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The corporate executive leadership team and its diversity: impact on innovativeness and sustainability of the bioeconomy

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Senior executives have a major role in leading corporations both strategically and operationally. In large corporations, the executive team is leading through their respective organizations, ensuring that corporate strategy is executed efficiently and effectively. In addition, executive management plays the key role in shaping the culture and the values of the corporation. There exists a wealth of research conducted on executive management team dynamics and the success factors related to their performance. This study examines how diversity in executive management impacts the perceived innovativeness of companies. We compare the most innovative companies and the largest players in the bioeconomy. Currently, the bioeconomy has received a lot of attention as it is considered one of the industries associated with solving global societal and environmental challenges. However, it is not perceived as highly innovative and is considered to be lacking in diversity among senior executive teams. This study adds to the body of knowledge connecting innovation, diversity, and corporate leadership and highlights similarities and differences from diversity perspective related to the companies investigated.

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Introduction

In the current era of globalization, organizations have been increasingly addressing unconscious biases and equity as a means of creating a more innovative and inclusive work environment. Diversity has been discussed with interest in mainstream conversations about increasing efficiencies, strengthening ties with partners, and improving public image. More recently, the discussions on diversity have incorporated its impact on innovation. Innovation is the root of an organization's ability to obtain and maintain a core competitive advantage (Wang and Xiao, 2017). As such, it is high on the list of requirements to achieve corporate success. The main goal of diversity in upper-level governance is to achieve organizational ambidextrous innovation. Ambidexterity defined in this context is the ability for companies to explore new opportunities while exploiting past experience for stability and creating future efficiencies (Li, 2013). Previous research examined the impact of diversity on ambidextrous innovation, and some found that heterogeneity of top management teams may increase undesirable effects by impeding the sharing and dissemination of information between team members.

Smith and Tushman (2005) suggested that the composition of the executive team plays a crucial role in effectively managing exploration and exploitation for innovative purposes. Li (2013) found that there is a third dimension in play when analyzing the relationship between the diversity of executives and innovation, and that is social capital. Social capital is defined as the networks of relationships in a society that affects its ability to successfully function. It is largely linked to favorable outcomes in a variety of environments ranging from healthcare to economic performance to political participation (Fieldhouse and David, 2010). Social capital among executives can be seen as the relationships between executives that foster growth and efficiencies. In this context, Li (2013) states that diverse executive team composition in the form of heterogeneity of demographic factors of the executives can make it more complicated to achieve organizational ambidexterity because, with lower social capital among top executives, the diversity effects are not significant. Lower social capital is enhanced by differences in thought and identity between individuals by impeding the sharing and dissemination of information between team members. However, other factors play a role as well. Poverty has been found to affect social capital more negatively than diversity. A further variation that should be considered includes separation of community participation vs. political participation (Fieldhouse and David, 2010). To elaborate, lower social capital increases political participation while decreasing community participation activities such as volunteerism. This variation is important to note because the authors wish to clarify the effects of diversity on social capital on ambidextrous innovation. While social capital may have surface-level negative results on productivity, other factors such as poverty affect it, which does not apply to the study at hand because it can be assumed that the executive team members are not experiencing poverty at the time of the study. This assumption somewhat negates the relationship between social capital and diversity on innovation due to the environment in which it is studied. It must be noted that higher social capital positively enhances the effects of diversity on innovation.

In this article, the impact of diversity on innovation is examined through the lenses of companies both known for innovation and those less known for innovation within the Bioeconomy. The pulp and paper industries were selected as the main representation of the bioeconomy due to their focused efforts in sustainable and renewable resource use. This industry has recently made considerable advancements in sustainability, the advancement of digitalization, and the use of advanced sustainable materials such

as micro- and nano-fibrillated cellulose fibers and sustainable composite materials (Nagothu and Nagano, 2020). As such, there is tremendous potential in the pulp and paper industry to innovate and successfully address global challenges (Hakovirta et al., 2020; Hakovirta and Lucia, 2019).

The bioeconomy has several definitions that share a common terminology of an industry that emphasizes “the sustainable use of biological or renewable natural resources” (Nagothu and Nagano, 2020). The specific definitions themselves touch on the industry's ability to create value-added products, its knowledge-based production of sustainable items and ideas, and its impact on sustainability, in general, using renewable resources (EC, 2012; FAO, 2016; Golden and Handfield, 2014). Currently, the bioeconomy is deliberated in terms of its ability to solve environmental issues and other global challenges such as poverty and inequality (Nagothu and Nagano, 2020; Khavul and Bruton, 2013; Stewart, 2014).

The intent of this research is to find what type of diversity matters most for companies that need to constantly innovate. Innovation—as the study of sources of opportunities, where opportunities are found and exploited—has a strong people component (Shane and Venkataraman, 2000). The innovation competence and talent create the organizational capability to discover, evaluate, and exploit new business opportunities. As such, the makeup of the ‘people’ includes many factors and in this research, we are exploring the impact of diversity in its many forms. It connects to the organizational culture and diversity of thought, both of which are critical for successful innovation (Hakovirta et al., 2020). The executive management plays a major role in shaping the culture and the values of the corporation and therefore has a high impact to innovation. In this study we are exploring if the diversity of the composition of the executive team has an impact to the innovativeness of a corporation or industry groups. The factors that we examine include age, gender, educational discipline, race, and educational level as they are a widely used approach to view diversity (Ruigrok, Peck, and Tacheva, 2007; Brown, 2008). Our research connects therefore the disciplines of innovation research, humanities and social sciences, entrepreneurial economics, and management. More specifically we have approached this through a comparative analysis between the most innovative companies and firms engaged in the bioeconomy.

Corporate governance and executive team

Corporate governance is by definition a well-defined system that is purposed to direct and manage a company. This system is designed to set goals and objectives and determine how organizational performance is measured and optimized (Renee et al., 2010). One critical aspect of a governance model is also to ensure effective risk management. The system includes the development and enforcement of policies, procedures, and principles and it defines the management roles and responsibilities, and accountabilities (Brown et al., 2009). It can be stated that corporate governance includes the different mechanisms by which stakeholders' control is exercised over operational management. The stakeholder's community is broad and includes equity shareholders, lenders, employees, suppliers, customers, and governmental entities.

As the leaders in strategy implementation and formulation, the executive management team shapes the corporation's behavior through their active engagement and development of the corporate culture. In this capacity their role in building strategic direction and effective and responsible execution is critical. However, in certain industries, corporate strategies tend to lack

direction and dynamic change. These industries and corporations may fall into the trap of well-designed, rigid corporate governance models that facilitate low risk-taking and self-recognition. This can then result in problematic management thinking that leads to decreased technological and business model innovation output (Wang and Xiao, 2017). The methodology and discussion of this paper imply that companies in the bioeconomy somewhat fall into that category due to the industry's maturity and governance model-related ability to innovate.

Corporate executives may have agendas that are different from their owners' and therefore the governance challenge is to make sure that the resolution of conflicts is an open and fair process between all stakeholder entities (Monks and Minow, 2011). In corporate governance, the system is composed of three different bodies contributing to the corporate capital, talent and expertise, and making sure that maximum benefit of all is put into effect. The investors provide the capital and participate in gaining a return on their investment without taking responsibility for the corporate operations. The management orchestrates the appropriate and sufficient amount of skillful workforce and runs the company without the personal responsibility of providing the capital. Lastly, the board of directors provides the expertise and has limited liability and limited operational involvement in the company's affairs (Monks and Minow, 2011).

The single major challenge addressed by corporate governance that connects to innovation and sustainability, is how to approve and monitor the company's business strategy to achieve long-term value creation (Eloranta, 2019). This comes in the form of granting executives discretionary power over the conduct of the business. With greater power also comes higher executive compensation and therefore a major interest exists in the shareholder community to make sure the executive compensation is fair and appropriate. Investors want a compensation plan with volatility based on performance thus aligning management interests and reducing agency costs (management). Clearly, managers are inclined to want less volatility and more certainty in their compensation. One additional facet of this discussion is how market forces and risk-taking (e.g., profitable growth and innovation) play into incentives for executives (Holmstrom, 1999). While some describe the linear and positive relationship between pay and performance and the shareholders' relationship to it, Holmstrom claims that a simple linear relationship does not adequately explain the executive incentive system. He argues that multitasking must be considered for example, there are two ways to provide pay-for-performance incentives—measure the quality of the work or reduce incentives on quantity. This dichotomy emphasizes the need for further discussion on how incentives affect executive performance and what identifying factors play into (Holmstrom, 2017).

Accompanying high compensation packages provided to executives by the board relates to the gender gap in similar executive roles and connects to our research. Earlier research on the gender pay gap attempted to examine the factors behind the gap as well as how to resolve it (Cook et al., 2019). It has been stated that adding women to executive teams contributes to lower firm risk and better performance. However, the pay gap persists until more than a minimum number of women are added to the team making it more gender-diverse, which then results in a reduced wage gap in compensation packages. (Perryman et al., 2016). The compensation gap may also be narrowed if female executives display agentic traits (qualities relevant for goal-attainment, such as assertiveness, competence, or persistence) through risk-taking, or alternatively, work in female-dominated industries where communal traits are valued (qualities relevant for the establishment and maintenance of social relationships) (Wang et al., 2019).

Diverse executive management team composition is but one factor that affects the gender pay gap. Highly diverse companies are more likely to introduce new product innovations. Diversity is also particularly important for companies that are working in or expanding to international markets and serving a cosmopolitan population. It has also been reported that migrant status has positive links to entrepreneurship (Nathan and Lee, 2013). Despite the research that supports claims that diversity is an economic asset, there still exists a debate on the issue of diversity in organizations, which is concentrated around two positions. The first argues for diversity because it is the right thing to do. The second analyzes diversity through the prism of financial performance and sees diversity in upper-level management as a lever for creating value for the company and its stakeholders (Ouni et al., 2020). This paper examines diversity through the second lens as a more utilitarian approach.

Diversity ties in with the culture of an organization by influencing thought leadership and opinions as well as influences how an organization conducts its business (Barney, 1986). For strategic and growth purposes, organizational knowledge is a crucial factor in creating sustainable advantage and success; and since knowledge issues are closely interlinked with organizational culture, knowledge management becomes a cultural management issue (Alvesson, 2002). It can be stated that one of the most important responsibilities of a leader is to manage the organization's culture (Schein, 2010). In general, there currently lies three components of organizational culture: content of cultural norm, the general agreement and consensus of the norm, and the intensity of the agreement on norm (Chatman and O'Reilly, 2016). The role diversity plays in this is on how culture affects the way that organizational knowledge is created, shared, maintained, and utilized. For example, a more diverse group can create more knowledge due to the group's collective experiences, but there will be a slower rate of consensus and spread of the knowledge due to inherent barriers that diverse groups often encounter (i.e., inclusion/exclusion) (Cummings, 2004).

The impact of culture on innovation has been recognized as a critical factor in international management and organizational development given its relevance and contribution to business and economic development (Tian et al., 2018). Additionally, the executive team plays a major role in defining the values and norms that support an organization's innovativeness (Topping, 2002). Innovation in a company can be defined as the ability to take risks, employ a future market orientation, be open-minded, and be able to learn (Brettel and Cleven, 2011; Wang et al., 2012). Within this environment, organizations frequently invest in R&D to promote new product development to increase market share and profitability. In this context the organizational diversity of knowledge base has been linked to improved problem-solving activities and technologically diverse firms have been found to be innovative and resilient (Dosi, 1988; Breschi et al., 2003; Suzuki and Kodama, 2004).

From an organizational perspective, diversity can also be seen as a double-edged sword (Ramasamy and Yeung, 2016). While heterogeneous teams can promote positive effects in certain fast-paced and dynamic business environments, the effects differ in stable environmental conditions (Bengtsson et al., 2020). Homogenous teams working in a stable environment have been reported to achieve better financial performance because of more traditional team dynamics (Bengtsson et al., 2020). By matching team composition to environmental contexts over time, organizations can successfully weather both turbulent and stable times (Bengtsson et al., 2020). The complexity of the discussion on diversity regarding executive teams is widely accepted. By finding the moderating effects of diversity on a firm it is possible to

further the discussion of the relationship between diversity and innovation in both turbulent and stable times.

Research methodology

Our current research is comparing different companies' innovation capabilities between bioeconomy firms to some of the most innovative companies in the world. We analyze these two company groups by specifically looking at their executive team composition from a diversity perspective and conclude on how factors that are known to affect innovation can be different comparing the bioeconomy and the most innovative companies. Our null hypothesis is no statistical difference in the data comparing the diversity factors to the innovativeness of the two groups of companies analyzed.

For the list of the most innovative companies in 2020, we used the Boston Consulting Group's (BCG) methodology. It is widely used in corporate planning, consulting, and research (Ercis and Unalan, 2015). The reasoning behind the selection of this definition and data is due to the complicated process of analyzing innovation in companies including their intangible intrinsic risks and considerable benefits (Heskett, 1996). The intricacy of the problem lies in how firms demonstrate their abilities to generate new products, markets, and revenue streams; in how executives underestimate the risks they face in the foreseeable future; and in how firms adapt to changing business conditions such as the advent of the digital world and big data (Ercis and Unalan, 2015). These factors have a significant impact on innovation in every industry, but many companies do not have a clear way of identifying how their respective firm lies in its ability to innovate if their abilities and results are not compared to other firms.

BCG methodology is well established and easily communicates to the academic and corporate field, the degree to which their company is considered innovative. The BCG ranking used in this study is from 2020 as this was the most up-to-date list of the most innovative companies in the world (Ringel et al., 2018). The ranking is based in large part on a survey of 2500 global innovation executives (63% C level, 37% senior vice-president or vice-president level) who were polled in 2019. BCG assessed companies' performances on four dimensions (global mindshare, industry peer review, value creation, and industry disruption) and for the final ranking, the average normalized score of the dimensions were used. Global mindshare was measured by votes received from global innovation executives; industry peer review was measured by votes received from executives in a company's own industry; value creation was measured by votes received for TSR (the total shareholder return including share buybacks from January 2017 through December 2019). The fourth dimension (industry disruption) is a relatively new indicator in the BCG methodology and is measured by the Herfindahl-Hirschman Diversity Index (HHI). It is purposed to capture the variety and intensity of competition and thus the ability to breach the barriers of entry (Matsumoto et al., 2012). The HHI is measured by the following equation:

$$HHI = S_1^2 + S_2^2 + S_3^2 + S_4^2 \dots + S_n^2$$

where S_i = market share of firm i in the market

HHI is an indicator of the amount of competition among the firms in a specific industry. As the HHI increases it indicates decreased competition and increases market power. A decrease in HHI shows the opposite, increased competition, and decreased power.

While the BCG study may have its limitations, it is important to note that there are only a few rankings available for global companies' innovativeness, especially ones that have as consistent and structured a methodology as BCG's. It is usually challenging

to measure innovativeness accurately as well as obtain access to senior-level executives to solicit their opinions. BCG does this by using a sufficiently methodological rigor that fits with the research thrust of this paper.

The list of pulp and paper or bioeconomy companies was selected by reviewing the corporate annual reports and by selecting the largest players in this space based on the revenue. The executive teams' composition was identified using selected companies' annual reports and information from company websites and each individual was analyzed using a variety of diversity and inclusion-related data that was collected using web search tools such as google.com. By going through websites through the web, such as yahoo.com, company websites, crunchbase.com, and other websites that detailed non-protected identifying data, we were able to find data comprised approximately of 315 data points including gender, age, level of education, type of education, career background, and diversity of the discipline and experience. A simple statistical test was performed using two-sample t -test in order to see if there is a significant difference in means between the two different groups: bioeconomy and the most innovative companies. An excel t -test function was used with two-sample heteroscedastic variance and two-tailed distribution.

Results

Educational discipline. Looking at the diversity of the types of education, Table 1 and Fig. 1 finds that the total spread of the different number of majors (showcased by the total amount of engineering, business, social science, science, and natural resource majors) is nearly identical between both groups. This illustrates the similarity in diversity of disciplines among executive team members. The engineering discipline includes all engineering fields as well as computer science. The business discipline encompasses fields and degrees, such as an MBA, accounting, and economics. The social science discipline encompasses majors such as history, sociology, law, and others. The sciences included mathematics, physics, medicine, and other related fields and lastly, the natural resources discipline only includes forestry. Only the bioeconomy companies have natural resource discipline members, which can be explained by these companies having forestry or natural resource-related operations and products.

There is a 10-percentage point difference between the number of engineering majors and business majors for the Bioeconomy companies (leaning towards business). In comparison to the most innovative companies, there is only a 1 percentage point difference between both majors. Interestingly, these results differ from earlier published results for the educational discipline focus on the boards of directors in similar research (Hakovirta et al., 2020). For boards of directors, 9 percentage points were leaning towards business majors for innovative companies and 18 percentage point difference leaning towards business majors for Bioeconomy companies. The difference between business and engineering majors for executives in the Bioeconomy is almost half of that of the boards of directors in the Bioeconomy. Additionally, compared to the results found for the boards of directors of the innovative companies, there is very little difference between the disciplines for executives (1%). One explanation of the difference in engineering vs. business degrees is the fact that the most innovative companies are relatively new compared to the Bioeconomy companies. Henceforth, they are still in the growth phase of their life cycle. Bioeconomy companies are more mature and thus more focused on stability and sustainable strategies. With these goals in mind, the most innovative companies focus on recruiting both engineering majors and business majors for product innovation, building

Table 1 Educational disciplines for executive team members in both company groups.

Company name	Engineering	Business	Social science	Science	Natural resources	
<i>Bioeconomy companies</i>						
International Paper	5	7	2	0	0	
Kimberly Clark	2	7	2	0	0	
WestRock	4	10	1	2	1	
UPM	8	4	3	0	0	
Stora Enso	3	8	3	0	1	
Mondi Group	3	5	1	1	1	
Sappi	4	7	7	2	1	
Domtar	2	4	2	0	0	
Arauco	8	4	0	0	0	
Metsaliitto	5	1	1	0	0	
Total	44	57	22	5	4	132
	33%	43%	17%	4%	3%	100%
<i>The most innovative companies</i>						
Apple	10	8	2	2	0	
Google	7	11	4	2	0	
Microsoft	8	9	3	1	0	
Amazon	3	2	1	0	0	
Samsung	3	0	1	0	0	
Huawei	4	6	0	0	0	
Facebook	2	2	2	1	0	
IBM	9	7	9	3	0	
Sony						
Alibaba	5	7	3	0	0	
Total	51	52	25	9	0	137
	37%	38%	18%	7%	0%	100%

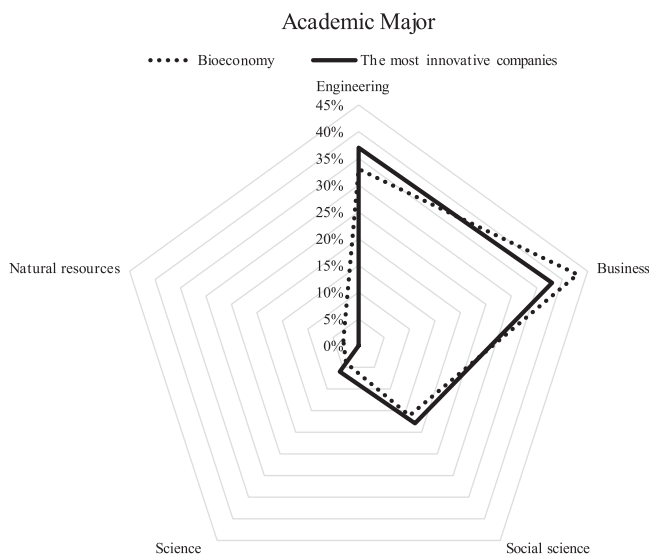


Fig. 1 Radar chart of types of education for the executive team members in both company groups. Educational disciplines for bioeconomy companies (dotted line) and the most innovative companies (solid line).

novel technology platforms, and creating a competitive corporate strategy. In contrast, Bioeconomy companies seem to recruit executives with business majors with a more focused management agenda to enhance their manufacturing capacity building (large investments) and financial stability.

Table 1 also showcases how social science majors are considered more valuable than pure science or natural resources majors for leadership positions (disregarding business and engineering). This occurs even though science and natural resources are STEM fields, as is engineering, and both examined groups (Bioeconomy and innovative companies) are in STEM

disciplinary areas. Comparing the below results to the ones for the boards of directors, the Bioeconomy companies had a 23% share of major disciplines for social sciences while for executives, it was only 17% (Hakovirta et al., 2020). The differences in social science majors between the board of directors’ results and executive team results for the most innovative companies were slightly more negligible with only a 3-percentage point difference between the social science major disciplines compared to the 6-percentage points difference for Bioeconomy.

Educational level. The next area of analysis was the level of degree held with regard to both their qualitative and quantitative values. The numerical values were labeled a ‘1’ for bachelors, ‘2’ for a masters-level degree, and a ‘3’ for anything above that. However, as seen below there was no need to assign a ‘3’ as no company held a majority JD or Ph.D. level degree holders. The average degree of education leans towards a master’s with the Bioeconomy coming at a 1.60 versus the 1.67 for the most innovative companies (Fig. 2). The similarity of the value (only a 4% difference) illustrates how both groups value higher-level degree holders but not to the extent of going to doctoral degrees. One thing to note is that there is no information for Sony. Per the research, there was very little educational background information for Sony executives. Another slight difference is that there are more MBA-majority companies in the Bioeconomy list compared to the most innovative companies (Table 2).

Ethnic and racial diversity. The ethnic and racial diversity of the executives in both groups was analyzed and the data can be seen in Table 3. For each company, executive team members are divided into five major racial-ethnic groups—White, African American, Hispanic, Asian, and Middle Eastern. By looking at the location of each company’s headquarters, we can establish which ethnic group is in the majority and which are the minorities in a particular country. For example, International Paper (IP) is headquartered in the US, and so ‘White’ is considered to be the

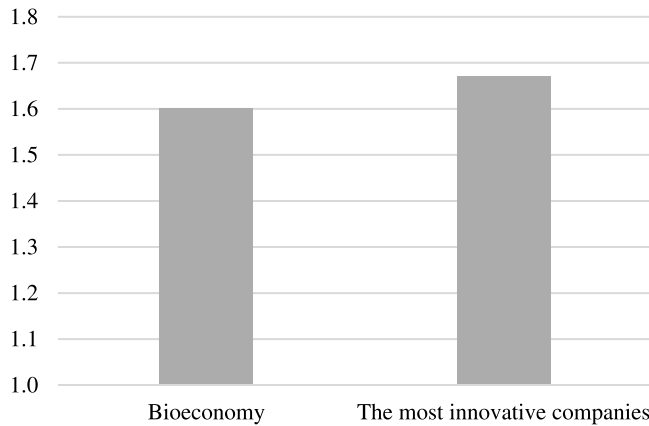


Fig. 2 Average degree of education using the mode approach. The mode approach illustrates that the average number of degrees in the boards of directors' is slightly higher for the most innovative companies (1.67) compared to the bioeconomy companies (1.60).

Bioeconomy companies		The most innovative companies	
Company name	Degree most held	Company name	Degree most held
International Paper	MBA	Apple	Masters
Kimberly Clark	MBA	Google	MBA
WestRock	Masters	Microsoft	MBA
UPM	Masters	Amazon	Bachelors
Stora Enso	Masters	Samsung	Masters
Mondi Group	Bachelors	Huawei	Bachelors
Sappi	MBA	Facebook	Masters
Domtar	Bachelors	IBM	Masters
Arauco	Bachelors	Sony	-
Metsaliitto	Masters	Alibaba	Bachelors

majority ethnicity, which would make all the other ethnicities in IP a minority. In comparison, Arauco is located in Chile, which makes the ethnicity 'Hispanic' the majority ethnicity and every other ethnicity other than 'Hispanic,' a minority.

One additional aspect to ethnic diversity is also the consideration of the societies in which the companies are mainly operating and having their Headquarters. The authors compare three groups instead of the usual two groups examined in this paper. This is due to the Bioeconomy company Sappi. Sappi is based out of South Africa, which is currently a majority Black-African ethnicity country (81% Black-African, 8% Caucasian), however, the ethnic majority in the executive team Sappi is dominated by Caucasians. This could be attributed to historic power balance issues between ethnically White and Black groups in the country. South Africa, during 1961–1994 went through apartheid, which resulted in largely homogeneous (white) management teams (Scholtz and Kieviet, 2017). When apartheid ended and the UN lifted sanctions off the country, the movement began to make boards more diverse (Scholtz and Kieviet, 2017). However, it seems as if there is still a long way to go.

As such, the authors separated the data for Bioeconomy companies into two different sets—one with Caucasians in Sappi being the minority and the other with Caucasians in Sappi being the majority. With a white minority from Sappi, the Bioeconomy company data gets a strong outlier with 93% of Sappi having minority ethnic leadership. On the opposite end of the spectrum, with Whites being identified as a majority, the ethnic minority leadership percentage goes down to 7%. Since these are quite different results, the authors decided to include both percentages due to the observation that each portrays. In the first case, the average minority leadership comes to 15%, which is a figure higher than the 9% for the innovative companies' minority leadership. This would make Sappi a clear outlier that would skew the results to a higher average. However, when the white leadership of Sappi is identified as a majority ethnicity, the average minority ethnicity leadership percentage for Bioeconomy companies goes down to 7%. This 7% is a more accurate indicator of minority leadership than the 15% due

Company name	White	African American	Hispanic	Asian	Middle eastern	% of minority ethnicity
<i>Bioeconomy companies</i>						
International Paper	12	0	0	0	0	0%
Kimberly Clark	7	0	2	2	0	36%
WestRock	13	0	0	0	1	7%
UPM	12	0	0	0	0	0%
Stora Enso	14	0	0	0	0	0%
Mondi Group	9	0	0	0	0	0%
Sappi	11	1	0	1	1	93%/7%
Domtar	5	0	1	0	0	17%
Arauco	0	0	10	0	0	0%
Metsaliitto	6	0	0	0	0	0%
Average	8.9	0.1	1.3	0.3	0.2	15%/7%
<i>The most innovative companies</i>						
Apple	15	0	0	2	0	12%
Google	11	3	0	2	0	31%
Microsoft	14	0	0	3	0	18%
Amazon	6	0	0	0	0	0%
Samsung	0	0	0	3	0	0%
Huawei	0	0	0	10	0	0%
Facebook	7	0	0	0	0	0%
IBM	22	1	0	1	0	8%
Sony	6	0	0	33	0	15%
Alibaba	1	0	0	13	0	7%
Average	8.2	0.4	0	6.7	0	9%

Table 4 Gender diversity in the bioeconomy and the most innovative companies.

	No. of executives	No. of male	No. of female	% Female
<i>Bioeconomy companies</i>				
International Paper	12	10	2	17%
Kimberly Clark	11	7	4	36%
WestRock	14	11	3	21%
UPM	12	10	2	17%
Stora Enso	14	8	6	43%
Mondi Group	9	6	3	33%
Sappi	14	12	2	14%
Domtar	6	6	0	0%
Arauco	10	9	1	10%
Metsaliitto	6	6	0	0%
Average	10.8	8.5	2.3	21%
<i>The most innovative companies</i>				
Apple	17	13	4	24%
Google	16	10	6	38%
Microsoft	17	15	2	12%
Amazon	6	5	1	17%
Samsung	3	3	0	0%
Huawei	6	6	0	0%
Facebook	7	5	2	29%
IBM	22	15	7	32%
Sony	39	31	8	21%
Alibaba	14	8	6	43%
Average	14.7	11.1	3.6	24%

to how close the number is to the average minority leadership for innovative companies it is (9%).

Gender diversity. The fourth analysis looked at the gender diversity between both groups. The total number of executives was divided into females and males and the percentage of females was taken to illustrate how diverse the genders were. The most innovative companies were slightly more diverse than the Bioeconomy companies but not significantly (Table 4). The authors’ previous paper on the diversity of the board of directors in Bioeconomy companies versus the most innovative companies examined the same value. In the previous paper (Hakovirta et al., 2020) both groups had 25% females on the board of executives. This value is very similar to the 24% of the gender diversity in the innovative company groups. This shows that the lowest gender-diverse group is the executive teams in the Bioeconomy. Overall, the figures are still quite small considering that true gender diversity aims for around a 50% value. Compounded onto the findings is that the average number of executives is very similar to the number of directors. The data from previous work (Hakovirta et al., 2020) also indicates a higher percentage of females in the board of directors’ positions. It can be stated that in the case of a lower number of members on the board, the number of females that are on the board would be more visible to the public.

Age diversity. The fifth and final analysis comes in the form of examining age diversity. Both groups have similar average ages for executive teams (Table 5). The data for both groups appear similar, when comparing the normal distribution spread between the two graphs in Fig. 3. While the data center around the same value for both groups, the most innovative companies have a larger spread ranging from 45 to 60 compared to the 50.1 to 57.7 of the Bioeconomy group. This display of variability demonstrates how the Bioeconomy industry tends to recruit similarly aged executives while innovative companies recruit a wider range of executives concerning age. Furthermore, the wider spread of age

Table 5 Age diversity in the bioeconomy and the most innovative company groups.

	Average age
<i>Bioeconomy companies</i>	
International Paper	54.8
Kimberly Clark	51.6
WestRock	57.7
UPM	55.4
Stora Enso	50.1
Mondi Group	52.3
Sappi	53.3
Domtar	57.7
Arauco	56.9
Metsaliitto	53.8
Average	54.4
<i>The most innovative companies</i>	
Apple	55.0
Google	56.5
Microsoft	51.6
Amazon	54.7
Samsung	60.0
Huawei	54.9
Facebook	45.0
IBM	54.0
Sony	56.6
Alibaba	47.8
Average	53.6

for innovative companies means more diversity in ages and thus that executives of innovative companies are more age diverse.

We performed a *t*-test, using null hypothesis and α of 0.05, showed high *p*-values, except for major in natural resources education (age: $p = 0.64$, gender: $p = 0.74$, race: $p = 0.55$, education level: $p = 0.78$, majors: $p = 0.04$). The results clearly show no evidence against the null hypothesis (no relationship between the variables), and moderate evidence against it in case of natural resources education. This is because there were only 4 executives that majored in natural resources, and they all were in the bioeconomy group.

Discussion and conclusions

The findings of the study showed an interesting insight into the diversity aspects of the selected company groups. In education discipline and the normal distribution of the age diversity, we found the largest differences between the two groups. Other diversity metrics were surprisingly similar. This implies that the executive team composition between both groups is somewhat identical, which is interesting because both groups differ significantly from the service and product offering perspective, business model perspective, and their positioning in the respective value chains. An interesting finding was also in the comparison of these results to the earlier research done for the boards of directors’ diversity (Hakovirta et al., 2020). Those results showed many similarities in for example the number of board of directors, age diversity, and gender diversity. However, differences were clear looking at the educational degrees and majors held and the ethnic diversity. The observations are notable when comparing the differences between the two industry groups and their role in society.

Innovative companies are known to enable digitalization globally and use big data to create efficiencies for society while the Bioeconomy is known to make renewable and sustainable products (Carus and Dammer, 2018; Gobble, 2018). Some say that most innovative companies—no matter how innovative or popular they are—are quite harmful to the environment in the

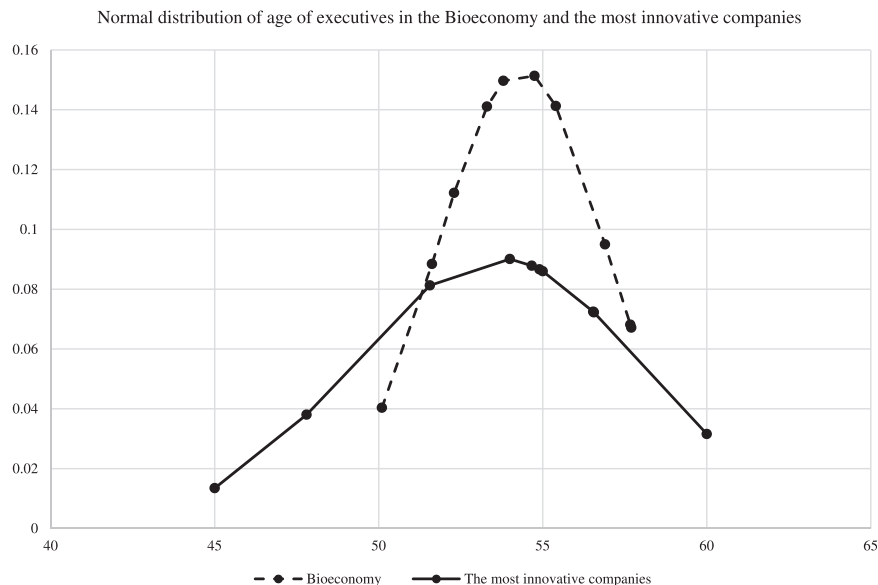


Fig. 3 Normal distribution of age in the bioeconomy and the most innovative companies. Age diversity in bioeconomy (dotted line) versus the most innovative companies (solid line). A narrower age spread is observed in the case of the bioeconomy companies.

materials and products they use (Biser and Lorenz, 2018). On the other hand, the Bioeconomy has recently been focusing on, and seen as, an answer to the waste problem that society is currently facing (Leong et al., 2021). This is another difference that lies between the two groups.

As stated earlier for the methodology of ranking the most innovative companies we used the BCG rankings, which is well accepted by the business community and the details of this methodology are connected to driving many initiatives in improving innovativeness in these companies by the executive teams we analyzed in this article (Kiron et al., 2013). As we reviewed the options for rankings, the BCG methodology's details were the best fit for this study. Other methodologies traditionally seem to rely more on investors' ability to identify firms they expect to be innovative now and, in the future, or on the overall company R&D spending. The BCG is using more quantitative metrics including total share return and HHI as stated earlier. Also, their methodology is using a multiple construct approach rather than singular like many other methodologies traditionally have done (Cai and Hanley, 2014).

The main dependent variable of this study is innovation. We decided to use BCG ranking as its methodology is well established and accepted by the innovation practitioners. Using other rankings to complement the study would have strengthened our methodology and assumptions, however as established earlier, there are only limited number of quantitative approaches that can be used. An additional limitation lies on the independent variables of 'diversity' that we do not examine in this research. This is because the definition of 'diversity' is constantly changing in society. For example, diversity factors that have recently emerged in society are sexual orientation, cultural diversity, and disability (Pincus, 2011). Sexual orientation is hard to identify because it is an identity that is private to an individual and a complex identifying value with various dimensions defining it (Coleman, 2010). Corporations in the US do ask about disability status; however, this is an internal question for the company and the results do not tend to be available to the public (North Carolina General Statutes). As for cultural diversity, it is a very ambiguous value to quantify. Cultural diversity is similar to multiculturalism where an individual respects acknowledges other cultures, respects them, values them, and celebrates them in the pursuit of

growth. This type of diversity is imbued within an individual's personality and is challenging to quantify but several attempts have been made, which include the Sterling Index as well as the previously mentioned Herfindahl-Hirschman Index (Ranaivoson, 2007).

Our methodology is simple: we examined each of the independent variables separately in order to get an indication on which diversity factor was most predictive in innovation. It is likely that a combination of several different variables is responsible for the management culture, and as such, our research is a starting point in finding single significant variables that are predictive of innovation. For future work more conclusive evidence of the relationship between diversity and innovation can be evaluated by using for example multiple correlation coefficient for evaluating correlation between data. However, the general implication of this research and other current work, is that the pursuit to find conclusive evidence may take time.

Furthermore, more research needs to be done looking at the Bioeconomy and its management, its incentive system, and governance because of the high impact of management on the success and failure of a company (Irani et al., 2001). The Bioeconomy has a large amount of influence in dictating the materials that we can use to reduce waste and increase efficiencies; still, the industry is in the emerging phase to reinvent itself as an innovator in sustainability (Kiron et al., 2013). The direction is correct, but old practices and culture do slow the progress and investments in innovation down (Hansen, 2016). The more innovative Bioeconomy firms become or are perceived as, the more our societies and the firms themselves benefit. One aspect for future research includes the role of the Chief Executive Officer, who has major impact to the culture of the company and the role of Executive Team (Berson et al., 2007).

Organization culture plays a big part of risk-taking including investments into new technologies and break through new businesses (Abu-Jarad et al., 2010). The Executive Team is not as collegial body as in the case of Board of Directors where each Director has one vote; in tie vote, the Chair's opinion is decisive. At the end of the day, the Chief Executive Officer defines the authority of each Executive Team member and makes the final decisions and is ultimately responsible for them (Breene et al., 2007). The Executive Team authority and mandate then connects

to what level of investments, R&D projects or management recruitment are decided or accepted by the Executive Team (Breene et al., 2007). Both Chief Executive Officer and the Board (and sometimes even a dominant owner) may have a large impact to the culture and openness in the Executive Team's work (Breene et al., 2007; Lipton et al., 2011). For example, do Executive Team members have the courage to express different views; are they encouraged to think differently and out-of-the-box? Furthermore, the additional dimension here is that the organizational structure and its principles (e.g., level of integration, role of headquarter) influence the role of Executive Team as a group (Guadalupe et al., 2013).

In Hakovirta et al.'s previous paper, the argument was made that the greater the diversity in education, ideas, opinions, and team dynamics, the higher the likelihood for diversity of thought (Hakovirta et al., 2020). And diversity of thought is closely tied to innovation (Post et al., 2009). In 2013, an article in the Harvard Business Review (HBR) differentiated two types of diversity in organizations: acquired and inherent (Hewlett et al., 2013). Acquired diversity traits are traits that are 'acquired' through experiences, while inherent traits are more characteristic attributes and thus connected to gender and ethnicity. The traits we examined in this paper are a combination of both type of diversity traits. As the HBR article stated, both types of diversity are needed to out-perform on innovation and profitability (Hewlett et al., 2013). As such, it is best for companies to recruit diverse people into leadership positions, presenting both inherent and acquired traits (Đặng et al., 2020).

Results in this paper show across the different variables slight differences between the two company groups. One of the most interesting differences being the large age spread of the most innovative companies ranging from 45 to 60 in comparison to the 50 to 58 of the Bioeconomy group. While there exist many published scholarly articles and books looking into diversity in top management teams, not many take industry differences into account. In our paper, we used diversity as the variable to examine the difference between both groups and thus are adding to the discussion on what kind of diversity can be affecting innovation and in which ways. It was the main topic of study as with an increasingly globalized workplace, diversity truly matters. Diversity drives the positive perception of companies which in turn affects marketability, sales, and finally profitability (Hunt et al., 2018). However, diversity affects not just perception but also plays a role in the amalgamation of ideas and opinions that drives the company forward (Østergaard et al., 2011). Our research adds the Bioeconomy to the diversity in the top management team conversation by seeing how diversity in an older, more established, and mature industry compares to the more celebrated innovators and whether the differences in diversity have any impact on the innovativeness of these groups.

Data availability

All data generated or analyzed during this study are included in this published article. Raw data in excel format is available from the corresponding author on reasonable request.

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References

Abu-Jarad IY, Yusof N, Nikbin D (2010) A review paper on organizational culture and organizational performance. *Int J Bus Soc Sci* 1:26–46

- Alvesson M (2002) *Understanding organizational culture*. SAGE Publications Ltd
- Barney J (1986) Organizational culture: can it be a source of sustained competitive advantage? *Acad Manag Rev* 11(3):656–665
- Bengtsson M, Raza-Ullah T, Srivastava MK (2020) Looking different vs thinking differently: impact of TMT diversity on cooperation capability. *Long Range Plann* 53(1):101857
- Berson Y, Oreg S, Dvir T (2007) CEO values, organizational culture and firm outcomes. *J Organ Behav* 29(5):615–633
- Biser J, Lorenz H (2018) An approach to assess indirect environmental effects of digitalization based on a time-use perspective. In: *Advances and new trends in environmental informatics*. Springer, pp. 67–78
- Breschi S, Lissoni F, Malerba F (2003) Knowledge-relatedness in firm technological diversification. *Res Policy* 1(32):69–87. [https://doi.org/10.1016/S0048-7333\(02\)00004-5](https://doi.org/10.1016/S0048-7333(02)00004-5)
- Breene RTS, Nunes PF, Shill WE (2007) The chief strategy officer. *Harv Bus Rev* 85(10):84–93
- Brettel M, Cleven N (2011) Innovation culture, collaboration with external partners and NP performance. *Creat Innov Manag* 20(4):253–272
- Brown SL (2008) Diversity in the workplace: a study of gender, race, age, and salary level. Capella University
- Brown I, Steen A, Foreman J (2009) Risk management in corporate governance: a review and proposal. *Corp Gov Int Rev* 17:546–558. <https://doi.org/10.1111/j.1467-8683.2009.00763.x>
- Cai Y, Hanley A (2014) Innovation rankings: good, bad, or revealing? *Appl Econ Lett* 21(5):325–328
- Carus M, Dammer L (2018) The circular bioeconomy—concepts, opportunities, and limitations. *Ind Biotechnol* 14(2):83–91
- Chatman JA, O'Reilly CA (2016) Paradigm lost: reinvigorating the study of organizational culture. *Res Organ Behav* 36(36):199–224
- Coleman E (2010) Assessment of sexual orientation. *J Homosex* 14(1-2):9–24
- Cook A, Ingersoll AR, Glass C (2019) Gender gaps at the top: does board composition affect executive compensation? *Hum Relat (New York)* 72(8):1292–1314
- Cummings J (2004) Work groups, structural diversity, and knowledge sharing in a global organization. *Manag Sci* 50(3):352–364
- Dosi G (1988) Sources, procedures, and microeconomic effects of innovation. *J Econ Lit* 26:1120–1171
- Đặng R, Houanti L'H, Reddy K, Simi M (2020) Does board gender diversity influence firm profitability? A control function approach. *Econ Model* 90:168–181
- EC (European Commission) (2012) The bioeconomy strategy. Available at: <https://publications.europa.eu/en/publication-detail/-/publication/1f0d8515-8dc0-4435-ba53-9570e47dbd51>
- Eloranta J (2019) Board of directors-focus on value creation. *Alma Talent, Keuruu, Finland*
- Ercis A, Unalan M (2015) Analysis of the world's most innovative companies on the basis of industry: 2005–2014. *Procedia Soc Behav Sci* 195:1081–1086
- FAO (Food and Agriculture Organization) (2016) How sustainability is addressed in official bioeconomy strategies at international, national and regional levels: an overview. FAO, Rome
- Fieldhouse E, David C (2010) Does diversity damage social capital? A comparative study of neighbourhood diversity and social capital in the US and Britain. *Can J Polit Sci* 43(2):289–318
- Pincus FL (2011) *Understanding Diversity*. Lynne Rienner Publishers
- Gobble MM (2018) Digitalization, digitization, and innovation. *Res Technol Manag* 61(4):56–59
- Golden JS, Handfield RB (2014) Why biobased? Opportunities in the emerging bioeconomy. USDA iopreferred Program. USDA, Washington, DC
- Guadalupe M, Li H, Wulf J (2013) Who lives in the C-Suite? Organizational structure and the division of labor in top management. *Manag Sci* 60(4):805–1081
- Hakovirta M, Denuwara N, Bharathi S et al. (2020) The importance of diversity on boards of directors' effectiveness and its impact on innovativeness in the bioeconomy. *Humanit Soc Sci Commun* 7(116). <https://doi.org/10.1057/s41599-020-00605-9>
- Hakovirta M, Lucia L (2019) Informal STEM education will accelerate the bioeconomy. *Nat Biotechnol* 37:103–104. <https://doi.org/10.1038/nbt.4331>
- Hansen (2016) Responding to the bioeconomy: business model innovation in the forest sector. In: *Environmental Footprints and Eco-design of Products and Processes*. Springer, 227–248
- Heskett J (1996) Technological development and design innovation. *Class Notes*, Institute of Design, Illinois Institute of Technology, Chicago, US, Spring
- Hewlett SA, Marshall M, Sherbin L (2013) How diversity can drive innovation. *Harvard Business Review*
- Holmstrom B (1999) Managerial incentive problems: a dynamic perspective. *Rev Econ Stud* 66(1):169–182
- Holmstrom B (2017) Pay for performance and beyond. *Am Econ Rev* 107(7):1753–1777

- Hunt V, Prince S, Dixon-Fyle S et al. (2018) *Delivering through Diversity*. McKinsey and Company, New York, NY
- Irani Z, Sharif AM, Love PED (2001) Transforming failure into success through organisational learning: an analysis of a manufacturing information system. *Eur J Inf Syst* 10(1):55–66
- Kiron D, Kruschwitz N, Reeves M et al. (2013) The benefits of sustainability-driven innovation MIT Sloan Manag Rev 54(2)
- Khavul S, Bruton GD (2013) Harnessing innovation for change: sustainability and poverty in developing countries: innovation, sustainability, and poverty. *J Manag Stud* 50(2):285–306
- Leong HY et al. (2021) Waste biorefinery towards a sustainable circular bioeconomy: a solution to global issues. *Biotechnol Biofuels* 14(1):1–15
- Li C-R (2013) How top management team diversity fosters organizational ambidexterity: the role of social capital among top executives. *J Organ Change Manag* 26(5):874–896
- Lipton M, Neff DA, Brownstein AR et al. (2011) Risk management and the board of directors. *Bank Corp Gov Law Rep* 45(6):793–799
- Matsumoto A, Merlone U, Szidarovszky F (2012) Some notes on applying the Herfindahl-Hirschman Index. *Appl Econ Lett* 19(2):181–184
- Monks RA, Minow N (2011) *Corporate governance*. John Wiley & Sons, Hoboken, NJ
- Nagothu US, Nagano T (2020) *Bioeconomy approach: constraints and opportunities for sustainable*. Routledge, New York, NY
- Nathan M, Lee N (2013) Cultural diversity, innovation, and entrepreneurship: firm-level evidence from London. *Econ Geogr* 89(4):367–394
- Ouni Z et al. (2020) Board/executive gender diversity and firm financial performance in Canada: the mediating role of Environmental, Social, and Governance (ESG) Orientation. *Sustainability (Basel, Switzerland)* 12:8386
- Østergaard CR, Timmermans B, Kristinsson K (2011) Does a different view create something new? The effect of employee diversity on innovation. *Res Policy* 40(3):500–509
- Perryman AA, Fernando GD, Tripathy A (2016) Do gender differences persist? an examination of gender diversity on firm performance, risk, and executive compensation. *J Bus Res* 69(2):579–586
- Post C, De Lia E, DiTomaso N, Tirapak TM, Borwankar R (2009) Capitalizing on thought diversity for innovation. *Res Technol Manag* 52(6):14–25
- Ramasamy B, Yeung MCH (2016) Diversity and innovation. *Appl Econ Lett* 23(14):1037–1041
- Ringel M et al. (2018) Innovation and digital. In: *Most Innovative Companies (2018)*. Boston Consulting Group
- Ranaivoson H (2007) Measuring cultural diversity: a review of existing definitions. UNESCO
- Renee AB, Hermalin BE, Weisbach MS (2010) The role of boards of directors in corporate governance: a conceptual framework and survey. *J Econ Lit* 48(1):58–107
- Ruigrok W, Peck S, Tacheva S (2007) Nationality and gender diversity on Swiss Corporate Boards. *Corp Gov Int Rev* 15:546–557
- Scholtz H, Kieviet S (2017) The influence of board diversity on company performance of South African companies. *J Afr Bus* 19(1):105–123
- Shane S, Venkataraman S (2000) The promise of entrepreneurship as a field of research. *Acad Manag Rev* 25(1):217–226
- Schein EH (2010) *Organizational culture and leadership*. Jossey-Bass, San Francisco
- Smith WK, Tushman M (2005) Managing strategic contradictions: a top management model for managing innovation streams. *Organ Sci* 16(5):522–536
- Stewart F (2014) Sustainability and inequality. *Development (Soc Int Dev)* 57(3-4):344–361
- Suzuki J, Kodama F (2004) Technological diversity of persistent innovators in Japan: Two case studies of large Japanese firms. *Res Policy* 33(3):531–549. <https://doi.org/10.1016/j.respol.2003.10.005>
- Tian M, Deng P, Zhang Y et al. (2018) How does culture influence innovation? A systematic literature review. *Manag Decis* 56(5):1088–1107
- Topping P (2002) *Managerial leadership*. McGraw-Hill. Internet resource, New York
- Wang JC, Markóczy L, Sun SL et al. (2019) She'-E-O Compensation Gap: a role congruity view. *J Bus Ethics* 159(3):745–760
- Wang H, Begley TM, Hui C et al. (2012) Are the effects of conscientiousness on contextual and innovative performance context specific? Organizational culture as a moderator. *Int J Hum Resour Manag* 23(1):174–189
- Wang S, Xiao X (2017) The relationship between institutional environment and enterprise's technology innovation performance—the visual angle based on MOA theoretical model. *EDP Sci* 100(3):05027

Author contributions

All authors contributed meaningfully to this study.

Competing interests

The authors declare no competing interests.

Ethical approval

This article does not contain any studies with human participants performed by any of the authors.

Informed consent

This article does not contain any studies with human participants performed by any of the authors.

Additional information

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