

Productivity and the California Global Warming Solutions Act: An Examination of Cost
of Compliance Utilizing Plant Level Data in the Portland Cement and Manufacturing
Industry
by
Rick Ardito

Doctoral Study Submitted in Partial Fulfillment
of the Requirements for the Degree of
Doctor of Business Administration

Liberty University

December 2017

Abstract

This dissertation examined the effect of California environmental regulation, AB32 on the Portland Cement Mining and Manufacturing industry which was directly targeted by the legislation. The researcher examined the effect of productivity on the Portland Cement industry operating within California by comparing changes specific labor and fuel use productivity measures to changes in the same measures for organizations operating outside of California. These differences were examined using an independent samples T-test to determine if any changes were statistically significant. The results showed statistically significant increases in productivity for direct labor, total employee labor and combustible fuel use when analyzed to the $p = .05$ level of significance. The results of this dissertation suggest that Porter's hypothesis that environmental regulations can increase operational efficiency for organizations could be true. While the results do seem promising for those who advocate for stricter environmental regulation, the limitations of the study, specifically the infancy of the data set, and the lack of specific financial measures should also be considered. Regardless of the limitations, the results of this research project are useful to business leaders, accountants, and legislatures who are dealing with possible incoming regulations, or trying to write those regulations.

Keywords: Environmental regulation, AB32, Porter's Hypothesis, productivity, California, Portland Cement

Productivity and the California Global Warming Solutions Act: An Examination of Cost
of Compliance Utilizing Plant Level Data in the Portland Cement and Manufacturing

Industry

by
Rick Ardito

Doctoral Study Submitted in Partial Fulfillment
of the Requirements for the Degree of
Doctor of Business Administration

Liberty University

December 2017

[Enter Name of Dissertation Chair]

[Enter Name of Dissertation Committee Member]

[Enter Name of DBA Director]

[Enter Name of Dean, School of Business]

Dedication

This dissertation is dedicated to my beautiful wife, Cassie and our two amazing children, Reagan and Rocco. Without their constant motivation, and Cassie's dedication to our family, this would not have been possible.

I also want to dedicate this to my parents, Mike and Sandy. Without their love and constant support and emphasis on the importance of education, I would have never made it this far.

Acknowledgments

Table of Contents

List of Tables	v
No table of figures entries found.	v
Section 1: Foundation of the Study.....	1
Background of the Problem	1
Problem Statement	4
Purpose Statement.....	5
Nature of the Study	6
Research Question	10
Hypotheses (Quantitative Only)	11
Theoretical Framework.....	12
Activity Based Costing	12
Matching Principle.....	14
Incremental Budgeting.....	14
Definition of Terms.....	15
Assumptions, Limitations, and Delimitations.....	17
Assumptions.....	17
Limitations	18
Delimitations.....	19
Significance of the Study	19
Reduction of Gaps.....	20
Implications for Biblical Integration.....	22

Relationship to Field of Study	24
A Review of the Professional and Academic Literature.....	24
Environmental Regulations and Porter’s Hypothesis	25
Biblical Perspective on Environmental Preservation.....	29
Secular Perspective on Environmental Preservation	32
History of California’s Environmental Policies.....	34
California’s Global Warming Solutions Act.....	36
California’s Legislative Effect on Business.....	38
Lean Manufacturing.....	39
ERP Systems.....	42
Accounting Theory	44
Managerial Accounting.....	45
The Matching Principle.....	47
Activity Based Costing	47
Standard Costing.....	49
Influences and Design.....	51
Results Conflicting with Porter’s Hypothesis.....	52
Christiansen and Haveman.	52
Denison	53
Kendrick.....	54
Results Supporting Porter’s Hypothesis	62
Bovenberg and Van der Ploeg.	62

Berman and Bui.....	63
Transition and Summary.....	65
Section 2: The Project.....	67
Purpose Statement.....	68
Role of the Researcher.....	69
Participants.....	69
Research Method and Design.....	70
Method.....	70
Research Design.....	72
Population and Sampling.....	77
Data Collection.....	80
Instruments.....	80
Data Collection Technique.....	81
Data Organization Techniques.....	81
Data Analysis Technique.....	82
Reliability and Validity.....	84
Reliability.....	84
Validity.....	87
Internal Validity Threats.....	87
External Validity Threats.....	88
Statistical Conclusion Validity Threats.....	90
Construct Validity Threats.....	90

Transition and Summary.....	91
Section 3: Application to Professional Practice and Implications for Change.....	93
Overview of Study.....	93
Presentation of the Findings.....	95
Research Question One.....	95
Research Question Two.....	5
Research Question Three.....	8
Results and Theoretical Framework.....	11
Applications to Professional Practice.....	12
Business Application.....	13
Accounting Application.....	14
Biblical Application.....	16
Recommendations for Action.....	18
Recommendations for Further Study.....	22
Reflections.....	23
Summary and Study Conclusions.....	27
References.....	30
Appendix A: Financial Data Requested.....	40

List of Tables

No table of figures entries found.

Section 1: Foundation of the Study

In this research project, the researcher presented the initial concepts for this dissertation. The background of the problem and problem statement were provided prior to the researcher addressing the purpose statement and other areas important to the study. The study proposed examines the cost of compliance for one of the nine specific industries targeted by California's AB32, Global Warming Solutions Act and seeks to compare their overall cost of complying with environmental regulations with similar businesses outside of California's regulatory environment.

Background of the Problem

Many environmental regulations are designed to target specific industries that legislators consider gross polluters. Legislatures have even been quoted admitting that specific regulations have been designed to target individual industries due to a belief that those industries are responsible for significant environmental damage (Bigger, 2015). These regulations, particularly those which govern air and ground pollution are some of the most controversial impediments imposed by government on industry. One reason for this is due to the difficulty in estimating the cost of compliance with such pollution reduction acts (Greenstone, 2002). Some research even suggests that environmental regulations do not cause harm to companies at all, but rather, organizations actually benefit from governmental regulation related to environmental causes (Berman & Bui, 2001; Bovenberg & van der Ploeg, 1996; Porter & van der Linde, 1995). The viewpoint that environmental regulation increases efficiency is known as Porter's Hypothesis. Porter's Hypothesis essentially states that environmental regulations that are well

designed can have a net neutral or positive affect on organizations due to the innovations and efficiencies that are developed as a direct response to the legislation (Porter & van der Linde, 1995). This point, at least under California's regulatory environment, appears to be countered when looking at Great Recession recovery figures, particularly comparing California's jobs added in the area of manufacturing, to the rest of the United States (U.S.). The United States added 871,000 jobs in this area, or 7.6% of total jobs from January 2010 through December 2015, while California only added 25,600, or 2.1% of their jobs in this sector for the same period (U.S. Bureau of Labor Statistics, 2016; California Employment Development Department, 2016). Environmental regulations are thought to impact the manufacturing, construction and trucking industries primarily, and regulators often admit that specific sectors of these industries, including the Portland cement manufacturing industry are targeted by the legislation (Bigger, 2015). In fact, California's Global Warming Solutions Act (AB32) is funded by approximately 250 "fee payers" statewide, consisting of seven industries, including cement manufacturers (California Air Resources Board, 2015). These fees are calculated based on a term known as "common carbon cost" (CCC), which charges polluters 12.1-18 cents per metric ton of carbon dioxide emissions (California Air Resources Board, 2015). The question then remains, why is California experiencing such sluggish growth in the manufacturing industry, especially considering the ease of major port access for many of the states populated regions? Could the slow growth numbers be contributed to regulations, and particularly the cost of complying with those regulations?

The 2006 Global Warming Solutions act AB32 in California, established environmental goals for the state including greenhouse gas emissions reduction targets for the year 2020 (Weiss & Sarro, 2009; Bigger, 2015). The standards introduced by California, are the strictest in the nation, and additional regulations imposed by the California Air Resources Board further regulate emission standards in the state (Rabe, 2008). Due to the strict regulatory environment, it follows that manufacturers who have the option to open or expand production outside of California, would choose to do so in order to sidestep California's strict environmental regulations. If companies perceive the cost of doing business in California as being too high, then the question of what California's regulations are costing manufacturers must be examined. California is consistently ranked by fortune CEOs as the worst state to conduct business, due to tax and regulatory policies (Husing, 2016). Despite this fact, research has not been conducted that determines the actual cost of complying with California's environmental policies, specifically those enacted by AB 32 and the California Air Resources Board. California businesses spend money replacing and retrofitting equipment and facilities, as well as testing and certifying that those pieces of equipment are in compliance with regulations, in order to stay in compliance with California's strict standards. Heavier polluters, including Portland cement manufacturing facilities are required to pay the AB32 fee which funds the implementation of the legislation, in addition to their other costs of compliance (California Air Resources Board, 2015). The cost of purchasing, replacing, retrofitting, testing and certifying compliance of these assets is a real cost to California's manufacturers, and it affects their return on assets and return on investment.

These financial statement impacts have very real implications for accountants and controllers of these organizations, particularly when considering capital and operational budgeting for compliance related issues.

Problem Statement

The problem to be addressed was examining the impact of complying with California's Global Warming Solutions Act (AB32) and its effect on productivity of plants by examining the total plant inputs, including materials and labor and plant outputs, before and after the implementation of the regulation. The study then examined how those items impact the financial statements Southern California Portland cement manufacturing and mining facilities. California has been ranked as one of the worst regulatory markets for business in the U.S. (Husing, 2016). Environmental regulations have a role in this regulatory problem which is evidenced by California's lagging job growth in manufacturing industries which are most affected by this regulation (California Employment Development Department, 2016; Ryan, 2012; U.S. Bureau of Labor Statistics, 2016). Examining the cost of complying with these regulations within Southern California cement mining and manufacturing facilities and comparing their results with other organizations not subject to the regulation provided the researcher with insight into what impact the regulations had on businesses within the state. By determining impact on asset costs, testing and certification costs, return on assets and return on investment the researcher was able to better understand the true cost of doing business while subject to California's stringent regulatory environment. Understanding of these costs is important for the decision-making process of controllers and other

persons responsible for making capital budget and other financial and investment decisions for firms that are subject to California's environmental regulations.

Purpose Statement

The purpose of this descriptive quantitative study is to examine the effect of California's Global Warming Solutions Act on the productivity of a specific business sector (Portland Cement manufacturing), to determine whether or not the regulation has a statistically significant impact on the productivity of businesses complying with the aforementioned regulation when compared to organizations not required to meet California's stricter environmental standards. While legislatures of first world western countries, including California's representatives support ever increasing environmental regulation (Bigger, 2015), it is important to note that even the most favorable theory for environmentalists regarding the impact of regulations on business productivity is careful to state that only well-designed regulations have a positive impact on business productivity (Porter & van der Linde, 1995). Thus, it is vital for organizations complying with ever progressing environmental regulation to track and understand how the compliance with regulations affects the overall productivity of their organizations.

The aim of this study is to provide measurable data that can help organizations understand better how compliance with certain types of environmental regulations impacts their business processes. The researcher studied the productivity impact of organizations by examining certain productivity measures, such as direct labor hours per unit of production, and total production costs per unit of production for a series of years before and after the implementation of new environmental regulation, and compared

those results to similar organizations outside of that compliance environment utilizing a difference in differences approach. The researcher examined these differences to determine whether or not the variable of specific compliance within the state of California appears to have a measurable effect on the productivity of organizations required to comply with the more stringent regulations.

Nature of the Study

The researcher selected a quantitative method for this study that utilized a difference in difference approach in examining the effect of the regulation examined on the productivity output of the participating organizations. This method of study provided more accurate and useful analysis of the data collected for those who wish to utilize the study to improve accounting practices for companies required to comply with California's AB32 (Creswell, 2014). The study compared the financial and productivity results by examining the effect that spending on pollution abatement measures had on the productivity of plants across the Portland cement manufacturing industry. Firms operating inside of California were compared with firms that operate outside of California's regulatory environment, which allowed the researcher to examine the effects of California's Global Warming Solutions Act. Because it was very difficult for companies to quantify the amount of capital spending that is necessitated by the environmental regulations that they were subject to, and separate those from ordinarily necessary expenditures, the study instead focused on the expenditures that organizations made for all pollution abatement measures and attempted to determine the effect those expenditures had on the overall productivity level of each firm examined. The researcher

utilized a difference in differences comparison analysis of the data to determine how the implementation of AB32 within California affected the plants examined during this study.

Generally, quantitative research methods are thought to be most useful in accounting research, since accounting deals with usually readily available financial data (Humphrey, 2014). Humphrey also notes that few researchers are performing qualitative studies in the area of accounting (pp. 53-54). Malina and Selto note that in performing research, the researchers must be careful to utilize a systematic approach to understanding the data and how different variables relate to each other and affect the overall data (2011). While there is plenty of evidence supporting both quantitative and qualitative methods, studies that examined similar questions relied on quantitative design (Berman & Bui, 2001; Shadbegian & Gray, 2003).

Once the quantitative design was chosen for this study, the type of quantitative design had to be selected. Other similar studies utilized a difference in differences approach of statistical analysis (Shadbegian & Gray, 2003). Since this study examined more than one natural group, and the researcher did not have any specific experimental intervention in the study, the descriptive quantitative design was clearly the best fit. Other quantitative methods that were considered, but ultimately rejected were correlational, experimental and quasi-experimental (Creswell, 2014).

The correlational design examines variables and seeks to determine if there is a cause and effect relationship between those variables (Creswell, 2014). This study examined groups of cement mining and manufacturing organizations inside and outside

of California and attempted to quantify the cost of complying with California's AB32. Based on the natural design and focus of this research, the correlational design was not appropriate for this study.

Experimental research is a design in which the researcher establishes two groups to run an experiment and then analyze results of that experiment (Creswell, 2014). These groups will be set up as an experimental group, or the group in which the new variable is introduced, and a control group, which is not altered and is used to compare the experimental group results against (Abbott & McKinney, 2013). The experimental method of research design requires the researcher to randomly assign study participants into each group, (the control group and the experimental group). This random assignment, as well as other efforts are part of the researcher's effort to control for external factors that might affect the study and are not part of what the researcher is trying to examine (Creswell, 2014). Since there was no experiment conducted in the current study, the researcher rejected the experimental research design, as it was not appropriate for the current research. The researcher utilized financial data obtained from cement manufacturers and compared that data to determine the cost of compliance with AB32 regulations.

The quasi-experimental research method is analogous to the experimental method, as it is also used to run an experiment on groups of study participants and utilizes control of variables. The difference however is that the quasi-experimental method of research design uses groups that are naturally occurring, rather than trying to randomly assign study participants to groups (Creswell, 2014). While the current study does utilize

naturally occurring groups, the researcher did not seek to run an experimental procedure on those groups. For this reason, the quasi-experimental method of research design was rejected.

Through examining the body of literature in which the researcher compared the operating costs or productivity of groups of businesses under different regulatory environments, the common method of analysis was the descriptive quantitative design (Shadbegian & Gray, 2003). This examination of research however did not yield any studies that examined the cost for individual or small groups of businesses for complying with an environmental regulation as is the goal of this research project. The researcher did however identify similar studies that looked at larger groups or industries and utilized the same type of difference in differences approach to examine the effect that pollution abatement spending had on the productivity of plants. For example, Shadbegian and Gray examined three industries affected by earlier pollution abatement measures in both 1994 and 2003 utilizing a similar approach. Additionally, the researcher identified studies that took a macro level approach and generalized over entire nations or economies the effects of environmental laws on businesses. Ryan (2012) for example utilized an economic model in his descriptive study of the effects of the 1990 amendments to the Clean Air Act on the Portland cement manufacturing industry. Based on this review of literature, and the novel concept of the current study, the researcher determined that the most appropriate method of design was the observational descriptive quantitative analysis of the data examined.

The researcher examined two distinct, but similar groups of Portland cement manufacturers and compared specific financial results to determine the cost of complying with California's AB32 regulations. The researcher utilized a paired t-test to determine the statistical significance of the relationships between the two groups of Portland cement manufacturers. The goal of this project was to determine whether or not the cost of compliance with cutting edge environmental regulations were significant for companies operating in areas that are subject to those regulations.

Research Question

The researcher designed this study to determine whether compliance with AB32 caused additional expense when comparing both firms required to comply and those not required to comply with the regulation. This expense is measured in terms of productivity and operational efficiency. The first research question was: Do California's restrictive environmental regulation laws increase the cost of direct labor for Portland Cement manufacturers in the state when compared with similar businesses operating outside of California?

The second research question was: Do California's restrictive environmental regulation laws increase the cost of total labor for Portland Cement manufacturers in the state when compared with similar businesses operating outside of California?

The third research question was: Does compliance with California's restrictive environmental regulations increase the fuel-use efficiency of California's Portland Cement manufacturers when compared with manufacturing facilities operating outside the state of California? The researcher examined operational results of organizations

examined by examining their output productivity in tons as a percentage of their total inputs for a series of years both before and after the implementation of AB32. A positive correlation between pollution abatement spending and a decrease in productivity would be evident if California firms showed a decrease in overall productivity as a percentage of total inputs after the regulation took effect.

Hypotheses (Quantitative Only)

H₀₁: There is no statistically significant difference in the cost of direct labor measured through productivity for California's Portland cement mining and manufacturing businesses.

H_{A1}: There is a statistically significant impact on the cost of direct labor measured through productivity for California's Portland cement manufacturing and mining businesses.

H₀₂: There is no statistically significant difference in the cost of indirect labor for California's Portland cement mining and manufacturing businesses.

H_{A2}: There is a statistically significant impact on the cost of indirect labor for California's Portland cement manufacturing and mining businesses.

H₀₃: There is no statistically significant impact on the fuel use efficiency due to increased regulation and inputs resulting from efforts in compliance with AB32 for California's Portland cement mining and manufacturing businesses.

H_{A3}: There is a statistically significant impact on the fuel use efficiency results due to expenditures related to specific compliance with AB32 for California's Portland cement mining and manufacturing businesses.

Theoretical Framework

The motivation of a study can be better understood through the examination of the theoretical framework of the study in question (Creswell, 2014). Understanding and tracking the costs that organizations incur due to compliance with regulations is important for two reasons. First, organizations need to understand the costs incurred so that they can be correctly matched to the period in which they belong, as well as matched to the appropriate activity for cost tracking. Second, understanding these costs and matching them to the appropriate periods and activities is essential for strategic planning and budgeting of organizations. For these reasons, the researcher examined activity based costing, which seeks to identify all costs of production and matching them to the correct activity (Cooper R. , 1988a; Cooper R. , 1988b; Johnson & Kaplan, 1987), and the matching principle, which seeks to ensure all costs are recognized and matched with revenue from the correct accounting period (Ohlson et al., 2011). These practices are important in relation to the theory of Porter's Hypothesis, because for an organization to determine whether it is more efficient after the implementation of an environmental regulation, that organization must understand its costs related to complying with that regulation.

Activity Based Costing

Activity based costing is designed to allow firms to track specific activities of cost within an organization, and allocate those costs directly to products, or portions of those products, within their production cycle, to gain a more accurate picture of what it costs to produce those products (Raeesi & Amini, 2013). Activity based costing is primarily used

by management accountants to track specific activities within an organization, and provide details about those activities for the purpose of decision making. Management accounting is designed to help organizations track internal results so that management can make more informed decisions, based on accounting results and projections designed for internal use (Fullerton, Kennedy, & Widener, 2013).

Tracking these costs requires a careful design of the accounting system, so that important costs are entered in a way that makes them separable from other costs within the organization. This may mean that they can be searched by specific function, or that an extensive account code structure is used to separate costs into specific activity categories that can be allocated appropriately. These allocations aid management in running reports to analyze the data within the accounting system which is useful for decision making within the organization (Johnson & Kaplan, 1987).

Activity based costing is relevant to the current study because it encourages the tracking of specific costs so that they can be appropriately applied to the correct activity within the organization, so that management can better understand each activity. Focusing on tracking the costs specifically related to the compliance with environmental regulations is essential to determining whether Porter's Hypothesis is accurate in each case. The organization however would have to specifically track each cost that results from compliance with the regulation in question, to be able to correctly apply that cost to the appropriate activity within the production cycle. A review of the literature in this area shows that organizations have a difficult time identifying costs related specifically to pollution abatement. Careful consideration of activity based costing principles, and the

account code structure used by the organization would be helpful for organizations to determine their actual costs related to pollution abatement (Berman & Bui, 2001; Kaplan & Norton, 2007).

Matching Principle

The matching principle states that expenses should be matched to the revenues they are related to in the proper accounting period. This means that accountants must be able to track expenses and book or accrue them in the proper period to properly state total income on the financial statements (Ohlson, et al., 2011). The concept of matching is one of the principle concepts for accrual accounting under the generally accepted accounting principles in the United States (Warren, Reeve, & Duchac, 2016). Accountants must be careful to look for and track expenses that should be accrued in specific accounting periods so that they will be able to correctly match those expenses to revenues earned in the same period. For Portland cement manufacturers, this means that companies operating in California need to track their carbon emission output, in order to properly accrue their AB32 fee in the period in which the produced emissions resulted in sales revenue.

Incremental Budgeting

Incremental budgeting is a technique in which the accountant completing the budget for the upcoming period, takes actual results from the prior period, and copies those results to the new budget, adjusting from the actual numbers based on known factors for the upcoming period (Atkinson, Kaplan, Matsumura, & Young, 2012). This budgeting strategy has the advantage of allowing the user to easily compare the budgeted

numbers with known prior results, which is a good analytical test for reasonableness of budgeted numbers (Atkinson et al., 2012). This process increases the importance of reliable financial reporting, as the budget initially begins with numbers reported in the financial statements. Thus, accurate financial statements that represent the financial results of the organization are critical for incremental budgeting processes. For this reason, accurate assignment of costs, through systems like activity based costing can be even more beneficial for management. Not only can an accurate cost assignment system help with decisions in the current year, it can aid in budgeting decisions for the future period, particularly when incremental budgeting is used.

For organizations that have complicated manufacturing processes, incremental budgeting can be a useful decision-making tool. The strategic planning process of most organizations integrates directly with the budgeting process of the firm. Thus, decision makers are relying on the budget to make long-term decisions for the organization, which places specific importance on the quality of the budgeting process (Rivera & Milani, 2011). Organizations that place importance on the accuracy of financial reporting, the accuracy of cost assignment, as well as those that are subject to external audit to verify the material accuracy of their financial statements, are more likely to complete a budget process that is particularly helpful in the decision making and strategic planning process for their organization.

Definition of Terms

The researcher used several terms throughout the study which are defined below. The definitions below were confined to this study. The use of these definitions outside of this

study or in a broader context may lead to confusion, as they may not apply the same way that they were used for purposes of this study.

AB32 Fee: For the purposes of this study, AB32 Fee refers to the fee that certain firms must pay to the state of California for the funding of the implementation of AB32. Firms that must pay the AB32 implementation fee include cement manufacturers, electricity importers and in-state generating facilities, facilities that combust coal, coke, or refinery fuel gas, natural gas utilities and suppliers, oil and gas producers, producers and importers of gasoline and diesel fuel, and refineries (California Air Resources Board, 2014). These firms pay a fee based on their total carbon dioxide emissions and those specific fees are used expressly for the implementation of AB32 within the state of California. The cost per ton of carbon emissions is calculated based on the budget for implementation of AB32 and is also affected by the total carbon emissions for the required payers of the fee, thus the cost per ton of carbon dioxide emissions changes every year.

Portland Cement: Portland cement is the most common type of cement that is utilized in construction and home uses. It is manufactured from crushed limestone, rock and clay and hardens after being mixed with water. It is the same type of cement that home users might purchase by the bag from a home improvement store, as well as what is utilized in the construction of major structures, and roadways.

Productivity: For purposes of this study, productivity refers to the efficiency of an organization when comparing the amount of outputs per input dollar. For plants

examined in this study, inputs are raw materials and direct labor hours, and outputs are tons of finished product.

Assumptions, Limitations, and Delimitations

Recognizing the researcher's assumptions and biases, while also highlighting the merits of the study through the recognition of the study's limitations and delimitations are essential elements to creating a study that is useful and can be relied upon by readers (Creswell, 2014).

Assumptions

This study utilized data that was collected through company surveys as well as which were conducted by the Portland Cement Association as part of their annual reporting on labor productivity and energy efficiency. This reporting is produced specifically for the Portland Cement industry, and is ordinarily available for sale to organizations interested in the data. While the data gathered directly from accountants and other staff within each responding organization can be subject to error, the researcher was unable to find a more reliable method for collecting the necessary data. The data published by the Portland Cement Association relies on survey responses from organizations to compile data. To help verify the data, the researcher utilized data published by the United States Geological Survey (USGS) to measure the data against. It appeared that data reported to the Portland Cement Association matched data also published by the USGS. Furthermore, the researcher collected data from the United States Department of Energy's Energy Information Administration. The researcher has made the assumption that the data collected from these sources is accurate, and has made

every effort to ensure that the data appears accurate through analytical procedures. Since there are no other outside sources for this data available, the researcher must rely on the data and the assumption that respondents made every effort to accurately answer the survey questions.

Limitations

The researcher drew conclusions on the effects of California's AB32 on the cement manufacturing industry by utilizing data from 2007-2015. While this data provided a clear picture of the results from that period, it does not consider the possibility of innovative improvements that could result in increased efficiency and a reduction of cost in the future. It is important to note however, that Porter's hypothesis suggests that environmental regulation can push innovation, such as automation, which helps organizations maintain productivity even when under more profitability pressures due to environmental regulation. Thus, even if automation is a factor of the productivity increases of California manufacturers, that fact would not specifically negate the results of the study. Porter's hypothesis states specifically that well-designed regulations can have net neutral or positive effects on businesses through innovation (Porter & van der Linde, 1995), however the life cycle of AB32 appears too fledgling to determine if Porter's hypothesis will prove to be valid for this specific set of regulations. Due to the infancy of this regulation, certain statistical tests, that could prove useful were not feasible because additional data points would have been necessary to run these tests. One such test is an ANOVA (analysis of variance), which could have been used to help

determine whether there was statistical significance in the annual changes of productivity had there been enough samples available to run an ANOVA test.

Delimitations

The researcher designed the study to determine whether AB32 has a significant negative impact on the financial statements of Portland cement manufacturers when compared to organizations that do not have to compete under the same regulations. The research was not designed to examine costs that were not directly affected by this specific set of regulations. While other regulations and business environmental factors may have a measurable effect on the financial results of these companies, the research was not designed to examine these effects.

Significance of the Study

This study was significant because it provided valuable research in tracking and seeking to identify costs that are necessitated by the compliance of California's AB32. These costs have previously been hard to trace; frequently considered ambiguous and unknown to business people both inside and outside of California. Additionally, the research of these costs is significant to the study of accounting, because accountants should be able to budget for costs, and apply those costs to the correct activities to properly plan and provide value to the management function of the business. Finally, God commands all Christians to be stewards of the resources that they are responsible for managing. Christians cannot steward resources if they do not understand the expenses required to operate.

Reduction of Gaps

The researcher designed this study to provide valuable information for organizations considering opening or expanding manufacturing businesses inside of California, particularly when they have the option to operate outside of the state. Furthermore, businesspersons with understanding of their industry should be able to utilize the information provided by this study to aid in the creation of budgets, particularly capital budgets for organizations that must do business within California. At the time of this research, no studies had been conducted to examine the additional cost that compliance with the Global Warming Solutions Act placed on businesses. Research has been conducted on the topic of costs of compliance with specific environmental regulations, but there have been inconclusive results in these studies. Porter and van der Linde (1995) hypothesized that well-designed environmental regulation can result in innovations that drive efficiency for industries and result in net gains for those industries. Other studies have been conducted that support Porter's hypothesis (Ambec et al., 2013; Berman & Bui, 1998; Berman & Bui, 2001; Bovenberg & vand der Ploeg, 1996). Yet Ryan (2012) who examined specifically the 1990 amendments to the federal Clean Air Act, found that the amendments greatly increased the barrier to entry on the Portland cement and manufacturing industry. Additionally, Shadbegian and Wayne (2003 & 1994) in two separate studies found that environmental regulation decreased productivity in a variety of examined industries. To examine these conflicting views in relation specifically to California's AB32 this study examined the effects of compliance on the productivity of plants in question.

Unfortunately, studies in this area have not been frequent, and have almost entirely ceased since the discontinuance of the Pollution Abatement Costs and Expenditures (PACE) survey that was previously conducted by the US Census bureau. Even studies that had the data from the PACE survey at their disposal often noted that the tracking of these costs by companies was likely inaccurate, and was certainly incomplete at best (Shadbegian & Gray, 2003). The problem with the lack of cost tracking is that organizations do not seem to fully understand their costs of compliance. William Thomson, a physicist also known as Lord Kelvin said in his 1883 lecture,

I often say that when you can measure what you are speaking about and express it in numbers, you know something about it; but when you cannot express it in numbers, your knowledge is of a meagre and unsatisfactory kind; it may be the beginning of knowledge, but you have scarcely, in your thoughts, advanced to the stage of science, whatever the matter may be.

The concept of measuring data to better manage it is often applied to business, and this is a concept that translates well into the accounting area. While many studies have been conducted to further develop the idea of specific cost tracking (Kaplan & Norton, 2005; Raeesi & Amini, 2013), organizations still seem to lack sufficient data to understand and manage their cost of compliance with new environmental regulations (Shadbegian & Gray, 2003). Thus, the current study was designed to provide additional details on the areas that can be more easily monitored to more thoroughly understand the cost of compliance with similar regulations. Furthermore, the study was designed to help

determine whether the effect of compliance was significant enough for accountants to focus additional time tracking and budgeting for the costs associated with compliance.

Implications for Biblical Integration

In Genesis, God appointed man to be the keeper of his creation. Man was to be in charge of the world and the living animals on that Earth. This means that man is responsible for caring for that creation. Businesses and governments thus have a responsibility to ensure they are properly stewarding that creation. The goal of this study is to help quantify the cost of caring for that creation under the increased scrutiny of California's stricter environmental regulations when compared to other states. Van Duzer (2010) points out that business leaders are responsible to be stewards of this creation, and to ensure that it is properly cared for and guarded against irreparable damage caused by business practices.

The stewardship principle that Van Duzer (2010) discussed is illustrated throughout the Bible. In Genesis 1:26-28 God states that mankind is responsible for caring for His creation. This means that not only was man charged with ruling over, and naming God's creation, but man was placed in charge of maintaining that creation. The beginning of the Bible in Genesis 1, God's entire creation was explained. The Bible speaks of the creation including the land, sea and sky as well as all living plants and animals. After explaining the entire creation, Genesis 1:29 states, "Behold I have given you every plant yielding seed that is on the face of all the earth, and every tree with seed in its fruit. You shall have them for food" (ESV). This verse is the earliest indication in the Bible that mankind would be tasked with caring for every part of God's creation. It

only took 29 verses in a collection of books that spans 23,145 verses that make up the Bible for God to make it clear that man was responsible to care for earth and God's creation on it.

The Bible continues to speak about man's responsibility of caring for God's creation. For example, the book of Deuteronomy gives a lot of rules to God's people, including how to deal with human waste so that it doesn't ruin the land. Deuteronomy also gives God's people guidelines on how to treat fruit trees. The book forbids the destruction of such trees, even in the event of war. Another book in the Bible that focuses on rules is Leviticus, which commands the Israelites to utilize ever seventh year as a Sabbath, by leaving land barren. At the time, this probably seemed only a sacrifice, but current knowledge shows the value rotating crops and allowing soil to recover from constant farming. This was another way that God ensured man cared for and preserved his creation.

In addition to caring for creation, the Bible speaks to Christians about cost management and planning. In Luke 14:28 the Bible says, "Suppose one of you wants to build a tower. Won't you first sit down and estimate the cost to see if you have enough money to complete it?" (NIV). This verse makes it clear, that Christians should take careful planning, specifically financially if they wish to partake a specific project or business venture. For Christians to do this, there needs to be a clear understanding of the costs associated with a specific project. The current study aimed to quantify the cost of complying with specific California regulations, which is important for business owners in

the sense that planning for the costs is key to the overall strategic planning for their businesses.

Relationship to Field of Study

Accountants are generally in charge of creating and maintaining budgets for an organization, including ensuring that the organization does not exceed its budget for expenditures. Capital assets are a significant investment for most manufacturers that require attention and financial resources for upkeep (Geert & Pintelon, 2002). Thus, the examination of a particular environmental regulation on the capital expenditures of an organization is significant for the budgeting considerations for businesses. Furthermore, the accounting and tracking of the effects of these regulations should be something that businesses are more interested in tracking so that quantification of the cost of these regulations could be more easily determined.

A Review of the Professional and Academic Literature

The researcher examined the literature in order to review and gain an understanding of the literature currently available and identify issues that were paramount in developing the theoretical framework of this study. This literature review was also conducted in an effort to identify gaps in the available literature that the researcher could help fill through careful design of this particular study. According to Creswell (2014), literature reviews are an important step in a research project, because they aid the researcher in identifying core principles of the topic, and how the study in question can fill a gap, or fit in with the currently available literature on the topic. The literature review covered the following major topics. A review of environmental regulations and

Porter's hypothesis, Biblical perspectives on environmental preservation, secular perspectives on environmental preservation, a history of California's environmental policies, California's Global Warming Solutions Act, lean manufacturing, accounting theory including managerial accounting, the matching principle, activity based costing and standard costing, influences and design of the research project, and an overview of previous studies both agreeing and conflicting the premise of Porter's hypothesis.

Environmental Regulations and Porter's Hypothesis

Environmental policy has been an item that seems to divide political parties in America today. Despite the common assumption that those on the right of the political spectrum have been at war with the environment, Richard Nixon famously said the following during his 1970 State of the Union message:

The great question of the seventies is, shall we surrender to our surroundings, or shall we make peace with nature and begin to make reparations for the damage we have done to our air, our land and our water? Restoring nature to its natural state is a cause beyond party and beyond factions. It has become a common cause of all the people of America.

The Nixon quote above was a symbolic beginning for serious environmental regulation for the United States. Environmental regulations in the United States were sparse and narrowly focused until the 1970s, when more than a dozen regulations were passed by the federal government, which included the Clean Air Act, and created the Environmental Protection Agency (EPA) (Andrews, 2006). These regulations were a direct result in a dramatic increase in the expenditures by organizations within the U.S. intended to

accomplish specific pollution abatement efforts. Due to massive increases in regulation during beginning in the 1970s, pollution abatement costs grew over 150% from \$7 billion to \$18 billion, adjusted for inflation between the years 1973 and 1993, according to data collected from the U.S. Census Bureau's Pollution Abatement Cost and Expenditure Survey (Shadbegian & Gray, 2003). The introduction of the Clean Air Act and the EPA both required states to comply with the federal guidelines, and made state governments proxy enforcers of the federal environmental standards, for which they received funding. This change resulted in a drastically different relationship between the federal and state governments, which resulted in legislative stagnation when it came to environmental policy.

Congress did not pass significant environmental reforms until the amendments to the Clean Air Act of 1990 (Andrews, 2006; Porter & van der Linde, 1995). For years, those who examined environmental regulations and considered them to be a hindrance to the economic competitiveness of the United States. Michael Porter however posited, in 1990 and in 1991 that environmental regulations do not necessarily hinder a nations ability to compete in the global economic marketplace. Porter (1991) compared the export success of countries in the early nineties that had surpassed the United States in their environmental regulations, and noted that many of them, including Japan and Germany had companies that were experiencing success when compared to their US counterparts, despite the stricter environmental regulations that they were contending with in their home countries. In a later study, Porter and van der Linde (1995) argued that companies with the greatest success are not those which have the cheapest inputs and

largest scales, but are instead organizations that are able to adapt, improve and innovate their processes to stay ahead of the curve. Porter and van de Linde (1995) also expanded on Porter's original hypothesis and state that "properly designed environmental standards can trigger innovation that may partially or more than fully offset the costs of complying with them" (p. 98). While it seems that there are many pieces of literature available that support Porter's hypothesis suggesting either no statistically significant negative affect on business, or a net positive affect (Becker, 2011; Berman & Bui, 2001; Bovenberg & van der Ploeg, 1996), there are other papers available that show at least some measurable negative affect experienced by businesses due to environmental regulation (Becker & Henderson, 2000; Greenstone, 2002; Ryan, 2012).

Greenstone (2002) looked specifically at polluting industries divided by what they called attainment and non-attainment counties. The author noted that for the first 15 years the Clean Air Act was in force, the industries examined in nonattainment counties lost approximately 590,000 jobs, \$37 billion in capital stock, and \$75 billion (1987 dollars) of output. Becker and Henderson (2000) found an incentive for polluters to seek out areas that offer fewer regulations, indicating that organizations perceive regulations as a hindrance to their economic success. Ryan (2012) examined the Portland cement mining and manufacturing industry to determine consumer welfare cost increases as a result of the 1990 amendments to the Clean Air Act. He found that this specific industry the Clean Air Act resulted in at least \$810 million additional cost to consumers of concrete products, which he attributes to substantial increased sunk costs required for entry into the cement manufacturing market. Essentially, barriers to entry have reduced

competition and caused increase cost to consumers. Shadbegian and Grey (2003) posit that “the only way regulation will consistently improve a firm’s innovation is if the firm is currently making systematic errors” (p. 6). They base this statement on observation that studies that did find improvement due to pollution abatement efforts were primarily based on anecdotal evidence that a few firms which modified processes due to abatement regulations found new processes to be more efficient. Many of these findings were based on process designs that were focused on reduction of waste and by-product recycling. The authors note that the studies which cite these examples fail to recognize that innovation unhindered by environmental regulation may have well produced similar, if not more favorable results (Shadbegian & Gray, 2003).

While Porter’s hypothesis has been accepted by many researches, and cited by governments to influence public opinion of their regulatory proposals, it remains unclear whether governments are actually providing benefit to businesses through progression of environmental regulation. Basic understanding of Neoclassical microeconomics also supports the theory that government regulation hinders the operations and productivity of an organization. The theory of Neoclassical microeconomics makes the primary assumption that firms, by their very nature, seek to maximize profits. Therefore, any additional regulations placed on a firm by a government entity cannot create more productivity within a firm. Instead, that regulation serves to constrain the firm in some way, and thus reduces the profit-maximizing efforts the firm will undoubtedly seek, due to the nature of business (Shadbegian & Gray, 2003). This economic analysis has been applied to many areas of business and regulation, however it does not consider the

possible environmental benefits received by pollution control measures, and what the value of those benefits might be for society. Research has shown that regulation that targets known pollutants has had a positive effect on the environment of individual states as well as the United States as a whole (Bigger, 2015). This benefit is not insignificant, and is in fact one responsibility of Christian business leaders. Examining the Biblical scripture and writings on this topic is important for this review.

Biblical Perspective on Environmental Preservation

In Genesis, God gives the responsibility to man to be the steward and shepherd of his creation. Christians are responsible to care for and preserve that creation, while ensuring that they do not cause irreparable damage to the Earth (Van Duzer, 2010). Business leaders have an important role to play in the furthering of God's purpose on earth. Hardy (1990) states that each member of the church fits into an interwoven fabric that makes up the plans that God has for earth, including his plans for business on earth. Reading further into Genesis as well as the book of Psalm it we learn that Man was created in God's image and thus given a privileged place among all creation. Mankind is responsible for caring for all of creation, including plant and beast. Furthermore, mankind was commanded by God to exercise stewardship of his creation (Gen 1:26-28; Ps. 8:5). God however also commands Christians to be good stewards of the gifts given to them in addition to God's creation. This can include talents, personal gifts and interests, and financial resources. God expects Christian's to plan carefully and track how their resources are spent to ensure they are accomplishing the task at hand. In Luke 14 the Bible says,

Suppose one of you wants to build a tower. Won't you first sit down and estimate the cost to see if you have enough money to complete it? For if you lay the foundation and are not able to finish it, everyone who sees it will ridicule you, saying, 'This person began to build and wasn't able to finish (NIV).

The interpretation of this verse is clear in that God is telling believers that they must consider the financial cost of their plans, and carefully account for those costs before jumping into a project that they may not have enough resources to complete.

Organizations subject to particularly tough environmental regulations must be careful to plan how they will accomplish the following two tasks: compliance with the environmental regulations, purposeful environmental conservation and stewardship, while simultaneously maintaining good stewardship of their financial resources.

The Bible speaks further on pollution and general conservation in many books and chapters. Deuteronomy chapter 23 speaks about how to properly deal with human waste so as not to defile the land where God's people lived. The problem of water pollution is discussed in the book of 2 Kings where the prophet Elijah uses God's power to clean water that was causing miscarriages in the land. In Habakkuk chapter two God appears to condemn the destroying of lands, cities and animals. In Leviticus 19 the Lord commands the Israelites to plant fruit trees in the holy land upon entrance, and to let those trees fully mature before partaking in the fruit of those trees. God specifically instructs the Israelites to consider the fruit forbidden and not eat of it until the fifth year. Deuteronomy chapter 20 also speaks to the value of fruit trees, forbidding God's people from destroying them, even when conquering another land. The Lord states that "the tree

of the field is man's life" (NIV). Other verses in the Bible warn against overusing land. Leviticus 26 for example commands that every seventh-year land should be left barren as a Sabbath to the Lord. Current understanding of farming shows that rotating land and crops and allowing land to recover is crucial to restoring nutrients to the ground and increasing annual harvests in the years of use.

This viewpoint of conservation also applies to businesses. In tackling the question of which portions of the creation mandate business are responsible for at the current time in history, Van Duzer (2010) states, "First, business appears to be uniquely well situated to work the fields, to cause the land to be fruitful and to fill the earth – what we might in modern parlance characterize as 'to create wealth' (p. 41). He goes on to posit that the intrinsic purpose of business is,

as stewards of God's creation, business leaders should manage their businesses (1) to provide the community with goods and services that will enable it to flourish, and (2) to provide opportunities for meaningful work that will allow employees to express their God-given creativity (2010, p. 42)

Notice that Van Duzer precedes his explanations for business' purpose on earth with the qualifier that businesses should be stewards of God's creation. To Van Duzer, this was first and foremost before talking about creating jobs, goods and services. Essentially, to Van Duzer businesses cannot fulfill God's purpose unless the leaders of businesses are specifically caring for the environments in which they operate; and considering the impact that their specific operations will have on those environments.

Secular Perspective on Environmental Preservation

While there are many spiritual influences on the concept of preservation of the environment and animals that make up natural habitats, there are also many influences that are uniquely secular in this area. As early as the 17th century people began noticing the drastic effects of stripping land, particularly in oceanic islands to build ships and for other business purposes that had started in the 14th century. The expansion of colonialism resulted in increasingly aggressive business practices driven by profit resulted in at least some cases of island colonies experiencing drought due to the drying of streams and soil erosion that at the time was linked to the stripping of forests on these islands. It did not take long for organizations to realize that there was at least some need for conservation, especially in isolated ecosystems like oceanic islands (Grove, 2002).

Early records of legislation designed to protect the environment, or specific ecosystems date back to the early 18th century. This legislation put limits on logging in a specific area because it had been determined that unregulated logging caused soil erosion and lead to flooding in some areas due to that soil erosion (Grove, 2002). These early environmental laws were mainly focused on protecting vital resources such as fuel, food and timber, as well as some species that were recognized as rare, primarily those being found in specific island ecosystems. Pierre Poivre from France originally theorized that there was a connection between mass deforestation and the amount of rainfall an ecosystem receives. His theory was adopted by the British who instituted laws based on this theory in islands under their control. Specifically, they passed environmental protection to stave off possible drought in highly valuable crop lands in the islands of

Tobago, Grenada and St. Vincent in 1764. One regulation aimed to protect the rainforests of Tobago, and designated an area of protected forest, a designation that still exists on that land today (Grove, 2002). The regulators of this time knew that these restrictions would reduce total profits for their industries, however they determined that reduction in profit was necessary to preserve the resources and allow them to regenerate over time. This mindset began to take hold among British lawmakers. Thus, additional regulations were enacted in Barbados and Dominica to protect the resources and farmland in those territories (Grove, 2002).

It was during the next century that the theories and beliefs of environmentalism would first start to take hold in Europe and surrounding areas. This period saw the birth of zealous climate advocates that believed man and nature were at odds with one-another. Bernardin de Saint Pierre one of Poivre's later contemporaries in the field of environmentalism pointed out that the expansion of colonialism was one of the clearest pictures of man's destruction of nature for his own short-term benefit. Over the next two hundred years the ideas of these early environmentalists began to spread across the world, resulting in the eventual common appearance of regulations aimed at protecting the environment and specific natural resources (Grove, 2002).

Although the history of environmental protectionism is longstanding with many of its ideals prevailing even today, the original ideas of colonial protectionism are sometimes not enough to keep aggressive business interest from destroying habitats and other natural resources. A Hilton location in Tobago famously blew up a coral reef to construct a marina for its guests in 2002. Although it is well accepted that the violent

destruction of species rich habitats should not be accepted, it takes local communities and concerted government effort and regulation to stop large business interests from doing so (Grove, 2002). Not all environmental regulation however is as clear as preventing the use of dynamite on a natural species rich habitat. Some environmental regulations are so cutting edge that their merit can possibly come into question, especially if one considers the cost of complying with those regulations on specific businesses and industries.

History of California's Environmental Policies

Today California's regulatory body that enforces many of the state's environmental regulations, including AB32 is the California Air Resources Board (CARB). Although CARB was not formally established until 1991, most of its current functions existed under the Bureau of Air Sanitation and the Motor Vehicle Pollution Control Board which were established in 1967. The air resources board is now housed within California's own environmental protection agency. California's legislature and ARB personnel are very proud of the state's history as one of the leaders in environmental regulation in the United States (California Environmental Protection Agency, 2017). California established the first regulations on vehicle emissions in 1966, which resulted in the need for California to petition the federal government for the right to define and enforce emissions standards separately from the regulations set by Washington D.C. One reason this special treatment was granted to California at the time, was because the state had the most vehicle miles traveled when compared to any other state in the nation. The amount of automobile travel within the state contributed to air quality issues that were seen in the late sixties into the seventies which propelled some of

the regulation passed by the state legislature to deal with the air quality issues that the state was suffering from at the time (California Environmental Protection Agency, 2017).

The Air Resources Board (ARB) often works with local agencies to enforce state-wide regulations. This history of working with local regulatory bodies dates back to the 1940s when the city of Los Angeles formed the state's first Bureau of Smoke Control which was a response to the pollution and air quality issues that the city was experiencing. Within two years of the formation of the L.A. Bureau of Smoke Control, governor Earl Warren directed that every California county must form an Air Pollution Control District (California Air Resources Board, 2017). Today each California county has an Air Quality Management District, which is responsible for monitoring the quality of the air, and enforcing many of California's regulations regarding emissions and pollution control (California Environmental Protection Agency, 2017). California's air quality management districts have been an important leader in environmental standards nationwide, as some standards, such as those adopted by the South Coast Air Quality Management District in the 1980s became a model for regulations adopted by the United States Environmental Protection Agency (Berman & Bui, 2001).

The state continued to be a trendsetter in the realm of environmental regulation. California's clean air act of 1988 was even the model utilized by federal lawmakers when developing the intricacies of the 1990 amendments to the federal Clean Air Act of 1970. A 2001 California policy requires all new statewide regulations to study and consider the environmental impact likely to occur from the implementation of a proposed regulation. Although California has some of the most progressive standards when it comes to

environmental regulations, some areas of the state still suffer from extremely poor air quality (Bigger, 2015). It is however important to note that some of the air quality issues are exacerbated by the geographical make up of certain highly populated areas of the state. For example, the South Coast Basin has experienced the worst air quality in the state, but much of that is due to the climate of the basin. The South Coast Basin is a dry climate with little rain, and wind, lacking natural ventilation phenomena. These factors in addition to the abundance of sunshine are contributive conditions to the building of air pollution and ground-level ozone (Berman & Bui, 2001).

California's Global Warming Solutions Act

In 2006 California passed Assembly Bill 32, titled the California Global Warming Solutions Act. This bill was designed to allow California to “lead the way” in environmental regulation, and make the state a leader in this area (Bigger, 2015). The legislation gave tremendous power to California's own clone of the Environmental Protection Agency, dubbed the California Air Resources Board. The bill gave CARB the responsibility of enforcing California's strict environmental standards while also tasking the agency with designing California's cap-and-trade carbon emissions program. Bigger (2015) points out when speaking of a Sacramento insider: “the politically appointed Chairman of the ARB, [is] ‘the most powerful person in the state of California. She could shut down California's entire economy tomorrow’” (p. 5). Rabe (2008) points out that the standards adopted by California in the passing of AB 32 are the strictest standards in the nation, and CARB's ability to interpret those standards and how they will be enforced can even cause the standards to become stricter than the current perception.

Rabe (2008) notes in speaking of California that, “In climate, it has literally ‘run the table’ by adopting virtually every kind of climate policy imaginable” (p. 111). While California’s environmental regulation certainly has an impact on economic development within the state, Rabe notes that California’s standards even influence manufacturing outside of California as well. For example, all cars registered in California must comply with California’s emissions standards, yet most cars that are registered within the state are manufactured outside of California. This has also resulted in many registered vehicles operating outside of California complying with the stricter California standards (Rabe, 2008).

While California has some of the strictest standards in the nation, the question remains whether it is worth it for the state to regulate environmental factors to the level that they do. According to the CARB (2014), the primary goal of AB32 is to “establish a first-in-the-world comprehensive program of regulatory and market mechanisms to achieve real, quantifiable, and cost-effective reductions of greenhouse gas (GHG) emissions needed to reach 1990 levels by 2020” (p. 1). While the greenhouse effect, in which certain gasses can cause warming to at least some extent, is undeniable, the effect that humans have had on any temperature increase is, in fact, ambiguous. A study conducted by Flato and Marotzke (2013) with contributions from 67 other scientists from around the world observed the misunderstanding of the effect that human activity has on global warming by examining climate models, which have been the basis for many environmental regulations. The examination of these models proved that they have consistently overestimated how much warming should have been experienced by now

(Flato & Marotzke, 2013). The errors in the previous models suggest that there has been a misunderstanding by climate scientists of the amount of warming that is being or will be caused by human emissions of greenhouse gasses (Flato & Marotzke, 2013). Since there is some legitimate question as to the actual effect that human activity has on the changing climate, legislatures should carefully consider how imposed environmental regulations effect businesses which ultimately feed the economy.

This careful consideration however does not seem to have been taken in the case of California's flagship environmental regulation. The law was intentionally designed to be on the leading edge of environmental regulation by forming some of the most extreme rules of any jurisdiction in the world (Bigger, 2015).

California's Legislative Effect on Business

According to data collected from the California Employment Development Department, as well as from the United States Bureau of Labor Statistics, California has experienced a subdued job recovery in its manufacturing sector since 2010 (Husing, 2016). During the recovery period from January 2010 through December 2015 the United states added 871,000 jobs in the manufacturing sector, which was equal to 7.6% of the total job growth nationwide (U.S. Bureau of Labor Statistics, 2016). For the same period, California added 25,600 jobs in the manufacturing sector, which only equaled 2.1% of California's total job growth for the period, which indicated a much slower recovery in the manufacturing area in California, when compared to the same numbers nationwide (California Employment Development Department, 2016). Husing (2016) posits that this slow job growth in the manufacturing sector within California is a result

of regulations in the state of California, including environmental regulations, like those imposed by AB 32. The fact that AB32 specifically targets some areas of California's manufacturing industry, such as Portland cement manufacturers, and oil refineries (California Air Resources Board, 2014) lends some credence to Husing's theory that regulations is at least partially responsible for the slow job recovery in the manufacturing sector of California's economy.

More recent analysis from the state economic snapshot report published by the Joint Economic Committee of the United States Congress (2017) shows California has the 12th worst unemployment rate in the country despite showing promising job growth rates. One reason for this is that California during the heart of the recession held one of the nation's highest unemployment rates which peaked at 12.2 percent. While California's GDP growth has slightly outpaced the national average by six tenths of a percentage point, its poverty rate has also outpaced the national average by the same margin (Joint Economic Committee of the United States Congress, 2017).

Lean Manufacturing

Garza-Reyes et al. (2012), state that lean manufacturing is a management strategy in which managers' focus on eliminating all forms of waste to make an organization more efficient and create competitive advantage in their market place. This process involves collecting data from an organization and utilizing that data to eliminate all non-value-added activities, also known as "wastes" or "mudas" to achieve optimal operational efficiency. Lean concepts allow businesses to create competitive advantage by "running operations at the lowest cost, with greater reliability and speed and a superior ability to

change and continuously improve” (Drohmeretski, Da Costa, Lima, & Grabuio, 2014, p. 804). Since Porter’s hypothesis states that well designed environmental regulations can have the effect of making businesses more efficient, lean manufacturing and Porter’s hypothesis are related concepts. Organizations that seek to achieve waste-free operations that allow for the best efficiency available should thus be on the leading edge of environmental regulation compliance that actually does increase efficiency. As an example, one concept of lean would be to minimize the number of times a product moves, and ensure that orders are packed and shipped as full shipments to minimize the cost of transportation (Chen, Li, & Shady, 2010). This same concept would decrease the negative ecological impacts of an organization, because they would use less energy in cranes, and fuel for shipment than if they would if they did not focus on eliminating this waste. As an added benefit, this focus on waste and the effort of continuous improvement of business processes makes the organization more flexible, allowing them to better deal with changing market conditions (Belekoukias et al., 2014; Chen et al., 2010).

Staatsa, Brunner and Upton (2011), posit that the focus of lean is to deliver high quality products to the end user by identifying waste in the production cycle as an effort to reduce the effort of employees in production, minimize stocks, shorten delivery time, and minimize space required for production.

For businesses to accomplish lean management, organizations must place a focus on gathering data in order to evaluate processes and initiate improvements. One of the main tools used for this is value stream mapping. Value stream mapping is a process in

which managers take the time to map out the entire journey of a product through a production line in a business from the time a customer places an order, to the time the product ships to that customer (Singh, Garg, Sharma, & Grewal, 2010). A 2010 study showed that thorough value stream mapping a firm significantly improved the efficiency of its processes. Specific areas of improvement included a reduction in work in process inventory by 89%, a reduction in processing time of materials by 12.62% and a reduction in the value of inventory on hand of 17.85% (Singh, et. al.). While this study focused on the process of value stream mapping, another key component to ensuring the effort of value stream mapping achieves the desired results is the collection and analysis of data (Kaplan & Norton, 2007).

Kaplan and Norton (2005) pioneered the use of the balanced scorecard as a tool businesses use to collect and measure key points of data, they called key performance indicators, that drive their business success. The balanced scorecard gave businesses a way to track data that had gathered and utilize that data to analyze and improve business operations. If key performance indicators are selected, tracked and analyzed correctly, they could prove to be important measures that drive the performance of an organization (Kaplan & Norton, 2005). In order to drive that performance and utilize tools like the balanced scorecard, careful collection and compiling of data must take place. Ultimately, the continuous improvement process relies on careful accounting in all areas of an organization to improve the processes of the firm, and as is the goal for lean manufacturing, eliminate wastes (Kaplan & Norton, 2005; Chen et al., 2010). The concept of internal data collection and measurement for the purposes of management

decision making is one of the key principles of managerial accounting (Schroeder, Clark, & Cathey, 2014).

Kennedy and Widener (2008) point out that lean manufacturing directly affects how an organization processes transaction. Their study found that firms processed transactions in a more efficient fashion when the examined organizations placed a priority on lean manufacturing strategy. Furthermore, Fullerton and McWatters demonstrated that organizations, which have reached the advanced stages of lean manufacturing, tend to have more simplified methods of accounting (2001). While it may seem that simplifying the accounting method does not lend itself to tracking all the data necessary for proper lean implementation, studies have shown that making the right adjustments to the accounting system and the process that accountants follow is the key to lean accounting (Fullerton, Kennedy, & Widener, 2014). Lean accounting requires the adjustment of the accounting function of an organization so that the lean goals of that organization are enhanced rather than limited by the accounting function (Cunningham & Fiume, 2003). These adjustments are best made within an environment that utilizes a fully integrated enterprise resource planning (ERP) system.

ERP Systems

For organizations to understand the cost of complying with a regulation, in this case AB32, the firm must utilize a system to gather and analyze various points of data. The most common system that large enterprises use to gather and analyze various points of business data is an enterprise resource planning system. An ERP system is a computer information system that consists of a single database that allows organizations to gather

data from multiple points in their business, such as purchasing, sales, production and accounting. This extended data allows the firms to facilitate data flow and information to multiple areas of the business, and even the flexibility to share this data with its supply chain partners, if it desires (Rajib, Tiwari, & Srivastava, 2002; Sánchez-Rodríguez & Spraakman, 2012). ERP systems Excel at allowing organizations to collect, organize, and analyze data from multiple areas of the business (Wong, Lai, & Cheng, 2011). While an ERP system is an Excellent tool for the accounting function, as well as many others in a business, many businesses rely on the accounting function, including budgeting as their primary method of cost control for projects. One of the primary issues with controlling costs through the accounting function is that accounting principles are not designed to be particularly helpful for controlling costs, but are instead designed to ensure the proper reporting of the income and expenses of an organization. Accounting is inherently historical, showing data that reports what has already happened within an organization. Managers trying to control the costs of a specific project need to look both in the past and the future. They need to be able to analyze what is required and determine the budget for specific steps within a project based on those requirements. The benefit of an ERP is that specific plug-in modules can be utilized to help managers control costs without having to enter and further manipulate data beyond the normal accounting data entry function (Wulke & Kohl, 2004). It is key however for managers to determine the needs of their specific systems upon implementation of the ERP system. Implementation of new modules is difficult and costly, and is best done as part of the entire system implementation. Furthermore, implementation of ERP systems so that a system fits the

goals of the organization and meets its needs often requires extensive work in modifying the specific system plug ins at a significant expense to the organization (Wulke & Kohl, 2004).

Previously, ERP systems were thought to be only affordable to large firms, however, recently ERP systems have become affordable enough that researchers have seen them in use in mid-sized and even small firms in some cases (Sánchez-Rodríguez & Spraakman, 2012). This means that the affects that ERP systems have on the accounting and other functions of an organization are now trickling down to organizations that were previously unaffected due to being unable to afford ERP system implementation. Sánchez-Rodríguez and Spraakman point out that to thoroughly examine the management accounting function, one needs to look at multiple dimensions that affect management accountants. The study conducted by Sánchez-Rodríguez and Spraakman examined four dimensions, including performance measures, management accounting techniques, management accountant activities, and non-financial information, and attempted to determine how each of these areas affected the management function in environments where ERP systems were in use (2012).

Accounting Theory

Accounting is in a sense a type of information system that keeps track of and provides management with information that summarizes the economic activities of the business. According to Warren, Reeve and Duchac (2016), “The role of accounting in business is to provide information for managers to use in operating the business” (p. 3). To provide that information, accurate records must be kept, and expenses should be

applied to the correct business activity for managers to make informed decisions. Furthermore, accountants need a firm grasp on accounting principles to be able to properly apply them to ensure the information is accurate and useful (Warren et al., 2016).

Managerial Accounting

Managerial accounting, also known as cost accounting is a system of accounting designed to provide information internally and specifically for decisions makers within an organization. Ordinarily, the cost accounting function utilizes special outputs from the accounting system to produce internal reports designed to aid in the decision-making rather than for financial reporting purposes. Cost management systems help organizations associate costs with specific areas of the business. For example, this allows, for example, a software company to assign research and development costs to a specific product, or a drug manufacturer to assign testing costs to a specific drug. These critical inputs allow managers to make business decisions, such as whether to make or buy a specific component utilized in their manufacturing process (Hansen & Mowen, 2015). Tracking items such as the cost of complying with a specific regulation can be helpful in allowing business managers to decide whether to expand operations in a specific jurisdiction, versus the option of opening new operations or expanding outside of the regulatory environment in question.

A study by Kennedy and Widener (2008) posits that the purpose of management accounting is to oversee and regulate the behavior of the organization to improve operations. The authors examined employee empowerment as a key indicator of

improvement within an organization. They provided visual performance measures so that shop-floor workers could more easily process performance information. The concept of collecting and then providing performance information to shop-floor employees is one that is also practiced by the balanced scorecard approach to management and continuous improvement. Not only does this method allow employees outside of the management suites understand the areas that need to be improved, it also allows managers to continually analyze performance indicators and adapt those indicators as necessary to achieve the desired results (Morard, Stancu, & Jeannette, 2013). Furthermore, employees that have data available presented in an understandable fashion become invested in the success of their operations, and are better at making quick and effective decisions, which is one way to reduce waste and achieve the goals of a lean manufacturing initiative (Fullerton & McWatters, 2002).

ERP systems have proven to be a useful tool for management accounting as well. Some research has shown that the introduction of ERP systems to the accounting function has changed the responsibilities of management accountants within organizations (Spathis, 2006; Spathis & Ananiadis, 2005). This has been a positive change for organizations as management accountants have spent less time entering data into a system and more time examining reports to analyze that data (Berry et al., 2009; Sánchez-Rodríguez & Spraakman, 2012). This change allows the organization to better utilize some of the skills of its financial professionals by reducing the time they spend in remedial tasks, and maximizing time they spend examining the results of the organization

and helping to make management decisions based on those results (Sánchez-Rodríguez & Spraakman, 2012).

The Matching Principle

The matching principle is one which requires a company's revenues and expenses to be recognized in the same period. In other words, expenses should be matched in the same period in which they are used to generate revenues (Dichev & Tang, 2008). While matching is still considered to be a critical principle in accounting standards, research has shown that matching expenses to revenues is declining, though the research is unclear on what should be blamed as the cause of this decline (He, 2015). Dichev and Tang (2008) found matching to be a very critical accounting principle in their study, by looking at the earnings of companies that failed to follow traditional matching principles. They found that these companies had more volatile earnings from year to year, and that their accounting records could not be relied upon to the same extent as companies that more closely followed matching principles (Dichev & Tang, 2008).

Activity Based Costing

During the 1980s, firms, mostly in the manufacturing sector, recognized that currently available product costing techniques were not allowing accountants to accurately represent the cost of their products. Prior to the development of activity based costing, cost systems focused on trying to determine the cost of products and tracing costs back to the products that the firm produced. These systems focused on direct inputs to the product cycle, such as machine hours or materials used in the production process. Activity based costing examines all activities of an organization, and each product's

demand for those activities in an effort to assign all costs of production to the products themselves (Cooper, 1988a). This shift to examining activities as a basis for cost allocation created the use of new cost drivers as a means of tracing costs to specific products. Conventional systems generally utilized only three separate cost drivers which were, direct labor hours, machine hours and materials as a means to trace costs to products. Activity based costing uses many more possible drivers such as number of orders, product movement in the shop, set up hours, and number of times shipped, to name a few (Cooper, 1988a). The use of these new cost drivers allows firms to more completely capture their cost of production and assign that cost to the products the firm produces. This shift in focus has allowed firms to overcome the downfalls of the traditional volume-based costing systems that were used prior to the development of activity based costing systems. These downfalls were caused by distortions of cost assignment that were the result of idiosyncrasies in firm's manufacturing process, such as production volume diversity, size diversity, complexity diversity, material diversity and setup diversity among product lines (Cooper, 1988b). The addition of these new allocation methods allows firms to better capture the "economic nonproportionalities" among their production processes, which allows them to more accurately capture, assign and report product costs (Cooper, 1988b, p. 41).

The goal of activity based costing systems is to accurately capture product costs so that managers can make more informed decisions about production. Simple cost systems allow firms to capture costs and assign them to products inexpensively, however, the inaccuracies that can go along with a cheap costing system can ultimately cost the

organization more money through poor decision making that is a result of inaccurate costing data. As such it is important to develop a costing system that best handles the inverse relationship of the cost of providing data, and the likely expense of data errors due to decisions made using inaccurate data (Cooper, 1988b). More recently, firms have begun developing better ways to capture and assign costs to products because activity based systems can be complex and costly to implement and maintain, despite their obvious benefits for managers. Since cost drivers are not exact science, and the consumption rate in dollars for each driver can vary depending on circumstances, firms have developed systems in which approximate ranges are used to reduce the cost and time associated with true activity based costing. One such approximation method is known as grey activity based costing (G-ABC). G-ABC uses a range for each activity based on known data, and allows managers to assign costs based on the known parameters, as well as hard data that is available. A fully implemented G-ABC system has a higher degree of uncertainty than conventional ABC systems, so managers typically utilize easily available data of their cost drivers, and then use that data to approximate a range for each activity, turning the system into a hybrid ABC-Grey ABC system to increase the level of accuracy in their cost allocations (Raeesi & Amini, 2013).

Standard Costing

Standard costing is a practice in which the accounting and purchasing departments of an organization utilize available data to set a standard cost for a particular material or inventory item. This standard cost is what flows through the accounting system to the cost of goods sold section of the income statement. To adjust for these

standard costs when compared to the actual cost spent for each item, several variance accounts are used. These variance accounts include materials use variance and purchase price variance. Materials use variance is where the difference between the budgeted or standard amount of materials used in manufacturing and the actual amount used are reconciled. Similarly, purchase price variance is where the difference in the standard cost to purchase a material and the actual cost spent on a specific material is reconciled (Hansen & Mowen, 2015).

There has been some evidence to suggest that standard costing systems are not particularly strong selections for a managerial accounting technique, however despite this evidence, there appears to be wide continued use of standard costing practices among manufacturing firms (Dosch & Wilson, 2010). This is not just a trend in the United States either. De Zoysa and Herath (2007) found that despite the shortcomings of standard costing techniques, many Japanese firms continue to use it, if not for their entire cost system, at least for some specific applications. Further studies have found that standard costing was common among organizations that focused on lean accounting techniques (Cooper & Slagmulder, 2006), and specific environments, such as those focusing on just-in-time inventory fulfillment found standard costing useful, particularly when attempting to value the inventory quickly with relative accuracy (Arnoff, 2010).

Since standard costing is prevalent in manufacturing environments, accountants should utilize the tools of standard costing to their full extent. For accountants seeking to track the cost of specific compliance activities, costs can be researched and included as a standard for those specific activities. This is the same way costs are included for items

such as welding or painting a part (Hansen & Mowen, 2015), but could be applied instead for something like checking a sensor, or servicing a piece of monitoring equipment. In that way managers could more closely plan and budget for costs associated with environmental compliance.

Influences and Design

The author of this research project noted in the literature review stage that published articles on the cost of complying with regulation seemed to cease in the first few years of the 21st century. Up until that time researchers in this area seemed to rely on PACE survey data, which was conducted by the US Census Bureau (Berman & Bui, 2001; Christiansen & Haveman, 1981; Gray & Shadbegian, 1995). The PACE survey relied on firms to self-report their costs for pollution abatement which gave researchers easily accessed current and legacy data regarding the costs of complying with environmental regulations. Unfortunately, the PACE survey was discontinued by the US Census Bureau in 2005, so current data is not available. Studies that attempted to determine the cost of complying with environmental regulation relied on PACE data, but ultimately the theme of these studies was consistent in that each tried to approach the issue by examining total productivity of a firm which was a function of abatement cost divided by total production, while attempting to control for other variables (Berman & Bui, 2001). A common theme however was that there was disparity in the conclusions of the published literature. While many found that the cost of pollution abatement contributed to a reduction in productivity (Christiansen & Haveman, 1981; Gray & Shadbegian, 1995), others found evidence that abatement investment actually resulted in

increased productivity in the long run, leaving firms better off than those that chose not to, or were not required to invest in abatement measures (Berman & Bui, 2001; Jaffe, Peterson, Portney, & Stavins, 1995). While some research seemed to agree with the premise of Porter's hypothesis, other papers utilizing a similar approach appeared to disprove it.

Results Conflicting with Porter's Hypothesis

The researcher examined many studies specifically examining pollution abatement costs as the main factor in compliance with environmental regulation. Several studies appeared to make conclusions that refutes Porter's hypothesis that well-designed environmental regulation will have a net positive effect on the productivity of firms' subject to that regulation. The author will review the design and findings of those studies.

Christiansen and Haveman.

Christiansen and Haveman (1981) studied the apparent slowdown of productivity within the United States from 1965-1979. Their study specifically points out that "output per person-hour in the private sector grew at an average annual rate of 3.44%" from 1947 to 1966 (Christiansen & Haveman, 1981, p. 381). Directly following that period, productivity growth fell to an average annual rate of 2.15% from 1966 to 1973. Productivity took another downturn from 1973 to 1978, dropping another full percentage point to 1.15% per year. This rate was essentially one third of the productivity growth rate experienced from 1947 to 1966. Thus, Christiansen and Haveman sought to determine whether they could prove that the reduced productivity

among United States firms was driven by costs of compliance with newly adopted environmental regulations.

Christiansen and Havemen created their research method by examining multiple other studies which utilized abatement cost data to determine the regulatory effect on productivity decreases. The authors were critical of many aspects of the studies, and pointed out good and bad aspects of each. Each major study utilized in their study is examined in the next section.

Denison.

One study extensively discussed and utilized in the Christiansen and Havemen research is one conducted by Denison. According to Christiansen and Havemen (1981), Denison utilized a measure deemed total environmental costs, which were made up of “annual costs of operation, maintenance and repair (OMR) costs for environmental purposes, plus the sum of depreciation on pollution abatement equipment and an imputed return on the net pollution abatement stock” (p. 383). To calculate the imputed return Denison (1979) utilized the average rate of return on the organization’s capital stock multiplied by the net stock of pollution abatement equipment. Finally, Denison then subtracted an estimate of the probable costs of environmental abatement in the absence of the regulations being studied as an effort to normalize the data, since some pollution abatement costs would have been realized even in the absence of the new regulations.

Based on the aforementioned model, Denison calculated the impact of post-1967 environmental regulations on the productivity of firms, concluding that the regulations

had an impact that moved between .05 and .22 of a percentage point during the years examined from 1967-1978 (Christiansen & Haveman, 1981).

Christiansen and Haveman (1981) noted that Denison's approach was reasonable, but adjusted their approach for the following factors. They noted that the estimate utilized in Denison's approach was based on data collected from employer surveys, and that such data can be inaccurate due to incentives of employers to exaggerate claims of required costs of compliance. They argue that new equipment that has more than one purpose including pollution abatement is likely to be recorded as pollution abatement equipment entirely. Second, Christiansen and Haveman (1981) noted that Denison assumed pollution-control-mandated investments replaced other possible investments on a dollar-for-dollar basis. Because this may not be the case, Christiansen and Haveman noted that, "If, in fact, because of factor substitution, pollution control expenditures do not divert equivalent expenditures on standard factor inputs, output would not fall to the extent estimated by Denison" (1981, p. 383).

Christiansen and Haveman (1981) followed this critical process across all studies examined by their research to control for variables that they felt were not controlled for well in the original studies. Ultimately, they determined based on the available data from the examined studies that pollution abatement costs likely caused somewhere between 25% and 40% of the productivity declines experienced from 1965-1979 (Christiansen & Haveman, 1981).

Kendrick.

Christiansen and Haveman (1981) examined Kendrick's study and noted

that Kendrick used a similar approach to Denison, however Kendrick tried to assign how much cyclical weather effects played a role in the decreased productivity of the firms examined by his study. Kendrick found that approximately 40% of the observed decrease in productivity from 1970 through 1976 was due to cyclical weather patterns (Kendrick, 1978). Christiansen and Haveman (1981) point out however that this number is possibly inflated, due to the last year of the study having particularly low resource utilization when compared to other years. Since the study conducted was a longitudinal difference in differences study, this anomaly likely had a significant effect on the results of the authors estimate.

Shadbegian and Gray 1994.

Gray and Shadbegian published two separate studies, one in 1994 and one in 2003. This section will address the 1994 study, with the 2003 study to follow. According to the authors, a U.S. Census Bureau survey cited over \$17 billion in operating costs and \$6 billion in capital expenditures spent for the purposes of pollution abatement (Shadbegian & Gray, 1994). Shadbegian and Gray however posit that abatement costs are difficult to measure and report because, for example costs in designing a new production process are difficult to track. Additionally, other costs may not even be covered by the survey, such as managerial attention that is directed to completing the required paperwork in compliance with a specific regulation (Shadbegian & Gray, 1994). Because of the difficulty in tracking pollution abatement costs, the authors posit that a better approach may be to measure them by tracking changes in the productivity of firms over time. Productivity, for purposes of this study is measured by output per unit of

inputs. Based on this simple formula, any additional spending for pollution abatement (inputs), should show in a decrease of productivity, since inputs would be the denominator of the equation (Shadbegian & Gray, 1994).

Shadbegian and Gray (1994) decided to analyze plant-level productivity data for three industries in their study using data obtained through the Longitudinal Research Database. The data that they examined included information from 117 pulp and paper mills, 101 oil refineries and 51 steel mills. The data examined included pollution abatement expenditure information, as well as enforcement, compliance and emissions data for the years 1979 through 1990. The study utilized a measure known as total productivity factor, and overall found that plants that spend more on pollution abatement were substantially less productive. In quantifying their findings, the authors state that a plant that spends \$1 more on abatement costs has \$1.74 lower productivity in paper, \$1.35 lower in oil and \$3.28 lower in steel (Shadbegian & Gray, 1994). The authors posit, based on the lower productivity found in their study related to abatement expenditures, that the actual abatement expenditures are significantly understated in the available survey data. The study also found that other regulatory measures, such as enforcement, compliance and emissions did not specifically result in decreased productivity. These factors of increased regulation seemed to not directly relate to productivity at all, based on the findings of the paper. The study did find that the most significant impact on productivity appeared to be rising abatement costs. This finding suggests that new regulations have a significant impact on productivity, but that this

effect may significantly shrink after the firm's initial expenditures on abatement measures (Shadbegian & Gray, 1994).

In designing their method, Shadbegian and Gray (1994) decided to focus on the operating costs of a production facility while deciding not to examine the new capital expenditures. The authors argue that new capital expenditures are not a good picture of abatement costs for any one firm, because they can easily go up and down depending on how the firm invests in new equipment during any given year. Instead operating costs capture a more complete picture of the regulation's effect on the firm. Additionally, operating costs already capture the depreciation and amortization of equipment and other assets, so the cost for investing in those assets is more accurately affected in any given year, as depreciation and amortization tend to be immune to the spikes that can be caused by a single equipment purchase. Shadbegian and Gray (1994) also utilized data from the EPA's Compliance Data System, which could help the authors determine whether the firm is staying in compliance with EPA regulations.

Finally, the authors used a formula to determine the total factor productivity. The formula calculated the "difference between an output (Q) and the weighted average of inputs: Labor (L), Materials and energy expenditures (M) and capital stock (K)" (Shadbegian & Gray, 1994). The formula is shown as:

$$TFP = \log(Q) - a_L \log(L) - a_M \log(M) - a_K \log(K)$$

Where the a coefficient before the log is the weight factor determined by regressing each log and year dummies for each individual industry. Shadbegian and Gray (1994) decided to divide pollution abatement costs by the plant's capacity which were determined by top

two years of output for the data sample examined. They argue that this measure of the plant's potential production capacity will not change from year to year. Because of this consistent measure, the authors refute one of their previous studies, finding this time that abatement costs do not significantly affect productivity, where the previous study found a negative effect of abatement costs on productivity. Shadbegian and Gray (1994) posit this earlier result was falsely driven by the reality that productivity in any given year can change substantially where abatement expenditures tended to change more slowly. After performing their analysis, the authors find that there is a negative relationship between a plant's pollution abatement costs and its total factor productivity level, meaning that as abatement costs go up, productivity goes down. This analysis seems to support the theory that compliance with environmental control measures does indeed increase the costs of operation for at least some industries.

Shadbegian and Gray (1994) also address the theory that regulation increases productivity. They argue that this theory is based on "anecdotal observation that some firms, forced to modify their production processes for environmental reasons, later found that the new process was also superior strictly in economic terms" (p. 5). Their argument points out that while Porter's Hypothesis seems to be supported by some studies, the studies fail to recognize that the innovations made have both measurable and immeasurable costs. In some cases, firms do find ways to improve processes and lower costs overall, however, the researchers in support of this hypothesis fail to consider the opportunity cost of possible innovation that was lost due to the organization spending its resources to ensure compliance with a specific environmental regulation. Shadbegian

and Gray argue that the innovation that was lost through opportunity cost could have feasibly provided an even greater benefit in productivity (1994).

Shadbegian and Gray 2003.

Shadbegian and Gray's second report in 2003 took a similar approach in examining paper mills, oil refineries, and steel mills and attempting to determine the effect of pollution abatement costs on plant wide productivity. In this study, they utilized the Cobb-Douglas approach to production function framework. The Cobb-Douglas framework considers the capital stock, production hours, real materials, and pollution abatement operating costs to determine the abatement cost effect on productivity. These costs are summed as variables in a log linear function, and each category takes into consideration both the productive and pollution abatement costs of that specific category. Shadbegian and Gray (2003) further explain their function of production, noting that all measured or measurable inputs are utilized to produce output. They also note that while firms attempt to measure and record pollution abatement expenditures, it is likely that some costs go uncaptured, such as time spent on specific paperwork, or workers utilizing hours to monitor or repair pollution abatement equipment.

While the authors recognize the issue that could cause under reported pollution abatement expenditures, despite this likely underreporting, the authors found that pollution abatement costs significantly affected productivity in plants much like their earlier 1994 study (Shadbegian & Gray, 2003). The study examined 68 pulp and paper mills, 55 oil refineries, and 27 steel mills, and found that for every dollar of pollution abatement input, firms experienced productivity decline of \$3.11, \$1.80 and \$5.98

respectively for the three industries examined (Shadbegian & Gray, 2003). Again, while the authors found significant reduction in productivity across the three industries examined, their study also showed substantial differences between these industries in their individual sensitivities to the pollution abatement measures in terms of effect on productivity. Deeper analysis of their data showed that plants within the same industry experienced different sensitivities to pollution abatement costs, depending on the individual technologies in use within their plants. Plants with technologies considered “more polluting” experienced higher productivity sensitivities to the pollution abatement costs. Furthermore, the authors found that the strategy for pollution abatement also greatly affected a plant’s sensitivities to pollution abatement expenditures. Plants that focused their pollution abatement efforts in developing changes in their production process show significantly higher productivity overall when compared with plants that focused on “end-of-line abatement,” (Shadbegian & Gray, 2003, p. 3) however despite their overall higher productivity these process-focused plants appeared to be more sensitive to pollution abatement expenditures when examining those expenditures effect on their overall productivity. Shadbegian and Gray (2003) posit that this increased sensitivity to pollution abatement expenditures for plants that focus their expenses on process level improvements could be due to the difficulty in capturing the operating costs associated with pollution abatement measures. Firms rarely completely capture to costs of employee time spent monitoring pollution abatement equipment, or filling out compliance forms for the government.

Shadbegian and Gray (2003) utilize a model in this study that seeks to determine how much each type of input, capital, labor and materials contributes to the overall production of a firm. They divided each of these three inputs into two categories, which included inputs for production and inputs for pollution abatement. The authors found that in most cases, inputs for pollution abatement did not increase output (productivity), particularly when compared with their production focused equivalents. As previously noted, firms experienced a decrease in productivity of \$3.11, \$1.80 and \$5.98 for every dollar spent on pollution abatement in the paper mill, oil refinery and steel mill industries respectively. The authors conclude based on their analysis, that due to this decrease in productivity, simple reporting of pollution abatement expenditures does not accurately quantify the effect of pollution abatement measures on firms. Since firms in these industries have a coefficient of 3.11, 1.8 and 5.98 respectively, the effect of pollution abatement expenditures is between 180% and 598% reduction on productivity, when compared to expenditures specifically chosen for production purposes (Shadbegian & Gray, 2003). The authors indicate that pollution abatement expenditures equaled approximately \$18 billion nationwide, which means these expenses resulted in productivity decreases between \$32.4 billion and \$107.64 billion, depending on the specific industry mix and the sensitivity of those industries to pollution abatement's effect on productivity. Based on the author's analysis, the number of reduced productivity is likely close to \$65.34 billion in 1993.

Results Supporting Porter's Hypothesis

The researcher examined many studies specifically examining pollution abatement costs as the main factor in compliance with environmental regulation. The following studies appeared to reach conclusions that were in support of Porter's hypothesis, specifically indicating that environmental regulation increased the overall productivity or profitability of plants that were subject to specific environmental regulations.

Bovenberg and Van der Ploeg.

Bovenberg and Van der Ploeg (1996) attempted to determine how environmental regulation affects consumption and employment under what they determine is an optimal tax system. The authors suggest that under a tax system that is sub-optimal, environmental regulation will not have the positive effect of increasing the demand for labor, and thus reducing unemployment. However, under a tax system that is optimal, which they posit is a small profit based tax, then employment will likely rise since it is preferable for organizations to hire additional employees than it is for them to overspend on capital assets to comply with environmental regulations. The authors state that under the proper tax system, "after-tax profits absorb the additional tax burden so that wages can fall, thereby boosting the demand for labor" (Bovenberg & van der Ploeg, 1996, p. 79). Essentially, through economic models, the premise of Bovenberg and Van der Ploeg's argument is that if designed correctly, environmental regulation paired with an optimal tax system will allow organizations to increase profits while complying with regulations through lower overall wages and increased labor demand.

The authors conclude in stating that increase in employment, decrease in pollution and an increase in public consumption is only possible if regulations are appropriately designed and initial environmental concern is small. Their argument is that if environmental regulations are too onerous, they can increase costs to a point where labor demand decreases and consumption overall decreases, resulting in an overall negative effect of the regulations. The premise of the arguments made by Bovenberg and Van der Ploeg (1996) are such that a state like California trying to push environmental regulation to an extreme as an effort to remain on the cutting edge and encourage others to follow, is a philosophy that will be doomed by decrease in labor and consumption demands. Thus, while Bovenberg and Van der Ploeg do make an argument that well-designed environmental regulation can be beneficial to organizations and economies, the key is that the regulations are well-designed. Based on the models presented in this study, well-designed regulation is incremental, not radical.

Berman and Bui.

Berman and Bui's (2001) study focuses on the impact of air quality management district regulations on the oil refining industry, specifically in the south coast area of California. The study examined labor demand as a metric of measurement of the effects of the environmental regulations placed on plants within the south coast district. Like other studies, Berman and Bui also utilized data from the US Census Bureau's PACE survey. The authors utilized this data to examine investment and operating costs to help determine the impact of the regulations on the specific oil refineries studied. The reason their study focused on the south coast area was because

this region suffered from uniquely bad air quality due to the population density and natural geographic and weather patterns that allowed smog to remain in the south coast valleys. Since this area suffered from such bad air quality, the South Coast Air Quality Management District (SCAQMD) created strict air pollution control measures that were more radical than any other in the nation from 1976 through 1993 (Berman & Bui, 2001).

Berman and Bui (2001) attempted to compare their data to other jurisdictions with less stringent environmental regulations. To track these regulations, the authors identified 46 separate air regulation localities and tracked the adoption, compliance dates and changes (increases) in stringency of the regulations. The authors primarily compared the SCAQMD region to plants located in Texas and Louisiana, both because the composition of the oil refining industry is comparable to California's, and because the environmental regulation in those areas was less stringent than the SCAQMD area (Berman & Bui, 2001).

After performing their analysis, Berman and Bui (2001) concluded that local regulations in the SCAQMD region were not responsible for the decline in employment that was experienced between 1979 and 1992. The authors posit that the reason the employment declines were not driven by the environmental regulations was because the regulations generally targeted capital-intensive industries with minimal employment. They also posit that labor and abatement activities complement each other, meaning that abatement measures increase demand for labor. The authors do however concede that although plants didn't experience lost demand for their products, this is likely because these industries mostly sell to local markets, which caused them to be protected from

firms outside of their local area that were unaffected by similar environmental regulation. Berman and Bui (2001) go on to theorize that in a closed system, where all firms are subject to the same regulation, the level playing field will eliminate unfair advantages, and cause a net increase in the demand for labor through increased productivity. Finally, Berman and Bui (2001) state that they have observed productivity gains at a greater rate in the south coast region when compared with outside regions.

Transition and Summary

Organizations rely on effective and accurate budgets and financial forecasts to plan operations (Warren, et al., 2016). In order to create accurate budgets and forecasts, firms must thoroughly understand their costs for specific activities within the organization. To capture the information necessary for these forecasts, diligent and deliberate data collection and aggregation is necessary (Spathis & Ananiadis, 2005). Through this deliberate collection of both financial and non-financial measures, organizations can better manage their operations and drive the performance of their firms to new efficient and productive levels (Kaplan & Norton, 2005).

Christian business leaders have a responsibility to ethically care for and manage the Earth's resources. Van Duzer (2010) shows that Christian business leaders have been entrusted with the well being of their employees, the assets of the business and the communities in which those businesses operate. This includes the natural resources and ecosystems of those communities. Additionally, the Bible commands Christians to be stewards of the gifts granted to them by the Lord, which includes nature, which God placed humans in charge of (Gen 1:26-28; Ps. 8:5).

The current study aimed to address gaps in the literature and practice that was discussed above. While businesses understand that compliance with environmental regulations does impose some burdens, there is disagreement with whether the ultimate result is increased or decreased productivity (Porter & van der Linde, 1995; Shadbegian & Gray, 2003). Furthermore, the literature suggests that organizations have not done a good job understanding and tracking the costs associated with complying with these regulations. Organizations have a hard time quantifying costs associated with time and effort necessary to comply that has not been specifically tracked as part of the effort of compliance (Shadbegian & Gray, 2003).

The next section will discuss the dissertation, including the design of the study, the techniques used to collect data, and the approach and methods used to analyze the data collected. The researcher aimed to answer the questions posed by this study through the collection and analysis of this data.

Section 2: The Project

Legislation aimed at environmental and ecological conservatism have become prevalent in first world legislative bodies. California is one of the global leaders in this area, constantly pushing the outward limits of conservation efforts through increasingly aggressive regulations (Bigger, 2015). While Christians are commanded to care for the environment, Christian business leaders also have a responsibility to steward the other resources at their disposal, including the financial and personnel resources of the organization (Van Duzer, 2010).

Research that examines the topic of environmental regulations and their effects on the productivity of business have shown mixed results. Porter's Hypothesis suggests that well-designed environmental regulations have net positive effects on the productivity of businesses (Porter M. , 1991). On the other hand, various other published research has shown regulations to have a net negative effect on the productivity of the companies subject to those regulations (Shadbegian & Gray, 2003).

The researcher designed this project to examine the effect of a specific environmental regulation by examining a group of businesses subject to that regulation and then comparing multiple year's results to another group of businesses not subject to the environmental regulations, designed to be more strict by California's regulatory bodies. The goal was to determine whether or not organizations have become more or less productive while adapting to comply with California's stricter regulatory environment. Additional details about the project will be discussed in the subsequent sections, and will include: (a) purpose statement, (b) role of the researcher, (c)

participants, (d) research methods and design, (e) population sampling, (f) data collection, (g) data analysis technique, and (h) reliability and validity.

Purpose Statement

The purpose of this descriptive quantitative study is to examine the effect of California's Global Warming Solutions Act on the productivity of a specific business sector (Portland Cement manufacturing), to determine whether the regulation has a statistically significant impact on the productivity of businesses complying with the aforementioned regulation when compared to organizations not required to meet California's stricter environmental standards. While legislatures of first world western countries, including California's representatives support ever increasing environmental regulation (Bigger, 2015), it is important to note that even the most favorable theory for environmentalists regarding the impact of regulations on business productivity is careful to state that only well-designed regulations have a positive impact on business productivity (Porter & van der Linde, 1995). Thus, it is vital for organizations complying with ever progressing environmental regulation to track and understand how the compliance with regulations affects the overall productivity of their organizations.

The aim of this study is to provide measurable data that can help organizations understand better how compliance with certain types of environmental regulations impacts their business processes. The researcher studied the productivity impact of organizations by examining certain productivity measures, such as direct labor hours per unit of production, and total production costs per unit of production for a series of years before and after the implementation of new environmental regulation, and compared

those results to similar organizations outside of that compliance environment utilizing a difference in differences approach. The researcher examined these differences to determine whether the variable of specific compliance within the state of California appears to have a measurable effect on the productivity of organizations required to comply with the more stringent regulations.

Role of the Researcher

The researcher's role for this project was as follows. First, the researcher requested data from the organizations required to perform the quantitative analysis of the productivity factors that were utilized to determine the difference from year to year of results of organizations both inside and outside of California's regulatory environment. To make contact, the researcher called and spoke with accounting departments of different Portland Cement manufacturers. The researcher then provided basic information about the project and information about how the confidentiality of the data would be protected through careful safeguard by the researcher, and only aggregated presentation within this dissertation. This helped the organizations feel more comfortable providing the data to the researcher. After gathering the data, the researcher compiled the data into two sub-groups, one for organizations required to comply with California's regulations, and one for organizations who were not required to comply. The following sections provides a brief review of each of the roles of the researcher discussed above.

Participants

First contact with participants was made through a personal reference of the researcher who is the environmental compliance manager of a local Southern California

Portland Cement manufacturing facility. This contact was able to provide the researcher with additional names both within his facility, as well as other facilities to aid the researcher in making contact to request data. Through a series of contacts, the researcher discovered that an organization called the Portland Cement Association (PCA) collects a large amount of data from every cement manufacturer in the United States, and utilizes that data to produce several annual reports. One of the reports produced by the PCA is the annual labor energy report. The researcher was able to contact two of the economists working for the PCA, and speak to them about the project. These economists at the PCA agreed to provide the researcher with the data necessary to complete the research project.

Research Method and Design

The following sections discuss the research methods and design for the study. The researcher began by developing a research design based on the current available literature, as well as research of research methods. That review indicated that a quantitative research design would be most appropriate for the current study (Creswell, 2014). Next, the researcher gathered data for analysis through two semi-natural groups of Portland cement manufacturing facilities. Ultimately, the researcher analyzed the data using a descriptive quantitative approach. Additional details regarding this design are discussed below.

Method

The researcher selected a quantitative method of data analysis for this study due to its superiority in analyzing the type of data necessary to answer the research questions posed. The study utilized a difference in differences approach to determine the effect of a

specific set of regulations on the productivity of plants, by comparing their results to firms not subject to the regulation over a period of years. Firms that were operating outside of California and not subject to AB32 were compared with California firms before during and after the implementation of the regulations. Since other studies have noted that specific tracking of all expenditures related to compliance with environmental regulations is very difficult and often inaccurate (Berman & Bui, 2001), the study instead focused on isolating the affect that the regulation had on the productivity of plants that were required to comply with the law. Measures of productivity included total inputs as a percentage of tons produced, direct labor hours per ton produced, and raw material inputs per ton produced.

The researcher considered the qualitative method for this study. While it would allow the researcher to analyze the feelings or attitudes of managers and plant workers who perform the tasks required for compliance with AB32 (Stake, 2010), it was not appropriate to address the specific research questions posed by this project. Furthermore, a mixed-method approach was considered, however it too would have been inappropriate to specifically answer the research questions posed. While follow-up studies may choose to utilize an approach that also guages things like employee morale in plants required to comply with specific regulations, this type of approach was not appropriate in the current study, as the addition of qualitative data an analysis would have complicated the study unnecessarily.

This study attempted to determine whether statistically significant differences in productivity were the result of compliance with specific environmental regulations.

Cresswell (2014) suggests that quantitative analysis is the most appropriate approach for the type of data contained in this study. The individual plant data collected for the study contained specific financial data such as direct labor hours, raw materials inputs, total dollar inputs and total tons produced. The nature of this type of data necessitated that the researcher utilize quantitative methods of analysis, as qualitative analysis would have been insufficient to answer the research questions when utilizing this data.

Through examination of the literature, the researcher determined that other studies also utilized the quantitative approach to data analysis. Shadbegian and Grey (1994; 2003) analyzed the productivity of plants in three different industries through the implementation of specific federal EPA requirements to determine the effect compliance had on productivity of specific industries. Berman and Bui (2001) utilized quantitative analysis to determine the effect of environmental regulations on labor demand in specific markets. Ryan (2012) utilized an economic model for a descriptive quantitative analysis of the effects of the 1990 clean air acts on the Portland cement manufacturing industry. Based on the themes in other published literature, it seems that most researchers would agree that quantitative analysis is the appropriate form of data analysis for the current study.

Research Design

The researcher utilized descriptive quantitative research design which employed a difference in differences approach. This approach aims to examine the differences along two data set lines to determine if factors that affect one data set had a significant impact on the results of that set (Creswell, 2014). The study examined two separate groups of

Portland Cement manufacturers, and utilized aggregate data for each group to determine how the movement of productivity in one group compared to the other group, where the key variable was compliance with California's AB32.

Other research projects in the current body of academic literature that examined similar topics also used descriptive quantitative analysis. Shadbegian and Wayne (1994, 2003) utilized this approach when examining the productivity effects of EPA regulations on specific industries, including paper mills, steel mills and oil refineries. Becker (2010) utilized descriptive quantitative analysis when examining the effect of local environmental regulation on the plant level productivity of organizations subject to the specific regulations.

The researcher chose to utilize observational descriptive quantitative analysis rather than other quantitative methods for this study. Primarily, the descriptive method was selected because this study examined more than one group, and there were no instances of specific intervention. Furthermore, although multiple groups were examined, the study was not designed to determine the relationship between those two groups, but was instead designed to compare the results of those two groups considering an already occurring variable. Other quantitative methods considered, but ultimately rejected were correlational, experimental, and quasi-experimental.

The correlational method of quantitative research design seeks to examine variables and determine whether the two variables possess a cause and effect relationship (Creswell, 2014). This study however, was designed to examine two groups of cement mining and manufacturing facilities, both inside and outside of California. The study

attempted to quantify the effect on productivity caused by compliance with California's AB32. Since this research utilized natural design, and the focus did not contain any aspect of correlation, the correlational design for quantitative analysis would not have been appropriate.

The experimental design for quantitative research is one in which the researcher forms two separate groups to run an experiment on one group, usually by introducing an independent variable to one group, and then analyzing the results of the experiment (Creswell, 2014). The groups are ordinarily set up as one experimental group, or the group in which the variable is introduced, and one control group that does not experience the examined variable (Abbott & McKinney, 2013). Experimental research designs require the researcher to randomly assign participants to each group, so that the participants do not know whether they are in the experiment or control group. The random assignment is utilized to help the researcher increase control over external factors that might affect the study and are not part of what the researcher is trying to isolate for examination (Creswell, 2014). The current research did not contain an experiment. Instead, the researcher utilized financial data obtained from cement manufacturers to examine the changes in productivity over a period of time in which one group complied with environmental regulations and another, outside of that regulatory area did not. Considering this lack of an experiment, the researcher chose to reject the experimental research design.

The quasi-experimental design of research is similar to that of the experimental design, except for the fact that the groups that participate in the study are naturally

occurring groups. This means that the groups are not created by the researcher, but instead that they are naturally divided, such as running a study on males and females (Creswell, 2014). The current study does use naturally occurring groups in that organizations are grouped together by geographic area, such that organizations that operated inside California and were subject to AB32 were grouped together while those that operate outside of California and are not subject to the regulation formed a separate group. However, the study was not designed to run an experiment on any group, therefore the quasi experimental research design was deemed inappropriate, and subsequently rejected.

The study included independent, dependent, and moderating variables. Independent variables are those which can be changed or controlled or selected by the researcher (Leavy, 2017). In the current study, the independent variables were represented by the total tons produced, the total labor hours, and the tons of fuel used, or BTUs utilized by the cement manufacturing groups examined. Dependent variables are those which are driven or affected by the independent variable selected (Creswell, 2014). The dependent variables of the current study were productivity factors, such as labor efficiency and fuel efficiency per ton of finished product. Moderating variables are those which effect the strength of a relationship within a study (Leavy, 2017). Not every study contains a moderating variable, however the current study has a moderating variable which divided participants into natural study groups. The moderating variable in the current study was whether or not an organizaiton was subject to California's environmental regulations. These variables were chosen because they help to answer the

research questions of the study, which seek to examine the effect of compliance with AB32 on the productivity of cement manufacturing organizations.

The variables of this study allowed the researcher to examine the impact of California's environmental regulation by observing the changes in productivity factors that are produced by these variables. For research question 1, the independent variable, direct labor hours was examined against total tons produced, which determined the dependent variable, direct labor productivity. This allowed the researcher to examine the changes in direct labor productivity over the period examined by the study to determine if statistically significant differences were present. This examination when measured against the hypothesis that compliance with the environmental regulation would have a negative effect on direct labor productivity, allowed the researcher to make a connection to the direct labor efficiency and compliance with strict environmental regulation. Through the effort of controlling outside variables, the researcher could then make a determination of whether or not the environmental regulation in question had significant impact on the productivity of the study group that was subject to the regulation.

For research question 2, the independent variable, total labor hours was examined against total tons produced, which determined the dependent variable, total labor productivity. This allowed the researcher to examine the changes in total labor productivity over the period examined by the study to determine if statistically significant differences were present. This examination when measured against the hypothesis that compliance with the environmental regulation would have a negative effect on total labor productivity, allowed the researcher to make a connection to the total labor efficiency and

compliance with strict environmental regulation. Through the effort of controlling outside variables, the researcher could then make a determination of whether or not the environmental regulation in question had significant impact on the productivity of the study group that was subject to the regulation.

For research question 3, the independent variable, total fuel BTUs used was examined against total tons produced, which determined the dependent variable, total fuel use productivity. This allowed the researcher to examine the changes in fuel use productivity over the period examined by the study to determine if statistically significant differences were present. This examination when measured against the hypothesis that compliance with the environmental regulation would have a negative effect on fuel use productivity, allowed the researcher to make a connection to the fuel use efficiency and compliance with strict environmental regulation. Through the effort of controlling outside variables, the researcher could then make a determination of whether or not the environmental regulation in question had significant impact on the productivity of the study group that was subject to the regulation.

Population and Sampling

The researcher designed this project to examine the effect that compliance with AB32 had on the overall productivity of Portland Cement mining and manufacturing facilities operating in the state of California when compared with plants operating outside of California's strict regulatory environment. To examine this issue, the researcher selected two separate groups of Portland Cement manufacturers, comprised of multiple facilities. Group (a) existed inside of California and was wholly subject to the strict

regulatory environment which exists inside the state. Group (b) of a similarly sized market, and included all manufacturers in the state of Texas. Group b firms were not subject to the regulations inside of the State of California, and not subject to any other extensive regulations that were not a federal regulation which required compliance by all manufacturers within the United States. The goal was to isolate the key difference of compliance with AB32. The study data was collected from the Portland Cement Association's (PCA) Labor Input Energy Survey. Since this survey only reports aggregate (secondary) data the plants indirectly participating in the study remained anonymous and any data presented is presented in aggregate form.

The researcher chose the plant participants in the study by examining the size of different Portland cement markets as outlined by the Portland Cement Association. The PCA is an organization made up of every manufacturer of Portland Cement in the United States. The PCA's role is to collect and publish data that outlines the efficiency and market health of the Portland Cement industry in the United States. The Portland Cement industry is a concentrated industry, and consists of only 115 plants nationwide as of 2014 (United States Geological Survey, 2014). Only nine plants were operational inside the State of California at the time of the study. Additionally, the researcher identified an area with similar market demand and production through examination of the USGS Minerals Yearbook (2014), and requested data from eight plants in that area, consisting of plants operating in north and south Texas.

The type of sampling discussed above falls under the umbrella of purposive sampling. The researcher chose the groups out of a limited available population because

they were the most beneficial in addressing the research question and hypothesis. A random sample may not have produced plants with similar operations, which was important to eliminate undesirable variables such as plants that were less productive due to factors outside of the focus of the current study. Furthermore, the researcher chose only plants operating within the United States, so that all participants would be subject to the same baseline environmental regulations set by the federal government, and the environmental protection agency. Ryan, (2012) followed a similar sampling method in his study which examined the effects of the 1990 clean air act on the Portland cement industry. Leavy (2017) suggests that selecting groups for quantitative studies should be done in a way to eliminate as many untested variables as possible. This is why the researcher attempted to identify groups that were as similar as possible, except for the additional environmental regulations placed on California producers. This allowed the researcher to isolate the extra regulations that were unique to plants operating inside the state of California.

While the project could have been simplified by examining fewer plants both inside and outside of California, the researcher determined that maximizing the sample size would serve to smooth out any data anomalies present due specific situations affecting only one plant. Creswell (2014) states that quantitative analyses should include larger sample sizes, so that the researcher is able to obtain data from the greatest number of possible outcomes. Furthermore, the inclusion of all available plants within the study geographic areas made the aggregated data very similar to data already available and

published by the USGS, thus further protecting the confidentiality of all plant participants.

Data Collection

The next sections are comprised of the discussion of data collection methods. The sections include (a) instruments used, (b) data collection technique, and (c) data organization techniques. This discussion was designed to address the research question and aid in the data analysis required to complete the study.

Instruments

The researcher did not use any official or specific data gathering instruments such as surveys for the data gathering phase of the study. Instead, the researcher utilized secondary archival data available from the Portland Cement Association. The data available from the PCA included state by state information that grouped manufacturing facilities and aggregated their data based on the state they operated in. As the researcher gathered the data, it was entered the data into a Microsoft Excel spreadsheet to aid in the performance of the statistical analysis required for the study. Ryan (2012) used similar archival data provided by the United States Geological Survey for his study examining an EPA regulation on the Portland Cement manufacturing industry. Furthermore, Berman and Bui (2001) utilized similar data sources which gather self-reported data, including the Pollution Abatement and Control Expenditures survey, conducted by the USGS, the Annual Survey of Manufacturers, and the Census of Manufacturers conducted by the Center for Economic Studies of the Census Bureau. While any self-reported data can be subject to error (Creswell, 2014), the data collected by the PCA is also data that is

examined by the Environmental Protection Agency, and is subject to compliance audit. Cement manufacturers can face steep penalties for reporting false data to the EPA, so they spend significant resources to ensure the data is correct. Since organizations have a lot of oversight in this area, the researcher determined that it was reasonable to rely on the data provided. While companies may have some incentive to falsify this data to make it appear that they are in compliance with regulations when they are not, the risk would be extremely high to do so. Thus, the researcher determined that the chance of the data being invalid was miniscule.

Data Collection Technique

The data utilized was obtained through a specific request to the Portland Cement Association, which is an organization that collects and analyzes data from Portland Cement manufacturers. The data was preexisting financial data, that was previously reported to the Portland Cement Association. Appendix A includes a list of data that was requested for the project. The researcher did not use any other instruments or data collection techniques to obtain data for this study. Data utilized was provided by the Portland Cement Association voluntarily.

Data Organization Techniques

The researcher compiled the data that was collected for the study into an Excel workbook to keep track of individual data provided by each participant organization. The data was grouped into two groups, one containing participants within the state of California that were subject to AB32, and the other containing participants outside of California that were not required to comply with California's regulation. The researcher

also utilized a written journal to help identify specific productivity factors that should be included in the study. Additionally, the researcher kept track of geographical areas that made the most sense for comparison, so that the selected groups would be included in the data requested from the Portland Cement Association.

The Excel spreadsheet was designed so that each group had a separate tab for data entry and storage. The sheet had a separate column for each entity participant in the study, and individual lines were used for specific financial data that was provided and utilized in the analysis. Sections were set up as multiple rows on the spreadsheet to account for data from different years. This allowed the researcher to combine data from all the applicable entities for each group into aggregate data which was used for the analysis, and to present in this study. The researcher presented only aggregate data to protect the private financial data of each entity participant.

All the documents discussed above were stored on the personally owned computer of the researcher, which is in his home and is password protected. Additionally, the computer has a subscription to CrashPlan encrypted online automatic backup, which protects the researcher's files from data loss. It also protects the security of the data, since the information transmitted for backup is first subject to 128-bit encryption. This allowed the researcher extra protection against computer malfunction, data loss, or catastrophe, such as flood or fire.

Data Analysis Technique

The data collected from the PCA on each study participant included the following for the years 2008 through 2015; total tons of finished goods produced, annual direct

materials cost, annual direct labor hours, and annual total production cost. The data selected and gathered assisted in the current research project because it related directly to the productivity level of the firms. It allowed the researcher to examine productivity from a few metrics to determine whether compliance with California's regulations over the introduction period of those regulations had a negative impact on plant productivity.

The researcher compiled the data into a Microsoft Excel spreadsheet, where it was analyzed. The statistical technique used was an independent samples t-test to help determine if there were statistically significant differences in the productivity between the two groups. The separation of groups was based on whether a firm was subject to California's environmental regulations prior to analysis. Independent sample t-tests are a popular statistical test that is used in many quantitative studies in the accounting field. For example, Dichev and Tang (2008) utilized t-tests when examining the changing properties of accounting earnings over a forty year period. Berman and Bui (2001) also utilized t-tests to look for statistically significant productivity differences among oil refineries which were subject to different sets of regulation.

The researcher chose a p-value of .05 in order to maximize the reliability of the results. While p-values of .05 or lower are generally considered to be statistically valid (Creswell, 2014), values lower than .05 are considered to show even stronger statistical significance. T-tests that identify blocks of variables with significance less than .05 are considered to show statistical significance.

Reliability and Validity

Creswell (2014) points out that any research study can be hindered by issues related to the reliability and validity of results. Different types of studies, such as qualitative, quantitative and mixed methods suffer from different issues that can affect the validity of the results. Furthermore, the approach of the researcher and the techniques chosen can further affect the validity of the results. For this reason, it is important for the researcher to understand the literature available, and which research approaches, methods of data collection and instruments are accepted in the academic community for the topic being researched.

Reliability

For the purposes of a quantitative research study, reliability refers to the accuracy of the data collected for analysis, the accuracy of the presentation of that data, and the ability of other researchers to replicate the results of the study (Creswell, 2014). While the concept of reliability is consistent, the application can be slightly different in other types of studies. For example, a qualitative study requires the researcher to maintain a consistent approach to the prevailing literature in their subject area, as well as with the different subject participants and data coding within their study.

The current research project was a quantitative study. Since the researcher chose the quantitative approach, the researcher focused attention to ensure the accuracy of the data collected. Furthermore, the researcher carefully designed the analysis procedures to ensure validity and accuracy of the data presented. The current study utilized secondary data, provided by organizations directly to the researcher. Since the researcher collected

data from reports published by the Portland Cement Association, the data was considered to be reasonably reliable. Research has shown that self-reported data is generally reliable if the organization's reporting the data do not have anything to lose from reporting accurate data (Burger & Owens, 2008). In this case, the Portland Cement Association publishes only aggregated data that does not sacrifice the anonymity of the companies reporting. Additionally, the reports published by the PCA are not generally consumed by the public, because they are primarily marketed directly to the member manufacturers as a way to gauge their own productivity within the industry. These factors lead the researcher to believe that the data utilized was relatively reliable. Furthermore, similar public data is available from the United States Geological Survey, and although the exact same geographic divisions were not used by both sets of data, the researcher was able to compare the data for reasonableness, and it appeared that the data agreed to the extent that comparisons could be made.

The researcher gathered data directly from the published reports of the Portland Cement Association. The researcher had to contact the PCA to get these reports delivered, because generally the PCA charges industry rates, or as much as \$1,500 each for these reports. Since the reports were being used for research purposes only, and the researcher was not connected to the Portland Cement industry, the PCA provided the reports free of charge. The data gathered for the PCA reports comes directly from the financial accounting systems of the organization participants. The researcher was careful to ensure complete understanding of the data provided in the reports and utilized for this study. Additional data definitions and descriptions can be found in Appendix A.

Researchers have recognized for many years that obtaining valid and reliable primary data can present significant challenges (Cowton, 1998). Because of these challenges, and the increased availability of secondary data facilitated by the growth of the internet, researchers have found significant value in the use of secondary data to conduct research projects (Calantone & Vickery, 2010). Since studies that utilize secondary data collect data that was not originally produced for the study, some researchers believe that the data is more natural, and thus valid, as it is not as susceptible to manipulation in order to achieve specific results (Calantone & Vickery, 2010). However, others still argue that data obtained through archival resources have disadvantages because the researcher does not have any control over the methods for gathering the data, and the quality of those methods (Bryman & Bell, 2015). The current study however was designed to allow the researcher to use secondary data, and specify how data is reported and gathered through specific data requests made to the PCA which collects data from individual organizations. This method allows the researcher to take advantage of the availability of secondary data, while also still controlling at least some aspects of the quality of the data collected. Finally, secondary data holds the advantage of being relatively easy to gather, as many studies utilize secondary data that is already published by public companies that are required to publish specific data to meet Securities and Exchange Commission requirements that are meant to protect investors (Calantone & Vickery, 2010).

In addition to the benefit of the ease of gathering secondary data, some researchers cite the fact that data gathered outside of a specific study, that is later

analyzed for a specific study tends to be less susceptible to specific manipulation in an effort to achieve specific study results (Calantone & Vickery, 2010). When researchers design specific studies, they can sometimes influence the gathering or interpretation of data prior to participants providing that data to them, thus inadvertently affecting the validity of said data. For this reason, secondary data, specifically that which is obtained from an archival database can be particularly reliable when compared with data gathered specifically for the purpose of a study (Barnes, et al., 2015).

Validity

Perhaps the most frequently cited definition of the term validity comes from Hammersley (1987, p. 69), which states, “An account is valid or true if it represents accurately those features of the phenomena, that it is intended to describe, explain or theorise [sic].” Although there are many definitions for the term validity, some of which seem at odds with each other (Winter, 2000), a discussion about the nature of the term and its usefulness to research in general is beyond the scope of this study. Creswell (2014) points out four common threats to validity, which are: (a) internal threats, (b) external threats, (c) statistical conclusion threats, and (d) threats to construct. These threats to validity are important considerations for any research study. Thus, the researcher chose to consider individually, each of these threats as they may apply to the current dissertation.

Internal Validity Threats

Internal validity threats are those which arise from factors within the study itself. These threats have the potential to undermine the validity of the study by not allowing the

researcher to reach rational conclusions about the efficacy of specific study actions or instruments. These threats can include problems with the participants of a study or specific procedures selected and employed by the researcher (Creswell, 2014). This dissertation utilized secondary data, and did not rely on human participants. Instead, the study participants were organizations, and the data utilized was financial data already collected by the organizations. Participant organizations were carefully chosen to isolate groups of firms that either were subject to the specific study variable, or not subject to that variable in an effort to analyze the effect of that variable on the productivity of firms. Only organizations that fully met this criterion were selected for participation, which allowed the researcher to reduce threats to the internal validity of the study. No further threats to the internal validity were identified.

External Validity Threats

External threats to validity are those which originate from outside the study, such as when a researcher makes connections from study data to other outside situations or people. To avoid external validity threats, researchers must ensure that they do not extrapolate their results to groups beyond the scope of the study group “For example, if the setting or the research subjects have highly unique characteristics, you cannot generalize to other settings or groups” (Leavy, 2017, p. 114). Creswell (2014) outlines common threats to the external validity of a study, which arise out of experimental treatment of the study setting, participants, and history surrounding the study. The current study did not contain any sort of experiment, and groups were not subject to experimental procedures. Still, the researcher attempted to ensure that any generalization

to outside groups, such as groups subjected to other environmental regulations were not over generalized.

The purpose of the study is to determine whether a specific set of regulations has measurable effects on productivity in a concentrated industry. Any results do not necessarily mirror other industries or sets of regulations. Further, the researcher attempted to draw conclusions about the potential of regulations to cause increased or decreased productivity to spur conversation and research in other areas. For the current study, the researcher made every attempt to ensure participant groups isolated this specific set of regulations to determine their affect. The researcher selected participant organizations based on their geographic locations and the size of the market they served. The groups utilized were also utilized by the United States Geological Survey for similar studies. This double-check helped the researcher ensure that unnatural groupings were not inadvertently created. Furthermore, this natural grouping allowed for aggregate result presentation that masked and protected individual participant privacy, and helped to minimize threats caused by differences in market conditions across the United States. Finally, since the current study is not a replication study, the threats related to history could not be addressed, as a follow up study would be required to address external validity threats related to history. Follow up studies to address history related external validity threats are discussed in Section Three under the recommendations for future research heading.

Statistical Conclusion Validity Threats

Statistical validity addresses whether statistical tests are properly selected, and results are properly analyzed to reach appropriate conclusions based on the data collected. According to Leavy, statistical validity is achieved when "...statistical analysis chosen is appropriate and the conclusions drawn are consistent with the statistical analysis and the rules of statistical law" (2017, p. 115). The researcher carefully selected the data points and type of statistical analysis for the current study. Data points were discussed above and included in Appendix A, all specifically deal with measures of productivity. Furthermore, the statistical test selected, independent samples t-tests are specifically designed to identify statistical significance of factors such as changes in productivity, when comparing the differences in means, and have been used by other researchers for similar studies (Berman & Bui, 2001; Dichev & Tang, 2008). Multiple authors suggest this type of statistical test for a study designed in the manner of the current study (Creswell, 2014; Kennedy & Widener, 2008; Leavy, 2017). Properly selecting a statistical test that was appropriately designed to accomplish the analysis aim of the study is one of the primary ways to address and mitigate threats to conclusion validity (Leavy, 2017).

Construct Validity Threats

To obtain construct validity a study must be designed so that the measure, in this case the statistical measure (productivity) is "tapping into the concept and the related concepts into which we propose that it is tapping" (Leavy, 2017, p. 115). The researcher ensured construct validity in dealing with productivity by choosing widely accepted

measures of productivity. For example, one measure of productivity the researcher utilized was the total number of labor hours it took to produce a unit of finished product, which in this study was a ton of portland cement. This is the same measure that researcher conducting similar studies used. Shadbegian and Gray (2003) utilized labor productivity in their study which examined effects of environmental regulation on oil refineries, paper mills, and steel production facilities. Following standards already set forth by the industry and research experts is one way to help ensure construct validity. The researcher thus chose to utilize standards that already existed prior to the current study.

The researcher recognized that it is impossible to create a study design that is void of any threats to validity. While the complete elimination of threats is not an obtainable goal, the researcher utilized all design choices possible to minimize the potential threats to validity. The researcher recognized and discussed all threats to validity that were not feasible to eliminate in the current study so that readers of the study would be aware of the threats. The awareness of these threats still present to the study should allow readers of the study to reach conclusions based on information analysis, rather than being lead to believe the study is completely flawless.

Transition and Summary

Legislation aimed at protecting the environment, though not new, is a growing trend worldwide. Many of these laws specifically target businesses directly, and others indirectly affect business operations. California has some of the most aggressive environmental regulations worldwide, and is thought by many to be a leader in the world

of environmental regulations (Ryan, 2012). The researcher designed this project to examine whether aggressive environmental regulation has a negative affect on the productivity of organizations within a concentrated industry.

The researcher developed and designed this project to specifically address the research questions posed. The researcher selected the independent and dependent variables of the study design because of their specific relevance to the research questions that were examined. The researcher selected the quantitative method of analysis of the data collected for the study because it both followed the convention set by other researchers in this general area, and it allowed the researcher to come to conclusions based on the productivity performance of the individual groups that were examined by the researcher.

The researcher made every attempt to eliminate threats to reliability and validity of the study results, however, the researcher recognized that it is not possible to design a research study that is completely void of threats (Creswell, 2014; Leavy, 2017).

Wherever threats could not be eliminated, the researcher recognized the threats and discussed them so that the reader would be aware of threats to the study, and fully informed so as to make conclusions based on the entirety of the information available.

The next section will discuss the findings of this research study. The findings discussed aided the researcher in answering the research questions posed that drove the design and purpose of this dissertation.

Section 3: Application to Professional Practice and Implications for Change

Environmental regulations have become a major focus of many governing bodies, primarily across western culture over the past half-century (Bigger, 2015). While the effect of these regulations has been well understood when it comes to their impact on the environment (Bigger, 2015), the understanding has been less clear cut in terms of the impact on productivity of businesses affected by the regulations (Porter & van der Linde, 1995; Berman & Bui, 2001; Shadbegian & Gray, 2003). Although Porter's hypothesis is a vital tool for legislatures who argue that environmental regulation improves productivity, even it admits that regulations must be well designed to achieve those productivity gains.

The goal of this research project is to examine some of the most aggressive environmental regulations in terms of their impact on productivity within a concentrated manufacturing industry. This section will divide information into seven parts, including (a) overview of the study, (b) presentation of the findings, (c) applications to professional practice, (d) recommendations for actions, (e) recommendations for further study, (f) reflections, and (g) summary and study conclusions.

Overview of Study

Legislatures making environmental regulation are faced with the difficult task of appeasing citizens, appeasing special interest groups, and not overregulating to the point of crippling business and innovation. Much research has been conducted on the effect of these regulations, but little has been done to examine some of the most aggressive regulations, like those established by California's AB32 (Bigger, 2015). One reason why

little research has been directed at these more aggressive environmental regulations, is because many are still in their infancy. California, being on the leading edge of aggressive environmental policy is an early opportunity to examine the effect of these aggressive regulations on the industries which they target. This dissertation study was designed and directed to add to the current body of literature which examines these issues surrounding environmental regulation.

This dissertation was designed to address the three research questions discussed in section one of this paper. All three of these questions focused on the effect that environmental regulations had on the productivity of Portland Cement manufacturing facilities. Overall the finding of the study indicated that Portland Cement manufacturers operating within California's regulatory environment showed a statistically significant difference in productivity in terms of direct labor employee hours when compared to manufacturers operating in Texas. The data however did not show any statistically significant difference in productivity among any other types of employee hours. Additionally, these plants did find statistically significant productivity gains in terms of the amount of fuel used per ton of finished goods produced. While some productivity increases were found, the data sample for years of operation within the regulatory environment created by California's AB32 is still very limited due to the age of the regulation. Additional observations would be helpful to determine whether gains in productivity are driven by other variables that could not be controlled in the current study.

Presentation of the Findings

The findings of this dissertation will be presented in this section. The researcher designed the project to address three research questions, discussed above. The findings presented in this section will be presented to address each of the previously discussed research questions. Furthermore, the researcher will relate findings to the current body of literature as such relations become available.

This project utilized historical secondary data that was originally collected from Portland Cement manufacturers by the Portland Cement Association. The analysis focused on plants operating in California and Texas, since these two states had comparable manufacturing markets for Portland Cement. Furthermore, the period analyzed for the study was the years 2007 through 2015 since this period represents the passing and original implementation of the environmental regulation being examined. According to the Portland Cement Association California and Texas have nine and 10 cement manufacturing facilities respectively, and all facilities responded to the requests for data from the Portland Cement Association for the periods in question. Therefore, the study utilized 18 points of data provided by 171 survey responses that were originally collected by the PCA.

Research Question One

The first research question was: Do California's restrictive environmental regulation laws increase the cost of direct labor for Portland Cement manufacturers in the state when compared with similar businesses operating outside of California? The researcher examined this question based on factors of productivity. Since too many

variables exist regarding state employment laws and costs, such as minimum wages, workers compensation insurance, and general employment law compliance, the researcher determined there were too many variables to isolate AB32's effect on basic cost of direct labor. Therefore, the researcher determined a factor of productivity would be the best way to determine if AB32 caused affected cost of direct labor through changes in productivity. The researcher examined the tons produced per direct labor hour for the groups of plants in California and Texas for the period of 2007 through 2015. This nine-year period represents the time in which AB32 was passed and implemented up to the most recent data year currently available. This period also covered the most recent economic recession beginning in 2008 and the subsequent recovery. The inclusion of this economic cycle may have introduced a variable that the researcher was unable to control for, however it also further tests Porter's hypothesis of increased productivity through a complete economic cycle, and it is likely that both groups experienced similar economic recoveries.

The researcher obtained the productivity data utilized for this question directly from the Portland Cement Association which reported both direct labor hours, overhead hours, and total hours, as well as the tons per hour for each of these three categories. This calculation was based on the total tons of finished cement that was produced by each plant for the year in question.

The California based Portland Cement manufacturing group examined by the study did appear to show some productivity gain over the study period when compared to the Texas group of manufacturers, the gains do appear slight, however an independent

samples t-test shows statistical significance when examining the direct labor productivity, indicating that the data shows a possible causal relationship between the environmental regulations and productivity gains within California. The following data shows the results including F values, degrees of freedom, significant value (2-tailed), mean difference, standard error and lower and upper values of the 95% confidence interval. The dependent variable, state, was dummy coded utilizing a 1 and a 2 for purposes of the independent samples t-test. The independent variable utilized for question one was total tons of product output per direct labor hour for each group.

Table 1: Direct Labor Productivity for California Portland Cement Manufacturers v. Texas Manufacturers for Period 2007-2015

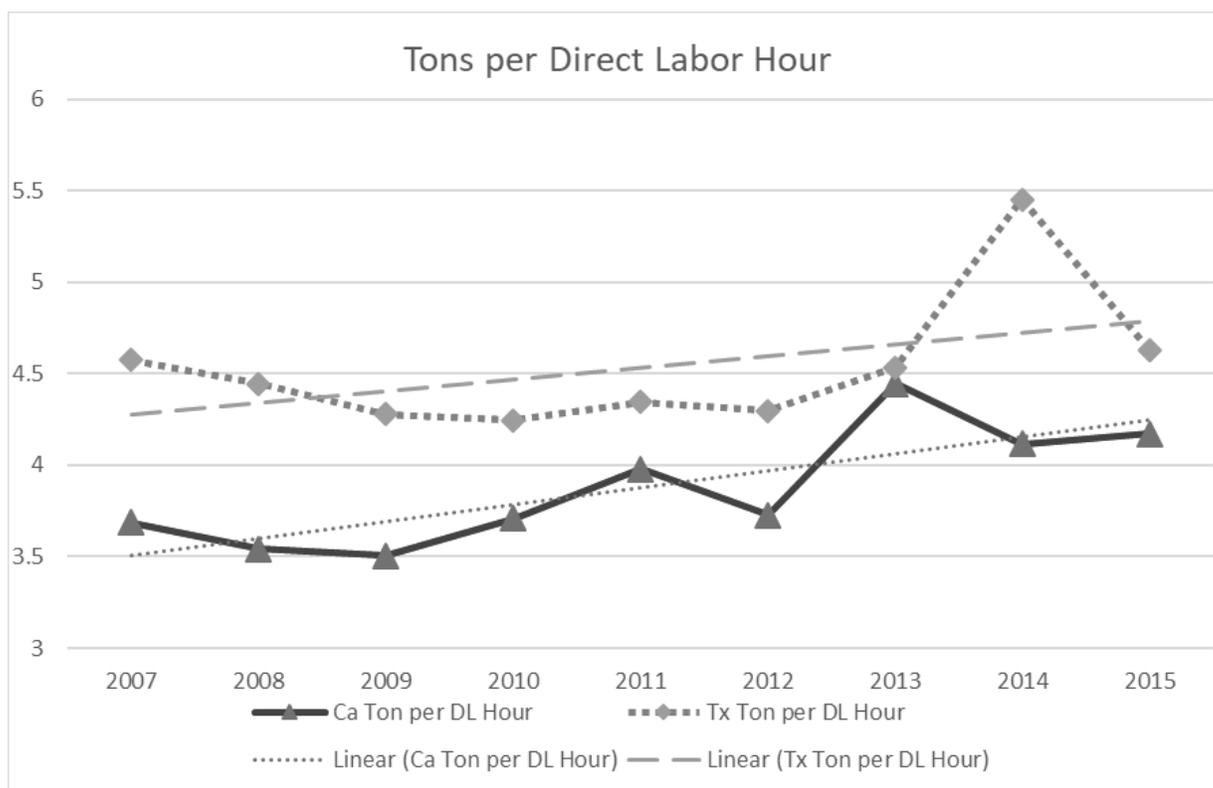
		Levene's Test for Equality of Variances		t-test for Equality of Means					95% CI of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
		Tons per DL Hour	Equal variances assumed	0.103	0.752	-4.035	16	0.001	-0.65729	0.16292
	Equal variances not assumed			-4.035	15.646	0.001	-0.65729	0.16292	-1.00330	-0.31129

Group Statistics					
State	N	Mean	Std. Deviation	Std. Error	Mean
Tons per DL 1	9	3.8764	0.31855	0.10618	
Tons per DL 2	9	4.5337	0.37068	0.12356	

The first research hypothesis was: There is a statistically significant impact on the cost of direct labor measured through productivity for California's Portland cement

manufacturing and mining businesses. Due to the nature of the data available and the hypothesis in question, the researcher performed an independent samples t-test, with Lavene's test for Equality of variances to determine whether there was a statistically significant change in productivity among the groups examined for direct labor, and whether the test should assume equal or unequal variances. The differences in productivity for the California manufacturers and the Texas manufacturers was significant for the period examined.

The means of the population examined for hypothesis one were 3.876 and 4.534, with a standard deviation of 0.319 and 0.371 for California and Texas plants respectively. The results of the independent samples t-test analyses for the blocks examined where tons per direct labor hour showed statistically significant results were: $t(16)$, $p = .001$. The p value of .001 indicates that the results of the t-test were statistically significant. This result lead to the rejection of the first null hypothesis of no statistically significant difference in the cost of direct labor as measured through productivity as a result of California's environmental regulation required by AB32. Once the researcher determined that there was a statistically significant difference in the efficiency of direct labor between the two groups, the researcher chose to examine the differences in the productivity numbers. The differences can be seen in the following graph.



Although the group examined from California started with less efficiency per direct labor hour, the trend shows that the California group gained efficiency faster than the Texas group. In other words, the California group gained productivity at a faster rate than the group of Texas manufacturers examined. This is illustrated by the decrease in the gap of the trend lines from 2007 through 2015. Although there seems to be an outlier in the Texas data, additional examination of PCA data for the years 2013 and 2014, efficiency increases were seen among many manufacturers due to increased market demand allowing plants to reach full capacity in many cases. This demand jump impacted California plants during 2013, which can also be observed in the graph above. This result tends to contradict with the findings of Shadbegian and Grey (2003, 1994). Both studies found decreased productivity for businesses forced to comply with new

environmental regulations. The results do however support Porter's hypothesis (Berman & Bui, 2001; Porter & van der Linde, 1995), that environmental regulations can have the effect of making businesses more productive.

The researcher designed this study to test Porter's hypothesis. While Porter's hypothesis does state that increased productivity can be a result of environmental regulation, it also includes a qualifier that the environmental regulations need to be well-designed in order to realize these productivity gains. Because California's regulations are cutting edge and generally radical compared to regulations across the rest of the United States, it begs the question of whether or not they were designed in such a way that could result in increased productivity.

While the current findings suggest that some productivity gains have been made during the implementation period of AB32, it should be clear that the results are limited by the infancy of the regulation. Furthermore, the results do not take into account the total cost of compliance, including fixed asset investment, maintenance, and payment of the AB32 fee. It is possible that organizations recognized labor hour based productivity gains as a result of cutting hours in an effort to maintain profitability in light of the strictly financial directly burdens related to AB32. Furthermore, one production supervisor from a California manufacturing facility suggested that this effort to maintain profitability in the face of increasing environmental regulation has resulted in reducing overall direct labor hours at his facility.

An independent samples t-test analysis of the data provided by the Portland Cement Association showed a statistically significant difference in the fuel use productivity of the two groups examined.

Research Question Two

The second research question posed by the researcher was: Do California's restrictive environmental regulation laws increase the cost of total labor for Portland Cement manufacturers in the state when compared with similar businesses operating outside of California? Like question one, the researcher examined this question in terms of productivity as a method to control for salary and other cost of employment variables that exist between States. The researcher wanted to look at other employee hour categories since additional positions have been added at many California Portland Cement manufacturing facilities to manage some of the aspects of the environmental regulatory compliance required by California. These positions included additional environmental compliance personnel, data analysts and engineers necessary to maintain monitoring equipment.

The researcher examined the tons produced per total labor hour for the groups of plants in California and Texas for the period of 2007 through 2015. This nine-year period represents the time in which AB32 was passed and implemented up to the most recent data year currently available. The California based Portland Cement manufacturing group examined by the study did appear to show some productivity gain over the study period when compared to the Texas group of manufacturers. An independent samples t-test analysis showed that the productivity gains observed in the

graph were also statistically significant. The following data shows the results including F values, degrees of freedom, significant value (2-tailed), mean difference, standard error and lower and upper values of the 95% confidence interval.

Table 2: Total Labor Productivity for California Portland Cement Manufacturers v. Texas Manufacturers for Period 2007-2015

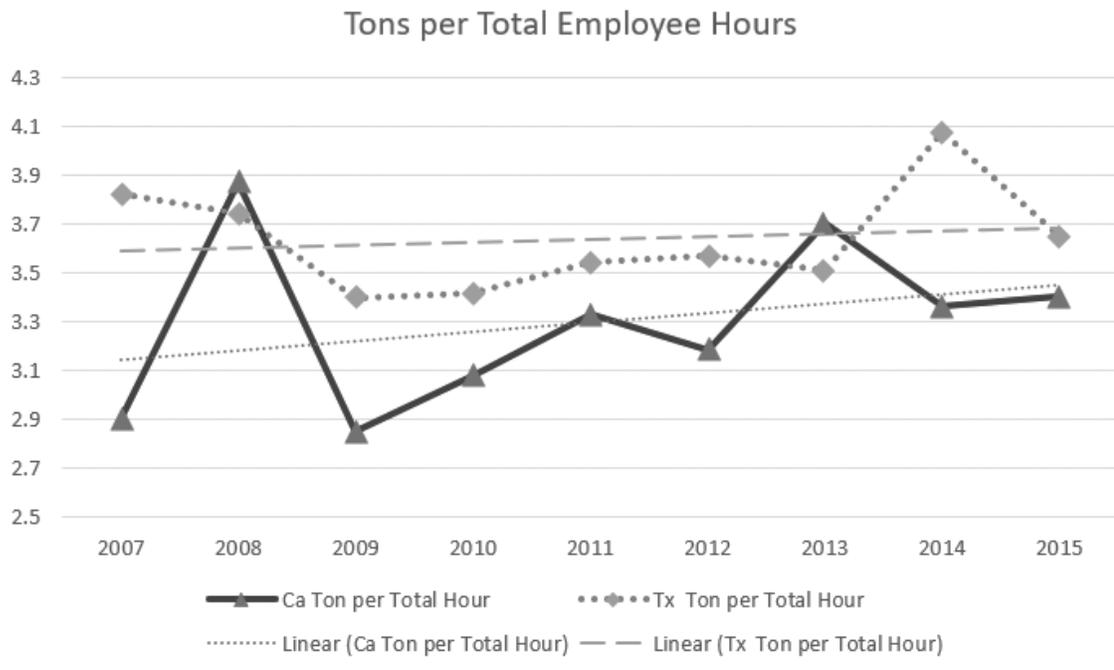
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error	95% Confidence Lower	Upper
Tons per Employee Hour	Equal variances assumed	1.522	0.235	-2.504	16	0.023	-0.336	0.134	-0.621	-0.052
	Equal variances not assumed			-2.504	13.573	0.026	-0.336	0.134	-0.625	-0.047

Group Statistics

State	N	Mean	Std. Deviation	Std. Error Mean
Tons per Employee 1	9	3.30	0.340	0.113
Tons per Employee 2	9	3.63	0.216	0.072

The means of the population examined for hypothesis two were 3.30 and 3.63, with a standard deviation of 0.34 and 0.216 for California and Texas plants respectively. The results of the independent samples t-test analyses for the blocks examined where tons per direct labor hour showed statistically significant results were: $t(16), p = .023$. The p value of .023 clearly show that the t-test indicates the difference of means analysis performed resulted in a statistically significant result. The result of the t-test analysis specifically for question two lead the researcher to reject the null hypothesis, which was: There is no statistically significant difference in the cost of indirect labor for California's

Portland cement mining and manufacturing businesses. The differences analyzed by the t-test model can be observed in the graph below.



The group examined from California once again started with less efficiency than the Texas group, the California group appears to gain efficiency in indirect labor productivity while the Texas group appears to be losing productivity. One plant supervisor inside California posited, that prior to California's AB32, plants within the state were able to throw more labor at a problem, whereas after implementation, margins were much tighter, thus plants were forced to be more efficient in dealing with challenges. Therefore, it stands to reason that Texas manufacturers when faced with increased demand during the economic recovery, solved that problem through labor hours, whereas California manufacturers have been forced to find new efficiencies to save money and remain competitive. Not only does the result appear to be significant

when observing the graph, the individual sample t-test determined that the results were statistically significant. Once again, this result appears to support the conclusions drawn by Porter's hypothesis.

Research Question Three

The third research question posed by the researcher was: Does compliance with California's restrictive environmental regulations increase the fuel-use efficiency of California's Portland Cement manufacturers when compared with manufacturing facilities operating outside the state of California? Fuel use efficiency looks at fuels used by the organizations which are burned to heat the kilns which are used to alter the chemical makeup of limestone in the creation of cement. There are approximately thirteen different types of fuel used, but reporting to the Portland Cement Association reports both the amount used, in tons, gallons and individual units depending on the fuel, as well as the BTUs produced by the fuel. To examine the productivity or fuel use efficiency, the researcher examined the tons produced per BTU of fuel utilized to determine which groups were most efficient.

Since AB32 specifically targeted the use of burned fuels and the amount of emissions created by those burned fuels, the researcher expected to see some statistically significant difference in productivity. The following data shows the results including F values, degrees of freedom, significant value (2-tailed), mean difference, standard error and lower and upper values of the 95% confidence interval.

Table 3: Fuel Use Efficiency for California Portland Cement Manufacturers v. Texas Manufacturers for Period 2007-2015

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Differenc	Std. Error	95% Confidence Lower	Upper
Tons per Fuel BTU	Equal variances assumed	0.305	0.588	3.798	16	0.002	24.078	6.339	10.640	37.516
	Equal variances not assumed			3.798	13.621	0.002	24.078	6.339	10.447	37.709

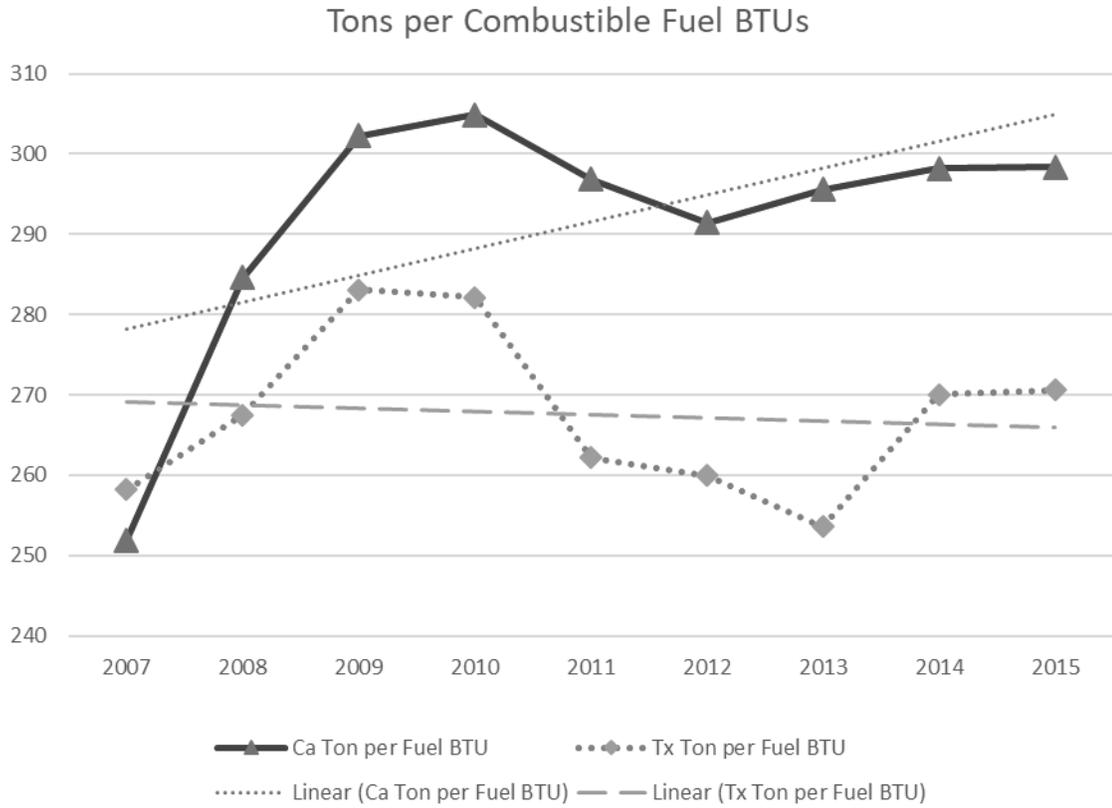
Group Statistics

State	N	Mean	Std. Deviation	Std. Error Mean
Tons per Fuel 1	9	291.56	16.012	5.337
Tons per Fuel 2	9	267.49	10.260	3.420

The third research hypothesis was: There is a statistically significant impact on the fuel use efficiency results due to expenditures related to specific compliance with AB32 for California's Portland cement mining and manufacturing businesses. Due to the nature of the data available and the hypothesis in question, the researcher performed an independent sample t-test to determine whether there was a statistically significant change in productivity among the groups examined for fuel use efficiency. The differences in productivity for the California manufacturers and the Texas manufacturers was significant for the period examined.

The means of the population examined for hypothesis three were 291.56 and 267.49, with a standard deviation of 16.012 and 10.260 for California and Texas respectively. The results of the independent samples t-test analyses for the blocks examined where tons per direct labor hour showed statistically significant results were: $t(16), p = .002$. The p value of .002 indicates that the results of the t-test were statistically

significant. This result lead to the rejection of the third null hypothesis of no statistically significant difference in the cost of fuel as measured through productivity as a result of California’s environmental regulation required by AB32. Once the researcher determined that there was a statistically significant difference in the efficiency of fuel use between the two groups, the researcher chose to examine the differences in the productivity numbers. The differences can be seen in the following graph.



Although the group examined from California once again started with less efficiency than the Texas group, the California group appears to gain efficiency in fuel use at rapid pace, while the Texas group actually appears to be reducing fuel efficiency over the period examined. This is illustrated by the rapid increase in the gap of the trend

lines from 2007 through 2015. This result tends to once again contradict with the findings of Shadbegian and Grey (2003, 1994). The results do however support Porter's hypothesis (Berman & Bui, 2001; Bovenberg & van der Ploeg, 1996; Porter & van der Linde, 1995), that environmental regulations can have the effect of making businesses more productive.

Results and Theoretical Framework

While the results of this study indicated that California plants achieved more productivity gain, than did the Texas plants examined, accounting techniques such as activity based costing could be used to further trace the productivity gains to specific processes within the entire manufacturing function of plants. The point of tracing costs by activity is to identify waste and increase productivity by increasing the understanding of the cost of specific products and activities within the functions of an organization (Raeesi & Amini, 2013). Activity based costing offers organizations a method to assign costs to specific activities within their manufacturing process. For examples, plants might assign fuel costs to the kiln heating process, in order to track and compare how changes in fuel types may affect their profitability in that area. They may also choose to assign maintenance of environmental monitoring equipment to a specific manufacturing process to allow them to trace those costs, and compare them to previous years in order to gain a more thorough understanding of how increased monitoring required by environmental regulation effects the profits of the organization.

Capturing data to track and categorize costs opens up new opportunities for analysis for organizations. Making costs searchable by specific functions within an

organization helps aid management in decision making (Johnson & Kaplan, 1987). Incremental budgeting allows management to examine financial measures by specific function within an organization, and make budget adjustments for planning purposes. Utilizing activity based costing makes it possible for managers to break these budgets down into specific activities within the organization. From there, managers can analyze historical data to determine how shifting regulatory environments have affected the costs and profitability within specific activities, and adjust their budgets based on those trends. This level of analysis increases the effectiveness of budgeting and can even have a positive impact on continuous improvement measures (Kaplan & Norton, 2007).

Finally, in order to maintain consistent accounting application, organizations have to be able to match costs with the period to which the income generated from those costs has been recognized (Ohlson, et al., 2011). Once again, tracking specific costs down to the activity level can help accountants ensure that all costs are captured for a specific activity, and that those costs are recorded in the correct period. This is the cornerstone of the matching principle. Understanding these effects on productivity can help organizations plan for and better manage the costs associated with regulations like the ones examined by this study, while also utilizing the expertise in their accounting departments to increase the effectiveness of their strategic planning process.

Applications to Professional Practice

The study conducted within this dissertation contains results that can be applied practically within the business environment. Understanding the effects of environmental legislation can help legislatures more efficiently write laws, businesses can alter their

strategic planning based on the anticipated effects of those laws, and accounting departments can more accurately forecast the financial impact of implementation and compliance with the regulations. This section is utilized to discuss the effects of these findings on businesses and managers, specifically those in charge of managing accounting and financial decisions. The conclusion of this section will include a discussion on the biblical application of the findings of this study, and how that relates to the biblical framework discussed in section one of this dissertation.

Business Application

The understanding of legislation that affects businesses is critical for managers who want to both run businesses efficiently and remain compliant with regulations (Jaffe et al., 1995). One of the most prominent type of legislation targeted at business today is environmental regulations (Bigger, 2015).

Porter and van der Linde (1995) originally hypothesized that businesses would see increased productivity due to innovation driven by environmental regulation. Follow up studies, such as the one conducted by Berman and Bui (2001) suggested that productivity increases were possible. This study did find some productivity increases when isolating certain productivity measures, such as direct labor productivity and fuel use productivity. While environmental regulation can result in increased productivity it seems, businesses should look for opportunities to increase productivity absent the imposition of environmental regulation. As Dennison (1979) suggests, it is possible that organizations could become more efficient through uninhibited innovation if the government did not force them to comply with specific regulations.

Christiansen and Havemen (1981), found that output per employee hour suffered in a period immediately following environmental regulation implementation. While this study found the opposite for plants operating in California, it is important for businesses to understand that specific regulations can have negative impacts on productivity. While this dissertation saw productivity increases overall, those increases did come at a cost of investment and equipment maintenance not specifically examined by this research project. Additionally, it is possible that California plants increased labor productivity entirely out of necessity due to the cost related to equipment investment as well as the payment of the AB32 fee to remain in compliance. If that is the case, negative results for California's Portland Cement manufacturers could be looming. Doing more with less man hours can cause serious concerns, as extreme pressure on productivity and worker safety are often considered to be at odds with each other (Teizer, Cheng, & Fang, 2013).

The results of this dissertation as well as the mixed results of studies dealing with similar topics should serve as a warning to businesses. Managers should not assume that they know how specific regulations are going to affect productivity at their organization. They should be involved and stay up to date on legislation that affects their processes, and they should understand that it is possible for regulations to increase or decrease productivity in a number of different areas of the organization.

Accounting Application

Accountants are often tasked with collecting and compiling information, as well as analyzing information to determine how specific processes are being performed and how productive an organization is. Accountants are often trusted to analyze and make

financial decision based on data collected within an organization (Kennedy & Widener, 2008).

One of the initial struggles of this dissertation was the collection of data from companies that were subject to the regulations within California. A common statement made to the researcher was that organizations simply did not track the cost of equipment and other costs including investment and personnel hours required to comply with California's environmental regulations. While the researcher was able to analyze the impact of the regulation through productivity measures, accountants should look to track items such as fixed asset investing, maintenance of testing equipment, and man hours dedicated to compliance when trying to understand the impact of specific programs or regulations on the organization. Specific tracking of performance indicators can help accountants obtain the data that they need to make decisions on how to increase the profitability of the companies they manage (Kaplan & Norton, 2007). Accountants are often tasked with compiling and analyzing these performance indicators to help management make informed decisions as part of an organizations strategic planning process (Rivera & Milani, 2011). Collection and analysis of data is the only way to make informed decisions for these purposes.

The results of this study indicated that organizations do have the opportunity to increase productivity, and that, at least so far, organizations subject to AB32 have found increased productivity, possibly as a result of the regulation. While it appears that AB32 drove some productivity increases for California organizations, Texas organizations should note that productivity increases are possible, and could even be more attainable

since they are not subject to specific rules as is the case for California organizations (Denison, 1979). Since most organizations are not subject to California's specific environmental regulation, accountants should look for opportunities to reduce cost and increase productivity while being creative and innovative and also learning lessons from the organizations that are subject to California's regulation. Finding these productivity increases can be difficult, but use of activity based costing (Raeesi & Amini, 2013), standard cost variances (De Zoysa & Herath, 2007), along with managerial accounting techniques such as variance analysis and the balanced scorecard (Kaplan & Norton, 2007; Morard, et al., 2013), accountants can lead the charge of increased productivity.

Biblical Application

The environment is one of the many gifts that God gave to Adam and Eve, and placed under the dominion of mankind. In Genesis, God commands man to care for the earth and the living things, both plant and animals. The Bible also encourages Christians to build and nurture not only their own gifts, but the gifts of those in fellowship with them also. For these reasons, it is important to understand both God's plan for business, and how that plan relates to the responsibility to care for the environment.

The results of this study suggested that it is possible for businesses to both reduce their negative impact on the environment and improve productivity at the same time. While it is still uncertain whether legislation can hinder productive improvement under certain conditions, the results do suggest that in some cases they can help spur productivity increases. Understanding the impact of regulations is one key to planning for that impact, and making sound investments considering the impact of a regulation.

Luke 14:28 says, “Suppose one of you wants to build a tower. Won’t you first sit down and estimate the cost to see if you have enough money to complete it?” (NIV). This verse speaks directly to Christians and how they should plan considering finances. Investments must be carefully considered, and for organizations dealing with environmental regulation, the effects of those regulations on business and investment should be accounted for in investment considerations.

Businesses face dozens if not hundreds of decisions when performing strategic planning and attempting to determine the best use of resources. Van Duzer (2010, p. 42) suggests that many of those decisions should be based on investing in people, productivity and protection of the environment. The findings of this study suggest that the investment worthy categories named by Van Duzer may in fact overlap in some cases. If this is in fact the case, businesses could conceivably be excellent stewards of the communities they operate in, the environments of those communities, and the people who live within those communities. In John 21:17, the Bible says,

The third time he said to him, ‘Simon son of John, do you love me?’ Peter was hurt because Jesus asked him the third time, ‘Do you love me?’ He said, ‘Lord, you know all things; you know that I love you.’ Jesus said, ‘Feed my sheep.’

What better way for business leaders to feed the Lord’s sheep than to care for the entire community that they operate in, including the people, and their homes?

Part of Van Duzer’s framework suggests that businesses should make every effort to ensure the work of the firm is both creative and redemptive (2010, p. 114). While there are many environmental concerns regarding business today (Bigger, 2015), firms

that are cognizant of their impact on the surrounding community and its environment have the opportunity to further God's purpose for business on Earth. The results of this dissertation help to show that businesses can likely find ways to both increase their creativity, while also improving their positive impact on the communities in which they operate. Thus, business leaders should ask themselves two questions: (1) what sort of environmental regulation is likely to be discussed or introduced within the next 10 years, and (2) what can our business do to improve our impact on the environment while increasing productivity and caring for our community? Businesses that are able to anticipate regulation are more likely to be ready for the changes that regulations mandate (Rabe, 2008). Furthermore, businesses that can make these adjustments while remaining cognizant of their communal impact are more likely to nourish both their communities and the people within their communities, building both up for the benefit of the business and the people it serves and employs. This type of impact is exactly what Van Duzer describes when he asks businesses to consider, "how can I best deploy my resources to (1) enable this community to flourish, and (2) provide opportunities for my employees to engage in meaningful and creative work?" (2010, p. 152).

Recommendations for Action

The results of this dissertation are relevant to all business that operate in industries typically subject to environmental regulation. Managers of businesses inside and outside of jurisdictions with stringent environmental regulation could learn from the results of this dissertation and use that knowledge to better improve their productivity, considering or despite the regulation in their jurisdictions. This information could be

valuable to operations managers, environmental compliance managers and accountants in businesses affected by environmental regulation.

The results of this study should be made available to interested parties, to allow them to utilize the information in making business planning decisions. To make the results available, the study should either be published in journals related to the topic, or disseminated through web publication. It is likely that the information could be cast with a wider net through non-academic publication, such as the utilization of news sites or blogs, and shared via social media platforms. Alternatively, a trade journal could be a good medium to disseminate the information, since business leaders are more likely to read trade journals related to their operations when compared to academic journals. Businesses could then use the information as an aid to decision making when faced with specific environmental regulations, or just as a tool to stay ahead of the curve while working to increase productivity.

For businesses operating in California or within other jurisdictions that have aggressive environmental regulations, the results show that improvements to business processes can still be achieved while maintaining in compliance with more stringent environmental regulation. This information, as well as the specific regulatory requirements of AB32 could be used by business leaders to develop plans to increase productivity, particularly for fuel use efficiency. While labor productivity increases were observed for California manufacturers in this study, it is unclear whether that was driven by the regulation directly, or was instead a result of increased profitability pressures that resulted from the regulation. Since it is uncertain what exactly drove the labor

productivity increases, this information may not necessarily prove useful in that area, but can still be used as a reference. For organizations to better understand the effects of regulations, they should develop plans to more closely track the costs of the regulations. Accountants should utilize strategies, such as activity based costing, to ensure all costs associated with the environmental regulation are tracked specifically. These costs should be applied to their own cost center to ensure items such as, machine and instrument maintenance, capital investment directly related to compliance, salaries dedicated to compliance measures, and all other compliance related costs are tracked for appropriate analysis. Intimate cost tracking would allow accountants not only to create better budgets, but also fully understand the cost of compliance with the specific regulation. While productivity measures are helpful, full cost accounting of the compliance requirements would bring a much deeper understanding of the effect of regulations on effected businesses. Once the costs are captured, they should be integrated into the continuous improvement and strategic planning processes of organizations. This would ensure that managers are observing and considering the effects of the costs, and considering options to increase profitability and productivity based on a total understanding of the cost of compliance with the regulations.

Organizations that do not operate in jurisdictions with strict environmental policy could use the results of this dissertation along with the requirements of AB32 to help find ways to increase productivity. These organizations have the advantage of not having specific environmental regulations that they must comply with. This reality could allow them to cherry pick some of the best strategies companies that are subject to strict

regulations are using, and combine them with their own innovative strategies to increase productivity. Dennison (1979) pointed out that although at times regulations have been found to result in increased productivity, it is possible that organizations could have been more innovative and seen larger increases if they did not have to comply with a very specific set of rules that most regulations require. Organizations outside of strict environmental jurisdictions could utilize the results of this dissertation and their own innovative strategies to test Dennison's theory. To do so, they should examine the results of operations for organizations that are affected. In many cases, parent companies own plants both inside and outside of California. They could institute information sharing to all of their plants, so that facilities outside of California can learn and implement strategies that are working to increase productivity and profitability already employed by plants facing regulations.

Accountants in all organizations could use the results of this dissertation to encourage their organizations to capture and analyze even more data. While this dissertation showed interesting results in terms of productivity, it was also limited due to unavailable data such as equipment uptime, compliance related investment expense, compliance related salaries expense, and other possible compliance related expenses. Data such as this can help drive decision making and understanding within an organization. Accountants could utilize this data to show that savings can be had in certain areas, and stress the importance of tracking other data that could also prove useful in understanding the effect of regulations, and aiding in the planning surrounding compliance with those same regulations.

Recommendations for Further Study

While there are many studies both academic and professional that examine the effect of specific environmental regulation, there are virtually no studies available that examine AB32, and other new and aggressive environmental policies. The results of this study show that productivity increases are possible, but the infancy of the data available introduced a limitation to the study that could skew the results. More research should be done in this area to further examine the effect of this legislation of the industries which it targets.

A follow-up to this study should be performed to examine the same data when more data points are available for examination. This type of follow up can help to control for the limitation of a small number of data points which were available for statistical analysis. Elimination of that limitation could help to solidify the results that California organizations showed productivity increases, or conversely might show the opposite and suggest that the increases were due to other factors outside of the regulations imposed.

Another follow-up to this study could be designed to test the total cost of compliance with California's AB32. While this study showed that productivity gains were possible for organizations required to comply with California's regulations, it was unable to determine the total cost of compliance and how those costs affected the profitability of organizations. To complete a study of this nature, researchers should work with the Portland Cement Association to develop a survey that captures to cost of pollution abatement measures utilized by organizations. Up until the early 21st century,

organizations were required to fill out the PACE survey which captured the cost of pollution abatement measures. The Portland Cement Association could model a survey after the PACE survey to capture pollution abatement costs from organizations and allow researchers to examine the cost of compliance and the effect of those costs on organizations required to comply with strict environmental regulations.

Next, a study could be performed that attempts to combine both productivity and costs to create a total compliance outcome score for organizations. This score could be used to benchmark how environmental regulations are affecting the entire operational efficiency of an organization, including productivity measures, direct costs, investment costs, and maintenance on equipment required for compliance. This compliance outcome score could help researchers develop a more complete understanding of the effects of environmental regulations on the operations of businesses.

Finally, a study could be conducted that attempts to examine the impacts of environmental regulations, utilizing the compliance outcome score in multiple countries. It is possible that different cultures could find different ways to adapt to regulations and innovate compliance strategies. A study that examines similar industries in countries with varying levels of environmental regulation could help to identify countries and cultures that have developed particularly effective methods of adapting to environmental regulation.

Reflections

Upon commencing this study, the researcher had expected to find results that showed that California organizations were struggling to keep up with organizations that

were not subject to environmental regulation as strict as those implemented in California. The researcher assumed that the regulation would have been too aggressive in conservation goals for organizations to keep up. Additionally, the researcher wanted to be able to develop a metric that looked at the overall effect of regulations, however the cost data simply was not available at the time of the study.

While breaking down the possible results of the study, the researcher identified four possible outcomes: (1) California organizations experienced productivity declines when compared to similar organizations operating outside of California, (2) California organizations experienced similar changes in productivity when compared to organizations outside of California, (3) California organizations experienced productivity gains when compared to similar organizations operating outside of California, and (4) California organizations experienced mixed results when examining productivity in comparison to organizations operating outside of California. The results of the dissertation showed that the California organizations had mostly positive, although somewhat mixed results when compared to organizations operating outside of California. Based on the results, the researcher would conclude that option three turned out to be the most accurate prediction, since all research questions showed productivity gains for California facilities with statistically significant results.

The researcher originally hoped to obtain results that were clearer as to how the regulations affected California organizations. While the results did show some statistically significant gains, the limitations of the study, particularly the fact that the data set is limited due to the infancy of the regulations, and the fact that cost data was not

available for analysis at the time of this study, were disappointing. While the study did not illuminate all the mysteries about California's aggressive legislation that the researcher had hoped, it did show that at least by the measures currently available, California organizations have been able to find productivity gains. The indication that organizations are adapting well to regulations is a promising result that warrants future study of this topic.

The researcher believes that the study provided measurable benefit to businesses, accountants, and legislatures. The results of the study showed that productivity gains can be spurred by environmental legislation. The study limitations showed how important data collection and analysis is for understanding the complete effect of a new compliance measure. The researcher hopes that in the future, organizations, and particularly accountants will make every effort to collect data that can be useful in determining the complete effect of regulation and compliance strategies. While the results of this study may embolden legislatures to adopt additional environmental compliance bills, the researcher hopes that legislation is always carefully considered, and effort is taken to balance the effects both positive and negative on business and the environment to reach a fair balance between economic growth and environmental protection.

The researcher was slightly surprised by the findings of this study. Since California's environmental regulation is particularly aggressive, the researcher expected to see more negative effects on California organizations. While some of these negative effects would have certainly been seen if cost of compliance data was available, it was

still surprising to see only positive effects in the area of productivity shown through the data collected.

The results of this dissertation also provided an opportunity for the researcher to reflect on the Biblical implications of environmental regulations, conservation, and business. Many verses in the Bible, particularly in the old testament give instruction on how to properly care for the land and resources granted to man by God. In Deuteronomy chapter 20, the Bible speaks about the importance of preserving fruit trees, which were a valuable resource for people at the time. It commands the Jews not to destroy fruit trees, even when conquering their enemies. This advice given to Jews nearly six thousand years ago is still valuable advice today. The resources we have on this earth are limited, and each of us, including organizations should do our best to use those resources as wisely as possible. Additional verses speak to God's command for to care for his creation. Genesis 1:26 reads, "Then God said, "Let us make mankind in our image, in our likeness, so that they may rule over the fish in the sea and the birds in the sky, over the livestock and all of the wild animals, and over all the creatures that move along the ground" (NIV).

This study showed that there are possible improvements to be had in terms of fuel use for Portland Cement manufacturers. Furthermore, there were labor productivity gains possible for organizations subject to the strict environmental regulations. The result showing increased labor productivity was surprising to the researcher, and will likely be surprising to others. Learning new things and the pursuit of wisdom is a common theme

throughout the Bible. Proverbs chapter 4 is all about gaining wisdom. Verses 5 through 8 read,

Get wisdom, get understanding; do not forget my words or turn away from them. Do not forsake wisdom, and she will protect you; love her, and she will watch over you. The beginning of wisdom is this: Get wisdom. Though it cost all you have, get understanding. Cherish her, and she will exalt you; embrace her, and she will honor you (NIV).

There are many additional verses in the Bible speak towards the value of seeking and gaining wisdom (Psalm 37:30, Proverbs 1:7, Proverbs 13:1, Ecclesiastes 2:26). While these are only a few examples of the value the Bible places on wisdom, there are many others. It is clear from the common occurrence of wisdom related themes that the Bible values wisdom and learning.

Finally, the researcher though surprised, was encouraged by the results of the study. There are many opportunities for follow up research, and the results are useful for organizations that may be facing new environmental regulation. The researcher was pleased to fill a gap in the current body of literature, and hopes to conduct follow up studies that help to bring further understanding to the effects of environmental regulation in this area.

Summary and Study Conclusions

This dissertation was designed to examine the effect of an aggressive environmental regulation on the operational efficiency of organizations which were targeted by that legislation. The researcher gathered data to compare specific

productivity measures for organizations operating inside and outside of California to determine if the legislation was having a positive or negative effect on the operations of organizations subject to the regulations. The researcher compared labor productivity measures, as well as fuel use efficiency measures for Portland Cement Manufacturers operating in California and Texas to determine whether the regulation caused measurable increases or decreases in productivity. The researcher then discussed the results of these productivity measures and their variances in terms of statistically significant changes between the two groups of organizations examined.

Academic literature that examines the effect of specific environmental regulations does exist, however at the time of this dissertation, no articles were published on specific effects of AB32 on the Portland Cement Manufacturing industry. Furthermore, prior studies did not target cutting edge aggressive legislation, like California's Global Warming Solutions Act. Thus, this dissertation provided significant new information to the current body of literature that addresses the effects of environmental regulation on the operational efficiency of organizations.

In examining the results, the researcher points out that there were statistically significant increases in productivity for all productivity measures examined when analyzed with an independent sample t-test. The three hypotheses posed by the study examined productivity changes of direct labor, total labor and fuel use efficiency. The results were statistically significant at the $p = .05$ threshold for the data set examined for all three hypotheses. This along with an examination of the differences tracked in the productivity measures indicated that California facilities experienced productivity gains,

even in the face of new, radical environmental regulations. This result indicates that Porter's Hypothesis is supported by the productivity data examined for this study. The result almost certainly will be met with some surprise, and even skepticism from the Portland Cement industry; yet there is much to be learned from the result and many more factors that can be studied.

This dissertation examined a very new environmental regulation and its impact on productivity for a large and concentrated industry impacted by the regulation. While not all environmental regulations are created equally, the results of this dissertation showed that productivity increases are possible for organizations subject to strict environmental regulation. The limitations of this dissertation also highlighted the need for accountants and operations managers to collect even more data to help understand the total effect of regulations on the operational efficiency and profitability of organizations subject to the regulations. The results of this dissertation, and discussion thereof are useful to businesses, managers, accountants and legislatures who want to learn more about the effects of environmental regulation on businesses.

References

- Abbott, M. I., & McKinney, J. (2013). *Understanding and applying research design*. Hoboken, NJ: John Wiley & Sons, Inc. .
- Adcock, R., & Collier, D. (2001). Measurement validity: A shared standard for qualitative and quantitative research. *American Political Science Review*, 95(3), 529-546.
- Andrews, R. (2006). *Managing the environment, managing ourselves: A history of American environmental policy*. New Haven: Yale University Press.
- Arnoff, G. (2010). No-inventory standard costing for JIT manufacturers: Maximizing backflush costing. *Cost Management*, 24(1), 34-37.
- Atkinson, A., Kaplan, R., Matsumura, E., & Young, M. (2012). *Management accounting information for decision-making and strategy execution*. Upper Saddle River, NJ: Pearson.
- Barnes, C. M., Dang, C. T., Leavitt, K., Guarana, C. L., & Uhlmann, E. L. (2015). Archival data in micro-organizational research: A toolkit for moving to a broader set of topics. *Journal of Management*, 20(10), 1-26.
doi:10.1177/0149206315604188
- Becker, R. A. (2011). Local environmental regulation and plant-level productivity. *Ecological Economics*, 70(12), 2516-2522.
- Becker, R. A., & Henderson, V. (2000). Effects of air quality regulations on polluting industries. *Journal of Political Economy*, 108(2), 379-421.
- Berman, E., & Bui, L. T. (2001). Environmental regulation and labor demand: Evidence from the south coast. *Journal of Public Economics*, 79(2), 265-295.

- Bigger, P. M. (2015). Environmental governance in the carbon economy: Regulating greenhouse gas emissions in California's cap-and-trade program. (*Doctoral Dissertation*). Retrieved from UKnowledge Database.
- Bovenberg, L. A., & van der Ploeg, F. (1996). Optimal taxation, public goods and environmental policy with involuntary unemployment. *Journal of Public Economics*, 62, 59-83.
- Bryman, A., & Bell, E. (2015). *Business research methods (4th ed.)*. New York, NY: Oxford University Press.
- Burger, R., & Owens, T. (2008). Promoting transparency in the NGO sector: Examining the availability and reliability of self-reported data. *CREDIT Research Paper*, 8(11), 1-34.
- Calantone, R. J., & Vickery, S. K. (2010). Introduction to the special topic forum: Using archival and secondary data sources in supply chain management research. *Journal of Supply Chain Management*, 46(4), 3-11.
- California Air Resources Board. (2014). *AB32 fact sheet*. Sacramento, Ca: California Air Resources Board.
- California Air Resources Board. (2015). *AB32 cost of implementation fee regulation*. Sacramento, Ca: California Air Resources Board.
- California Air Resources Board. (2017, February 6). *Key Events in the History of Air Quality in California*. Retrieved from <http://www.arb.ca.gov/html/brochure/history.htm>

- California Air Resources Board, & California Environmental Protection Agency. (2013). *Climate change scoping plan*. Sacramento, Ca: Office of the Governor.
- California Employment Development Department. (2016). *Labor market information for the state of California*. California EDD.
- California Environmental Protection Agency. (2017, February 5). Retrieved from The History of California Environmental Protection Agency:
<http://www.calepa.ca.gov/About/History01/>
- Chen, J. C., Li, Y., & Shady, B. D. (2010). From value stream mapping toward a lean/sigma continuous improvement process. *International Journal of Production Research*, 48(4), 1069-1086.
- Christiansen, G. B., & Haveman, R. H. (1981). The contribution of environmental regulations to the slowdown in productivity growth. *Journal of Environmental Economics and Management*, 8(4), 381-390.
- Cooper, R. (1988a). The rise of activity based costing-part one: What is an activity based cost system? *Journal of Cost Management*, 2, 45-54.
- Cooper, R. (1988b). The rise of activity based costing-part two: When do I need an activity-based cost system? *Journal of Cost Management*, 2, 41-48.
- Cooper, R., & Slagmulder, R. (2006). *Integrated cost management*. New York: Oxford.
- Cowton, C. J. (1998). The use of secondary data in business ethics research. *Journal of Business Ethics*, 17, 423-434.
- Creswell, J. (2014). *Research design: Qualitative, quantitative, and mixed methods*. Thousand Oaks, CA: Sage Publications, Inc.

- Cunningham, J. E., & Fiume, O. J. (2003). *Real numbers: Management accounting in a lean organization*. Durham, NC: Managing Times Press.
- De Zoysa, A., & Herath, S. K. (2007). Standard costing in Japanese firms: Reexamination of its significance in the new manufacturing environment. *Industrial Management & Data Systems*, 107(2), 271-283. doi:10.1108/02635570710723840
- Denison, E. (1979). *Accounting for slower economic growth: The U.S. in the 1970's*. Washington, DC: Brookings Institution.
- Dichev, I. D., & Tang, V. W. (2008). Matching and the changing properties of accounting earnings over the last 40 years. *Accounting Review*, 83(6), 1425-1460.
- Dosch, J., & Wilson, J. (2010). Process costing and management accounting in today's environment. *Strategic Finance*, 92(2), 37-43.
- Drohmeretski, E., Da Costa, S., Lima, E., & Grabuio, P. (2014). Lean, six sigma and lean six sigma: An analysis based on operations strategy. *International Journal of Production Research*, 52(3), 804-824.
- Financial Accounting Standards Board. (2016). *Accountings standards codification: 360*.
- Flato, G., & Marotzke, J. (2013). *Evaluation of climate models*. Cambridge, UK: Cambridge University Press.
- Fullerton, F. A., & McWatters, C. S. (2002). The role of performance measures and incentive systems in relation to the degree of JIT implementation. *Accounting, Organizaitons and Society*, 27, 711-735.

- Fullerton, R. R., & McWatters, C. S. (2001). The production performance benefits from JIT implementation. *Journal of Operations Management*, 19, 81-96.
doi:10.1016/S0272-6963(00)00051-6
- Fullerton, R. R., Kennedy, F. A., & Widener, S. K. (2013). Management accounting and control practices in a lean manufacturing environment. *Accounting, Organizations and Society*, 38(1), 50-71. doi:10.1016/j.aos.2012.10.001
- Fullerton, R. R., Kennedy, F. A., & Widener, S. K. (2014). Lean manufacturing and firm performance: The incremental contribution of lean management accounting practices. *Journal of Operations Management*, 32(7-8), 414-428.
- Garza-Reyes, J. A., Oraifige, I., Soriano-Meier, H., Forrester, P. L., & Harmanto, D. (2012). The development of lean park homes production process using process flow and simulation methods. *Journal of Manufacturing Technology Management*, 23(2), 178-197.
- Geert, W., & Pintelon, L. (2002). A framework for maintenance concept development. *International Journal of Production Economics*, 77(3), 299-313.
- Gray, W. B., & Shadbegian, R. J. (1995). *Pollution abatement costs, regulations and plant level productivity*. National Bureau of Economic Research working paper no. 4994.
- Greenstone, M. (2002). the impacts of environmental regulations on industrial activity: Evidence from the 1970 and 1988 clean air act amendments and the census of manufacturers. *Journal of Political Economy*, 110(6), 1175-1219.
doi:10.1086/342808

- Grove, R. (2002). Climatic fears: Colonialism and the history of environmentalism. *Harvard International Review*, 23(4), 50-55.
- Hammersley, M. (1987). Some notes on the terms 'validity' and 'reliability'. *British Educational Research Journal*, 13(1), 73-81.
- Hansen, D. R., & Mowen, M. M. (2015). *Cornerstones of cost management*. Mason, OH: Cengage Learning.
- Hardy, L. (1990). *The fabric of this world*. Grand Rapids, MI: William B. Erdmans.
- He, W. (2015). International evidence on the matching between revenues and expenses. *Contemporary Accounting Research*, 1-37.
- Humphrey, C. (2014). Qualitative research - mixed emotions. *Qualitative Research in Accounting & Management*, 11(1), 51-70. doi:10.1108/QRAM-03-2014-0024
- Husing, J. (2016). *Southern California Economic Update*. Yorba Linda, CA.
- Jaffe, A. B., Peterson, S. R., Portney, P. R., & Stavins, R. N. (1995). Environmental regulation and the competitiveness of U.S. manufacturing: What does the evidence tell us? *Journal of Economic Literature*, 33(1), 132-163.
- Johnson, H., & Kaplan, R. (1987). *Relevance lost: The rise and fall of management accounting*. Boston, MA: Harvard Business School Press.
- Joint Economic Committee of the United States Congress. (2017). *State economic snapshots*. Washington D.C.: United States Congress.
- Kaplan, R. S., & Norton, D. P. (2007). Using the balanced scorecard as a strategic management system. *Harvard Business Review*, 1-15.

- Kaplan, R., & Norton, D. (2005). The balanced scorecard: Measures that drive performance. *Harvard Business Review*, 83(7-8), 71-79. doi:00178012
- Kendrick, J. (1978). Testimony before the Congressional Joint Economic Committee. *U.S. Government Printing Office*, 616-636. Washington D.C.
- Kennedy, F. A., & Widener, S. K. (2008). A control framework: Insights from evidence on lean accounting. *Management Accounting Research*, 19, 301-323.
- Leavy, P. (2017). *Research Design: Quantitative, Qualitative, Mixed Methods, Arts-Based, and Community-Based Participatory Research Approaches*. New York, NY: Guilford Publications.
- Malina, M. A., & Selto, F. H. (2011). Lesons learned: Advantages and disadvantages of mixed method research. *Qualitative Research in Accounting & Management*, 8(1), 59-71. doi:10.1108/11766091111124702
- Moore, W., & Myers, J. (2010). Using geographic-attribute weighted regression for CAMA modeling. *Journal of Property Tax Assessment and Administration*, 7(3), 5-28.
- Morard, B., Stancu, A., & Jeannette, C. (2013). Time evolution analysis and forecast of key performance indicators in a balanced scorecard. *Global Journal of Business Research*, 7(2), 9-27.
- Ohlson, J. A., Penman, S. H., Yuri, B., Bloomfield, R. J., Glover, J. C., Jamal, K., & Tsujiyama, E. (2011). Accounting for revenues: A framework for standard setting. *Accounting Horizons*, 25(3), 577-592. doi:10.2308/acch-50027
- Porter, M. (1991). America's green strategy. *Scientific American*, 264(4), 168.

- Porter, M. E., & van der Linde, C. (1995). Toward a new conception of the environment-competitiveness relationship. *Journal of Economic Perspectives*, 9, 97-118.
- Rabe, B. G. (2008). States on steroids: The intergovernmental odyssey of American climate policy. *Review of Policy Research*, 25(2), 105-128.
- Raeesi, R., & Amini, A. (2013). Developing a grey activity based costing (G-ABC) method to capture the inherent uncertainty in identifying cost drivers' consumption rates. *Academy of Accounting and Financial Studies*, 17(2), 41-56.
- Rajib, P., Tiwari, D., & Srivastava, G. (2002). Design and development of an integrated supply chain management system in an internet environment. *Journal of Services Research*, 2(1), 75-93.
- Rivera, J., & Milani, K. (2011). Budgeting for international operations: Impact on an integration with strategic planning. *Management Accounting Quarterly*, 12(4), 1-13.
- Ryan, S. P. (2012). The costs of environmental regulation in a concentrated industry. *Econometrica*, 80(3), 1019-1061. doi:10.3982/ECTA6750
- Sánchez-Rodríguez, C., & Spraakman, G. (2012). ERP systems and management accounting: A multiple case study. *Qualitative Research in Accounting & Management*, 9(4), 398-414. doi:10.1108/11766091211282689
- Schroeder, R. G., Clark, M. W., & Cathey, J. M. (2014). *Financial accounting theory and analysis : text and cases*. Hoboken, NJ: Wiley.
- Shadbegian, R., & Gray, W. (1994). *Pollution abatement costs, regulations and plant level productivity*. Washington D.C.: Center for Economic Studies.

- Shadbegian, R., & Gray, W. (2003). Pollution Abatement Expenditures and Plant-Level Productivity : A Production Function Approach Pollution abatement expenditures and plant-level productivity: A production function approach. *National Center for Environmental Economics*(Mc1809), 1-29.
- Singh, B., Garg, S. K., Sharma, S. K., & Grewal, C. (2010). Lean implementation and its benefits to the production industry. *International Journal of Lean Six Sigma*, 1(2), 157-168. doi:10.1100/20401461011049520
- Spathis, C. (2006). Enterprise systems implementation and accounting benefits. *Journal of Enterprise Information Management*, 19(1/2), 67-63.
- Spathis, C., & Ananiadis, J. (2005). Assessing the benefits of using an enterprise system in accounting information and management. *Journal of Enterprise Information Management*, 18(1/2), 195-211.
- Staats, B. R., Brunner, D. J., & Upton, D. M. (2011). Lean principles, learning, and knowledge work: Evidence from a software services provider. *Journal of Operations Management*, 29, 376-390. doi:10.1016/j.jom.2010.11.005
- Stake, R. (2010). *Qualitative research: Studying how things work*. New York, NY: The Guildford Press.
- Teizer, J., Cheng, T., & Fang, Y. (2013). Location tracking and data visualization technology to advance construction ironworkers' education and training in safety and productivity. *Automation in Construction*, 35, 53-68.
- U.S. Bureau of Labor Statistics. (2016). *Current Employment Statistics*. US BLS.

- United States Geological Survey. (2014). *USGS Minerals yearbook*. Washington D.C. : US Government.
- Van Duzer, J. (2010). *Why business matters to God (and what still needs to be fixed)*. Downers Grove, Illinois: IVP Academic.
- Volaufova, J. (2009). Heteroscedastic ANOVA: Old p values, new views. *Statistical Papers*, 50(4), 943-962. doi:10.1007/s00362-009-0262-4
- Warren, C. S., Reeve, J. M., & Duchac, J. (2016). *Accounting*. Boston, MA: Cengage Learning.
- Weiss, J., & Sarro, M. (2009). *The economic impact of AB 32 on California small businesses*. Union of Concerned Scientists. The Brattle Group.
- Winter, G. (2000). A comparative discussion of the notion of 'validity' in qualitative and quantitative research. *The Qualitative Report*, 4(3), 1-14.
- Wong, C., Lai, K.-H., & Cheng, T. (2011). Value of information integration to supply chain management: Roles of internal and external contingencies. *Journal of Management Information Systems*, 28(3), 161-200.
- Wulke, R., & Kohl, B. (2004). Cost management: Roadmap to project success - supplementing accounting systems for project cost management. *Cost Engineering*, 46(8), 11-13.

Appendix A: Financial Data Requested

The following productivity measures were obtained, or calculated utilizing data provided by the Portland Cement Association for plants operating in California and Texas, for the years 2007 through 2015:

Productivity Measure	Description
Direct Labor Productivity	Total Direct Labor Hours Divided by Total Production Tons
Overhead Labor Productivity	Total Overhead Labor Hours Divided by Total Production Tons
Total Employee Hour Productivity	Total Employee Labor Hours Divided by Total Production Tons
Combustible Fuel Efficiency	Total Combustible Fuel BTUs Used Divided by Total Production Tons
Electricity Use Efficiency	Total Electricity BTUs Used Divided by Total Production Tons