .001$.

Table 4. Results of Brant Test

Variables	χ^2	$p > \chi^2$
Overall model	113.38	.003 **
Moral values		
Care	1.56	.906
Fairness	3.76	.585
Loyalty	3.07	.689
Authority	3.26	.661
Purity	9.57	.088
Combined sector (Referent: Computer/Electronics/IT)		
Manufacturing	3.94	.558
Infrastructure	2.99	.702
Consumer	3.71	.592
Others	8.25	.143
Position (Referent: Lower position)		
Higher position	5.42	.367
Age (Referent: Middle age)		
Older age	12.95	.024 *
Younger age	13.89	.016 *
Gender (Referent: Male)		
Female	0.56	.990
Race (Referent: White)		
Asian	17.61	.004 **
Others	20.49	.001 **

*$p < .05$. **$p < .01$. ***$p < .001$.

Table 5. Mean and Standard Deviation of Political Ideology (1 = strongly liberal; 7 = strongly conservative)

	Political Ideology		Political Ideology
	Mean (SD)		Mean (SD)
All participants	3.80 (1.88)	**By Age**	
By Sector		Less than 30	3.10 (1.58)
Retail	2.50 (1.18)	30-49	3.75 (1.78)
Computer/Electronics/IT	3.40 (1.76)	50+	4.48 (2.02)
Consulting	3.43 (1.65)	**By Gender**	
Food	3.53 (1.64)	Male	4.03 (1.90)
Healthcare	3.60 (1.87)	Female	2.93 (1.54)
Consumer Products	3.64 (1.68)	Others	3.44 (1.51)
Transportation	3.65 (1.42)	**By Race**	
Construction	3.68 (1.80)	White	4.08 (2.02)
Utilities	3.72 (2.05)	Asian	3.17 (1.48)
Government	3.81 (2.23)	Others	3.71 (1.51)
Manufacturing – Other[a]	4.04 (2.07)	**Position**	
Military/Defense/Aerospace	4.05 (2.02)	Entry level	3.26 (1.52)
Others	4.17 (1.84)	Individual contributor	3.48 (1.77)
Oil and Gas/Mining	4.17 (2.22)	Project manager	3.63 (1.86)
Automotive	4.39 (1.52)	Mid-level manager	4.24 (2.01)
		Top-level manager	4.28 (1.72)
		Executive/C-level	4.51 (2.11)

Table 6. Results of Partial Proportional Odds Model

Variables	Odds Ratio (OR)					
	[1]	[2]	[3]	[4]	[5]	[6]
	Pr(x=2,3,4,5,6,7) / Pr(x=1)	Pr(x=3,4,5,6,7) / Pr(x=1,2)	Pr(x=4,5,6,7) / Pr(x=1,2,3)	Pr(x=5,6,7) / Pr(x=1,2,3,4)	Pr(x=6,7) / Pr(x=1,2,3,4,5)	Pr(x=7) / Pr(x=1,2,3,4,5,6)
Combined sector (Referent: Computer/Electronics/IT)						
Manufacturing	1.66 *	1.66 *	1.66 *	1.66 *	1.66 *	1.66 *
Infrastructure	1.21	1.21	1.21	1.21	1.21	1.21
Consumer	1.14	1.14	1.14	1.14	1.14	1.14
Others	1.74	1.74	1.74	1.74	1.74	1.74
Position (Referent: Lower position)						
Higher position	1.46 *	1.46 *	1.46 *	1.46 *	1.46 *	1.46 *
Age (Referent: Middle age)						
Older age	0.68	1.11	1.82 *	1.62 *	1.62 [a]	1.90 *
Younger age	0.50	0.79	0.92	0.87	0.38 *	0.18 *
Gender (Referent: Male)						
Female	0.41 ***	0.41 ***	0.41 ***	0.41 ***	0.41 ***	0.41 ***
Race (Referent: White)						
Asian	1.59	0.76	0.79	0.28 ***	0.32 **	0.34 *
Others	1.60	1.27	1.22	0.32 ***	0.51	0.77
Pseudo R^2	.078					

*p < .05. **p < .01. ***p < .001.

[a] While not significant at .05 level, the p-value was .051, which is very close to the borderline.

Table 7. Results of Multiple Linear Regression Analyses

Variables	**Care**	**Fairness**	**Loyalty**	**Authority**	**Purity**
	Model 1	Model 2	Model 3	Model 4	Model 5
	B	*B*	*B*	*B*	*B*
Intercept	20.537 ***	20.623 ***	14.127 ***	13.463 ***	12.323 ***
Combined sector (Referent: Computer/Electronics/IT)					
Manufacturing	-1.214	-.004	1.561 *	1.577 *	1.402
Infrastructure	-.409	-.552	.123	1.686 *	1.122
Consumer	-.260	-.708	.310	1.677 *	1.046
Others	.205	-.638	1.694	2.679 **	2.646 *
Position (Referent: Lower position)					
Higher position	-.669	-.269	.405	.561	.972
Age (Referent: Middle age)					
Older age	.057	.187	.993	1.804 **	2.354 ***
Younger age	.306	.509	.064	.553	-.491
Gender (Referent: Male)					
Female	2.026 ***	1.554 ***	-1.831 **	-1.116	-.675
Race (Referent: White)					
Asian	1.751 **	1.664 ***	1.636 **	1.617 **	2.345 **
Others	.768	1.174 *	.401	.934	1.703 *
R^2	.088	.073	.058	.055	.060
Adj. R^2	.070	.054	.038	.034	.041

*p < .05. **p < .01. ***p < .001.

Table 8. Results of Partial Proportional Odds Model

Variables	Odds Ratio					
	[1]	[2]	[3]	[4]	[5]	[6]
	Pr(x=2,3,4,5,6,7) / Pr(x=1)	Pr(x=3,4,5,6,7) / Pr(x=1,2)	Pr(x=4,5,6,7) / Pr(x=1,2,3)	Pr(x=5,6,7) / Pr(x=1,2,3,4)	Pr(x=6,7) / Pr(x=1,2,3,4,5)	Pr(x=7) / Pr(x=1,2,3,4,5,6)
Moral values						
Care	0.89 ***	0.89 ***	0.89 ***	0.89 ***	0.89 ***	0.89 ***
Fairness	0.89 ***	0.89 ***	0.89 ***	0.89 ***	0.89 ***	0.89 ***
Loyalty	1.08 **	1.08 **	1.08 **	1.08 **	1.08 **	1.08 **
Authority	1.10 ***	1.10 ***	1.10 ***	1.10 ***	1.10 ***	1.10 ***
Purity	1.10 ***	1.10 ***	1.10 ***	1.10 ***	1.10 ***	1.10 ***
Combined sector (Referent: Computer/Electronics/IT)						
Manufacturing	1.23	1.23	1.23	1.23	1.23	1.23
Infrastructure	1.00	1.00	1.00	1.00	1.00	1.00
Consumer	0.88	0.88	0.88	0.88	0.88	0.88
Others	1.20	1.20	1.20	1.20	1.20	1.20
Position (Referent: Lower position)						
Higher position	1.18	1.18	1.18	1.18	1.18	1.18
Age (Referent: Middle age)						
Older age	0.49	0.79	1.61	1.26	1.20	1.46
Younger age	0.40 *	0.78	1.02	1.01	0.42 *	0.26
Gender (Referent: Male)						
Female	0.65 *	0.65 *	0.65 *	0.65 *	0.65 *	0.65 *
Race (Referent: White)						
Asian	1.16	0.56 *	0.68	0.20 ***	0.27 ***	0.28 *
Others	1.13	1.19	1.25	0.27 ***	0.55	0.99
Pseudo R^2	.205					

*p < .05. **p < .01. ***p < .001.

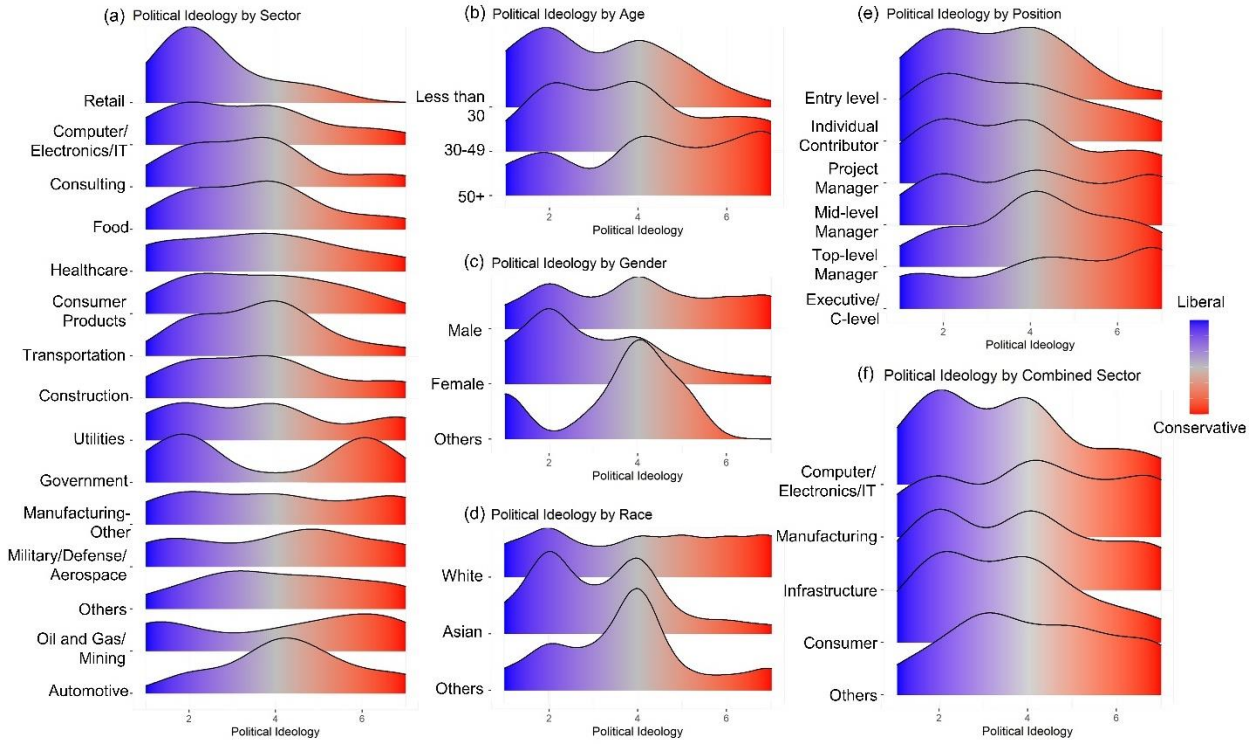

Figure 1. Density plot of political ideology by sector (a), age (b), gender (c), race (d), position (e), and combined sector (f). Cautious interpretation would be needed for small groups including Sector – Retail, Consulting, Food, Transportation, Government; and Gender – Others.