Business Ecology: The Environmental Considerations of Enterprises in South Western Virginia

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ABSTRACT: *Business Ecology* sets out to establish how businesses engage with local or broader environmental issues. The project aims to describe the ways in which businesses include environmental considerations in their activities, ranging from environment-related community service, to explicit incorporation of the environment into mission statements or firm identity, and adjustments in organization and practices intended to reduce their ecological footprint. A second goal of the project is to determine the effects of industry, and firm-level factors, on the businesses' environmental initiatives. The research questions fit into the growing interdisciplinary literature on sustainable business, and fill gaps in the literature regarding these concepts on the microeconomic level. The Roanoke Valley and surrounding area represent a viable setting for exploring these questions empirically, because the municipalities and local chambers of commerce emphasize regional ecological wealth in their own development strategies. At the same time, the economic scene in the area is relatively diverse, with firms operating across three economic sectors—natural resource extraction, manufacturing, and services. The research questions are explored through a mix of qualitative and quantitative methods applied to a collected data set of firms' environmental practices and other characteristics. The data collection tools include surveys and archival research, for a sample representative of the industries in the area. From a policy standpoint, the findings inform strategies for local sustainable development and provide a picture of the current state of firm-level sustainability in the area. From a scholarly standpoint, the new data and the data collection instruments offer a more nuanced understanding of firm behavior, local sustainability, and motivations behind "going green."

INTRODUCTION

Business Ecology explores how local businesses interact with the environment, and, the determinants of businesses' environmental initiatives and considerations. Roanoke, Virginia is an ideal location to conduct this research, given the spectrum of industry operating here, and the locality's rating as one of the top twenty "Greenest Cities in America," (Mulliner 2017). Directly consulting local businesses is the most practical way to shed light on these questions. The dependent variable within this project's hypotheses is sustainable action at the firm level. The working definition of sustainability, in a corporate sense, is what businesses are doing to benefit the firm, their community, and the environment (Elkington, 1994). The explanatory variables in this project include, (i) firm awareness of the state of the global climate and local environment, (ii) industry and industry sector of the firm, as well as (iii) incorporation of environmental rhetoric into firm mission statements.

The theoretical framework for *Business Ecology* draws on cross-disciplinary insights from economics, environmental science, political science, policy, and business studies, to ground empirical findings in established macro-level theory about the greening of business. The framework includes, but is not limited to, increasing the productivity of raw materials and their extraction, transitioning to more biologically-inspired "closed loop" production processes, and innovating technology to decrease waste and increase energy efficiency (Lovins et. al., 2000). While the existing literature provides a solid basis for understanding macro-level processes of this necessary industrial shift to sustainability, it leaves room for further empirical study of the micro-level mechanisms that are assumed to underlie the framework. *Business Ecology* contributes to filling this crucial gap in the literature.

Given that businesses have operated on a single bottom line over history, the most viable way to evoke environmental action would be to translate the value of the environment into the preexisting, capitalist narrative. The method for doing so is ecosystem service valuation. The Millenium Ecosystem Assessment (2005) reported that 60% of 24 ecosystem services were being used unsustainably or were being degraded outright, across the globe. If these services were to halt, or be irreversibly damaged, it would be impossible for a human being to maintain homeostasis, let alone a business, an economy, or a nation's government. As was mentioned before, ecosystem service valuation is typically overlooked in market prices, as well as government and firm level decision-making. If environmental services are noted in these calculations, they are perceived as "free" goods (Holzman, 2012). This disregard can lead to outright market failure via climate change, or Hardin's "tragedy of the commons," (1968).

Some contend that, although the case can be made that sustainability transitions are economically beneficial, firms face an information deficit. Resources on how, why, and the fiscal benefits of becoming sustainable need to first be made available to firms, although this may not be enough. A partial owner of a printing firm from a UK sustainability case study made the claim that, "the problem is, from our point of view, we're that busy running the business; we tend to sort of let these things go," (Hillary, 2000).

The Intergovernmental Panel on Climate Change is in the process of releasing their sixth assessment, titled, *Special Report on Global Warming of 1.5°C* in accordance with the Paris Agreement. In their "Summary for Policymakers," (2018) the IPCC states that the global surface temperature has raised 1° Celsius past pre-industrial levels. While this comes with its own impact, the report, among others, focuses on disseminating this information to those responsible for constructing legislation to mitigate these oncoming damages, as well as reduce emissions to

avoid a 1.5°, or 2° increase in global surface temperature. While the report and summary do not include details at the microeconomic level, it is stated that reducing catastrophic impacts of extreme weather events, rising seas, and lost continental and sea ice "would require rapid and far-reaching transitions in land, energy, industry, buildings, transport, and cities."

On Black Friday of 2018, the United States Government released its own climate report, called The Fourth National Climate Assessment. Of interest to *Business Ecology* is the "Economy" section of this report. Most importantly, the report claims that, "without substantial and sustained global mitigation and regional adaptation efforts, climate change is expected to cause growing losses to American infrastructure and property, and impede the rate of economic growth over this century," and that, "climate change affects the natural, built, and social systems we rely on individually and through their connections to one another," (U.S. Global Change Research Program, 2018).

To recap: the global temperature has risen 1° celsius past pre-industrial levels. Internationally, researchers agree that robust action needs to be taken within the private-sector to avoid catastrophic future damages vis a vis market failure as a result of climate change. Business and economic literature contend that businesses must be transitioning to more sustainable modes of operation, and that, under the current economic regime, these transitions will benefit not only the planet, but the economic motivations of the firm itself. There is literature which contends both policy and economic initiatives, as well as effective information dissemination to firms, can, should, and will evoke these changes. What is missing within the metatext is the degree to which these theoretical concepts and necessary changes are taking hold-- or not. In this context, *Business Ecology* seeks to explore the the microeconomic implications of this pressing call to act in the face of a changing climate.

The *Business Ecology* survey set out to collect quantifiable data on whether or not sustainable development is taking place within the Roanoke Valley. Three hypotheses the survey data were used to discuss are: (I) firms which are aware of the state of the climate are likely to be operating under some parameters of sustainability, (II) firms within certain manufacturing industries are likely to be less sustainable than retail or consumer-focused businesses, and (III) firms which incorporate environmental rhetoric into their mission statements are more likely to take sustainable action. Information was accrued from 22 firms, producing a 6.7% response rate from 329 firms which were contacted. While the sample is not adequately large enough for statistical inference, the information it provides lends valuable insight into the project's 3 hypotheses. 76.5% of firms in the sample address more than 2 environmental issues, regardless of awareness level, and 58.8% of firms across industries within the sample have a sustainability coordinator. Of firms within the sample whose mission statements include environmental rhetoric, 100% of them have ongoing sustainability initiatives. Of those firms within the sample whose mission statements do not include environmental rhetoric, 85% of them also have ongoing sustainability initiatives. The data also reveals some interesting things about firms in the Roanoke area. For instance, 68.75% of firms in the sample rated themselves as 8 out of 10 or higher in their compliance with our definition of Corporate Social Responsibility, and 89% of firms within the sample reported having made donations to charity or politics within the last 5 years.

This manuscript proceeds as follows. Section 2 provides a background on the theoretical framework and motivations for the project. Section 3 is a literature review of other research projects which sought to answer similar research questions. Section 4 details the project's arguments and hypotheses. Section 5 describes the research design, data collection, and methods.

Section 6 describe the univariate statistics for the dependent and explanatory variables, followed by bivariate summaries to describe patterns within the collected data as they relate to the hypotheses. The study concludes with suggestions for further research, a list of references, and an appendix of figures.

BACKGROUND

The ecosystem services which the Earth provides -- atmospheric and hydrologic cycles, erosion prevention, soil formation, climate control, etc.-- are valued at forty-four *trillion* PPP dollars annually, not adjusted for inflation, as of 2012 (Holzman). For reference, America's gross national product is a little above 19 trillion PPP dollars (FRED, 2018). A lack of consideration for the essential services provided by the global ecosystem in business-as-usual operations since the industrial revolution has accounted for waste, and for the hampering of these services, at a tremendous scale (Lovins, Lovins & Hawken, 2000). Garrett Hardin warned of this form of market failure, dubbed "the tragedy of the commons," (1968). It is the notion that rational unregulated decisions by individual agents on public, "open" resources translate into suboptimal, even catastrophic, outcomes for environments, and thus society, as a whole. To be explicit: not accounting for the environment in day to day business practices yields market failure in the form of climate change.

Economic activity is contingent on ecosystem service ability (Field & Field, 2013). Conventional businesses, over the course of capitalist history, function off of a single bottom line: profit. Having only a single bottom line overlooks the cost of economic production, in dollars, on environments, natural resources, and ecosystem services. Economists have emphasized that the environmental externalities of economic activities—i.e., the costs of production not internalized in the price of goods and services—represent a threat to the Earth's

ability to sustain life. From a sustainability perspective, all business practices should consider environmental impacts, via the adoption of the triple bottom line: people, planet, and profit (e.g., Field & Field, Elkington, 2013, 1994).

The Sustainability Advantage contends that the single bottom line functioning within the corporate world does serve a purpose aside from profit accumulation (Willard, 2002). It serves to provide quarterly results, return on shareholder investment, and short paycheck periods, as history and Wall Street have deemed necessary. Further, while a corporate initiative such as pollution prevention expresses immediate financial benefit to a firm vis a vis the avoidance of lawsuits down the line, initiatives like increased resource efficiency and renewable energy use are less evidently beneficial to firms. For this reason, the author of *The Sustainability Advantage* suggests that, not only do the benefits of firm sustainability need to be identified, but also quantified and expressed in "business language as bottom line benefits relevant to the short and long-term priorities of senior executives," (Willard, 2002). The piece lists the benefits of firm- and industry-level sustainable development as: easier hiring and retention of top talent, increased employee productivity, reduced manufacturing expenses, reduced expenses at commercial sites, increased revenue/market share, and reduced risk, ergo easier financing (21).

Environmentally conscious business practices can be incentivized through policy and economic initiatives (Lovins, Lovins & Hawken, 2000). Economists, business scholars, and political scientists disagree on which method is best (Porter and Van Der Linde, 2000). The municipalities of the Roanoke Valley provide some policy-based and economic incentives for sustainable business. Within the limits of Roanoke City, businesses qualify for tax exemption on the installation and implementation of solar energy in commercial properties (roanokeva.gov, 2018). Otherwise, there isn't a tremendous amount of available sustainability information for

business owners and decision makers in the area. The best way for a business in any state or locality to know they are fully complying with and benefitting from federal and local environmental and sustainability laws in their area is to hire a lawyer. The additional burden of hiring and working with legal professionals disincentivizes exploring necessary sustainability shifts at the firm level.

The local governments for Roanoke City and Roanoke County discuss sustainability as being pertinent to city planning objectives. The government website explicitly states that, "Roanoke County recognizes the fact that it has the potential to positively or negatively impact the environment as a result of its operations," and that these operations are not only linked to the area's economic well-being, but also public health. They reinforce this notion by example, stating that energy reductions in municipal buildings "saves tax dollars and reduces air pollution at the same time," (roanokecountyva.gov, 2018).

In 2008, the Roanoke City Council joined the International Council for Local Environmental Initiatives, or ICLEI: Local Governments for Sustainability. In doing so, they adopted greenhouse gas (GHG) emissions reduction targets with the intention of reducing GHGs from municipal operations by 12.5%, and community emissions by 10% from January 2009 to December 2014. At the end of the timeframe, the municipality exceeded these goals, reducing municipal GHGs by 25% and community GHGs by 13%. Roanoke City Council has a current reductions target of an additional 12.5% for themselves and another 10% from the community by the end of 2019 (roanokeva.gov, 2018).

As of 2019, the city council for Roanoke, Virginia has been hard at work crafting their next twenty-year plan. The comprehensive 2020-2040 plan for the city of Roanoke includes six

main themes which all pertain to sustainability. They are: a “livable built environment,” “harmony with nature,” “resilient economy,” “interwoven equity” “healthy community,” and “responsible regionalism,” (planroanoke.org, 2019). Applied to various projects relating to sustainable architecture and renovations, increased access to healthier foods in lower income areas, et cetera, Roanoke is setting the stage to be on the leading edge of sustainable economies in the United States.

LITERATURE REVIEW

The literature gap that the project addresses is salient to the field of sustainability as a whole, as it currently stands. While there are countless works which serve as guidebooks for sustainability transitions at the firm level, there is a lack of aggregated data on firm sustainability operations in the United States. Some doctoral theses and research projects similar to *Business Ecology* have been conducted using a mixed methods approach within the United States and Internationally. These include “Small businesses and the environment—Turning over a new Leaf?” (Revell et. al., 2010), “The how and why of a firm’s approach to CSR and sustainability: a case study of a large European company,” (Pistoni et. al., 2015), “Impact of Sustainability and Manufacturing Practices on Supply Chain Performance: Findings from an Emerging Economy,” (Katiyar et. al., 2018), and “Restaurant Industry Sustainability: Barriers and Solutions to Sustainable Practice Indicators,” (Freeman, 2011).

To some extent, these studies do address the *Business Ecology* research questions as they seek to gauge or assess sustainable actions and/or their determinants. Revell et. al. found that 220 survey responses from owner-managers of small-medium enterprises (SMEs) in the UK indicated a high percentage of firms being actively involved in recycling, increasing energy efficiency, ethical buying and selling, and persuits to reduce carbon emissions. This piece also

found that owner-managers surveyed were willing to pay the cost of more stringent environmental regulations and taxes, should they arise (2010). Pistoni et. al. found that sustainability and CSR adoption do not follow a linear process in stages, rather, they suggest changes come about within a firm as a result of changing emphases on CSR and Sustainability issues across subcultures of individuals responsible for making those changes. Interestingly, they conclude the case study by claiming that "CSR and sustainability…is not an autonomous choice, but it is a consequence of the contingent role played by both the external and the internal drivers and by their relative importance during the company's CSR history," (2015). Katiyar et. al. collected data from 226 automobile firms on the Indian continent. They propose a framework for measuring supply chain performance (SCP) that incorporates TBL sustainability, and found that "sustainability performance mediates the relationships of supply chain functions to supply chain performance." In other words, that there is a positive linear relationship between sustainability and supply chain performance, particularly in an "emerging economy," (2018). Freeman's doctoral thesis explores sustainability indicators within the restaurant industry by analyzing 5 Tempe, Arizona restaurants, 2 of which identify as sustainable businesses. Along with general observations, freeman conducted in-depth interviews with owners of each restaurant. The findings detail that all 5 restaurants primary objectives are to stay in business and connect with the local community. The 5 businesses did not have a way of tracking their wastes and only one recycled. 0 restaurants in this study track the costs and results of practices which they consider sustainable. Freeman claims "restaurant managers sometimes implement sustainable business practices because they believe it is the right thing to do, not because it is a stated goal or trying to meet a regulation," (2011).

While these pieces provide beneficial insights to sustainability and the study of monitoring sustainable business practices and their determinants, their answers to the research questions are limited in several ways. Primarily, they tend to be industry specific, e.g., observing car manufacturers within India or restaurants in Arizona (Katiyar et. al., Freeman, 2018, 2011). Similarly, studies based on in-depth interviews offer a wealth of information about causal mechanisms within sustainability decisions, but evade quantitative methods to indentify systematic patterns of behavior. Interview-based research on the topic has a much smaller sampling frame of 5 individuals or firms (Freeman, 2011). Having a single firm be the focus of a case study is beneficial for nuanced understandings to be applied to theoretical concepts, however, they also do not provide methods for witnessing patterns in other firms or within the same industry (Pistoni, 2015). Otherwise, existing studies tend to focus at the national scale, in countries with vastly different economic, social, and cultural norms than the United States. For instance, the car manufacturing piece or the large-scale survey of SMEs in the UK (Katiyar et. al., Revell et. al., 2018, 2010). While these studies have started to unpack the firms' motivations for sustainable action, there is currently no available research that quantifies or discusses whether or not American firms across industries and scales are, have, or are trying to make sustainability transitions. This project attempts to fill this gap.

HYPOTHESES AND ARGUMENT

Business Ecology proposes the following hypotheses:

I. Firms which are aware of the state of the climate and environment are likely to be operating under some parameters of sustainability.
II. Firms within certain manufacturing industries are likely to be less sustainable than retail or consumer-focused businesses.
III. Firms which incorporate environmental rhetoric into their mission statements are more likely to take sustainable action.

“Sustainability” is a word used frequently, and has several attached meanings. For the purposes of this project and others like it, the phrases “sustainability,” and “sustainable action,” pertain to firm-level actions which are meant to produce triple bottom line, or TBL benefits, to the firm and surrounding community of stakeholders. Whereas a conventional business has a single, economic, bottom line, sustainable businesses and operations have a triple bottom line. Sustainable businesses are inclusive of conventional economic intentions like growth, development, and profit motive, while also emphasizing positive social and environmental impact, in equal parts. Given the guiding research questions of this project, a dynamic array of data on sustainable action was collected. They apply to the various hypotheses differently.

Hypothesis I deals with the level of awareness firms and firm representatives have about the global and local environment as they relate to firm operations. “Awareness” pertains to having heard of climate change and other environmental issues. To be “operating under some parameters of sustainability,” pertains to sustainable actions and operations which necessarily entail a TBL perspective. It is important to note that, even if the firm itself is not considered, or identified as, a sustainable business, they may still be taking sustainable action. Given firm representatives are aware of the state of the climate, as well as the current and future impacts of global surface temperature rise, it is more likely that they may propose operations within their firm to address it.

The explanatory variable in Hypothesis II uses industry data voluntarily disclosed by firm representatives within the survey process. Responses on which industries the firms might identify as were reworked in accordance with the three main divisions of an economy: primary, secondary, and tertiary industry sectors (Kenessey, 1987). Respectively, they are, (i) raw

material and natural resource extraction, (ii) manufacturing and the processing of raw materials, and (iii) services for both consumers and businesses. Responses from the eleven options were categorized by primary and secondary sectors versus the tertiary sector, so that, given response data, a claim on sustainable action can be made in one direction or another. Hypothetically, operational transitions at the tertiary scale (e.g., a regional restaurant chain with three branches, a brick and mortar insurance agency) have lower costs, as opposed to expensive R&D and operational transitions within the primary and secondary sectors (e.g., a vehicle manufacturer, a copper mine, a national-scale beer brewing and distribution facility).

Hypothesis III contends that firms which include environmental rhetoric into their mission statements are more likely to take sustainable action. The inclusion of words, phrases, or concepts which relate to a TBL or other environmentally-focused perspectives within a firm's mission are likely to be indicative of the overall operations of the firm. We contend that this likely indicates some degree of sustainability operation or action. Within this hypothesis, sustainable action is measured by reported sustainability initiatives, and charitable donations and events within the past five years. If decision-makers within a firm are willing to meet, debate, articulate and publicize their desire to have any type of triple-bottom-line impacts, it is anticipated that they would truthfully operate under those parameters.

RESEARCH DESIGN

The intention of *Business Ecology* is to deduce how and why local businesses may or may not be taking sustainable action at this crucial point in human and geologic history. The survey-based project was designed around an opportunity sample based on professional connections within the sampling location. The unit of analysis is the business. The final sample, used in the analyses, has 22 units. The sampling units individually represent a local business.

Respondents were generally managers or above, who worked with the firm for longer than three years (See Figure A1 in the Appendix); this is similar to the approach used in business surveys. The population is made up of businesses in the Roanoke Valley and surrounding areas. The sampling frame consists of units in the population that could be contacted through the channels available to the researcher. More details on data collection are provided in the "Data Collection" section below.

Measurement

Based on the hypotheses, the concepts operationalized in this project include:

Dependent variable:

A. "Operating under some parameters of sustainability," and sustainable action

Explanatory variables:

B. Awareness of the state of the climate or other environmental issues
C. The use of environmental rhetoric in firm mission statements
D. Industry/sector of the firm as it relates to extraction and manufacturing versus services

A. ***Sustainable action*** is featured as the dependent variable in all three hypotheses. The main indicators used for analysis of sustainable action are: (I) whether or not the firm's actions directly address climate change, and several other environmental issues, (II) whether or not the firm has a sustainability coordinator, and the firm's degree of transparency about its environmental impacts on a scale from 1-5, and (III) any initiatives, donations, or events the firm may conduct with a TBL framework. Another interesting indicator of firm sustainability, separate from the environment, is how the firm rated itself on a scale from 0-10 as complying with our definition of corporate social responsibility, or CSR. Other

indicators were present within the study, however, the main indicators are a best match to the concept, given our definition. Other indicators of sustainable action include:

- Whether or not the firm monitors the environmental impact of their day-to-day practices in any way.
- Whether or not the firm produces, monitors, and/or measures their solid, fluid, or gaseous emissions or production residuals.
- If they responded "yes" to any of the above emissions, they were asked if these emissions were being abated or mitigated.
- Whether or not the firm has any sustainability certifications: LEED, B Corps, Other, Unsure, or No.

B. ***Climatic and environmental awareness*** is the explanatory variable from Hypothesis I. Questions within the survey which sought to quantify environmental awareness at the firm level include a series of "Have you heard of..." questions that gauge employee awareness of climate change and other related issues, including sea level rise, acid rain, and increased frequency and intensity of erosion and weather events.

C. The use of ***environmental rhetoric in firm mission statements*** was quantified by voluntary responses as well as secondary research per firm response.

The coding standard used for representing whether or not firms have included sustainability or environmental rhetoric into their mission statements was similarly based on the representation of operations which are reminiscent of a triple bottom line, without necessarily having to hit all three key factors. Some examples of mission statements which were coded as incorporating environmental rhetoric are:

> "It is our mission at [Firm] to offer every restaurant, catering service, and food wholesaler in the Roanoke valley access to fresh, local vegetables at competitive prices while increasing product value through food source awareness and GAP certification," and,
>
> "To guide [our] patrons to lead more fulfilling lives through a deep personal connection to the adventure and wonders of the natural world."

To illustrate, two mission statements coded as not incorporating environmental rhetoric are:

> "Our mission at [Firm] is to provide fast, friendly service and quality products in clean and convenient locations. We work hard to make sure we deliver on our Mission promise every day. We continue to reinvent ourselves and bring innovation to our industry," and,
>
> "Shuckin' Seven Days a week for lunch and dinner. [Firm] provides the freshest and most complete raw bar in the area. A local restaurant with beachy vibes and a sports bar atmosphere, we strive to provide exceptional customer service and top quality food."

D. **Industry and sector** of the firm as it relates to extraction and manufacturing versus services was based on a multiple choice question which listed US Census Bureau industries, listed below. Based on the firm's self-identification of its industry, the firms were also categorized as follows:
    - Agriculture, Forestry, Fishing and Hunting
    - Mining
    - Utilities
    - Construction
    - Manufacturing
    - Wholesale Trade
        - These industries are part of the primary and secondary sector, and were coded as such
    - Retail Trade
    - Transportation and Warehousing
    - Information
    - Finance and Insurance
    - Real Estate Rental and Leasing
    - Professional, Scientific, and Technical Services
    - Management of Companies and Enterprises
    - Administrative and Support and Waste Management and Remediation Services
    - Educational Services
    - Health Care and Social Assistance
    - Arts, Entertainment & Recreation
    - Accommodation and Food Services
    - Other Services (Except Public Administration)
    - Public Administration

- These industries are and were coded as the tertiary sector

Data collection

The initial proposal for this project laid out one methodological framework, primarily rooted in quantified survey responses. The first step in this process was writing the survey. The literature gap between sustainability theory and practice made it difficult to find other corporate-level surveys to draw inspiration from. The survey questions were written in accordance with the research questions and the factors deemed salient therein. Examples of survey questions include: "How do you [the firm] define corporate sustainability?" and, "Is the firm monitoring or measuring [types of] emissions?"

Survey distribution was structured in an integrated way and took place over 9 months, between March 2017 and November 2018. Multiple methods of survey distribution and data collection were employed. The initial approach was to contact various local chambers of commerce, including those of Roanoke City, Roanoke County, Salem City, and Floyd County, and have them either donate a list of contacts or distribute the survey in their weekly mailing lists. This way we would create a diverse opportunity sample. Points of contact at the various chambers were receptive to the idea and given digital materials to distribute. These individuals distributed the survey in their email chains to local business representatives.

During response collection, lists of contacts compiled by the principal investigator from the various points of contact were cold-called. Recipients of cold calls were not responsive. Specifically, one contact made the comment that a cold call for a survey response was "very unorthodox," and a "red flag." The internally generated list of contacts did include "Contact Us" boxes on various firm's websites, and the survey was submitted this way as well. The data do not show whether or not this was a successful approach, but the number of responses did grow.

While responses remain entirely confidential, researchers sent the survey directly to personal connections within the community. This was a viable method in terms of response percentage. Finally, turning to a more direct approach, a tablet device was acquired to head out into the sampling location and collect responses at various events, including a local African-American heritage festival, a Chamber of Commerce happy hour event, a Pumpkin Festival, a Women's Forum discussion, and a Rotary Club Luncheon. The ipad was not well received and no survey responses were collected this way. In conjunction with the tablet approach, scannable hard-copy QR codes leading to the survey and one other hard-copy flyer was made to warrant increased responses. While no single approach was entirely effective in collecting survey responses, the integration of multiple methods did yield a sufficient amount of usable data.

One significant prohibiting factor in response collection was the notion of confidentiality. Given the informed consent form and any other comments succinctly defining responses as confidential, many of those being surveyed were still weary about responding at all. This is not entirely unexpected. Questionnaire-based voluntary environmental assessment of firms is claimed to be "notoriously low," according to some scholars (Hillary, 2000). In conjunction with this, response rates for firm-level surveys overall is known to be low as well (White et. al., 2005).

While the goal of the project was to produce data that was generalizable beyond the Roanoke Valley, to businesses across industries, across the United States, the final sample that can be used for analyses (22 responses) is not large enough for us to make generalizable claims. However, we are able to make interesting observations about the domain of firm sustainability within Roanoke, Virginia and surrounding areas.

Methods

Due to the small sample size, inferential statistics cannot be employed. The results section below provides univariate descriptive statistics for the variables of interest, as well as some cross tabulations to explore patterns in the data and compare them to the hypotheses. The univariate statistics include the mode or median as best measures of central tendency for variables measured at the nominal and ordinal level, respectively. The variation ratio or quartile range are used as best measures of dispersion for nominal and ordinal-level variables, respectively. Crosstabs are used to provide bivariate summaries because both dependent and explanatory variables in the hypotheses are categorical. For ease of interpretation, the various statistics are presented in both tabular and graphic form. While these results are not generalizable beyond the sample, the findings remain interesting and can be used as building blocks for future theory-building.

RESULTS AND CONCLUSION

1. Patterns of sustainable behaviors in the Roanoke Valley

This study employs four main measurements of sustainable firm behaviors. Taken together, they tell an interesting story. Each indicator is discussed below.

(I) Whether or not the firm's actions directly address climate change, and several other environmental issues

Of paramount importance to this indicator is the degree to which firm operations address environmental issues. Within the survey, respondents were prompted to disclose whether or not their firm operations address 11 different environmental issues. They were asked about each issue separately, in 11 yes/no questions, and the data was used to compile an additive index of

addressing environmental issues (ADRIndex). Of 22 responses, 4 are missing and 18 are valid. The values of the index range from 0, meaning the firm does not address any environmental issues, to 10, meaning that the firm addresses 10 issues. The median for this variable is 3, suggesting a relatively low engagement with environmental issues. However, the quartile range is 4, with values of the variable distributed relatively uniformly across the 0-10 range of the variable. This suggests that, in the Roanoke Valley area, there is a wide variety of action being taken to address the environmental issues within the survey (Figure 1). A unifying standard for doing so does not appear to exist.

For analysis, ADRIndex was transformed into a 3-category ordinal variable, coded as follows: 0, when ADRIndex is 0; 1 when the ADRIndex takes vales between 1-6; 2 when the ADRIndex takes values between 7-10. The new variable is called ADRIndex3Cat. The median of the new variable is 1, suggesting that the majority of the firms in the sample take some level of action to address various environmental issues. Only 3 firms in the sample go to extreme lengths to address environmental issues, and 4 firms take no such actions (Figure 2). The dependent variable used for analyzing Hypothesis I is ADRIndex3Cat.

Figure 1

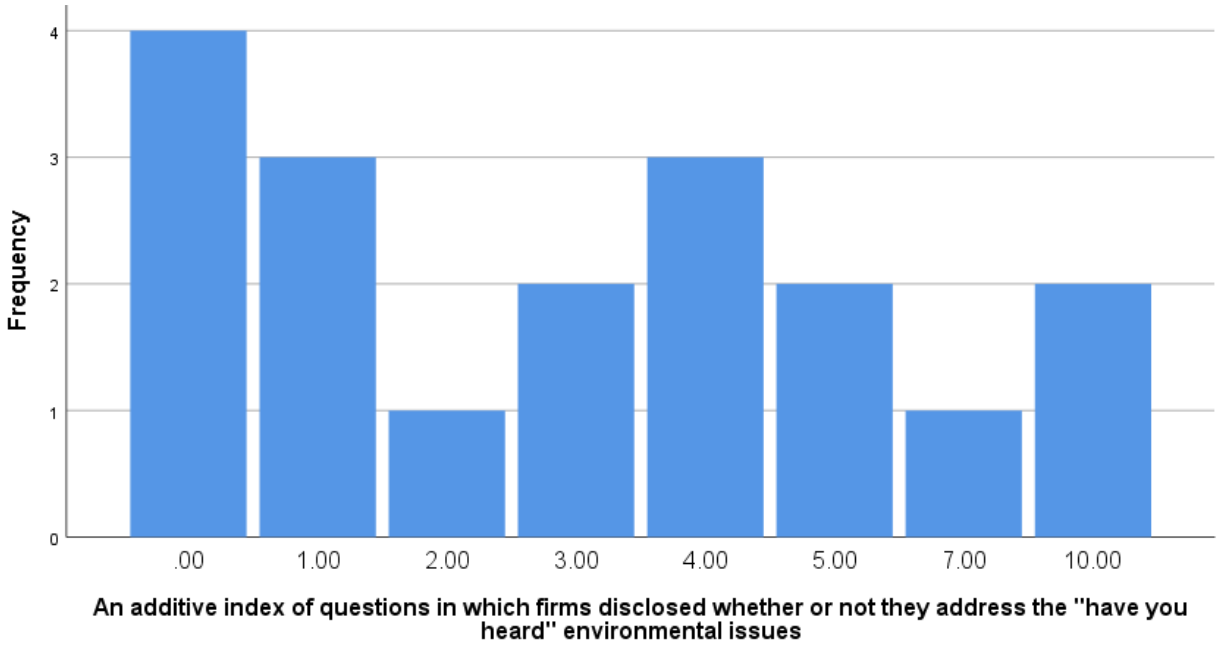
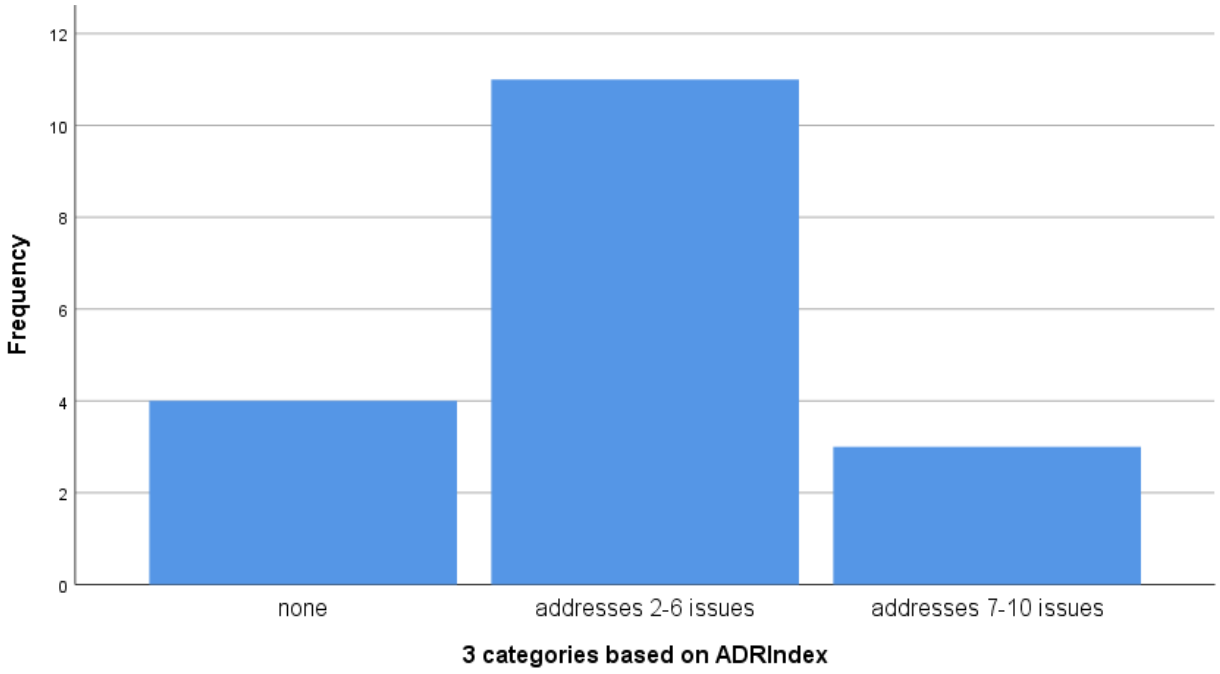


Figure 2



(II) Whether or not the firm has a sustainability coordinator, and their degree of transparency about firm environmental impacts.

All firms within the sample were asked whether or not they had a colleague within the firm dedicated to its sustainability operations (Sus_Person). Out of 22 responses, there were 4 missing values and 18 valid responses. There was an incredibly high degree of variance within this data, although the modal value is “Yes.” 11 out of 18 firms within the sample do have a sustainability coordinator, 5 do not, and 2 reported being unsure (Figure 3). Having a designated employee for sustainability operations necessarily entails sustainable action within the firm. The fact that the majority of firms in our sample have a sustainability coordinator is an encouraging indicator of sustainable action in the Roanoke Valley.

Another indicator of sustainability operations includes how transparent the firm may or may not be about their environmental impacts. Firm representatives were given an option from 1, being not at all transparent, to 5, being incredibly transparent. Interestingly, not a single firm within the sample rated themselves as not at all transparent. Of 22 responses, there were 18 valid responses and 4 missing values. The mean value is 4 and the quartile range is 1 (Figure 4). In the interest of our analysis, although this is a nominal variable, the modal value is 5. High degrees of transparency by private firms is a sustainability indicator as it relates to a triple bottom line in both social and environmental categories. Given the oncoming 2020-2040 plan for the Roanoke Valley, this is a positive mechanism for implementing the sustainable development goals of the Roanoke City Council.

Figure 3

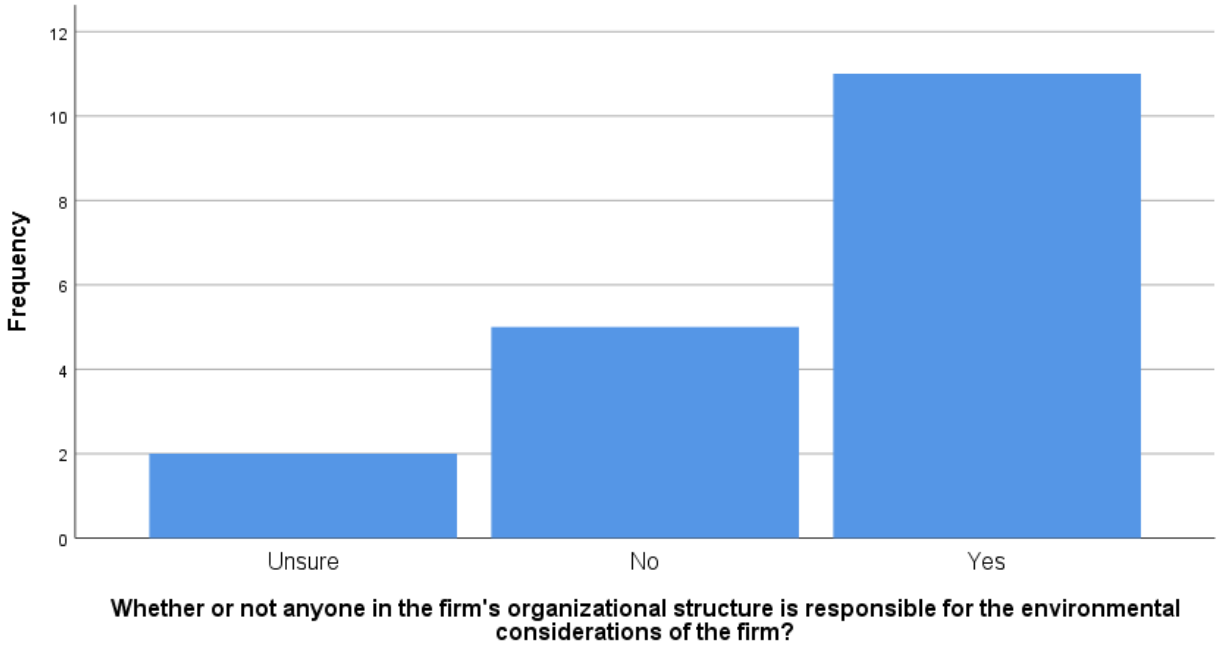
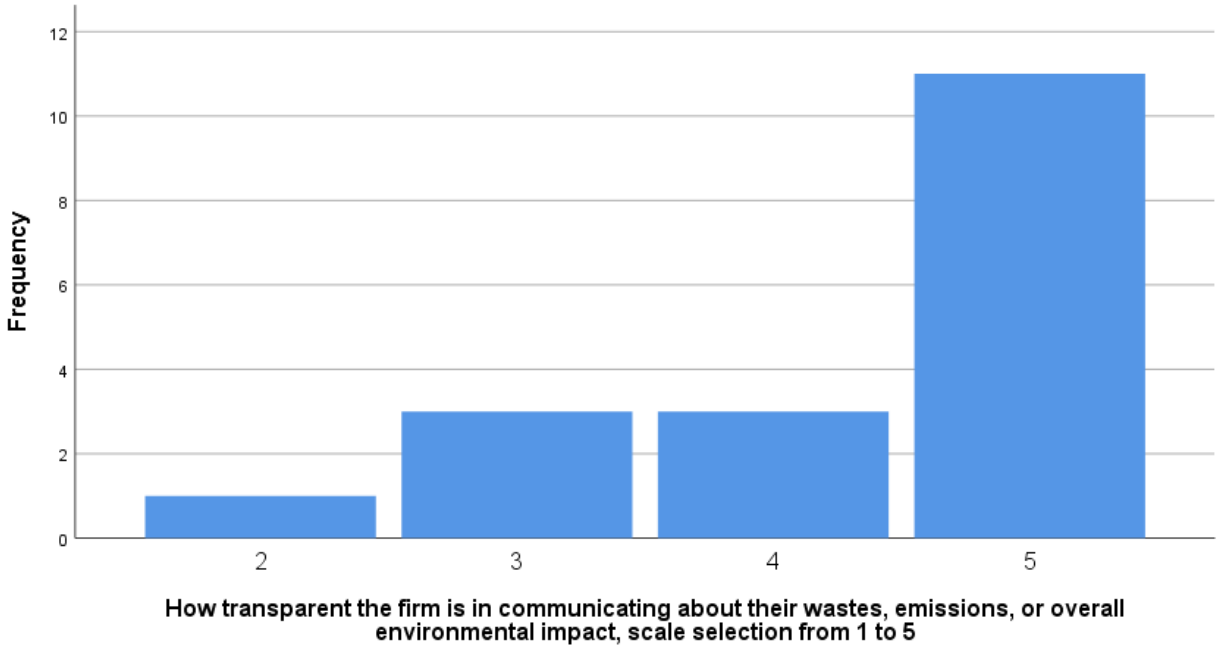


Figure 4



(III) Any initiatives, donations, or events the firm may conduct with a TBL framework.

Whether or not the firm has any ongoing sustainability initiatives (Initiatives) produced an interesting set of information. Not a single firm said they did not have any sustainability initiatives enacted, and the mode for the variable was "Yes," they do (Figure 5). There were 17 valid responses. 1 firm listed being "unsure." Within the survey question itself, examples of sustainability initiatives like recycling and improving energy efficiency were listed. Employee knowledge of, and firm enacting of sustainability in this sense necessarily describes tangible sustainable action being taken at the firm level.

Respondents were asked whether or not the firm has made any donations to charity or politics within the last 5 years (CDonations). Similar to the responses for sustainability initiatives within the firm, not a single respondent reported their firm NOT having made any charitable or political donations. Of 19 valid responses, 17 respondents answered "Yes," and 2 responded that they were "unsure," (Figure 6). Charitable and political donations, while not elaborated on in detail, are considered an example of a TBL sustainable action. At the same time, tax deductible donations made by businesses are an existing incentive towards sustainability.

Whether or not the firm has hosted any cause-related events is an indicator of sustainable action (CEvents). Out of 19 valid responses, 8 firms had hosted cause-related events, 6 had not, and 5 reported being "unsure." With high variance, the modal category for this variable is "Yes," (Figure 7). What's interesting within this variable is that, 5 firm representatives reported being "unsure," however, the majority of respondents had been with their firms for longer than three years (Figure A1). Cause-related events are a sustainable action unto themselves. They also serve as an incentive for sustainability within firms, given the attention they draw and positive public image they may produce.

Figure 5

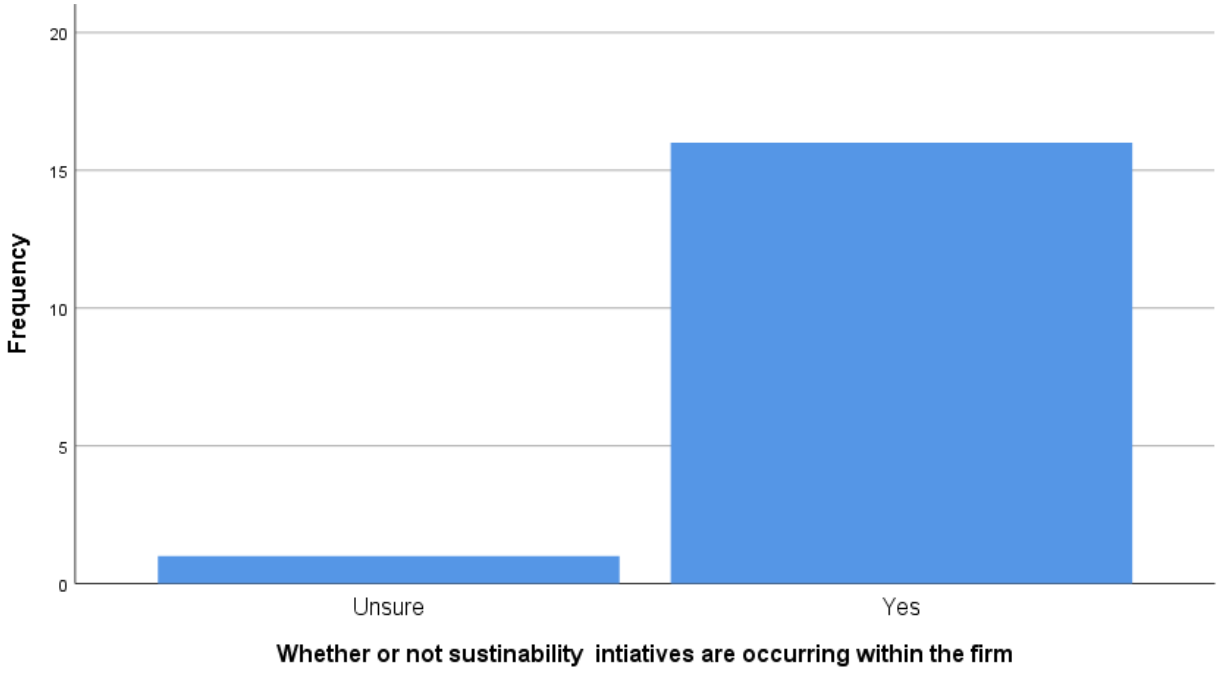


Figure 6

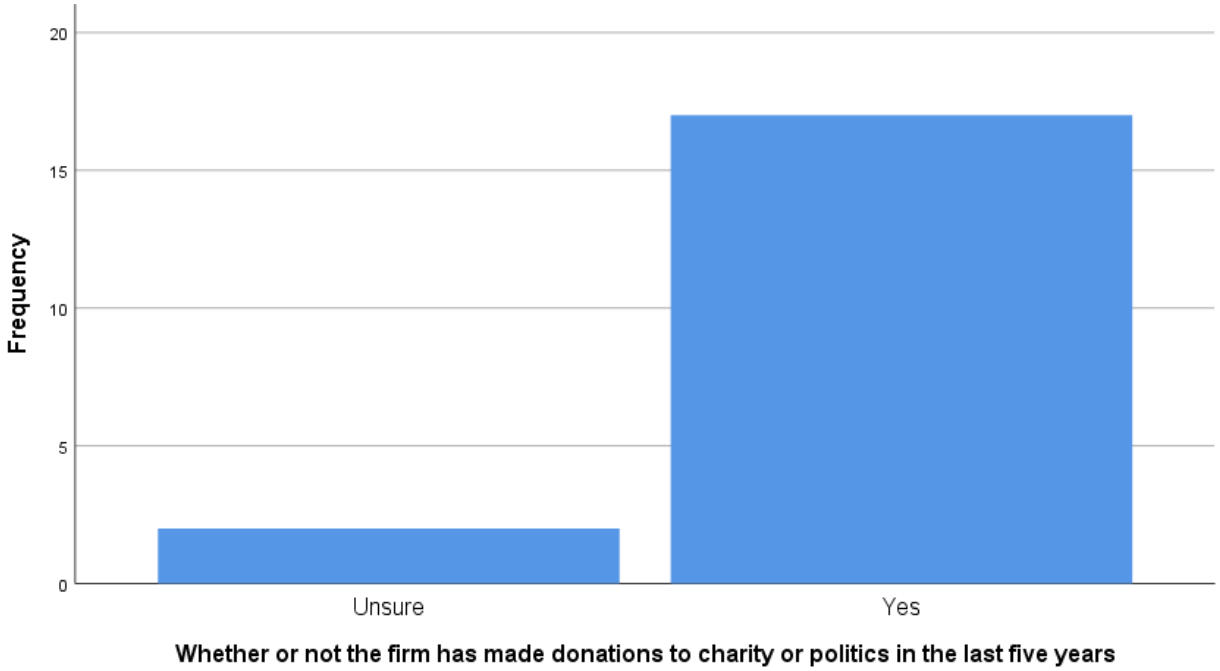
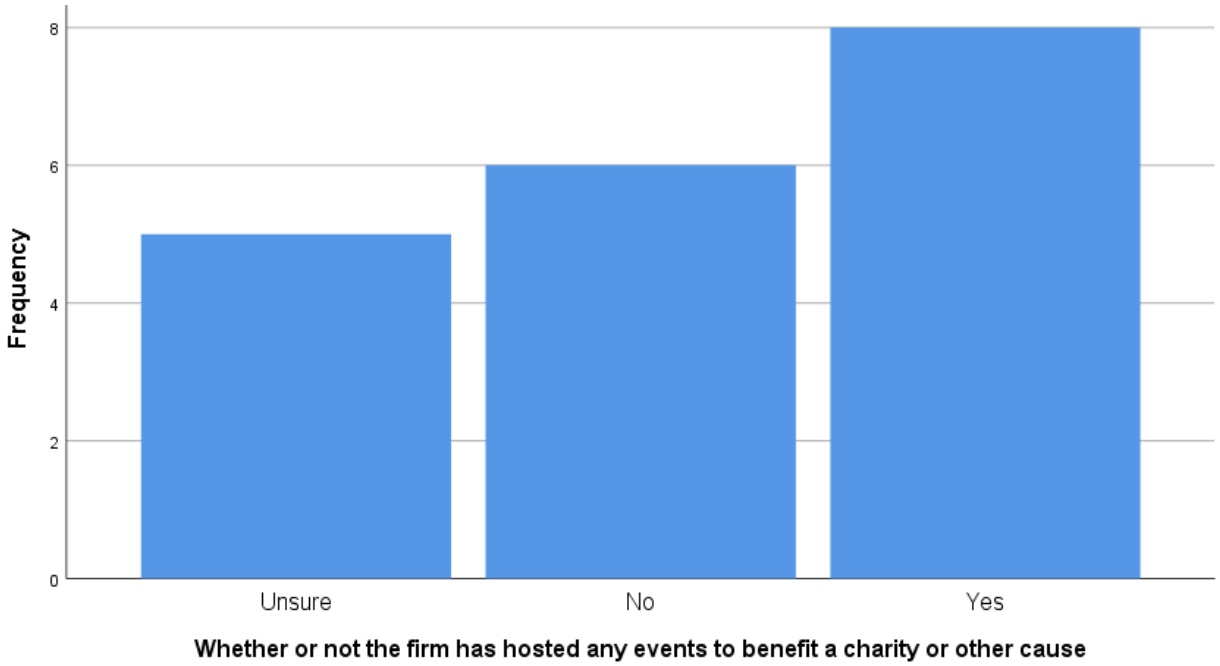


Figure 7



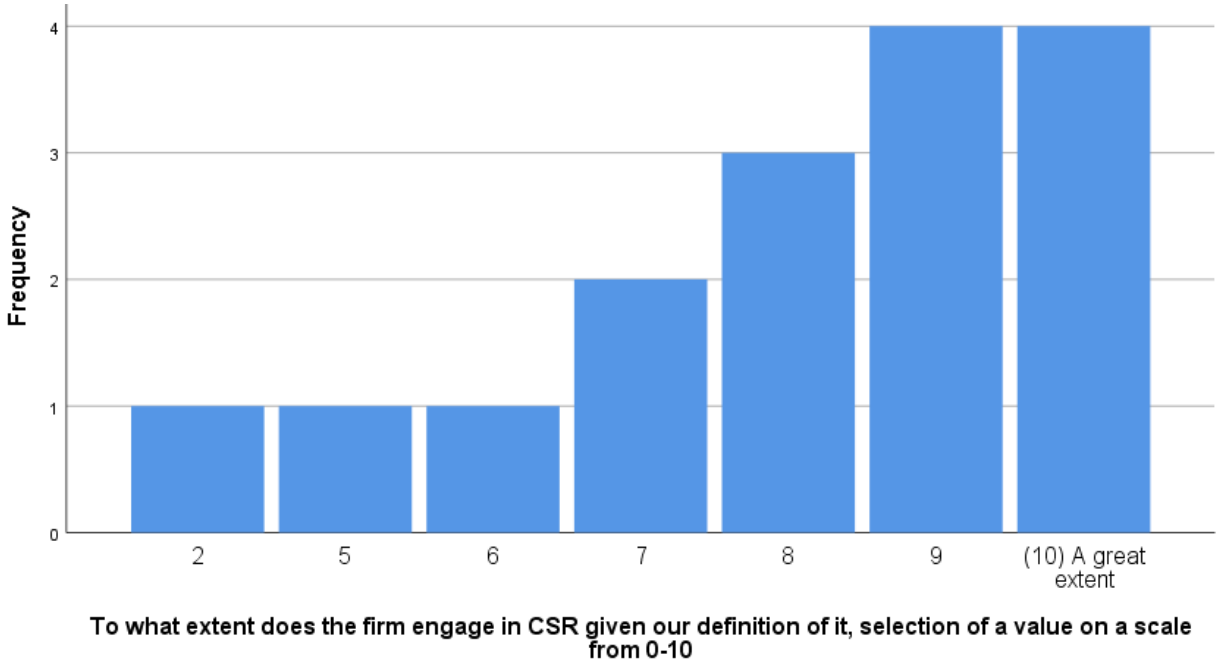
(IV) How the firm rated itself on its Corporate Social Responsibility (CSR) standing.

Another interesting indicator of firm sustainability, separate from environmental initiatives, is how the firm rated itself as complying with our definition of corporate social responsibility, or CSR, categorized into three groups (CSR_rating, CSRCat). *Business Ecology* focuses heavily on the environmental end of a triple bottom line. To fully explore the operational definition of the TBL concept, CSR is of paramount importance. This is the "people" part of the TBL trifecta—people, planet, profits. Within the *Business Ecology* survey, firms were asked to what degree they felt they complied with a given definition of CSR. The definition firms were prompted with was taken from the Financial Times (Mozier, 2018):

> Corporate social responsibility (CSR) is a business approach that contributes to sustainable development by delivering economic, social and environmental benefits for all stakeholders (Financial Times).

Of 22 responses, 16 valid responses and 6 missing values were accrued. The data shows that the mean value is 8, with a quartile range of 3 (Figure 8). 68.75% of firms within the sample rated themselves as an 8 or higher. Assuming responses were truthful, this is a very positive aspect of doing business in the Roanoke Valley: local business representatives feel as if they are working for firms which are doing something to benefit their communities in some way. This claim fits nicely into the proposed framework for the Roanoke City Council's 2020-2040 plan, and makes the case that, although reporting was low, businesses within Southwestern Virginia *do* feel obligated to give back to their community.

Figure 8



Within the sample, encouraging information about the sustainability happenings within Roanoke Valley enterprises was found. While the data are not generalizable, the analyzed sample provides the following insights: 77%, or the majority of the firms in the sample, take some level

of action to address various environmental issues (Figure 1, Figure 2). 61% of firms within the sample have a sustainability coordinator within their firm (Figure 3). 77% of firms in the sample rated themselves as either a 4 or 5 out of 5 in how transparent they are about communicating their environmental impact (Figure 4). 94% of firms within the sample reported having ongoing sustainability initiatives (Figure 5). 89% of firms within the sample reported having made donations to charity or politics within the last 5 years (Figure 6), and 42% of firms within the sample reported having hosted a cause-related event within the last 5 years.

2. Determinants of sustainable behaviors in the Roanoke area

Firm characteristics which likely serve as determinants for sustainable action or lack thereof are: awareness of environmental issues, the firm's industry/sector, and incorporation of sustainability rhetoric into mission statements. These concepts relate to sustainable action differently. Thus, sustainable action is measured differently per hypothesis. Before presenting the bivariate summaries that can be used to look for empirical patterns corresponding to the hypotheses, univariate statistics are discussed for each corresponding explanatory variable.

I. Firms which are aware of the state of the climate and environment are likely to be operating under some parameters of sustainability.

Awareness of the climate and environment was measured through a series of 11 questions about specific issues. Responses to 6 out of 11 of these questions exhibited no variation; 100% of respondents stated that they were aware of that particular issue (Figure A2). These are, climate change, sea level rise, increased natural disaster frequency and intensity, erosion, deforestation, and ocean acidification/acid rain. Since there is no variation in the responses, this set of questions are excluded from the analysis. The remaining 5 questionnaire items, which did exhibit

variation, are used to explore Hypothesis I. These issues are colony collapse disorder, local sustainability initiatives, saltwater intrusion, mass extinction, the pacific garbage patch.

Has the respondent heard of *colony collapse disorder*? Of 17 valid responses with 5 missing, the responses were fairly evenly split, with "yes" being the modal category. 9 respondents out of 17 are aware of colony collapse disorder and 8 are not (Figure 9).

Has the respondent heard of *local sustainability initiatives*? Of 18 valid responses with 4 missing, 15 respondents answered "Yes," (Figure 10).

Has the respondent heard of *saltwater intrusion?* Of 18 valid responses with 4 missing, 14 respondents answered "Yes," (Figure 11).

Has the respondent heard of *mass extinction?* Of 18 valid responses with 4 missing, 15 respondents answered "Yes," (Figure 12).

Has the respondent heard of the *pacific garbage patch?* Of 18 valid responses with 4 missing, 13 respondents answered "Yes," (Figure 13).

These univariate statistics for the collected "have you heard" variables are, for the most part, a positive indication that firm representatives have a moderately high degree of environmental awareness. To describe this point further, an additive index of the 5 "have you heard" variables within the analysis was created (HYHIndex2). At this point, the index was categorized into "Less Aware," meaning the respondent was aware of 0-3 of the remaining 5 issues, and "More Aware," meaning the respondent was aware of 4-5 of the remaining issues. The modal value for the additive index is "More Aware." Out of 22 responses, there are 17 total valid responses within the index, and 5 missing responses. Given the 5 environmental issues proposed by these survey questions, 8 respondents were "Less Aware," and 9 respondents were "More Aware," (Figure 14). This index (HYHIndex2) is cross tabulated below with the

dependent variable, the additive index of how many of these environmental issues firms are actively addressing (ADRIndex3Cat, Figure 2). Both indexes are cross tabulated to analyze any possible existing relationship (Figure 15). 10 out of 17 firms within the sample address 2-6 environmental issues. 3 firms within the sample claim to address 7-10 environmental issues, and 1 of those 3 firms is less aware of the 5 issues in the analysis. Within the sample, there is some correlation between being less aware of nuanced environmental issues and not addressing any within the firm. However, 87.5% of firms categorized as "More Aware" address more than 2 environmental issues, and 66.7% of firms categorized as "Less Aware" also address more than 2 environmental issues. Overall, 76.5% of firms within the sample, or 13 out of 17 firms, address more than 2 environmental issues. In terms of the hypothesis, it is not succinctly clear whether or not firms within the sample take sustainable action based on awareness of the climate and environment. This is further illustrated by Figure 16. Although a statement can't be made on the hypothesis, this information is still an encouraging indicator of sustainable action being taken by businesses in the Roanoke Valley.

Figure 9

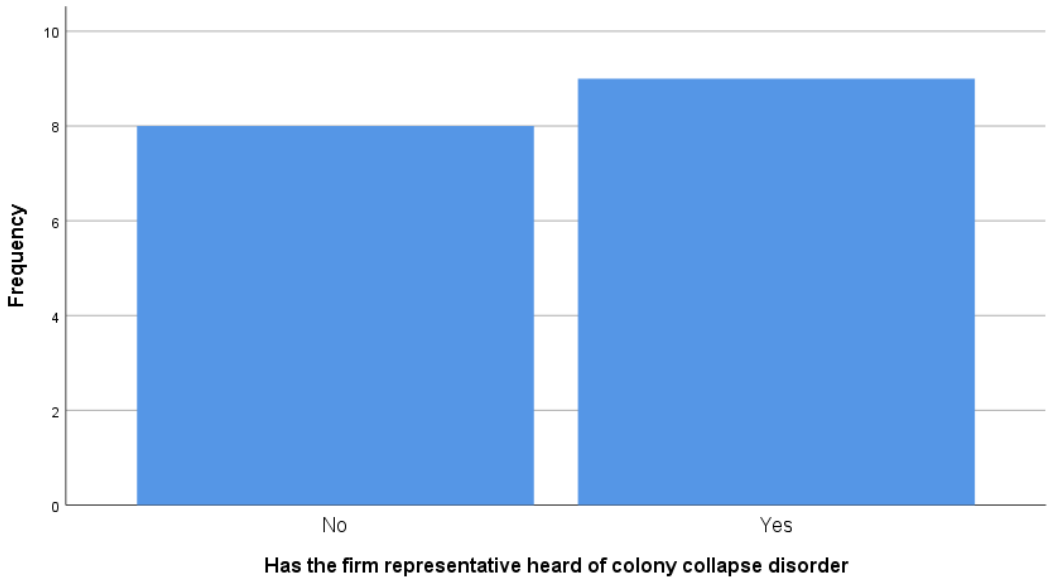


Figure 10

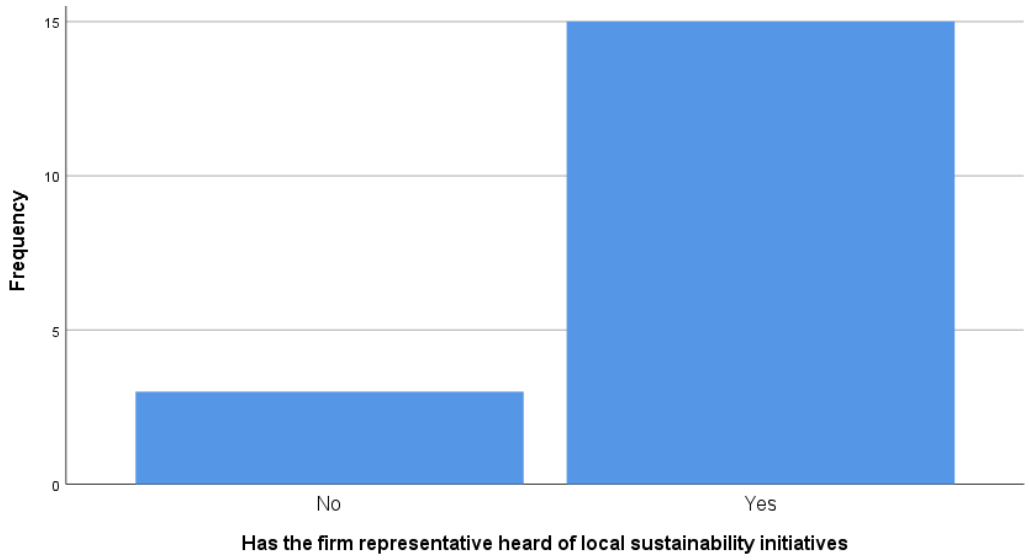


Figure 11

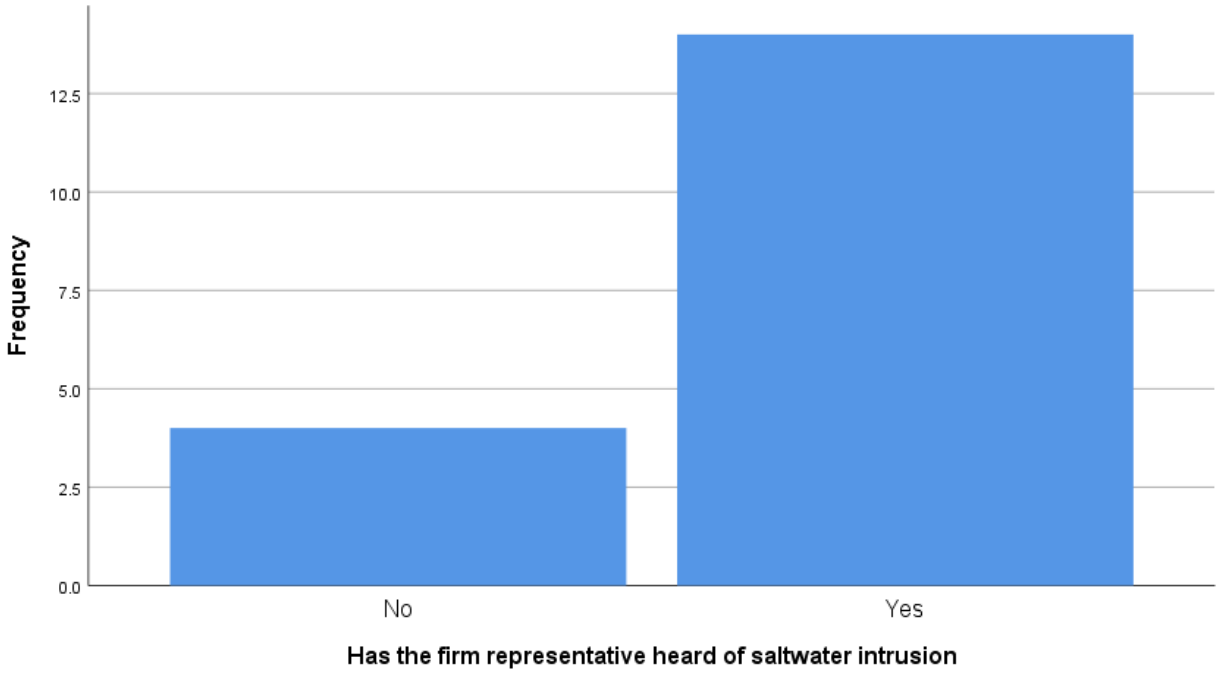


Figure 12

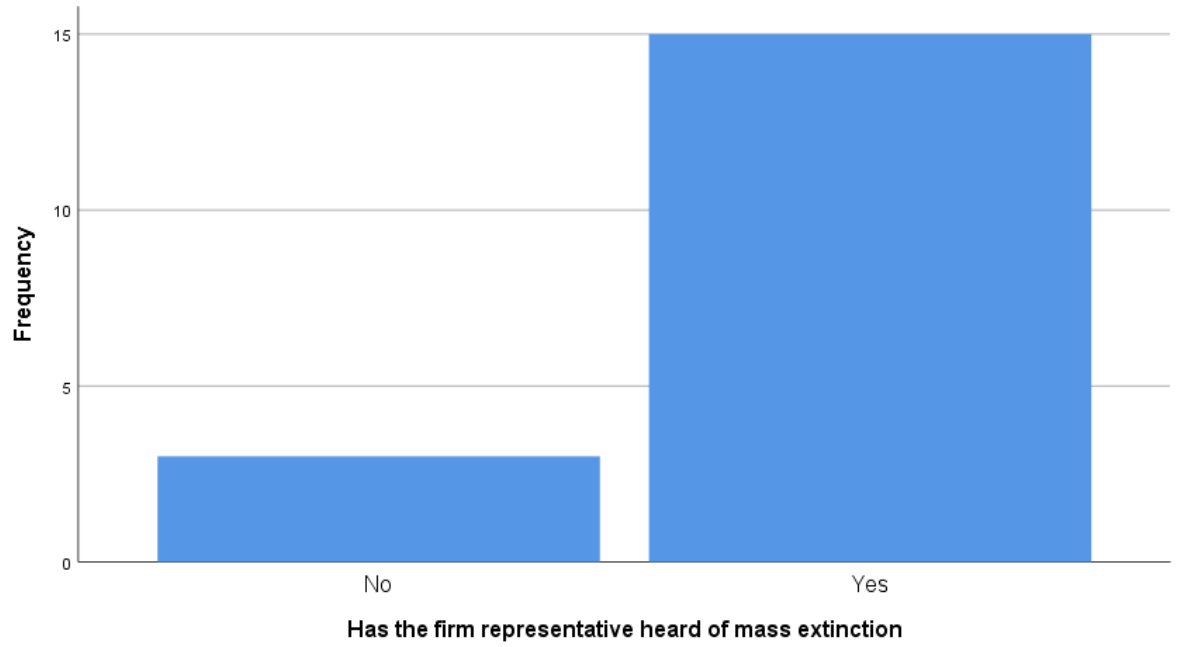


Figure 13

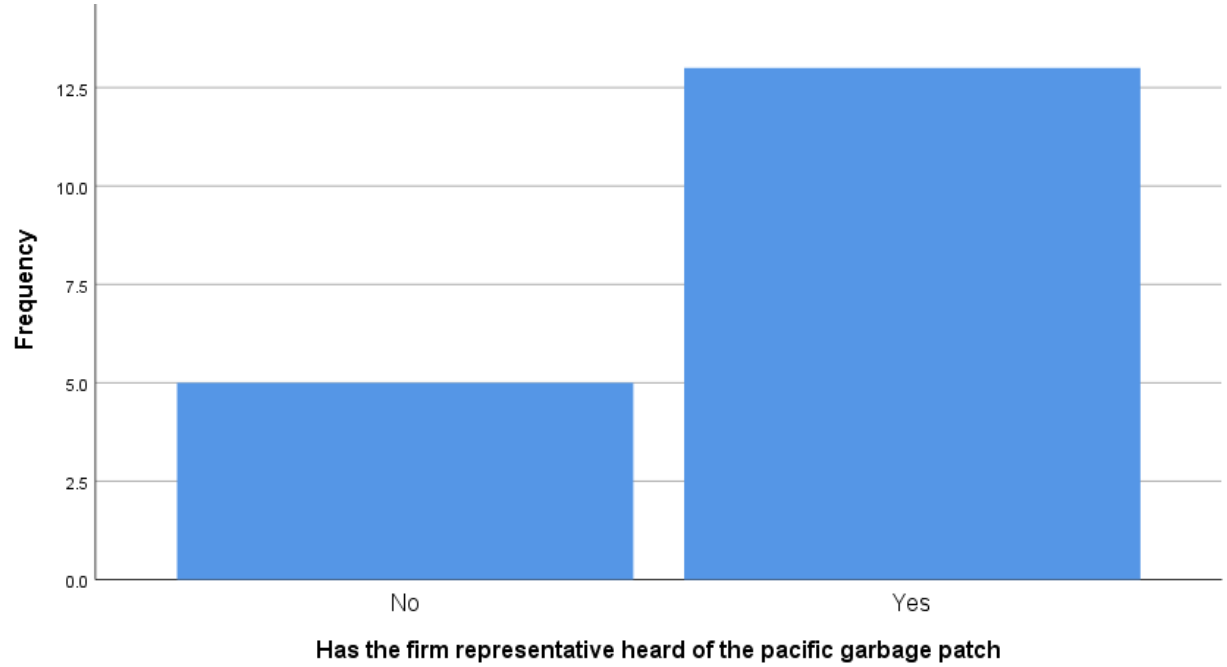


Figure 14

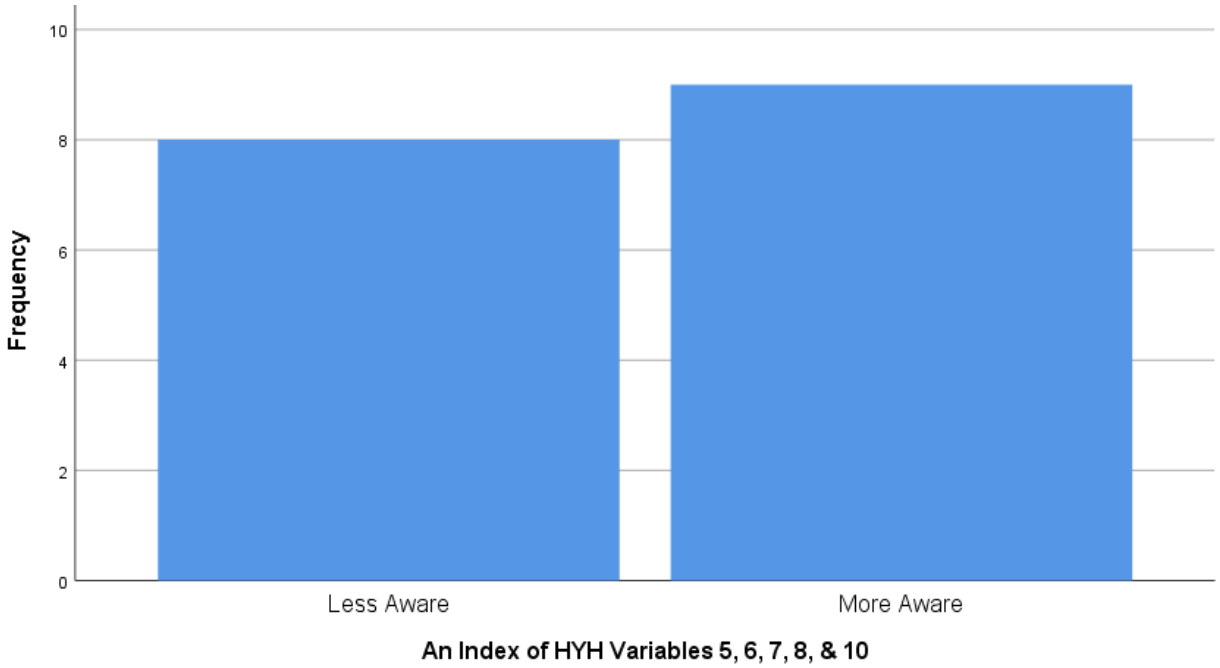
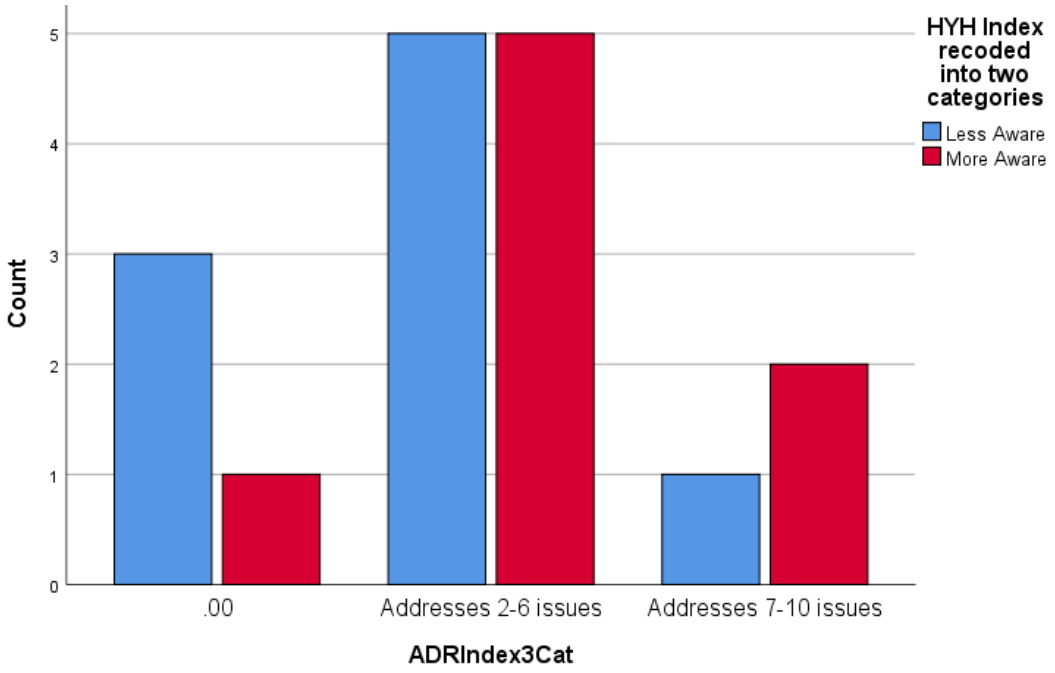


Figure 15

			HYH Index recoded into two categories		Total
			Less Aware	More Aware	
ADRIndex3Cat	.00	Count	3	1	4
		% within HYH Index recoded into two categories	33.3%	12.5%	23.5%
	Addresses 2-6 issues	Count	5	5	10
		% within HYH Index recoded into two categories	55.6%	62.5%	58.8%
	Addresses 7-10 issues	Count	1	2	3
		% within HYH Index recoded into two categories	11.1%	25.0%	17.6%
Total		Count	9	8	17
		% within HYH Index recoded into two categories	100.0%	100.0%	100.0%

Figure 16



II. Firms within certain manufacturing industries are likely to be less sustainable than retail or consumer-focused businesses.

Firms within the sample represent a large degree of industries (Figure 17). For this reason, the data was categorized into three overarching industry sectors: (i) extraction of raw materials and natural resources, (ii) manufacturing, and (iii) other services. The primary and secondary industry sectors were aggregated to be compared with the tertiary sector for the purpose of exploring the Hypothesis II. Out of 19 valid responses and 3 missing values, sectors i & ii have a frequency of 3 within the sample. Sector iii has 16 instances. The modal value is sector iii (Figure 18).

To analyze the second hypothesis, categorized industries were cross tabulated with variables: having a sustainability coordinator present (Figure 3), and degree of transparency (Figure 4). The crosstab for industry sector category compared to the presence or absence of a sustainability coordinator is found in Figure 19. Each firm in the primary and secondary sector

have a sustainability coordinator, whereas 50% of firms within the tertiary sector within the sample reported the presence of one. This relationship is also shown in Figure 20. Based on this very small amount of data, industry sector does not necessarily yield sustainable action outright. This may be because of infrastructural challenges or legal obligations of firms depending on industry/sector.

The crosstab for industry sector as it relates to transparency rating is seen in Figure 21. For the purposes of this analysis, transparency ratings from Figure 4 were categorized as "somewhat transparent" for ratings of 2-3, and "very transparent" for ratings of 4-5. 76.5% of firms in the sample across industries consider themselves to be "very transparent" about their environmental impact. This relationship is also depicted in Figure 22. It is not possible to conclude that a firm's likelihood of taking sustainable action is based on industry sector. Firms across industry sectors are transparent about their environmental impact for a wide variety of reasons. However, given the high skewness and spread of industry and small size of the sample, a solid, a veritable claim cannot be made on the topic of industry as a determint of sustainable action at this point in time.

Figure 17

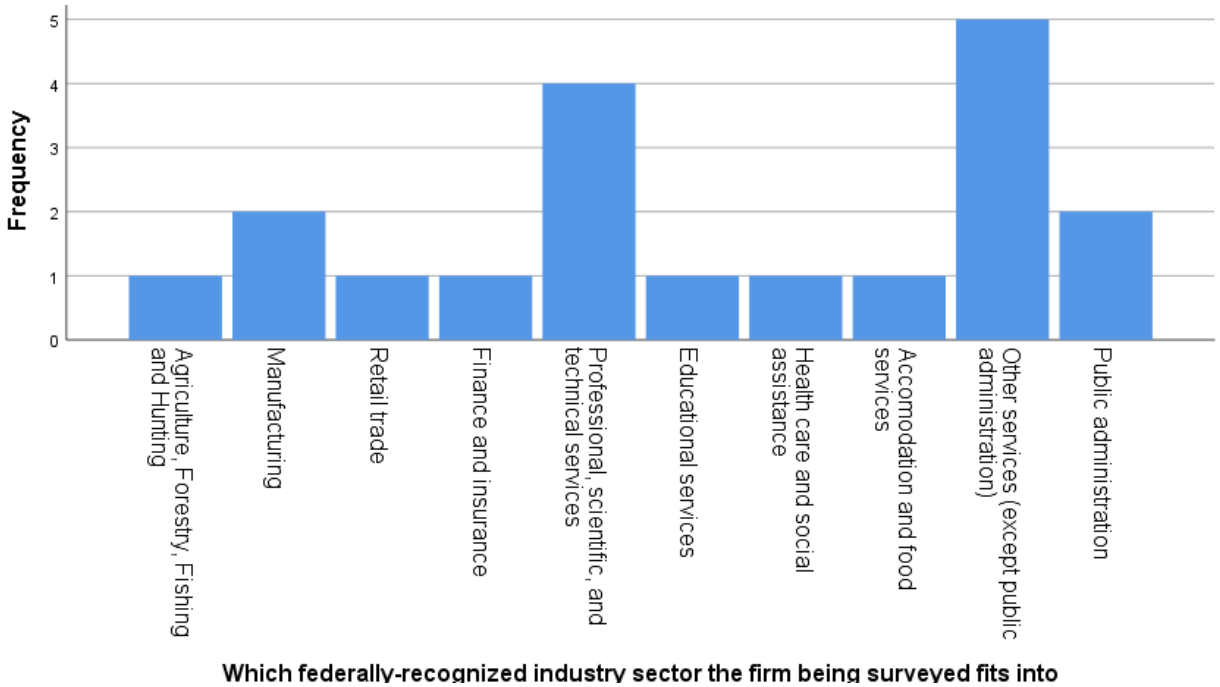


Figure 18

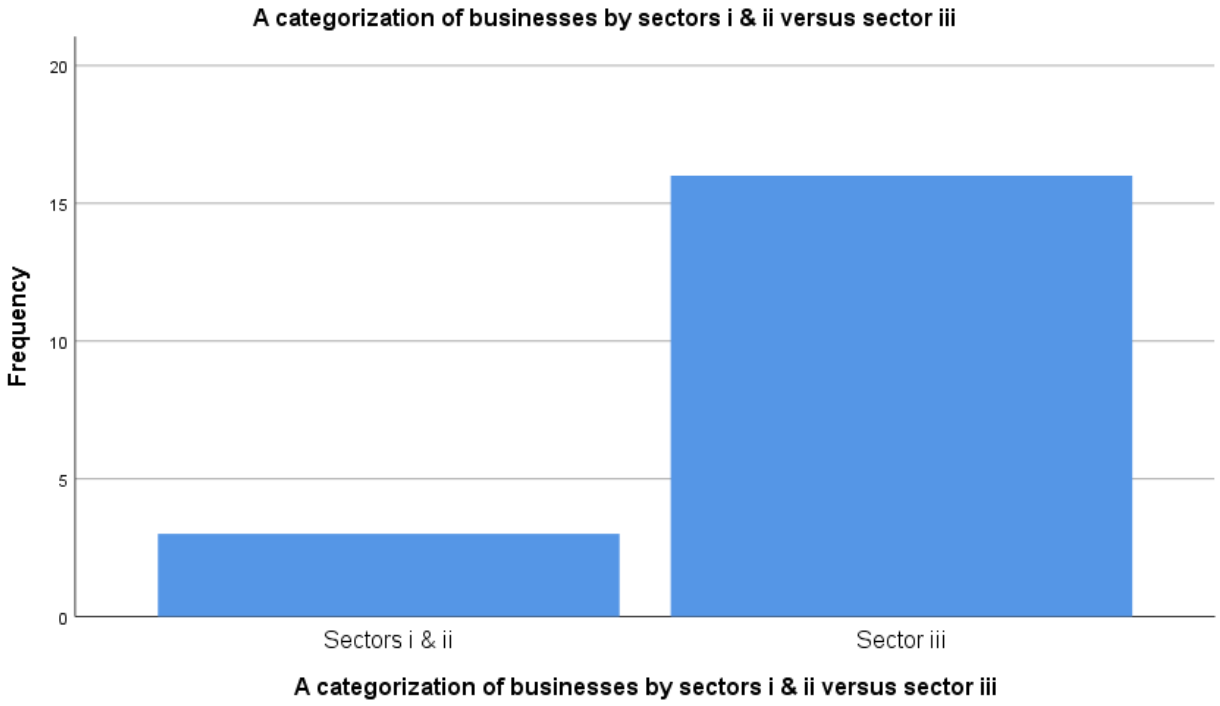


Figure 19

			A categorization of businesses by sectors i & ii versus sector iii		
			Sectors i & ii	Sector iii	Total
Whether or not anyone in the firm's organizational structure is responsible for the environmental considerations of the firm?	Unsure	Count	0	2	2
		% within A categorization of businesses by sectors i & ii versus sector iii	0.0%	14.3%	11.8%
	No	Count	0	5	5
		% within A categorization of businesses by sectors i & ii versus sector iii	0.0%	35.7%	29.4%
	Yes	Count	3	7	10
		% within A categorization of businesses by sectors i & ii versus sector iii	100.0%	50.0%	58.8%
Total		Count	3	14	17
		% within A categorization of businesses by sectors i & ii versus sector iii	100.0%	100.0%	100.0%

Figure 20

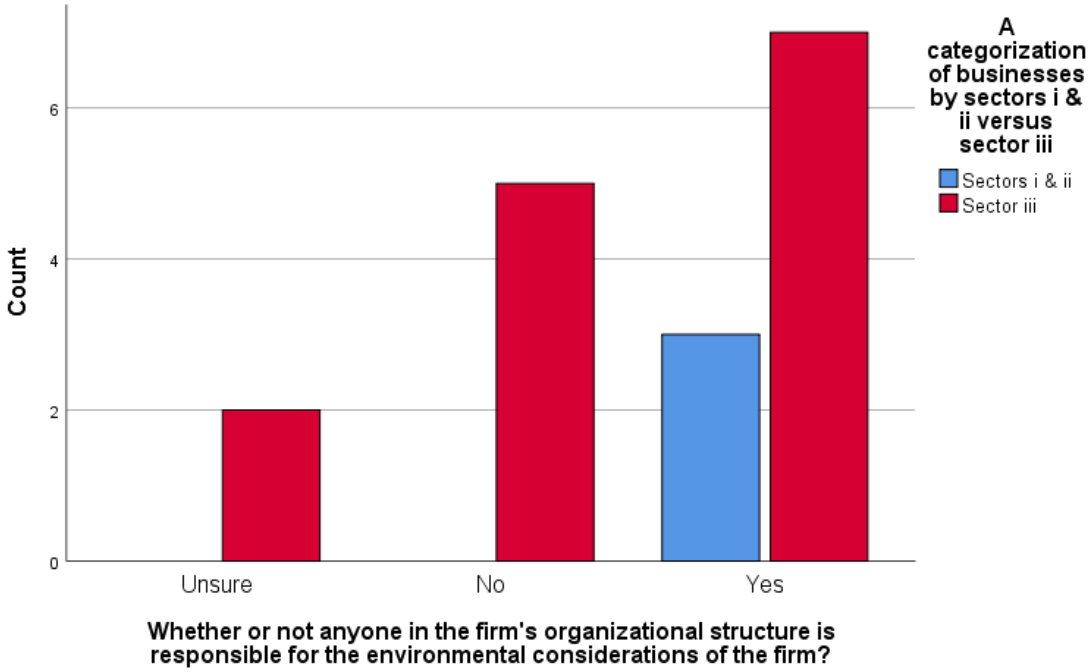
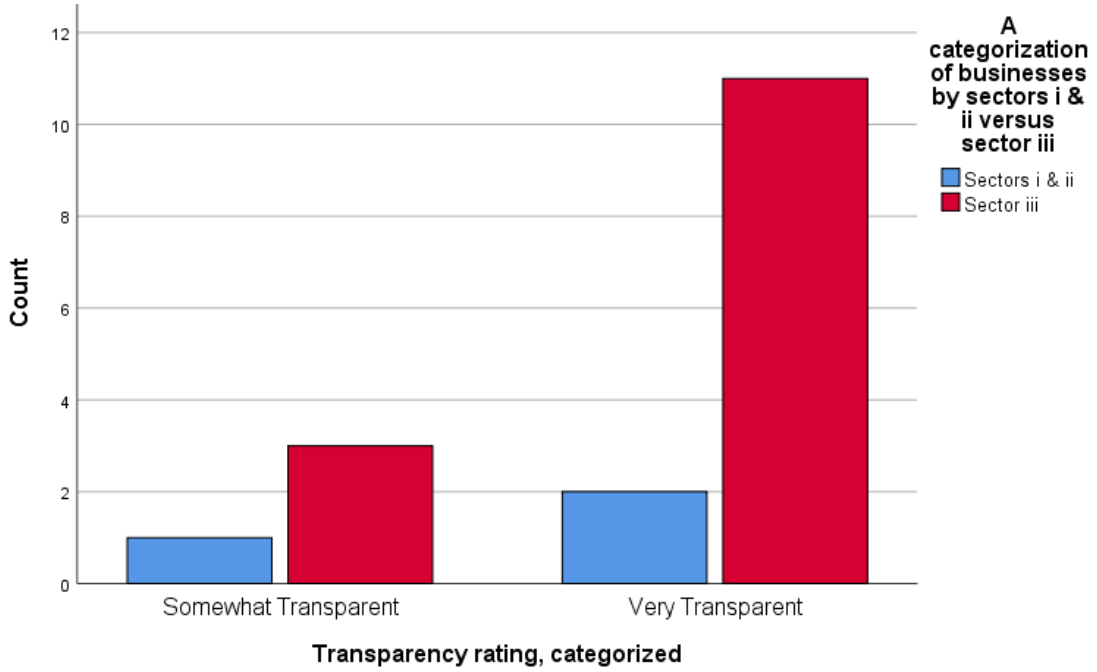


Figure 21

			A categorization of businesses by sectors i & ii versus sector iii		
			Sectors i & ii	Sector iii	Total
Transparency rating, categorized	Somewhat Transparent	Count	1	3	4
		% within A categorization of businesses by sectors i & ii versus sector iii	33.3%	21.4%	23.5%
	Very Transparent	Count	2	11	13
		% within A categorization of businesses by sectors i & ii versus sector iii	66.7%	78.6%	76.5%
Total		Count	3	14	17
		% within A categorization of businesses by sectors i & ii versus sector iii	100.0%	100.0%	100.0%

Figure 22



III. Firms which incorporate environmental rhetoric into their mission statements are more likely to take sustainable action.

Within the sample, more firms include environmental rhetoric into their mission statements as opposed to firms who do not (Figure 23). Out of 19 valid responses, 10 firms do incorporate environmental rhetoric into their mission statements and 9 do not. The measures for sustainable action within the third hypothesis include sustainability initiatives (Figure 5), whether or not the firm has made any donations to charity or politics (Figure 6), and whether or not the firm has hosted any cause-related events (Figure 7).

The crosstab comparing patterns on mission statement types with response data on environmental initiatives within each firm has a total of 17 valid responses, given data from the explanatory variable from Figure 5 (Figure 24). It is important to note that all firms responded either "Yes" or "Unsure" to whether or not there are sustainability initiatives going on within the firm. The table shows that 100% of firms who incorporate environmental rhetoric into their mission statements within the sample have ongoing sustainability practices and initiatives happening within the firm. However, 6 out of 7, or 85.7% of firms who do not incorporate environmental rhetoric into their mission statements, also have sustainability initiatives occurring within the firm. This relationship is also depicted in Figure 25.

With regard to the second sustainability indicator, donations to charity or politics, it is similarly important to note that, of 18 valid responses, firms either were certain or unsure that they had made donations within the last five years—0 out of 18 firms had disclosed that they had not made any charitable or political donations (Figure 6). While 80% of firms within the sample who had TBL-inclusive mission statements did make donations within the last 5 years, 100% of firms within the sample whose mission statements did not include TBL rhetoric also made donations to charity or politics (Figures 26, 27).

The final crosstab for Hypothesis III entails mission statement rhetoric as it relates to cause-related events the firm may have conducted within the last 5 years (Figure 28). The data depict a positive relationship between incorporating environmental rhetoric into firm mission statements with having hosted cause-related events within the past 5 years (Figure 29). 60% of firms with TBL mission statements have hosted cause-related events, whereas 25% of firms whose mission statements are not TBL-inclusive have hosted cause-related events. However, 44.4% of the total sample, regardless of mission statement rhetoric, have hosted cause-related events in the past 5 years.

The data within the sample does not fully support Hypothesis III. Firms which incorporate environmental rhetoric into their mission statements have more ongoing sustainability initiatives and have hosted more cause-related events. However, these firms make donations to charity and politics *in the same capacity* as firms without TBL mission statements. While the hypothesis is not supported by all 3 indicators of sustainable action, this information is encouraging about the prevalence of sustainability within Roanoke Valley enterprises.

Figure 23

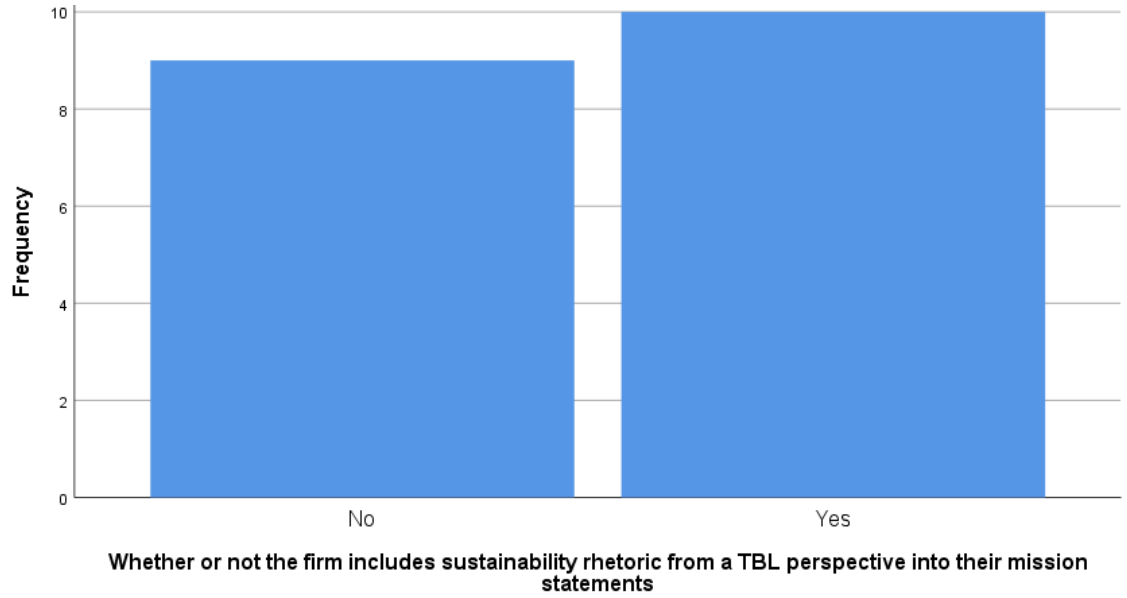


Figure 24

			Whether or not the firm includes sustainability rhetoric from a TBL perspective into their mission statements		
			No	Yes	Total
Whether or not sustainability initiatives are occurring within the firm	Unsure	Count	1	0	1
		% within Whether or not the firm includes sustainability rhetoric from a TBL perspective into their mission statements	14.3%	0.0%	5.9%
	Yes	Count	6	10	16
		% within Whether or not the firm includes sustainability rhetoric from a TBL perspective into their mission statements	85.7%	100.0%	94.1%
Total		Count	7	10	17
		% within Whether or not the firm includes sustainability rhetoric from a TBL perspective into their mission statements	100.0%	100.0%	100.0%

Figure 25

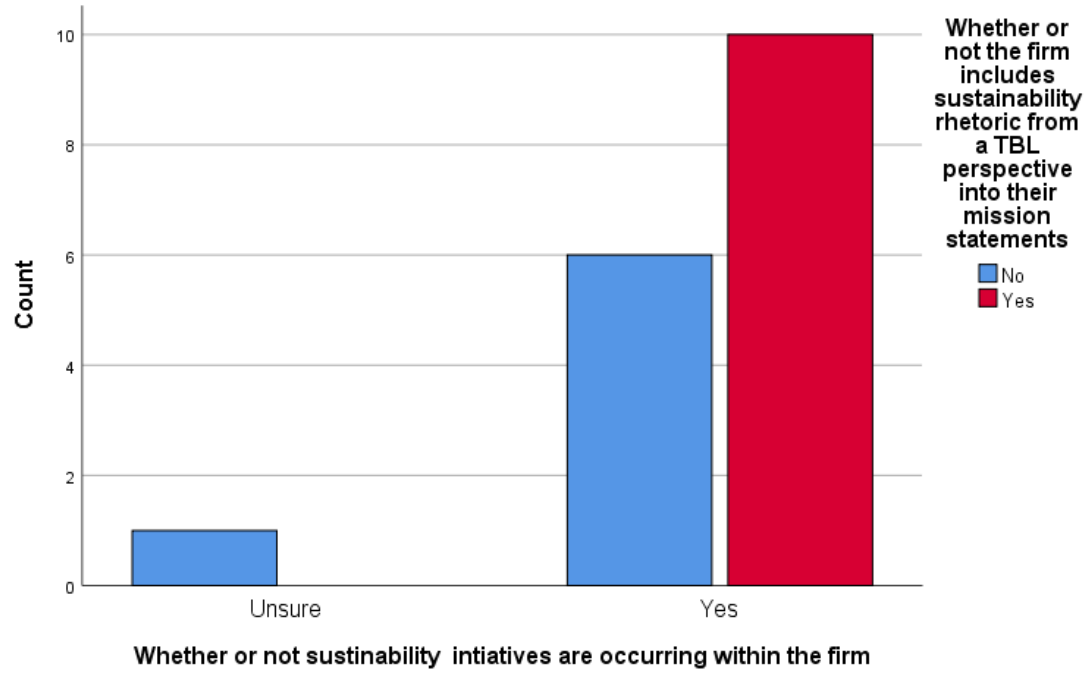


Figure 26

			Whether or not the firm includes sustainability rhetoric from a TBL perspective into their mission statements		
			No	Yes	Total
Whether or not the firm has made donations to charity or politics in the last five years	Unsure	Count	0	2	2
		% within Whether or not the firm includes sustainability rhetoric from a TBL perspective into their mission statements	0.0%	20.0%	11.1%
	Yes	Count	8	8	16
		% within Whether or not the firm includes sustainability rhetoric from a TBL perspective into their mission statements	100.0%	80.0%	88.9%
Total		Count	8	10	18
		% within Whether or not the firm includes sustainability rhetoric from a TBL perspective into their mission statements	100.0%	100.0%	100.0%

Figure 27

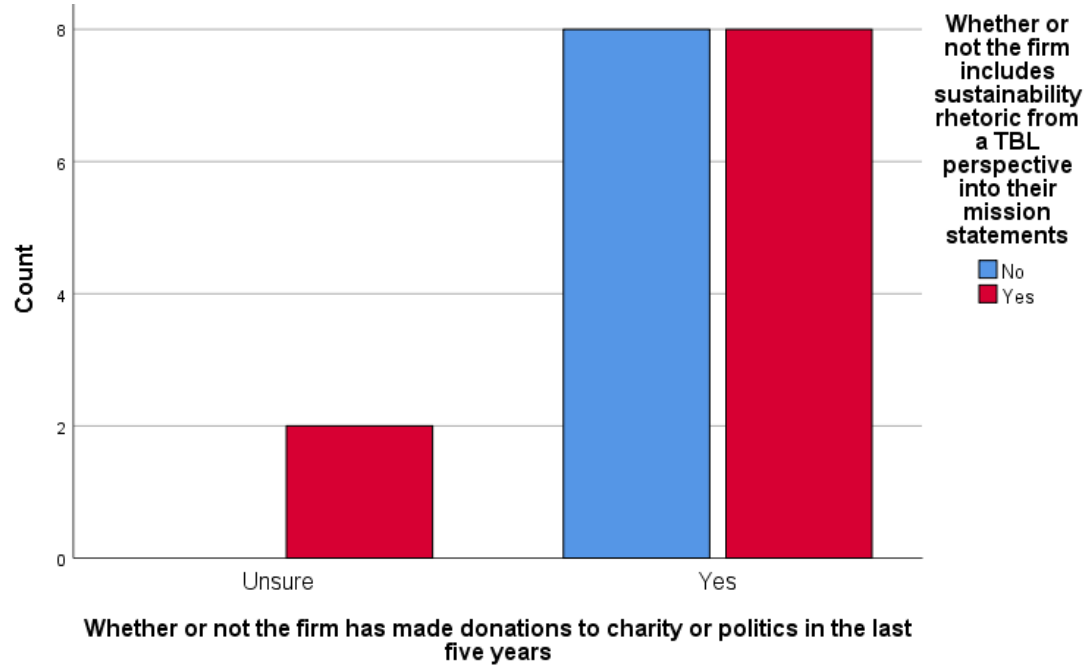
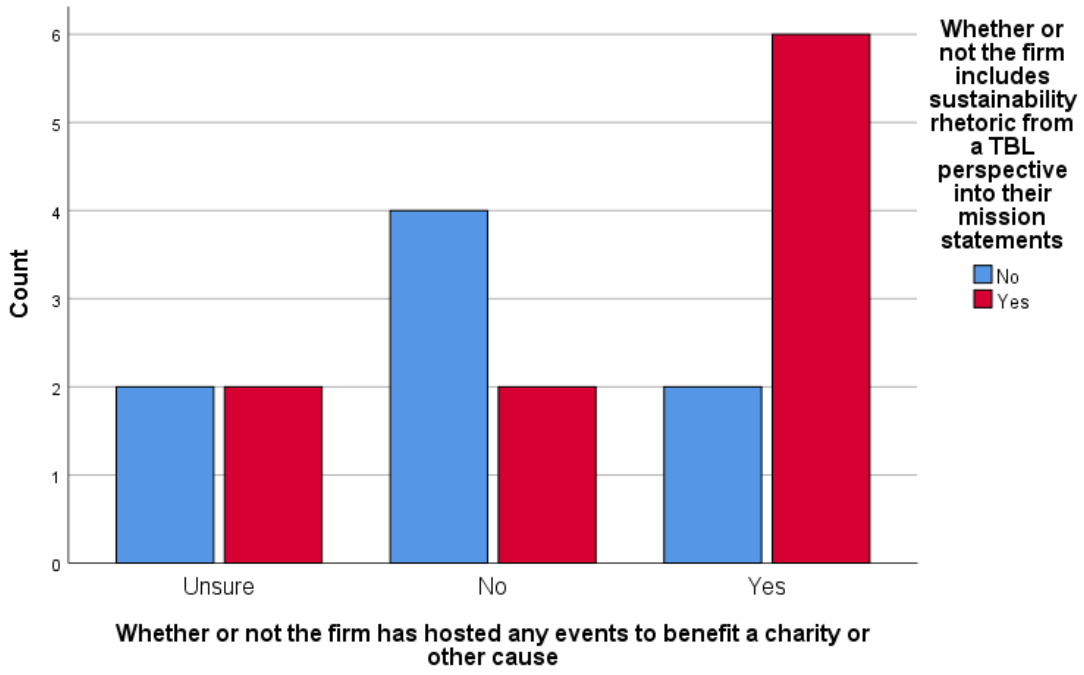


Figure 28

			Whether or not the firm includes sustainability rhetoric from a TBL perspective into their mission statements		
			No	Yes	Total
Whether or not the firm has hosted any events to benefit a charity or other cause	Unsure	Count	2	2	4
		% within Whether or not the firm includes sustainability rhetoric from a TBL perspective into their mission statements	25.0%	20.0%	22.2%
	No	Count	4	2	6
		% within Whether or not the firm includes sustainability rhetoric from a TBL perspective into their mission statements	50.0%	20.0%	33.3%
	Yes	Count	2	6	8
		% within Whether or not the firm includes sustainability rhetoric from a TBL perspective into their mission statements	25.0%	60.0%	44.4%
Total		Count	8	10	18
		% within Whether or not the firm includes sustainability rhetoric from a TBL perspective into their mission statements	100.0%	100.0%	100.0%

Figure 29



Hypothesis I sought to determine whether firms which are aware of the state of the climate and environment are likely to be operating under some parameters of sustainability. This was unable to be determined, given the high degree of environmental issues being addressed by businesses in the area regardless of awareness level. This is a positive piece of information with regard to the future of sustainability in the Roanoke Valley. Hypothesis II sought to determine whether firms within certain manufacturing industries are likely to be less sustainable than retail or consumer-focused businesses. The lack of an even distribution of firms across industries in the sample, coupled with the high degree of sustainable actions being taken by firms across industry sectors in Roanoke, does not yield a specific response to Hypothesis II. This information does, however, provide a positive indication of sustainability initiatives in the area. There are many other factors which play into sustainability transitions at the industry level, and

much more information is needed to make a veritable claim. Hypothesis III sought to determine whether firms which incorporate environmental rhetoric into their mission statements are more likely to take sustainable action. Data within the sample told us that firms with TBL mission statements do have more ongoing sustainability initiatives and have hosted more cause related events, however, mission statement rhetoric did not influence whether or not firms have made donations to charity or politics in the last five years.

With regard to sustainable action being taken by businesses in the Roanoke Valley, it is important to note that these hypotheses and conclusions are made to represent patterns in firm-level decisions and attitudes disclosed within the survey. Although the data is not generalizable beyond the sample, it does offer positive insights that would not have otherwise been deduced. These insights may serve as a positive indicator for the successful adoption and implementation of the Roanoke City Council's 2020-2040 plan, as well as a thriving future economy within the Valley, that is resilient in the face of a changing climate.

SUGGESTIONS FOR FURTHER RESEARCH

The intention of this project was to collect enough data to make generalizable claims to be applied to the entire country. Unfortunately, this goal was not accomplished. Future researchers are implored to continue this pursuit given the pressing necessity of the subject matter, explained in the Background and Introduction sections.

One key factor prohibiting the accumulation of survey responses may have been the length of the survey itself. According to the software used, it took about 13-15 minutes to complete. People who are running and maintaining businesses at any scale may not have time to

fully engage with a piece that long. Although the collected data may not be as complex, more responses would likely be garnered with a much shorter survey-- one that takes less than five minutes to complete.

Another mode of increased response accumulation would be to do more networking with potential distributors of surveys, or alter the survey location to a much more densely populated area. Even through working with the gracious members of Roanoke City Council and various business-leagues (who we are so grateful to) responses were still low. This could be for many reasons not pertaining to distribution channels, but, of the approximate 329 recipients of the survey in some manner, only 8% responded. If 3000 valid recipients were reached, more useful data would have been accrued. Further, this would likely be an easier task in a much more densely populated place. Not only are there more businesses in less of a distance, but responses collected in the field would likely garner more attention and response, in less time.

Aside from response collection and survey length, for similar future research, it is advised to pay careful attention to the wording of all materials meant for distribution. This includes promotional materials, emails to respondents and distributors, verbal communication with any stakeholder, informed consent documentation, and survey questions themselves. The style, syntax, and word choice of these materials is salient to garnering a large amount of responses. Lack of nuanced attention to these things could have been a prohibiting factor in response collection. This suggestion is based on the political mix in the survey area, which is demonstrated by the discourse following the proposal and construction of the Mountain Valley Pipeline. With a population which is colorfully split on energy, prosperity, and environmental issues, survey wording needs to be respectful of this diversity.

Improvements in survey design also include improving clarity in questions for people who have little to no knowledge of the environment. For more descriptive data, defining specific parameters for variables like “transparency” would serve the purpose of fine-tuning and better-articulating truthful responses. Other data that may be useful to collect in future sustainability research is firm size (in dollars, employees, or some other asset), as well as firm age. These pieces of information would hypothetically shed more light on challenges faced by firms making sustainability transitions in a more helpful way.

In terms of methods, there needs to be a balance between resources needed and information collected, to better describe sustainable actions and their determinants at the firm level in Roanoke and beyond. While interview-based research has limitations, a mixed-methods approach to collecting data which incorporates interviews and surveys with approximately 200 responses would be an ideal scenario. The survey data would hypothetically provide enough data to make generalizable claims, while the interviews would elaborate on specific motivations of firm decision-makers and the reality of sustainability implementing that cannot be gleaned by surveys alone. This balance would also lend itself to more applicability at the national scale while providing valuable regional statistics on sustainable development progress.

Sustainable development is being pursued robustly by the Roanoke City Council and other surrounding communities. While the data within this project was not as complete of a picture as we would have liked it to be, it still provides noteworthy insights that may be useful for the implementation of the six main themes of the 2020-2040 plan for Roanoke. Further research is fervently suggested so that milestones reached within the planning initiatives can be adequately justified, measured, monitored, and enforced by valid quantitative data.

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APPENDIX

Figure A1: Employment time of survey respondent

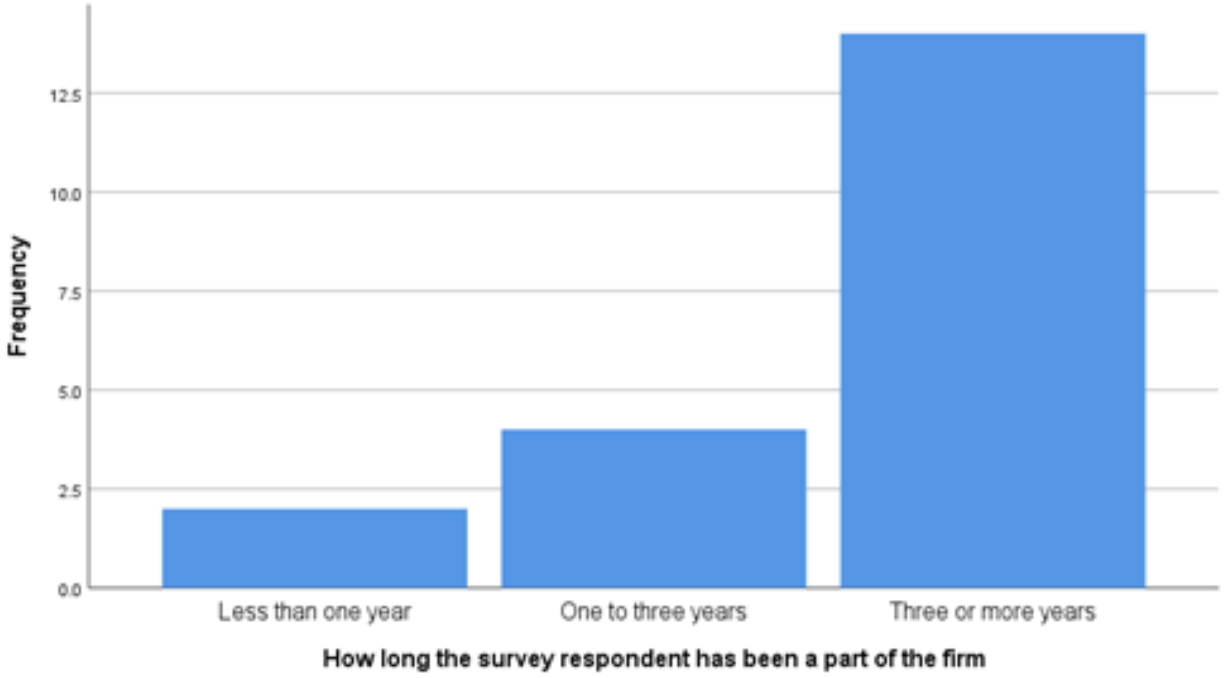

Figure A2: Responses for variables on respondent awareness of climate change, sea level rise, natural disaster frequency and tendency, & erosion.