Do Green innovations help companies increase their competitive performance?
Application on the U.S. automotive market

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Abstract

This research paper was inspired by the rising popularity of the topic of sustainability. It is always interesting to analyze the various externalities resulting from the implementation of a corporate Green Strategy. One of those externalities is the possible direct effect of companies` green actions on their competitive performance. Usually, it is expected that being green is beneficial for the corporate image and, therefore, stimulates the demand for a companies` products. A fair amount of scientific efforts have been made in order to identify the drivers of firm performance. However, none of them focuses specifically on sustainability actions and competitiveness. This paper fills in the gap, by elaborating on the effect of Hybrid/EV car introductions, green technology developments, share of green vehicle sales, share of green product advertising and manufacturing resource efficiency (CO^2, Water and Waste) on companies` market performance. The research is being executed within a specific environment - the U.S. automotive market. The twelve biggest car-manufacturers active in U.S. were selected and their market shares for a period of 10 years were used as an indicator of their competitive performance. For the purpose of answering the research question, three separate groups of 'green' actions have been formed and statistical models have been created in order to analyze the individual relationship between each action and the variation in companies` market shares. After performing necessary tests, it was concluded that Green Innovations (introduction of hybrid/EV vehicle, green technology developments and share of green vehicle sales with respect to total vehicle sales) can significantly accelerate the competitive performance of the automotive companies in U.S. Hopefully, this conclusion is also valid for other industries and on a global scale.

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1. Introduction

In the last decades, motor vehicles are often considered as the biggest source of pollution. Therefore, companies from the automotive industry invest a lot in developing green technologies/products, implementing green process improvements and organizing advertising campaigns to promote their green innovations. They do this in order to be in line with the sustainability topic that has become extremely popular on a global scale. There is no doubt that green automotive business practices are good for society. However, it is uncertain whether the green strategy of a car company is justified by the company`s performance.

This paper aims to investigate the effect of green actions on companies` performance in the U.S. automotive market. The green actions, which will be taken into consideration, are: hybrid/EV car introductions (along with the resulting hybrid car sales), green technological innovations, green advertising expenditures and environmental performance indicators (energy consumption, raw materials usage and waste disposal).

In general, managers of automotive companies expect that sustainability actions are going to have positive effect on the corporate image. Respectively, consumers will be more attracted to the company and will buy more cars, and in the end this will result in increased sales. But, is that really the case? It might as well be that consumers believe that green product means lower quality and, eventually, they are more willing to give up their social/eco responsibility for better quality. Also, consumers might get confused by a green product introduction. For example, if a certain company has been building its image on values such as top performance, highest quality, unique design/style, high-class status, it might be odd if this same company suddenly jumps into claims for Corporate Social Responsibility and eco-friendliness.

For the research I chose to focus on the U.S. market because it has been the largest automotive market, in terms of vehicle unit sales, for more than a century – from early 1980s to 2010 (Bloomberg, Jan 2011), when it was overtaken by China. And since it is such a big market, it will show most accurately any possible variations of market performance indicators.

There are many Key Performance Indicators (KPIs) that can be used to measure the performance of a company – Tobin`s Q, P/E ratio, Firm-based brand equity, Customer-based brand equity, Market Share, etc. For my research I chose to focus only on one of those parameters – Market Share. I made this choice because market share percentages provide the most relevant competitive information. The assumption is that the motivation of a company to

become a market leader might be reflected in its marketing strategy. For example, car-manufacturers are supposed to intentionally undertake environmental sustainability actions in order to keep up with their competitors.

Taking into account everything discussed so far, the following research problem is defined:

How do 'green' actions of automotive companies affect their relative shares on the U.S. market?

In order to answer this fundamental question, a number of sub-questions should be answered as well:

- What is the general definition of a green action?
- What are the typical 'green' actions for an automotive company?
- What are the standard drivers of the market share of an automotive company?
- Is there a correlation between 'green' actions and market shares of automotive companies?
- Which 'green' actions are correlated to the market share?
- If there are correlations, are they positive or negative? How strong are they?

Finding out the answers of those questions will have a significant contribution to the existing literature in this research area, and also will have strong implications for marketing managers of automotive companies.

From a scientific point of view, in existing literature, a lot has been discussed about the factors affecting firm performance. A lot of empirical investigations have been made within different frameworks. Examples of problems that have already been researched are: the impact of competitive marketing strategies (such as price, advertising expenditures, product attributes and country of origin) on automotive market shares (Epstein, 1996); the impact of consumer-level variables (such as car-size, fuel consumption, expected future value, car manufacturer, etc.) on automotive market shares (Train & Winston, 2007), the relationship between emission reduction and firm performance (Hart et al., 1996), the effect of environmental technologies on a firm's financial performance (Avagyan et al., 2011).

My paper will build up on all those previous investigations by putting together sustainability actions and market shares. Sustainability actions will be breaking down to a set of separate 'green' actions. The green actions that are being analyzed are divided into three groups –

Green Innovations, Sustainable Value in Manufacturing and Green Advertising Expenditures. Additionally, the dependency of companies` market shares on their sustainability actions will be tested in a very specific environment – the U.S. automotive market.

From a managerial point of view, answering the proposed research question will provide a valuable insight to automotive industry executives. They will be able to find out whether the green investments they make actually helps to maintain competitiveness on the market. Also, those executives will be able to identify which particular 'green' actions are justified in terms of market performance and which are not. Apart from automotive companies, also companies from other industrial sectors can use this research. Many businesses can benefit from the general inferences that will be made about 'Green' actions and their impact on firm`s market leadership. Companies can learn what the best green action is in terms of company return.

Further, the paper will continue with a short overview of existing literature in the same research area, hypotheses development, research methodology, findings and conclusions.

2. Literature Review

There are several previous researches, which aim to analyze the relation between marketing strategy and market share.

Gatignon et al. (1990) suggest that market share is a superior indicator of the long-term performance of a company. This indicator shows very clearly the competitive position that a company holds. According to Gatignon et al. (1990), in order for a company to be ahead of the competition, three things must be present – favourable competitive environment, strong product/brand capabilities and excellent marketing strategy. In my paper, I would like to take this theory one step further, by focusing specifically on the "Green Marketing Strategy" and breaking it down to a set of separate 'green' actions.

Another insight that was presented by Gatignon et al. (1990) is that the pace of technological change and the rapidly changing consumer needs shorten the product life-cycle and serve as an incentive to firms to modify their competitive strategy. In that sense, since sustainability has become a very hot topic for the last decades, companies are forced to adjust to that trend and quickly respond by introducing 'green' innovations. Not doing so might result in substantial losses in terms of competitiveness.

Slywotzky & Shapiro (1993) claim that the market leadership position of a company is a consequence of cumulative marketing expenditures. Therefore, the more a company spends on sales and advertising activities, the more competitive it becomes and the bigger share it gains. For that reason, I decided to take into consideration the 'Green Advertising Expenditures' factor. Based on the conclusion of Slywotzky & Shapiro (1993), and based on my personal assumption, it might turn out that the more a company invests in 'green' advertising, the better it performs on the market. This expectation is based on the high possibility that green advertising expenditures do not only aim to boost the sales of green products, but also to build up on the corporate image and create higher brand value. As for the automotive companies, this assumption would translate into the following statement: Even though the percentage of consumers interested in hybrid/EV vehicles is relatively low, advertising of green vehicles might increase the total brand equity and this will further influence the consumers` purchase choice not only for green cars, but also for the non-green ones.

In 1996, Shelley Epstein examines the impact of competitive marketing strategies on market leadership. The strategic elements, which are taken into consideration in this study are pricing, advertising expenditures, product attributes and country of origin. The model is tested in the framework of the automobile industry, which is identical to approach I am going to use in this paper.

Shelley Epstein (1996) proves empirically that there is, indeed, correlation between advertising expenditures and market share. Her interpretation of this phenomenon is that, when more resources are invested in advertising, a higher level of awareness is raised among the consumers. Respectively, as more consumers are reached, the sales are supposed to increase.

As for the 'country of origin' variable, the interpretation of Shelley Epstein (1996) is very controversial. This controversy stems from the fact that Shelley identified a multicollinearity effect between 'country of origin', 'product attributes' and 'pricing'. Probably, in the mind of the consumer the country where an automobile is manufactured tells a lot about the attributes and their quality, and, therefore, plays significant role in setting the price barriers. Because of this inference, I assume that it is logical to drop out price and product attributes, hoping that those two are going to be explained by the 'country of origin' of the particular car manufacturer. An additional reason to not consider the price and product attributes in this

research is that those factors can be analyzed only on product level and in this paper a decision has been made to perform all analyses on a corporate level.

Chen et al. (2006) differentiate between two types of environmental actions – Green Product innovation and Green Process improvement. The research of Chen et al. (2006) was conducted on a sample of 232 firms in the information and electronics industries in Taiwan. In the conceptual model created by Chen et al. (2006), 'green innovation' is defined as a software or hardware improvement related to energy-saving, pollution prevention, waste recycling, green product designs or corporate environmental management. On the basis of their empirical results, Chen et al. (2006) conclude that firms that are environmentally oriented are able to gain competitive advantage by successfully combining those two types of actions. While Chen et al. focus on the software and hardware innovations as drivers of firm performance, I will take a look at the market share effect of the sustainable value created through the innovations – O^2 efficiency, Water efficiency and Waste reduction. In my research, green product innovations will be represented by the hybrid car introductions and the development of green technologies. Green process improvements will be represented by following the environmental performance indicators of each car manufacturer.

In 2007, Hahn et al. introduce the Sustainable Value approach for measuring the sustainability performance of companies in their manufacturing process. Hahn et al. (2007) make a comparison between the historical resource-efficiency of selected European manufacturing companies and the recourse-objectives for 2010. The model is based on a very common indicator for financial valuation – return-on-capital employed. In management theory, it is assumed that the use of capital always creates value when it earns a higher return than if the capital had been employed elsewhere (Hahn, et al. 2007). The Sustainable Value approach treats environmental resources (such as water, energy, CO^2 emissions and landfill waste) as capital, which has to be used in a value-creating way. As a result, the environmental efficiency can be measured in monetary terms. The method for calculating sustainable value makes use of the opportunity cost concept. For example, the opportunity cost of generating 10 tons of CO^2 emissions for the production of 10 000 cars, is the difference between the return on those 10 tons of CO^2 emissions released and the average return in the industry for the same amount of natural resource. What matters is the environmental efficiency with respect to competitors. While Hahn et al (2007) analyze the yearly variations in Sustainable Value, my intention is to analyze the same variations, but with respect to the changes in companies` market shares.

The Sustainable Value model is recognized by car-manufacturers World-wide and is very useful tool for analyzing the environmental impact in the manufacturing process.In my research I will integrate the Sustainable Value concept created by Hahn et al. (2007) within the framework of Chen et al. (2006). My intention is to treat Sustainable Value creation elements (CO2 efficiency, water efficiency and landfill waste efficiency) as externalities of the companies` Green Process Improvements.

3. Hypothesis Development

Based on previous literature, a theoretical framework is built for this research and three hypotheses are being stated. The framework is represented by the conceptual model in *Figure 1*. The green actions that are being analyzed are divided into three groups – Green Product Innovations, Sustainability Value in Manufacturing and Green Advertising Expenditures. The goal is to investigate how each of those types of "green" actions affects the competitive position of the automotive companies on the U.S. market.

The first assumption that is made is that by developing innovative green technologies and introducing hybrid/EV cars on the market, car-manufacturers are able to increase their total vehicle sales. Chen et al. (2008) verify that Green Core Competence is positively correlated to company`s green image. Chen et al. (2008) define Green Core Competence as "the collective learning and capabilities about green innovation and environmental management in an organization". The tangible results of the green core competence of a company are the green products and green technologies that are being developed. Therefore, in this research, the introduction of green car technologies and the introduction of green vehicles will be considered as a natural representation of the core competences of car manufacturers. In the framework of Chen et al. (2008), developing green car technologies and introducing green vehicles to the market would significantly improve the green image of those car-manufacturers. In addition, due to the growing environmentalism, consumers are getting more eco-conscious and are valuing the green image of companies. Therefore, the improved green image must lead to a positive consumer attitude towards the organization and, thus, the market performance of this organization will improve. This reasoning leads to the first hypothesis, which will be tested:

H1: Green Innovations have positive effect on the Market share of automotive companies in the U.S.

The Green Innovations group consists of:

- Hybrid/EV vehicle introductions
- Green technology development
- Share of green vehicle unit sales with respect to total vehicle unit sales

The second assumption is based on the Sustainable Value model (Hahn et al. 2007) and the Green Process Improvement theory (Chen et al. 2006). Chen et al. (2006) empirically prove that, in general, Green Process Improvements lead to higher competitive performance. In the automobile industry, a green process improvement could be any innovation, which leads to a more eco-friendly manufacturing (with less CO^2 emissions, lower water consumption and less landfill waste generated). Therefore, by increasing the sustainable value in the manufacturing processes, a car-manufacturer is supposed to be able to gain competitive advantage on the U.S. market. More efficient energy consumption, decreased raw material usage and decreased disposal waste are key environmental performance indicators, which contribute significantly to the sustainability image of the company. My intention is to check whether the variations in automotive market shares are, indeed, driven by the sustainable value generated by the companies in their manufacturing processes. Therefore, the second hypothesis, which I am going to test, is:

H2: The Sustainable Value in Manufacturing has positive effect on the Market share of automotive companies in the U.S.

The Sustainable Value in Manufacturing group consists of:

- CO^2 efficiency
- Water efficiency
- Total Waste efficiency

The third factor, which will be included in my research, is related to Green Product Advertising. As already discussed, advertising, in general, has proven to have significant effect on market share (Epstein, 1996). However, the framework of this research will limit the concept of advertising to Green Product Advertising only. What is meant by the term "Green Product Advertising", is only the advertising efforts, which are dedicated to promoting green products (in this case – hybrid/EV cars). In this paper, those efforts will measured in monetary terms – the dollar value of Green Product Advertising Expenditures. Moreover, the Green Product Advertising Expenditures will be considered as a share of the Total Advertising

Expenditures of the automotive companies. The reason for that is to find out whether investing in Green Advertising is more worth it than investing in non-green advertising, when it comes to gaining market share. If this statement is true, maybe automotive companies should consider increasing their spending on green advertising in order to maintain their competitive position on the market. With regard to this assumption, the following hypothesis is formulated:

H3: Higher Green Product Advertising expenditures have positive effect on the Market share of automotive companies in the U.S.

Green Product Advertising expenditures will be considered as a share of total advertising expenditures. Using such approach will enable the interpretation not only of the absolute effect of green product advertising spending, but also the proportional one.

Based on previous literature, a decision has been made to take into account also the possible direct effect of the region of origin of the companies, their portfolio sizes and the year for which we are running the analyzes. We expect these variables will influence the effect of company's green actions on their market share.

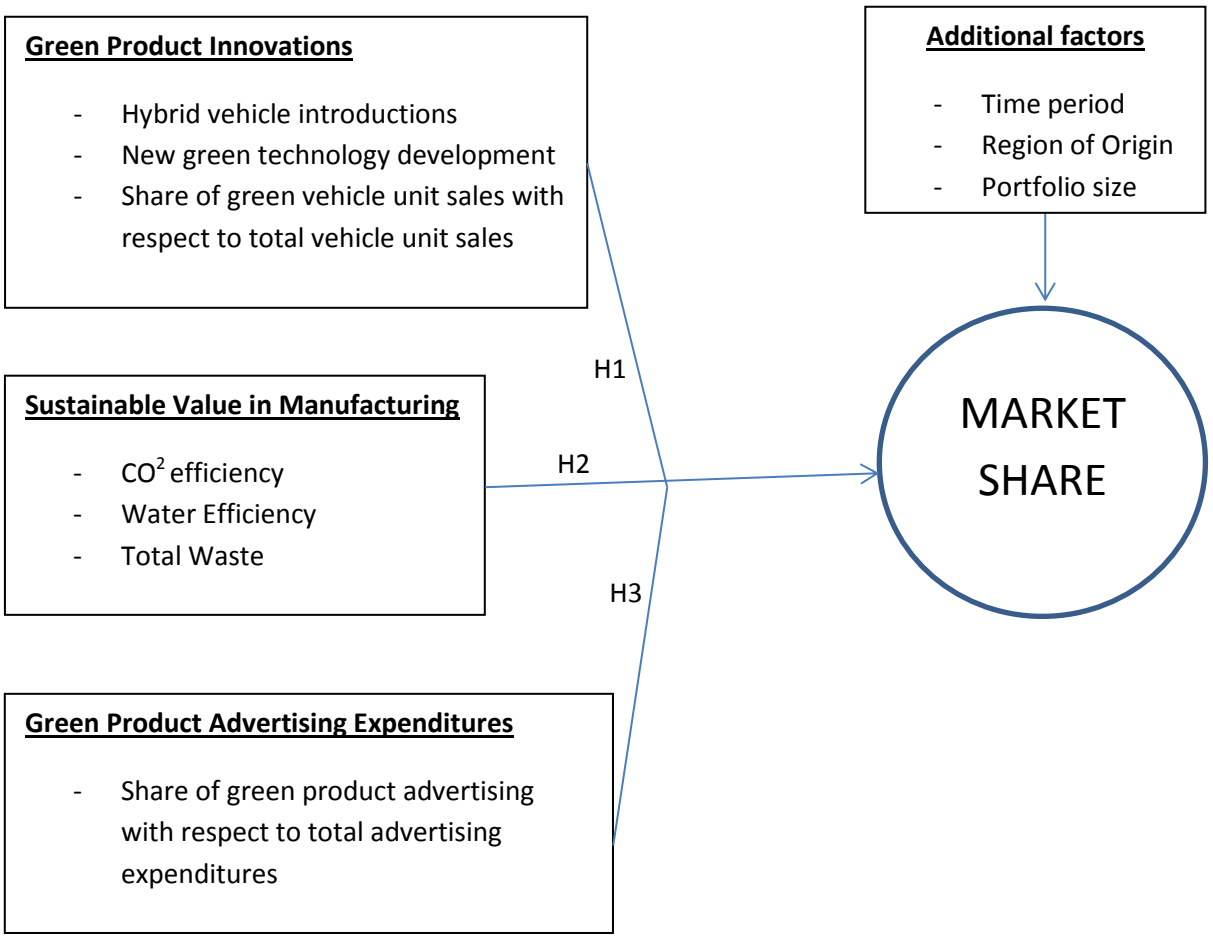
Region of origin could have a very big explanatory power as a driver of market share. Epstein (1996) proves that the country of origin of a certain company reflects its competitive performance. According to the interpretation of Epstein (1996), the region of origin incorporates vital information about the price-quality consumer perceptions. Therefore, consumers` country-related choice of purchase, might be driven by a pure nationalism (Americans might prefer to buy FORD cars just because it`s an American company) and/or quality perceptions related to the country of origin (Americans might be buying Mercedes just because they believe that German cars have the best quality). In both cases, 'Country of origin' is expected to have a significant effect on the market leadership of a certain company. In this research the car-manufacturers are divided by regions instead of countries, so the term that is going to be used is "Region of Origin".

Having 'Portfolio size' included also makes perfect sense. When a company offers a larger number of products, it has bigger chance to satisfy the different needs of consumers, thus, generating more sales and getting higher share of the market. Especially, in the case of automotive companies, it is very important that they offer a big variety of vehicle types to

satisfy the needs of more consumers. The more different vehicles a company offers – the bigger chances it has of becoming a market leader.

The time period is also supposed to have a direct effect on the firm performance. The years 2006 to 2009 were extremely bad for U.S. carmakers. Ford, GM and Chrysler reported some of their biggest losses in history. Ford was forced to sell its Jaguar and Land Rover operations in order to pursue getting back to profitability. For the same reason, GM and Chrysler were forced to take a government loans. Therefore, market shares of those companies might have dropped just because it was a bad year for them. In that case, green actions could still had a positive effect on firm performance, but that positive effect might have been offset by the unfavourable economic conditions in the particular year. With that respect, in my analysis, I would like to take into account the direct effect of the time period.

Figure 1: Conceptual Model



4. Methodology

This research is defined as being explanatory. The main object of the analysis is the variation in the competitive performance of automotive companies on the U.S. market. As an explanation of this phenomenon, a causal relationship has been proposed between companies` green actions and their market shares. This ad-hoc proposition has been made via the already stated hypotheses. The hypotheses will be confirmed/rejected after performing an empirical analysis. Relevant statistical data is gathered via various sources. Statistical models are designed with respect to the hypotheses of interest. Further, the models are tested with the data available in order to indicate whether the expected correlations exist or not. Based on the results it will be possible to make conclusions and answer the research question.

Sample

As already mentioned the research is being restricted to the U.S. automotive market. Therefore, all figures gather will be related only to the U.S. market. By following that restriction, it can be guaranteed that the data is consistent and the comparison between different observations is fair and reliable.

For choosing the appropriate sample size, the level of data aggregation had to be selected very carefully. The data points have to be gathered in a way that the data set is small enough to be easily analyzed and big enough to show reliable results.

There are three dimensions along which the data aggregation level could be adjusted – corporate Vs. individual product level; yearly Vs. daily data points; long Vs. short time span, number of companies to be included.

Since the main interest of the analysis is focused on the green investments and the overall competitive performance of automotive companies, it seems logical to observe corporate level data. The research question posed and the answer expected both require corporate level information. Therefore, a decision was made that the data points will be collected per company.

New automotive sales are realized every day. Market shares are changing constantly. However, focusing on those daily movements would be too detailed and not justified by our main research purpose. The goal is to assess the long-term performance of companies and how they manage to sustain their competitive position for a certain period. Important strategic decisions, such as Green Investments, are not made every day. They are made on a yearly or

at least on a quarterly basis. The metrics that are going to be included in this analysis are very specific. For some of them it is extremely hard, or impossible to gather daily or quarterly data. For those reasons, the statistical observations are going to be aggregated on a yearly basis. This methodological decision makes the data collection process possible and easier, and yet no explanatory power is lost. In fact, for this type of research, yearly data should give significant results.

The time-span that should be captured by the observations is defined by the research topic. The topic is related to sustainability and green actions of automotive companies in the U.S. Therefore, the follow-up of information should start at the moment when car-makers became environmentally-conscious and started undertaking green actions in the U.S. Maybe the most remarkable turning point, in that sense, is the first introduction of hybrid car in North America. That would be the Honda Insight, introduced in 2001. Honda as a first-mover, has been quickly followed in 2002 by Toyota with the introduction of the Toyota Prius hybrid. From that moment on, all automotive companies were forced to re-think their sustainability strategies in order to not let Honda and Toyota undertake the whole green automotive market, which was supposed to grow bigger in the future. This was the moment when U.S. car-makers started having incentives to go 'green' and compete in the green market. Therefore, 2002 was selected as a starting point also for this analysis.

Finally, the companies which are going to be analyzed have to be selected. Currently there are 27 car manufacturers active on the U.S. automotive market (Wall Street Journal, 2012) with total sales of 9.5 million vehicles (light vehicle + trucks). From those 27 – 13 companies are based in Europe, 9 are based in Asia and 5 in the United States.

There are two criteria on which the company selection was made. First of all, the business volume of the selected company should be big enough in order to contribute to the analysis. The business volume is defined by the total unit sales generated per period. Second of all, it is suggested that the dataset should be neutral in terms of companies' region of origin. A relatively equal number of companies should be selected from each region in order to avoid any bias related to the region of origin factor.

The option which would be closest to reality would be to observe all of those 27 companies. However, some of them account for very few unit sales. Because of that very low volume of their business, having them included in the research will not contribute significantly to the final results. Therefore, some of the car-manufacturers were dropped out of the sample. After

this filtering was implemented, 12 companies were left. Even though this is less than a half of the total number of 27 companies, we still manage to capture over 95% of the total unit sales in the U.S. market. Due to this high coverage, the analysis is expected to give results, which are reliable and valid for the U.S. market with a 95% confidence.

In addition, the 12 companies in the dataset have the following distribution in terms of region of origin: Asia Pacific - 5, Europe - 4, North America - 3. This distribution satisfies our condition for region-of-origin neutrality. Below you can see the final list of car manufacturers, which were included in the dataset:

Figure 2 List of Automotive Companies included in the research

Car Manufacturer	Region of Origin
1. General Motors Corp.	North America
2. Ford Motor Co.	North America
3. Chrysler LLC	North America
4. American Honda Motor Co. Inc.	Asia Pacific
5. Toyota Motor Sales USA Inc.	Asia Pacific
6. Nissan North America Inc.	Asia Pacific
7. Hyundai Motor America	Asia Pacific
8. KIA Motors America Inc.	Asia Pacific
9. Mercedes-Benz/Daimler	Europe
10. Volvo Group North America	Europe
11. BMW of North America Inc.	Europe
12. Volkswagen of America Inc.	Europe

In the end, the sample was defined through the following parameters:

Corporate level data, on a yearly basis, for 10 years (period: 2002-2011) for 12 car manufacturers. The total number of observations in the dataset is 120.

Variables

After the sample is defined, a choice has to be made about the types of information, which is required in order to perform the empirical analysis. The challenge here is that every piece of information has to be collected according to the sample format – for each of the 12

companies, there should be 10 data points (for each year from 2002 to 2011) per variable. The variables of interest were gathered through many different sources. Those sources were statistical databases, as well as the sustainability reports of automotive companies. Therefore, the numbers that are used in the research are considered as purely secondary data.

MARKET SHARE: The most important variable for the research is the one that represents the market shares of each company. For the purpose of building this variable, I first found the total unit sales number (for light vehicles and trucks) for each of the twelve companies on a yearly basis for each of the ten years. Then, in order to get the market share values, the total unit sales per year of a company was divided by the sum of total unit sales for the same year for all 12 companies. So, if:

i = company t = year

X_{it} = total unit sales of company i in year t

Mkt_Share_{it} = market share of company i in year t

Then: $\text{Mkt\_Share}_{it} = \frac{X_{it}}{\sum_{i=1}^{12} X_{it}}$

For this calculation an assumption is made that the whole U.S. automotive market consists only of the 12 car manufacturer given in the sample. The sum of all 12 market shares for a certain year will always equal 100%. *Check Appendix to see a pie chart, which illustrates the distribution of the average market shares per company for the period 2002-2011 (Figure 1.1)*

GREEN INNOVATIONS is the first group of 'green actions' to be taken into account. The variables, which fall within this category, are:

- *presence of hybrid/EV car introduction (for a given year)*
- *share of green vehicle unit sales with respect to total vehicle unit sales;*
- *presence of new green technology development (for a given year)*

In 2002, Toyota introduced the first hybrid car on the U.S. market – Toyota Prius. Ever since, hybrid cars were gaining more and more popularity. So far, it is one of the product innovations, which has changed (and keeps changing) the automotive industry a lot. After Toyota`s hybrid launch, the other car-manufacturers in the U.S. had to also follow the new trend. In 2010, 8 out of 12 companies included in our sample introduced a hybrid car to the

U.S. market. The main stimulus of those companies to undertake such product innovation, is to respond to the constantly rising need of the customers for eco-friendly and energy-efficient vehicles. Car-makers believe that satisfying those customer needs is an important tool for keeping their competitive position on the market. What needs to be checked, though, is whether this correlation between introducing a hybrid car (as a product innovation) and increasing market share (as a representation of competitiveness) really exists.

Testing this correlation will be enabled by creating the *hybrid car introduction* variable. In the dataset this will take the form of a dummy variable which will indicate for each company, and for each year, whether a new hybrid car introduction has occurred or not. After performing the statistical analysis, it will become clear whether green action, such as developing and introducing a hybrid car, has direct effect on market share.

Share of green vehicle unit sales with respect to total vehicle unit sales is also a very indicative variable. The purpose of having it included in the analysis is to see if having bigger proportion of green vehicles sold, out of all vehicles sold by a car-manufacturer, leads to an increase in market share. The presence of such positive correlation will be a significant proof that automotive companies should be even more pro-active in the green vehicle segment. This variable will be calculated as follows:

$$Share\_of\_hybrid\_sales_{it} = \frac{\#\ of\ hybrid\ car\ unit\ sales_{it}}{\#\ of\ total\ vehicle\ unit\ sales_{it}}$$

Another variable that falls into the 'Green innovations' category in the automotive industry is the *new green technology development.* Most of the automotive companies nowadays, invest a vast amount of money in research and development of new car technologies, which lead to higher energy-efficiency of the vehicles, less CO_2 emissions released and higher level of recyclability of car materials after disposal. As defined by Chen et al. (2008), green technology refers to any technology that is created with the purpose of energy-saving, pollution prevention, water recycling or corporate environmental management. This definition will be used as criteria to identify whether a particular automotive company has developed a new green technology or not.

The overall result from creating new green technologies is minimizing the environmental impact of the vehicles and the way they are produced, shipped, used and disposed. From a consumer`s perspective, those technologies are beneficial in two ways. First of all, driving a

car becomes more affordable, because of the higher energy efficiency (more MPG). Secondly, driving a car which is eco-friendly makes consumers feel more environmentally responsible.

Given all those statements, it is assumed that the development of new green technologies would have positive effect on the overall sales of car-makers. This assumption will be tested in the empirical analysis, by creating a dummy variable, which will indicate for each automotive company in the database, whether it has developed a new green technology in a particular year, or not. In case a positive correlation is found between new green technology development and company`s market share, that will serve as a significant evidence to claim that car-manufacturers can improve their market performance by investing more in R&D for new green technologies.

SUSTAINABLE VALUE IN MANUFACTURING includes the environmental efficiency indicators, which explain the environmental impact resulting from the car-manufacturing processes. The Sustainable Value concept, created by Hahn et al. in 2007, will be integrated in this research. Three are the variables, which are going to be used for analyzing the sustainability value in manufacturing for each automotive company:

- *CO^2 sustainable value contribution,*
- *Water sustainable value contribution*
- *Total Waste sustainable value contribution*

The sustainable value contribution metrics are given in monetary terms. The calculation method, which is applied in order to get those values, is the one introduced by Hahn et al. (2007) It explains the sustainable value of using a resource, by measuring the return (in dollar terms) on utilizing that resource with respect to the average industry return. In the model of Hahn et al. (2007), return is represented by the EBITA figure, taken out from the financial statement of the company of interest. The calculation includes the following four steps:

1) Estimate the monetary return per 1 unit of the particular resource used (Ex. $10 per metric ton of CO^2 emissions released)
2) Estimate the average monetary return per 1 unit of the particular resource used on an industry level (Ex. $9 per metric ton of CO^2 emissions released)
3) Compare company return with the industry average (company return – industry average) to receive the Value Spread or the resource efficiency difference (Ex. Value Spread = $10 - $9 K = $1)

4) Multiply the Value Spread by the amount of resource used to receive the Sustainable Value contribution of the resource (Ex. $1* 5000 t = $ 5000)

The mathematical expression for calculating the Sustainable Value contributions of CO^2, Water and Total Waste is:

$$\text{Sustainable\_Value}_{it} = \left(\frac{EBITA_{it}}{X_{it}} - \frac{\sum_{i=1}^{12} \frac{EBITA_{it}}{X_{it}}}{12} \right) \times X_{it},$$

, where

X = amount of resource employed in manufacturing

i = company

t = year

Please, note that negative Sustainable Value contribution is possible in case that the car-manufacturer is using the natural resources less efficiently than the industry average.

For easier interpretation, the Sustainable Value contribution values will be recorded in the dataset in billions of dollars per resource unit.

Part of the data for the three Sustainable Value variables needed has already been collected by Hahn et al. (2007) in the "Sustainable Value in Automobile Manufacturing" report from 2009. The figures that are ready to be used are recorded up until 2007. For the period 2007-2011, the numbers will be calculated manually. For the purpose of calculation, EBITA and natural resource usage level information will be gathered from the companies` annual financial and environmental statements.

Please, note that Sustainable Value data, for most of the companies in the dataset, is available only on a global scale. Therefore, in the empirical analysis, an assumption will be made that global Sustainable Value data is representative for the U.S. market.

GREEN PRODUCT ADVERTISING EXPENDITURES is the third type of 'green actions', which will be considered to have significant effect on automotive companies` market performance.

Advertising is known to be an extremely influential communication tool for connecting with the consumer – spreading awareness, creating associations related to a certain company/product/brand and make consumers step into action and buy certain product/service. Car-makers are also making use of that tool. They are investing a lot in communicating their sustainability efforts to consumers through advertising. What they are advertising are their new technologies and the new products (hybrid cars and EVs).

My intention is to test if the green product advertising expenditures of automotive companies have positive effect on their market share. If spending more on green advertising would lead to better overall market performance, it would then make perfect sense for car-manufacturers to consider increasing their green advertising budget for future periods.

One variable is going to be included in the dataset in order to cover green product advertising expenditures:

- *Share of green product advertising expenditures with respect to total advertising expenditures*

Taking a look at the effect of 'Share of green product advertising expenditures with respect to total advertising expenditures' variable on market share, will provide a valuable insight on how the proportion of green product advertising budget could affect market shares. The variable is being calculated as follows:

$$\text{Share\_of\_greenAd}_{it} = \frac{\$\, Green\ Product\ advertising_{it}}{\$\, Total\ Product\ advertising_{it}}$$

In addition to the green actions variables, several control variables are also considered. They aim to give even more explanatory power to the models by taking into account possible heterogeneity related to company characteristics and, also, time effects.

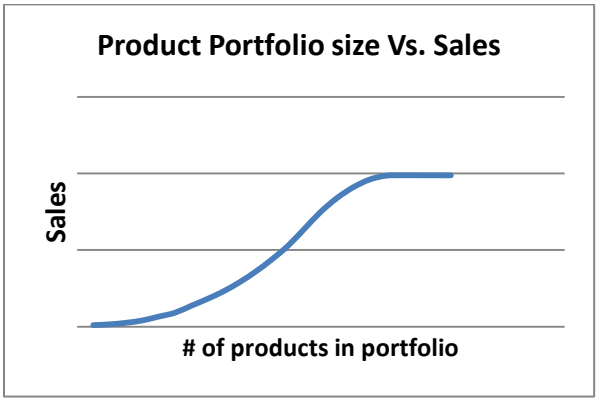
The first control variable is *region of origin.* For each company a country-specific dummy was created, which indicates the region, where the car-manufacturer resides. All 12 companies from the dataset were divided into three groups according to their location – North America, Europe, Asia Pacific. Two dummy variables were created (one per North America Region and one for Europe), and for every company, a value of 1 was assigned to the region where it origins from, and a value of 0 was assigned to the other two regions left in the data string. A dummy variable for the companies located in Asia Pacific was not created, because those companies were used as a reference for NA and European regions. By using this method

we will be able to tell, for example, whether, on average, North American companies have higher or lower market shares than Asian.

In the mind of the consumer, region of origin tells a lot about the quality and actual value of the product. Also, because of some unobservable reasons, some consumers have preference for products coming from a certain region. It is certainly one of the important drivers of making a purchase decision. Therefore, the *region of origin* variable is expected to contribute significantly to the analysis by capturing part of the variations in companies` market shares.

The second control variable is *product portfolio size.* This is a company characteristic, which could affect sales and, thus, boost or shrink the market share. The more products a company offers - the better chances it has for being competitive and performing well in terms of relative share of sales with respect to its competitors. This assumption is supported by the fact that product diversity is significantly correlated to firm performance (Tallman & Li, 1996). This correlation, however, is quadratic, which means that at a certain point the positive effect of extending product portfolio disappears (*see Figure 3*). Using the *product portfolio size* variable, will contribute to the analysis by accounting for any possible correlation between market share variations and the number of vehicles offered by a car-manufacturer.

Figure 3 – Correlation between the product portfolio size and volume of sales.



The purpose of creating the third control factor will be to explain any market share variations caused by the time-frame of each observation. In order to make the time-effect statistically visible and suitable for analysis, 9 time-specific dummy variables were created. Each of them represents a particular year – from 2002 to 2011. For every observation in the dataset, a value of 1 will be assigned to the year in which it was recorded, and a value of 0 will be assigned to

all other years. Then, in the final results, it will be clear whether there was a systematic change in market shares, caused by an economically bad or good year. For the year 2003 a dummy is not created. This year will be used as a reference for all other years. By using this method, we will be able to tell, for example, whether the year 2007, on average, had better influence on the automotive market shares than the year 2003.

Statistical Modeling

In order to test the three hypotheses of this research, four separate statistical models will be configured and analyzed. Three of them will consist of each of the three groups of green actions and the fourth model will put all of them together. The fourth models will be closest to reality, given that, usually, companies have all types of green actions integrated together in one consistent environmental marketing strategy. Since we are searching for the drivers of firm performance and market share is the variable, which represents firm performance, market share will also be the dependent variable in all four models.

The method that will be used in the empirical analysis will be Multiple Linear Regression..

MARKET SHARE Vs. GREEN PRODUCT INNOVATIONS (Model 1)

The first relationship, which is going to be tested, is between market share and Green Product Innovations. As already discussed, Green Product Innovations is a category, which includes three variables - *introduction of hybrid/EV car dummy (D_intro_car), , Share of green vehicle sales with respect to total vehicle sales (Share_Sales) and introduction of new green technology (D_intro_tech).* The mathematical expression of the relationship between Green Product Innovations and market share is:

(1) $\mathbf{Market\_Share_{it} = \beta_{0it} + \beta_{1it} * D\_intro\_car_{it} + \beta_{3it} * Share\_Sales_{it} + \beta_{4it} * D\_intro\_tech_{it} + \varepsilon_{it}}$

, where i = company and t = year

Running this linear regression with the data from our dataset will help us identify the individual effects of each specific green action on the competitive performance of automotive companies. The intercept of this regression equation is needed to identify the baseline market share level, which is not dependent on Green Product Innovations. This is the market share gained/lost due to company-specific or time-specific characteristics. In our dataset, those

characteristics are represented by the control variables. In order to incorporate them into the statistical model, a second level of the regression equation is added:

(2) $\beta_{0it} = \gamma_{0it} + \gamma_{1it}$***Portfolio_size**$_{it} + \gamma_{2it}$***Region_of_origin**$_{it} + \sum_{t=1}^{t=10}(\gamma_{3it} * \mathbf{Time_{it}}) + \varphi_{it}$

The γ_0 term here accounts for the variance in the β_{0it} term, which is not explained by the product portfolio size, the region of origin and the time period of the observation.

In both equations we have the error terms – ε_{it} and $\varphi_{it.}$ They are included in order to show, what part of the variance in market share and company-specific characteristics cannot be explained by the model at all.

MARKET SHARE Vs. SUSTAINABLE VALUE IN MANUFACTURING (Model 2)

The second statistical model, which is going to be tested with the data available in the research dataset, will focus on the sustainable value created in the manufacturing process and the market shares of automotive companies in the U.S. The sustainability value variables that will take part in the model are: *CO^2 efficiency sustainable value contribution (CO^2_value), Water efficiency sustainable value contribution (Water_value) and Total Waste efficiency sustainable value contribution (Waste_value).* The model will be built as a linear regression and its mathematical expression looks as follows:

(1) Market_Share$_{it} = \beta_{0it} + \beta_{1it}$***CO^2_value**$_{it} + \beta_{2it}$***Water_value**$_{it} + \beta_{3it}$***Waste_value**$_{it} + \varepsilon_{it}$

The results from running this regression will provide detailed information on the individual effects of CO^2 efficiency, water efficiency and total waste efficiency (in the manufacturing processes) on the competitive position of automotive companies in the U.S.

There is still a certain amount of market share, which is driven by factors other than sustainable value in manufacturing. The impact of those factors is captured by the β_{0it} term. Similarly to the first model, which was already presented, a second equation will be added to this model with the purpose of using the control variables we have in the dataset in order to determine what part of the intercept effect on market share is due to company-specific and time-specific characteristics. The second mathematical expression is exactly the same as in Model 1:

(2) $\beta_{0it} = \gamma_{0it} + \gamma_{1it}$***Portfolio_size**$_{it} + \gamma_{2it}$***Region_of_origin**$_{it} + \sum_{t=1}^{t=10}(\gamma_{3it} * \mathbf{Time_{it}}) + \varphi_{it}$

MARKET SHARE Vs. GREEN ADVERTISING EXPENDITURES

Following the conceptual model and the hypothesis formulated in the theoretical framework, the third relationship to be tested is the one between Green Product Advertising Expenditures levels and automotive companies` market shares. Just like Model 1 and Model 2, a liner regression equation is used for the analysis. The Green Product Advertising variable, which is going to be included in the model, is *Share of Green Product Advertising Expenditures with respect to Total Advertising Expenditures (Share_Adv).* The mathematical expression of the model is the following:

(1) $\mathbf{Market\_Share_{it} = \beta_{0it} + \beta_{2it} * Share\_Adv_{it} + \varepsilon_{it}}$

Similar to Model 1 and Model 2, the intercept in the equation, accounts for market share variations, which are not caused by the Green Advertising Expenditures. Therefore, a second equation is added to the model, aiming to explain the variations in β_{0it} with the control variables we have in hand:

(2) $\mathbf{\beta_{0it} = \gamma_{0it} + \gamma_{1it} * Portfolio\_size_{it} + \gamma_{2it} * Region\_of\_origin_{it} + \sum_{t=1}^{t=10}(\gamma_{3it} * Time_{it}) + \varphi_{it}}$

MARKET SHARE Vs. GREEN PRODUCT INNOVATIONS + SUSTAINABLE VALUE IN MANUFACTURING + GREEN ADVERTISING EXPENDITURS (Model 4)

The fourth model is a bit more complicated. Its purpose will be to put all 'green action' variables together. What is interesting to see is whether all types of green actions have better effect on market share when observed jointly. After all, in reality, car-makers do not chose to focus only on one type of sustainability actions. They rather integrate everything in a consistent sustainability strategy and all three types of actions have to be synchronized and their levels have to be optimized. Model 4 is expected to provide different results compared to the previous three models. The reason is that when analyzed simultaneously, the market share effects of all green actions will be different. The general assumption is that some of the variables might take away the explanatory power of others. The advantage of Model 4 over the previous three models is that it enables the comparison between different type of 'green'. Models 1,2, and 3 are limited in the sense that they allow only for one type of 'green' actions to be present. For example, Model 2 (Sustainable Value in manufacturing) assumes that car-manufacturers do not introduce hybrid vehicles, they do not develop new green technologies and they do not spend money on green product advertising.

The mathematical expression of Model 4 would be:

(1) $\mathbf{Market\_Share_{it}} = \beta_{0it} + \beta_{1it}\mathbf{*D\_intro\_car_{it}} + \beta_{3it}\mathbf{*Share\_Sales_{it}} + \beta_{4it}\mathbf{*D\_intro\_tech_{it}} + \beta_{5it}\mathbf{*CO^2\_value_{it}} + \beta_{6it}\mathbf{*Water\_value_{it}} + \beta_{7it}\mathbf{*Waste\_value_{it}} + \beta_{9it}\mathbf{*Share\_Adv_{it}} + \varepsilon_{it}$

(2) $\beta_{0it} = \gamma_{0it} + \gamma_{1it}\mathbf{*Portfolio\_size_{it}} + \gamma_{2it}\mathbf{*Region\_of\_origin_{it}} + \sum_{t=1}^{t=10}(\gamma_{3it} * \mathbf{Time_{it}}) + \varphi_{it}$

As you can see, the model, once again, takes the form of multilevel linear regression. All 'green action' variables available in our dataset are incorporated in the first level of the regression and the control variables are used to explain the β_{0it} coefficient in the second level.

Figure 4 - Summary of Statistical Models used in the Research

Model	Mathematical Expression
1	**(1)** $\mathbf{Market\_Share_{it}} = \beta_{0it} + \beta_{1it}\mathbf{*D\_intro\_car_{it}} + \beta_{3it}\mathbf{*Share\_Sales_{it}} + \beta_{4it}\mathbf{*D\_intro\_tech_{it}} + \varepsilon_{it}$ **(2)** $\beta_{0it} = \gamma_{0it} + \gamma_{1it}\mathbf{*Portfolio\_size_{it}} + \gamma_{2it}\mathbf{*Region\_of\_origin_{it}} + \sum_{t=1}^{t=10}(\gamma_{3it} * \mathbf{Time_{it}}) + \varphi_{it}$
2	**(1)** $\mathbf{Market\_Share_{it}} = \beta_{0it} + \beta_{1it}\mathbf{*CO^2\_value_{it}} + \beta_{2it}\mathbf{*Water\_value_{it}} + \beta_{3it}\mathbf{*Waste\_value_{it}} + \varepsilon_{it}$ **(2)** $\beta_{0it} = \gamma_{0it} + \gamma_{1it}\mathbf{*Portfolio\_size_{it}} + \gamma_{2it}\mathbf{*Region\_of\_origin_{it}} + \sum_{t=1}^{t=10}(\gamma_{3it} * \mathbf{Time_{it}}) + \varphi_{it}$
3	**(1)** $\mathbf{Market\_Share_{it}} = \beta_{0it} + \beta_{2it}\mathbf{*Share\_Adv_{it}} + \varepsilon_{it}$ **(2)** $\beta_{0it} = \gamma_{0it} + \gamma_{1it}\mathbf{*Portfolio\_size_{it}} + \gamma_{2it}\mathbf{*Region\_of\_origin_{it}} + \sum_{t=1}^{t=10}(\gamma_{3it} * \mathbf{Time_{it}}) + \varphi_{it}$
4	**(1)** $\mathbf{Market\_Share_{it}} = \beta_{0it} + \beta_{1it}\mathbf{*D\_intro\_car_{it}} + \beta_{3it}\mathbf{*Share\_Sales_{it}} + \beta_{4it}\mathbf{*D\_intro\_tech_{it}} + \beta_{5it}\mathbf{*CO^2\_value_{it}} + \beta_{6it}\mathbf{*Water\_value_{it}} + \beta_{7it}\mathbf{*Waste\_value_{it}} + \beta_{9it}\mathbf{*Share\_Adv_{it}} + \varepsilon_{it}$ **(2)** $\beta_{0it} = \gamma_{0it} + \gamma_{1it}\mathbf{*Portfolio\_size_{it}} + \gamma_{2it}\mathbf{*Region\_of\_origin_{it}} + \sum_{t=1}^{t=10}(\gamma_{3it} * \mathbf{Time_{it}}) + \varphi_{it}$

5. Findings

After running the four Multiple Linear Regression models in SPSS with the data I have available, I got some significant empirical results related to hypotheses stated in this research paper. Further in this section the most important statistical findings will be presented and discussed. The discussion will be separated into four sub-sections – each of them dedicated to one of the four models. Five are the main factors on which I will base my evaluation and discussion of the models – model fit (represented by the R^2 value), model significance (represented by the ANOVA F-value), significance of the independent variables (represented by the T-values), direct effect of each of the independent variables on companies` market share (represented by the sign and value of the unstandardized β coefficients) and the relative importance of each independent variable (represented by the standardized β coefficients). In the discussion, a significance level of 5% will be used to define if a β coefficient has significant contribution to the model. The VIF value of each explanatory variable will be checked to identify possible multicolinearity.

In addition, for each regression model the following standard linear regression assumptions will be checked: linearity of the relationship between dependent and independent variables (scatter plots), independence of the errors (Durbin-Watson test), and normality of error distribution (normal probability plot).

A detailed overview of the SPSS output for each of the four models can be seen in the Appendix.

Before reading my discussion of the findings, you can take a look at the table below, which summarizes the most important statistical information, which came out after running the regression models. For your convenience, in the table, for the statistically significant variables, you can see an indicator, which differentiates between three levels of significance – 1%, 5% and 10%. That way, it is easier to evaluate, which variables have the most significant contribution to the models (those, which are significant on a 1% level), and which have the least significant contribution to the models (those, which are significant on a 10% level).

Figure 5 Summary of findings

Summary of findings				
	MODEL 1	**MODEL 2**	**MODEL 3**	**MODEL 4**
R square	0,945	0,938	0,917	0,959
Variables	Beta Coefficients			
Constant	0,013**	0,022**	0,019**	0,022ᵗ
D_vehicle_Intro	0,007			0,010**
D_technology_intro	0,009**			0,011ᵗ
Share_hybridSales	0,609ᵗ			0,633ᵗ
CO2_value		-0,008ᵗ		-0,004*
Water_value		0,012ᵗ		0,005*
Waste_value		-0,002**		-0,003ᵗ
Share_green_ProductAD			0,192ᵗ	0,009
Portfolio_size	0,003ᵗ	0,003ᵗ	0,004ᵗ	0,002ᵗ
Region_NA	0,057ᵗ	0,047ᵗ	0,035ᵗ	0,059ᵗ
Region_AP	0	0	0	0
Region_EU	-0,027ᵗ	-0,042ᵗ	-0,038ᵗ	-0,026ᵗ
D_2002	-0,004	0,001	0	-0,006
D_2003	0	0	-0,002	0
D_2004	-0,005	-0,002	-0,068ᵗ	-0,005
D_2005	-0,01	-0,001	-0,069ᵗ	-0,009
D_2006	-0,011	0	-0,071ᵗ	0,01
D_2007	-0,017**	-0,005	-0,075ᵗ	-0,016**
D_2008	-0,018**	-0,009	-0,016*	-0,017**
D_2009	-0,027ᵗ	-0,012	-0,027ᵗ	-0,026ᵗ
D_2010	-0,022ᵗ	-0,008	-0,015*	-0,022ᵗ
D_2011	0,45ᵗ	0,055ᵗ	0,064ᵗ	0,03ᵗ

ᵗ - Statistically significant on a 1% significance level
** - Statistically significant on a 5% significance level
* - Statistically significant on a 10% significance level

Model 1

Model 1 is the one, which aims to support the first hypothesis made in the paper – Green Innovations have positive effect on the Market share of automotive companies in the U.S. The green innovation actions of automotive companies, that were taken into account in the mode were – Hybrid/EV car introductions, Share of green vehicle unit sales with respect to total vehicle unit sales and green technology introductions.

First thing that can be observed from the results is that the model fits the automotive data, which is included in the dataset, very well. The R^2 value is estimated at 0,945. This means that the three Green Innovation actions, together with the three control variables (portfolio size, region of origin and time period) manage to explain 94% of the yearly variation in companies` market shares for the period 2002-2011.

The ANOVA F-statistic has a P-value lower than 0,05 and, therefore, the model, as a whole, is statistically significant.

The variables, which appear to contribute significantly to the model are: *intercept, green technology introductions, share of green vehicle sales, portfolio size, the region of origin dummies and the time period dummies for the years 2007-2011.*

The linearity and normality assumptions prove to be correct according to the scatter plots and the normality plot. The reported Durbin Watson value is 1,013. There seems to be no violation of the error-independence assumption. All VIF values are smaller than 5. Therefore, no multicolinearity exists. For reference, please, take a look at the Appendix.

The intercept has a beta value of 0,013. This simply means that, even if all other factors in the model are equal to zero, each of the companies included in the research will have at least 1.3% of market share due to factors, which are not present in the model.

According to the results for this model, the introduction of a hybrid/EV car does not have a significant impact on the market shares of car-manufacturers. The P-value for the beta coefficient of the hybrid/EV introduction variable is higher than 5%. Therefore, the null hypothesis (which is H_0: $\beta_{D\_vehicle\_intro} = 0$) is not rejected. For that reason, the variable should be dropped out of the model.

The green technology development variable proves to have a statistically significant positive impact on the market shares. The magnitude of this impact is 0.009. So, it would be fair to claim, that in a year, when a company introduces a new green technology, the market share of this company is supposed to be boosted with 0.9% on average, due to the green technology introduction.

For example, in 2004, American Honda Motor Co. Inc. introduced its i-CTDi engine, which is one of the most CO^2 efficient (emissions are equal to 110g/mile) and fuel-consumption efficient (42.2 mpg) engines on the market at that moment. The historical market share of

American Honda Motor Co. Inc. recorded for the year 2004 is 8%. Considering the empirical results from this research, if it was not for the introduction of a new eco-friendly engine, the market share of American Honda Motor Co. Inc. for 2004 would be 7,1% instead of 8%. Given that the total industry sales in 2004 were estimated at 16 912 748 (Autodata Corporation of America, 2012), this drop of 0,9% in terms of market share will be equivalent to a 152 214 less vehicles sold. In the end, it is evident that, in the case of American Honda Motor Co. Inc., the introduction of a new green technology has boosted their yearly sales with over a 150 thousand units.

The next inference that can be made from the results of model 1, is that the share of green vehicle sales has a statistically significant positive effect on the total U.S. market share of an automotive company. The magnitude of this correlation is 0,609. So, if an automotive company manages to increase the share of its green vehicle sales with 1%, this will lead to a 0,6% increase in terms of total U.S. market share.

For example, in 2005, Toyota Motor Sales U.S.A. Inc. has sold 146 560 hybrid/EV vehicles in the U.S., which accounts for 6% of the total vehicle sales of the company for the same year. The market share, which Toyota Motor Sales U.S.A. Inc. holds on the U.S. market at the moment is 12,9%. According to the empirical findings of this research, if Toyota Motor Sales U.S.A. Inc. would have increased the proportion of green vehicle unit sales to 7%, their share on the U.S. market would have grew to 13,5% on average.

The size of the product portfolio proves to have a statistically significant positive effect on market shares. The beta value, which corresponds to the product portfolio size variable, is equal to 0,003. This implies that, when a company adds an extra car model to the product portfolio, the U.S. market share of this company will, on average, increase with 0,3%.

The region of origin also seems to have a significant impact on the dependent variable. The only case, when this effect is 0 is when the car-manufacturer observed is located in Asia Pacific. The American car-manufacturers, on average, have a 5,7% higher market share than the rest companies in the industry. At the same time, European car-manufacturers, on average, have a 2,7% lower market share than the rest in the industry. Such reasoning is absolutely acceptable, because most of the consumers on the U.S. market are Americans, and it is logical that they would prefer to buy American vehicles.

When we look at the time-effect results, a clear pattern can be seen, starting with a significantly negative impact of the year 2007 (β_{2007}= -0,017). This negative impact is progressing in 2008 and reaches its peak in 2009 (β_{2009} = -0,027). Afterwards, it diminishes and in 2011, it even gets highly positive (β_{2011}= 0,45).

This pattern can be explained with the economic crisis which had a very severe influence on the automotive sales in U.S. In 2007, just before the crisis, the shares of the 12 major car-manufacturers started dropping. They dropped even more, in 2008 and 2009, which were the worst two years for the U.S. economy. However, when the economic environment started to improve, the big 12 automotive companies gained back their competitive position on the U.S. market.

The standardized beta coefficients imply the following importance ranking of the explanatory variables (1 – most important, 2- least important):

1. Product portfolio size
2. Retion_NA
3. Share of green vehicle unit sales
4. Year_11
5. Region_EU
6. Year_09
7. Year_10
8. Year_09
9. Year_07
10. Green technology development

Finally, after obtaining the β coefficients, and getting rid of the variables, which do not show a significant contribution, Model 1 can be written down as follows:

$Market\_Share_{it}$ = 0,013 + 0,009* $D\_intro\_tech_{it}$ + 0,609* $Share\_Sales_{it}$ + 0,003*$Portfolio\_size_{it}$ + 0,057*Region_NA – 0,027*Region_EU – 0,017*Year_2007 – 0,018*Year_2008 – 0,027*Year_2009 – 0,022*Year_2010 + 0,045*Year_2011 + ε

Model 2

The goal of model 2 was to identify if there is any correlation between the Sustainable Value, which the automotive companies create in the manufacturing process and the market shares of those companies. The Sustainable Value in Manufacturing was measured via three indicators

– CO^2 efficiency sustainable value contribution, Water efficiency sustainable value contribution and Total Waste efficiency sustainable value contribution. Those three indicators were integrated in the linear regression model as explanatory variables together with the standard control variables.

As showed in *Figure 5*, Model 2 had an R^2 value of 0,938, which is slightly lower than the one we got for model 1. However, it is still high enough to say that Model 2 fits the available data very well.

The F-statistic from the ANOVA test corresponds to a P-value equal to 0, which means that the model not only fits the given data, but is also statistically significant.

The residuals are normally distributed. However, non-linear relationship patter has been identified between the dependent variable (market share) and the CO^2 efficiency, Water efficiency and Waste efficiency variables. In fact, CO^2 efficiency and Water efficiency both show high VIF values, which is a reason to think that multicolinearity exists between those two. Therefore, their interpretation will be rather controversial. The Durbin Watson value is 0,799, which is a clear indication of a data structural problem. This problem might be the already mentioned multicolinearity between two of the explanatory variables. For references, please, check the Appendix.

According to the statistical results, the intercept has a significant and positive impact on market shares. This impact has a value of 0,022. Therefore, even if all other factors in the model are equal to zero, the average company included in the research will have at least 2.2% of market share due to factors, which are not present in the model.

The effect of CO^2 value is statistically significant on a 1% significance level. This effect has negative direction and has a magnitude of 0,008 (beta= -0,008). The logic behind this partial correlation is that, a 1 billion dollars increase in Sustainable Value created through CO^2 efficiency in manufacturing, on average, will lead to a 0,8% decrease in a company`s market share. This interpretation is controversial, because it claims that the more CO^2 efficient a company is – the lower competitive performance it will have. The reason for that controversy is that, if we look at our dataset, we can see that the companies, which own the highest market shares, are the ones who are the least CO^2 efficient. In reality, probably the CO^2 inefficiency did not contribute to the performance of those companies, even though this is what the statistical analysis shows. I would like to leave this case opened for further discussions.

The Water efficiency contribution in terms of sustainable value has proven to have a significantly positive effect on market shares. The beta value for this variable is equal to 0,012. A proper way to interpret this number would be to say that a 1 billion dollars increase in Sustainable Value created through Water efficiency in manufacturing, on average, will lead to a 1,2% boost in market share.

The Total Waste efficiency contribution in terms of sustainable value has a significantly negative impact on the competitive performance of automotive companies. The magnitude of this impact is 0,002 (beta= -0,002). Similarly to the CO^2 efficiency results, the Total Waste efficiency effect on market share seems to be controversial. It turns out that the more efficient a company is in terms of Total Waste in manufacturing, the less market share it will have.

The product portfolio size of the company in model 2 has the exact same effect on the dependent variables, as in model 1 – statistically significant, positive, with beta= 0,003.

According to the research findings, the car-manufacturers from North America, on average, would have 4,7% higher market share than their competitors on the U.S. market. At the same time, car-manufacturers from Europe, on average, tend to have a 4,2% lower market share than their competitors on the U.S. market. For the Asian car-manufacturers, the market share is not affected by the region of origin.

As for the time-specific dummy variables, in model 2, only the year 2011 seems to have a significant impact on the companies` market shares. In the year 2011, the market share of an average automotive company would be boosted by 5,5%.

The standardized β coefficients imply the following importance ranking of the explanatory variables (1- most important, 2 – least important):

1. Water efficiency
2. Product portfolio size
3. CO^2 efficiency
4. Region_NA
5. Region_EU
6. Year_11
7. Waste efficiency

After obtaining the β coefficients, and getting rid of the variables, which do not show a significant contribution, Model 2 can be written down as follows:

$$\textbf{Market\_Share}_{it} = 0{,}022 - 0{,}008*\textbf{CO}^2\textbf{\_value}_{it} + 0{,}012*\textbf{Water\_value}_{it} - 0{,}002*\textbf{Waste\_value}_{it} - 0{,}003*\textbf{Portfolio\_size} + 0{,}047*\textbf{Region\_NA} - 0{,}042*\textbf{Region\_EU} + 0{,}055*\textbf{Year\_2011} + \varepsilon$$

Model 3

The third regression model was aimed to test the effect of Green Product Advertising on companies` market shares. The explanatory variable included in the model, which represents this effect, is the *Share of green vehicle advertising expenditures with respect to total advertising expenditures of automotive companies.*

First of all, it can be observed from *Figure 5* that the R^2 value for this model is the lowest among the four – 0,917. This means that Model 3 fits the data we have available the least. However, an R^2 value of 0,917 is still good enough to make relevant and reliable conclusions from the beta coefficients.

The P-value, which came out from the ANOVA test is very close to 0. Therefore, the model is statistically significant.

In this model, the residuals are normally distributed and there seems to be no multicolinearity. The linearity assumption is also confirmed. However, according to the extremely high Durbin Watson (0,888), it would be fair to mention that there is a clear violation of the independence of errors assumption. For more information, please, check the Appendix.

Except for the year dummies for 2002 and 2003, all other explanatory variables in the model turn out to have statistically significant impact on the dependent variable.

The intercept has a beta value of 0,019, which means that if all other factors are kept constant, on average, 1,9% of an automotive company U.S. market is explained by factors not included in the model.

The variable, which deserves the most attention here, is the *Share of green vehicle advertising expenditures*. The beta value assigned for it in the regression is statistically significant on a 1% significance level and is equal to 0,192. Theoretically, the interpretation of this value implies that if 100% of the advertising budget of an automotive company was spend on hybrid/EV vehicles advertising, the U.S. market share of this company would increase with 19%. However, in practice spending the whole advertising budget on green product

advertising is not realistic. The other products also need to be advertised. Therefore, if we assume a 1% increase in the share of green product advertising expenditures, it will result in 0,19% boost in terms of market share.

For example, in 2007, Ford Motor Co. had spent 3,1% percent of its total advertising budget for U.S. on green product advertising (the actual amount is $36 294 500). For the same year, the historical market share recorded for Ford Motor Co. is 14,9%. According to the research findings, if Ford Motor Co. had spent 4,1% of its advertising budget ($47 354 270) on hybrid/EV advertising, its market share would have been 15,09% instead. In terms of unit vehicle sales, this is an increase of 30 684 cars sold.

The control variables in Model 3 show the same direction of their effects on market as in Model 1. However, there are slight differences in the magnitude of those partial effects.

According to Model 3, adding an extra car model in the product portfolio of a car-manufacturer would reflect in the market share as a 0,4% average increase.

In case the automotive company observed origins from North America, its market share is expected to be, on average, 3,5% higher than the rest companies in the industry. On the other hand, if the observed automotive company origins from Europe, its market share is expected to be, on average, 3,8% lower than the rest companies in the industry. For the Asian companies, the market share is not dependent on the region of origin.

The year dummies, which have a significant negative impact on the U.S. market shares of automotive companies, are 2004 (beta= -0,068), 2005 (beta= -0,069), 2006 (beta= -0,071), 2007 (beta= -0,075) and 2009 (beta= -0,027). Similarly to Model 1, the year 2011 affects the market shares of the 12 companies in the dataset positively (beta= 0,064).

The standardized β coefficients imply the following importance ranking of the explanatory variables (1- most important, 2 – least important):

1. Portfolio Size
2. Year_11
3. Region_EU
4. Region_NA
5. Year_09
6. Share of green product advertising expenditures

After obtaining the β coefficients, and getting rid of the variables, which do not show a significant contribution, Model 3 can be written down as follows:

$Market\_Share_{it}$ = 0,019 + 0,192*$Share\_Adv_{it}$ + 0,004*Portfolio_size + 0,035*Region_NA – 0,038*Region_EU – 0,068*Year_2004 – 0,069*Year_2005 – 0,071*Year_2006 – 0,075*Year_2007 – 0,027*Year_2009 + 0,064*Year_2011 + ε_{it}

Model 4

The last model is a combination of Model 1,2 and 3. The purpose of Model 4 is to show how the partial effects of each of the 'green' actions change when they are considered non-exclusively. This way we are taking a look at the Green Innovations, Sustainable Value in manufacturing and Green Product Advertising Expenditures as part of an integrated Green Strategy. The question is – How does such strategy influence the competitiveness of automotive companies?

Model 4 has the highest R^2 value of all the models designed in this research paper – 0,959. Only 4,1% of the market share variance is not explained by the explanatory variables. Respectively, 95,9% of the market share variance depends on the: *hybrid/EV vehicle introduction; green technology introduction; share of hybrid/EV unit sales with respect to total vehicle unit sales; Total Waste efficiency sustainable value contribution in manufacturing; product portfolio size; region of origin and time.*

The model proves to be statistically significant based on the P-value of the F-statistic, which is lower than 0,05.

The normality and the independence of errors assumptions are not violated. However, as already indicated in Model 2, multicolinearity exists between CO^2 efficiency and Water efficiency. Also, the relationship between Market Share and CO^2 efficiency, Water efficiency and Waste efficiency appears to be non-linear. Nevertheless, the Durbin Watson value (1,006) shows that there are no significant structural problems in this model. Please, check the Appendix for more detailed information.

The intercept here has a beta value of 0,022 just as in Model 2. Therefore, the same interpretation is valid.

As for the hybrid/EV introduction, unlike Model 1, in Model 4 it shows a statistically significant positive effect on the market share. The beta value which came out from the

regression is 0,010. So, whenever a hybrid/EV car is being introduced by a company, the market share of this company, on average, will increase with 1%.

For example, in 2006, Toyota Motor Sales U.S.A. Inc. introduced the Toyota Camri Hybrid and the Lexus GS 450h. The historical market share of the company recorded for the same year is 14,9%. In case, Toyota Motor Sales U.S.A. Inc. had not introduced those two hybrid vehicles, the 2006 market share of the company would have been 13,9%. This is a decrease of 165 564 vehicle units in terms of sales.

Similarly to Model 1, the green technology introduction variable has a significantly positive effect on market share, with magnitude of 0,011. So, in a year when a new green technology is being introduced by an automotive company, the market share of this company is expected to grow with 1,1% on average.

The share of green vehicle unit sales with respect to total vehicle unit sales has statistically significant and positive impact on companies` market shares. The beta value of 0,633 implies that for every 1% increase in the share of green vehicle sales, a 0,63% in company`s market share will follow.

As for the metrics related to sustainable value in manufacturing, CO^2 efficiency and Water efficiency do not seem to contribute significantly to Model 4. The P-values for their beta coefficients are not significant on a 5% significance level. For that reason, they have to be excluded from the equation. However, the Total Waste efficiency sustainable value contribution has a statistically significant impact on market shares. This impact is negative with a magnitude of 0,3%. As in Mode 2, the interpretation of this phenomenon is controversial. The empirical evidence support the statement that the more Waste efficient a car-manufacturer is – the less competitive it is on the market.

The share of green product advertising expenditures, also does not contribute significantly to the explanatory power of Model 4. Nevertheless, after running couple of additional tests, it turned out that within an Integrated Green Strategy, green product advertising has a significant mediating effect between the hybrid/EV vehicle introduction and the market share (see Figure 6).

Figure 6 Mediating effect of Green Product Advertising – graphically explained

To prove this mediating effect, the four-step approach of Baron & Kenny (1986) was used. Four regression equations were run in order to test four correlations for significance. The correlations of interest are illustrated in Figure 6 as follow:

1. **C :** Market Share = $\beta_{c0} + \beta_{c1}$*Hybrid/EV_intro + ε
2. **A:** Green Product Advertising = $\beta_{a0} + \beta_{a1}$*Hybrid/EV_intro + ε
3. **B:** Market Share = $\beta_{b0} + \beta_{b1}$*Green Product Advertising + ε
4. **AB:** Market Share = $\beta_{ab0} + \beta_{ab1}$*Hybrid/EV_intro + β_{ab2}*Green Product Advertising + ε

All four regression equations are statistically significant, as well as the beta coefficients of the explanatory variables (see Figures 1.7 -1.10). Therefore, it can be claimed that a mediation effect exists. The share of green product advertising accelerates the positive effect of hybrid/EV introduction on the market share.

This mediating effect can be measured by using the method of Judd & Kenny (1981). This method implies the following calculation:

Mediating effect$_{Share\_GreenAd} = \beta_{c1} - \beta_{ab1} = 0{,}056 - 0{,}04 =$ **0,016**

This number should be interpreted as follows: An increase of green product advertising share will, on average, add 1.6% to the direct effect of hybrid/EV vehicle introduction on the market share.

The control variables in Model 4 have similar characteristics to the ones in the other three models.

Product portfolio size has a significantly positive impact on market share (beta= 0,002).

For the American car-manufacturers, on average, the shares of the U.S. market are 5,9% higher than their competitors. For European car-manufacturers, on average, the share of the U.S. market are 2,6% lower than their competitors. The U.S. shares of the Asian automotive companies are not dependent on the region of origin.

The evidences from Model 4 show that there is no time effect on market share up until 2006. From 2007, the market shares of the big 12 automotive companies start diminishing with a peak in 2009. Afterwards the performance of those companies starts improving and in 2011 the car-makers gain back their competitiveness on the U.S. market, with an average increase of 3% in terms of market share.

After obtaining the β coefficients, and getting rid of the variables, which do not show a significant contribution, Model 4 can be written down as follows:

$$\mathbf{Market\_Share_{it} = 0{,}022 + 0{,}010*D\_intro\_car_{it} + 0{,}633*Share\_Sales_{it} + 0{,}011*D\_intro\_tech_{it} - 0{,}003*Waste\_value_{it} + 0{,}002*Portfolio\_size + 0{,}059*Region\_NA - 0{,}026*Region\_EU - 0{,}016*Year\_2007 - 0{,}017*Year\_2008 - 0{,}026*Year\_2009 - 0{,}022*Year\_2010 + 0{,}03*Year\_2011 + \varepsilon_{it}}$$

Figure 7 Summary of Hypotheses

SUMMARY OF HYPOTHESES		
Model	H0	Status
1	Hybrid/EV introduction -> Market Share	rejected
	Green Technology development -> Market Share	not rejected
	Share of geen vehicle unit sales -> Market Share	not rejected
2	CO2 efficiency -> Market Share	not rejected
	Water Efficiency	not rejected
	Waste Efficiency	not rejected
3	Share of green product ad expenditures -> Market Share	not rejected
4	Hybrid/EV introduction -> Market Share	not rejected
	Green Technology development -> Market Share	not rejected
	Share of geen vehicle unit sales -> Market Share	not rejected
	CO2 efficiency -> Market Share	rejected
	Water Efficiency	rejected
	Waste Efficiency	not rejected
	Share of green product ad expenditures -> Market Share	rejected

***The direct effect of "Share of green product advertising expenditures" on market share is rejected, but the variable is considered to have significant mediation effect between Hybrid/EV vehicle introductions and arket shares.**

6. Conclusions & Limitations

In this research paper the goal was to investigate the effect of 'green' actions on companies` competitive market performance. To make this investigation possible, a statistical analysis has been performed on the U.S. automotive industry data. Three groups of 'green' actions have been pre-defined based on previous relevant literature and existing theories – Green Innovations, Sustainable value creation in the manufacturing process and Green Product Advertising Expenditures. Within each group, several specific actions have been chosen to be included in the statistical analysis in order to see how each of them correlates to the variations in companies market shares.

The findings of the research lead to several conclusions, which can have very strong practical implication in a real business environment.

There are four possible strategic orientations that a company can follow with regard to being green – Green Innovations focus, Sustainable manufacturing focus, Green Product Advertising focus and an integrated Green strategy.

In the first case, introducing green technological innovations and green vehicle unit sales both appear to be very powerful drivers of the competitive performance of automotive companies in the U.S. The general inference that can be made is that, a company has a Green Innovation focus, then creating new green technologies and stimulating the sales of green vehicles leads to a direct increase in a company`s market share.

In the second case, where resource efficiency in manufacturing is the strategic focus, it has been proven empirically that CO^2 efficiency and Total Waste efficiency both have small, but significantly negative effect on the market share of a car-manufacturer. On the contrary, Water efficiency seems to have significantly positive market share effect, which is also big enough to offset the negative effect of CO^2 and Total Waste efficiency together. Therefore, a recommendation for the automotive companies, which focus mostly on sustainable value in manufacturing, would be to set very strict targets for Water efficiency in order to improve their competitive performance on the U.S. market.

In situation three, the strategic orientation is engaged only with Green Product Advertising. Based on the empirical findings of this research, it can be concluded that it would be highly

beneficial for car-makers to assign bigger share of their total advertising budgets to Green Product Advertising. Statistically, it is proven that by increasing the share of Green Product Advertising, those car-makers can significantly improve their competitive position on the U.S. market.

When a Green strategy is a consistent combination of Green Innovations, Sustainable Manufacturing and Green Product Advertising, then the specific 'green' actions will have different effects compared to the first three situations. An Integrated Green Strategy is also the most realistic one, given that in real life companies are using all 'green' actions in a synchronized fashion.

In that case, Green Product Advertising does not have significant direct effect on the competitive performance. However, it was proven that it has a significant mediating effect between hybrid/EV vehicles introduction and market shares. Whenever there is a hybrid/EV vehicle introduction, the share of green product advertising expenditure grows, reflecting also positively on the market share of the company.

In terms of sustainable manufacturing, the only 'green' action that still has a statistically significant impact on market shares is Total Waste efficiency. However, this impact is negative, so it should fall out of the companies` focus. The only group of 'green' actions that still has significantly positive effect on competitive performance is Green Innovations. Therefore, it is concluded that, for an automotive company with an integrated Green strategy, the main drivers of good competitive market performance are *Hybrid/EV introductions; Green Technology introductions and Share of Green vehicle unit sales.*

Additionally, the market share effects of the *product portfolio size, the region of origin and the time-period*, that were suggested in previous literature, also have been proved by the empirical evidence. In all four models, the results are similar and, therefore, general conclusions can be made.

The positive effect of the product portfolio size on market shares confirms the product diversity theory of Tallman & Li, (1996), which states that the product diversity is positively correlated to firm performance. However, it should not be forgotten that this relationship is non-linear. At some point, adding an extra product to the portfolio will not contribute significantly to the firm performance.

As for the region of origin, a conclusion can be made that in the U.S. market, consumers prefer to by mostly American vehicles. The vehicles that are least preferred are the ones that are offered by European manufacturers.

A time-pattern has been identified in this research paper, which illustrates the fact that during the last economic crisis the market shares of the top 12 car-manufacturers in the U.S. have seen a decline. Those were the years in the period between 2007-2010. However, in 2011 a systematic market share growth is seen, which is a clear sign of recovery after the crisis.

This paper combined the Sustainable Value theory of Hahn et al (2007), the Product Innovations Vs. Process Improvements framework of Chen et al. (2008) and the Advertising Vs. Firm Performance correlation assumed by Epstein (1996). The interpretation of the market share effect of the Sustainable Value in manufacturing factors was a bit vague and controversial due to problems with the data structure. However, it has been proven for the automotive industry that Green Innovations have significantly positive effect on the competitive performance of car-manufacturers. This effect is even stronger, when combined with solid Product Advertising.

From a managerial point of view, this paper presented strong evidence that, in order to maintain their competitive position on the market, automotive companies should invest more in developing new green technologies and new green vehicles. Also, managers should focus on stimulating the green vehicle sales. Those 'green' actions will definitely reflect positively on the companies` market shares. Based on another conclusion of this research, it is suggested that auto-maker would improve their chances of meeting the mentioned objectives by investing more in Green Product Advertising.

There are various limitations of this research paper, which open a field for future scientific research efforts.

The analysis performed in this paper was restricted only to the U.S. market and to the automotive industry. It would be interesting to see if the relationships suggested here function identically in other geographical markets and among other industries. For example, a possibility exists that the market shares will respond more/less favourably to sustainable value indicators, if the research is done for the European market. Also, in the chemical industry, the market share effect of Green Product Advertising might be more/less significant than in the automotive industry.

The aggregate level of the data is also considered to be a limitation. Further investigations in the field of 'Green actions in the automotive industry' should try to differentiate between separate brands, or even better – separate car models. Such approach will enable the interpretation of product-specific externalities resulting from the sustainable product improvements.

Another limitation of this research is that it makes use only of secondary data. It would be a good idea to perform an analysis about Green Actions and Competitive firm performance, based on consumer evaluations. Taking the consumers` perspective of the problem is expected to provide valuable insights, because market shares are a representation of sales and sales are directly dependent on the purchase choice of the consumer. Therefore, it is important to understand how do consumer perceive the 'green' actions of companies and how does this reflect the competitive market performance of those companies.

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APPENDIX

Figure 1.1 Average market shares of selected Automotive Companies active in U.S. (2002-2011)

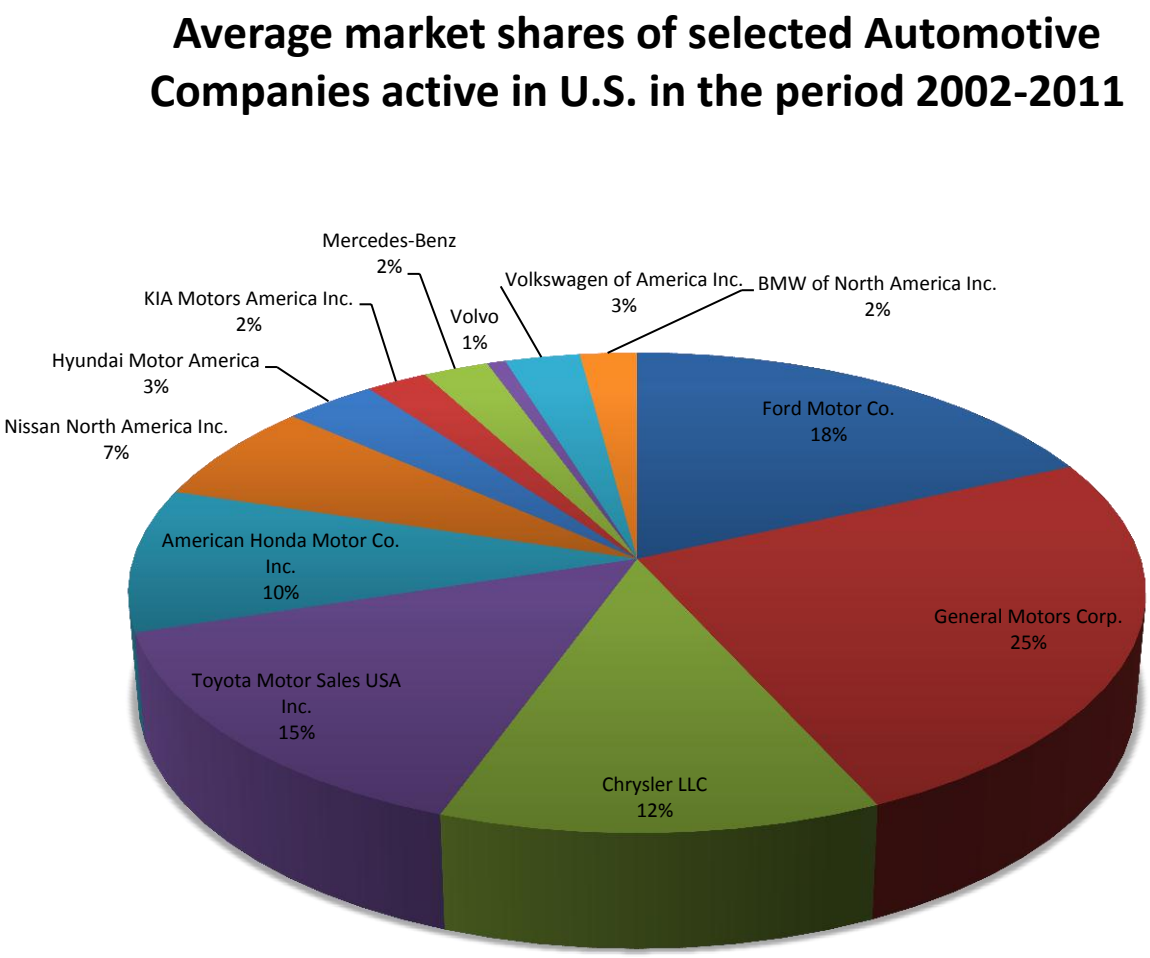
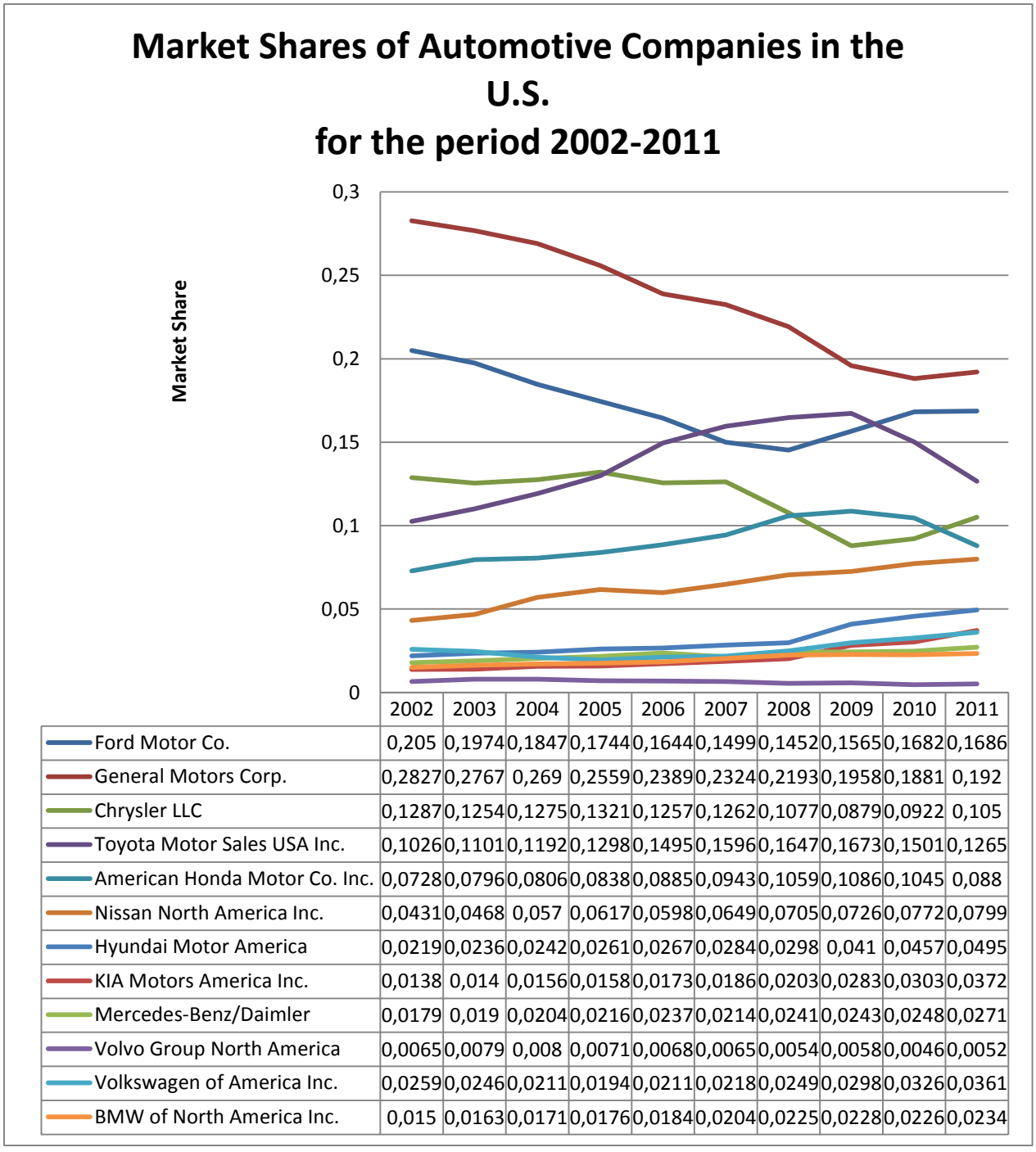


Figure 1.2 Market share trends of selected Automotive Companies active in U.S. (2002-2011)



	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Ford Motor Co.	0,205	0,1974	0,1847	0,1744	0,1644	0,1499	0,1452	0,1565	0,1682	0,1686
General Motors Corp.	0,2827	0,2767	0,269	0,2559	0,2389	0,2324	0,2193	0,1958	0,1881	0,192
Chrysler LLC	0,1287	0,1254	0,1275	0,1321	0,1257	0,1262	0,1077	0,0879	0,0922	0,105
Toyota Motor Sales USA Inc.	0,1026	0,1101	0,1192	0,1298	0,1495	0,1596	0,1647	0,1673	0,1501	0,1265
American Honda Motor Co. Inc.	0,0728	0,0796	0,0806	0,0838	0,0885	0,0943	0,1059	0,1086	0,1045	0,088
Nissan North America Inc.	0,0431	0,0468	0,057	0,0617	0,0598	0,0649	0,0705	0,0726	0,0772	0,0799
Hyundai Motor America	0,0219	0,0236	0,0242	0,0261	0,0267	0,0284	0,0298	0,041	0,0457	0,0495
KIA Motors America Inc.	0,0138	0,014	0,0156	0,0158	0,0173	0,0186	0,0203	0,0283	0,0303	0,0372
Mercedes-Benz/Daimler	0,0179	0,019	0,0204	0,0216	0,0237	0,0214	0,0241	0,0243	0,0248	0,0271
Volvo Group North America	0,0065	0,0079	0,008	0,0071	0,0068	0,0065	0,0054	0,0058	0,0046	0,0052
Volkswagen of America Inc.	0,0259	0,0246	0,0211	0,0194	0,0211	0,0218	0,0249	0,0298	0,0326	0,0361
BMW of North America Inc.	0,015	0,0163	0,0171	0,0176	0,0184	0,0204	0,0225	0,0228	0,0226	0,0234

Figure 1.3 MODEL 1 – SPSS Output

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	,972[a]	,945	,937	,01802	1,013

a. Predictors: (Constant), Dummy_11, Region_NA_D, Gree_intro_D, Dummy_08, Dummy_07, Green_tech_D, Dummy_06, Dummy_05, Dummy_09, Dummy_04, Region_EU_D, Dummy_02, Share_Green_Sales, Dummy_10, Portfolio_size

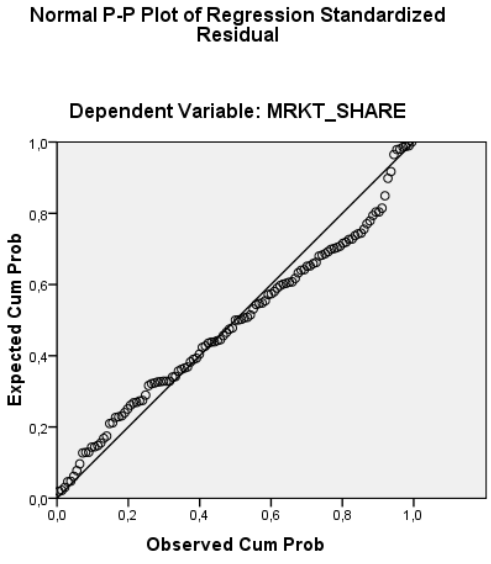
b. Dependent Variable: MRKT_SHARE

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	,577	15	,038	118,414	,000[a]
	Residual	,033	103	,000		
	Total	,610	118			

a. Predictors: (Constant), Dummy_11, Region_NA_D, Gree_intro_D, Dummy_08, Dummy_07, Green_tech_D, Dummy_06, Dummy_05, Dummy_09, Dummy_04, Region_EU_D, Dummy_02, Share_Green_Sales, Dummy_10, Portfolio_size

b. Dependent Variable: MRKT_SHARE



Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	,013	,006		1,989	,049		
	Gree_intro_D	,007	,005	,044	1,462	,147	,591	1,692
	Green_tech_D	,009	,004	,063	2,433	,017	,799	1,251
	Share_Green_Sales	,609	,095	,197	6,430	,000	,569	1,758
	Portfolio_size	,003	,000	,612	15,198	,000	,328	3,045
	Region_NA_D	,057	,006	,347	8,923	,000	,351	2,845
	Region_EU_D	-,027	,004	-,175	-6,171	,000	,659	1,516
	Dummy_02	-,004	,008	-,019	-,573	,568	,507	1,972
	Dummy_04	-,005	,007	-,020	-,657	,513	,553	1,807
	Dummy_05	-,010	,007	-,041	-1,303	,196	,546	1,832
	Dummy_06	-,011	,007	-,046	-1,461	,147	,545	1,836
	Dummy_07	-,017	,007	-,072	-2,297	,024	,539	1,854
	Dummy_08	-,018	,007	-,077	-2,472	,015	,544	1,838
	Dummy_09	-,027	,008	-,114	-3,535	,001	,509	1,965
	Dummy_10	-,022	,008	-,093	-2,858	,005	,507	1,972
	Dummy_11	,045	,009	,182	5,100	,000	,417	2,399

a. Dependent Variable: MRKT_SHARE

Figure 1.4 MODEL 2 – SPSS Output

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	,968[a]	,938	,929	,01920	,799

a. Predictors: (Constant), Waste_value, Dummy_04, Dummy_11, Dummy_10, Dummy_09, Region_EU_D, Dummy_05, Dummy_08, Dummy_06, Dummy_02, Region_NA_D, Dummy_07, Portfolio_size, Water_value, CO2_value

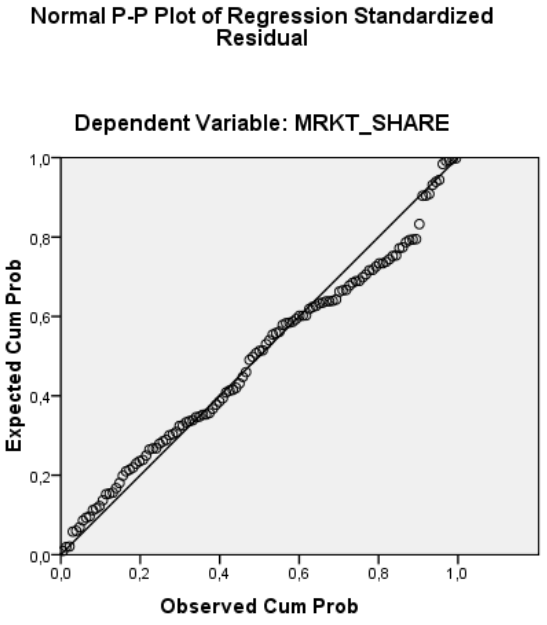
b. Dependent Variable: MRKT_SHARE

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	,572	15	,038	103,566	,000[a]
	Residual	,038	103	,000		
	Total	,610	118			

a. Predictors: (Constant), Waste_value, Dummy_04, Dummy_11, Dummy_10, Dummy_09, Region_EU_D, Dummy_05, Dummy_08, Dummy_06, Dummy_02, Region_NA_D, Dummy_07, Portfolio_size, Water_value, CO2_value

b. Dependent Variable: MRKT_SHARE



Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	,022	,007		3,114	,002		
	Portfolio_size	,003	,000	,586	12,116	,000	,258	3,873
	Region_NA_D	,047	,007	,282	6,408	,000	,311	3,219
	Region_EU_D	-,042	,005	-,272	-8,577	,000	,599	1,670
	Dummy_02	,001	,008	,006	,188	,851	,556	1,799
	Dummy_04	-,002	,008	-,008	-,236	,814	,555	1,801
	Dummy_05	-,001	,008	-,006	-,176	,860	,554	1,806
	Dummy_06	,000	,008	-,003	-,095	,924	,551	1,814
	Dummy_07	-,005	,008	-,022	-,668	,505	,550	1,817
	Dummy_08	-,009	,008	-,036	-1,093	,277	,548	1,823
	Dummy_09	-,012	,008	-,049	-1,469	,145	,544	1,839
	Dummy_10	-,008	,008	-,032	-,960	,339	,550	1,819
	Dummy_11	,055	,009	,222	5,958	,000	,436	2,291
	CO2_value	-,008	,002	-,458	-3,533	,001	,036	27,812
	Water_value	,012	,002	,623	5,799	,000	,052	19,142
	Waste_value	-,002	,001	-,119	-2,150	,034	,197	5,069

a. Dependent Variable: MRKT_SHARE

Figure 1.5 MODEL 3 – SPSS Output

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	,958[a]	,917	,907	,02192	,888

a. Predictors: (Constant), Share_GreenAd_exp, Dummy_06, Region_NA_D, Dummy_07, Dummy_08, Dummy_05, Dummy_10, Dummy_11, Dummy_04, Region_EU_D, Dummy_03, Dummy_09, Portfolio_size

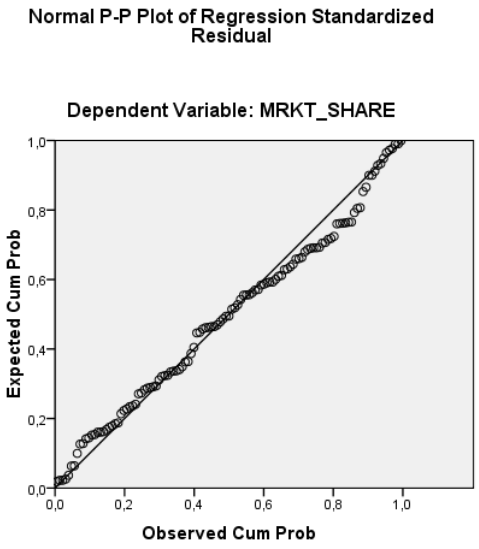
b. Dependent Variable: MRKT_SHARE

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	,560	13	,043	89,613	,000[a]
	Residual	,050	105	,000		
	Total	,610	118			

a. Predictors: (Constant), Share_GreenAd_exp, Dummy_06, Region_NA_D, Dummy_07, Dummy_08, Dummy_05, Dummy_10, Dummy_11, Dummy_04, Region_EU_D, Dummy_03, Dummy_09, Portfolio_size

b. Dependent Variable: MRKT_SHARE



Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	,019	,007		2,597	,011		
	Portfolio_size	,004	,000	,696	15,068	,000	,369	2,707
	Region_NA_D	,035	,007	,214	5,131	,000	,451	2,217
	Region_EU_D	-,038	,005	-,251	-7,947	,000	,787	1,270
	Dummy_03	-,002	,009	-,007	-,178	,859	,556	1,799
	Dummy_04	-,005	,009	-,020	-,538	,591	,555	1,801
	Dummy_05	-,006	,009	-,027	-,713	,477	,555	1,803
	Dummy_06	-,008	,009	-,033	-,870	,386	,553	1,807
	Dummy_07	-,013	,009	-,053	-1,398	,165	,551	1,816
	Dummy_08	-,016	,009	-,066	-1,740	,085	,549	1,821
	Dummy_09	-,027	,009	-,112	-2,822	,006	,502	1,993
	Dummy_10	-,015	,009	-,063	-1,669	,098	,548	1,824
	Dummy_11	,064	,010	,257	6,318	,000	,475	2,105
	Share_GreenAd_exp	,192	,060	,105	3,206	,002	,739	1,353

a. Dependent Variable: MRKT_SHARE

Figure 1.6 MODEL 4 – SPSS Output

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	,979[a]	,959	,951	,01593	1,006

a. Predictors: (Constant), Waste_value, Dummy_04, Gree_intro_D, Dummy_08, Dummy_05, Dummy_11, Dummy_07, Green_tech_D, Dummy_06, Dummy_09, Region_AP_D, Dummy_02, Share_GreenAd_exp, Dummy_10, Region_NA_D, Share_Green_Sales, Portfolio_size, Water_value, CO2_value

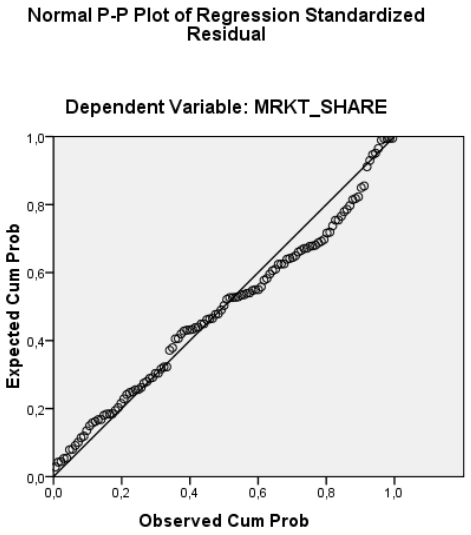
b. Dependent Variable: MRKT_SHARE

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	,585	19	,031	121,433	,000[a]
	Residual	,025	99	,000		
	Total	,610	118			

a. Predictors: (Constant), Waste_value, Dummy_04, Gree_intro_D, Dummy_08, Dummy_05, Dummy_11, Dummy_07, Green_tech_D, Dummy_06, Dummy_09, Region_AP_D, Dummy_02, Share_GreenAd_exp, Dummy_10, Region_NA_D, Share_Green_Sales, Portfolio_size, Water_value, CO2_value

b. Dependent Variable: MRKT_SHARE



Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	-,004	,006		-,642	,522		
	Portfolio_size	,002	,000	,469	10,640	,000	,214	4,673
	Region_NA_D	,085	,006	,514	14,602	,000	,336	2,976
	Region_AP_D	,026	,005	,180	5,701	,000	,416	2,401
	Dummy_02	-,006	,007	-,026	-,918	,361	,504	1,984
	Dummy_04	-,005	,007	-,019	-,705	,482	,552	1,812
	Dummy_05	-,009	,007	-,039	-1,403	,164	,535	1,868
	Dummy_06	-,010	,007	-,042	-1,509	,135	,528	1,892
	Dummy_07	-,016	,007	-,069	-2,430	,017	,520	1,925
	Dummy_08	-,017	,007	-,071	-2,528	,013	,532	1,881
	Dummy_09	-,026	,007	-,111	-3,702	,000	,463	2,158
	Dummy_10	-,022	,007	-,092	-3,150	,002	,487	2,055
	Dummy_11	,030	,009	,123	3,574	,001	,351	2,848
	Share_GreenAd_exp	,009	,053	,005	,160	,873	,488	2,049
	Share_Green_Sales	,633	,123	,205	5,134	,000	,262	3,818
	Gree_intro_D	,010	,005	,061	2,188	,031	,532	1,879
	Green_tech_D	,011	,003	,080	3,429	,001	,766	1,305
	CO2_value	-,004	,002	-,208	-1,810	,073	,031	31,746
	Water_value	,005	,002	,275	2,612	,010	,038	26,576
	Waste_value	-,003	,001	-,190	-3,993	,000	,184	5,439

a. Dependent Variable: MRKT_SHARE

Figure 1.7 Market Share Vs. Hybrid/EV vehicle introduction

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	,349[a]	,122	,114	,06751	,193

a. Predictors: (Constant), Gree_intro_D

b. Dependent Variable: MRKT_SHARE

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	,074	1	,074	16,320	,000[a]
	Residual	,538	118	,005		
	Total	,612	119			

a. Predictors: (Constant), Gree_intro_D

b. Dependent Variable: MRKT_SHARE

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	,063	,007		8,813	,000		
	Gree_intro_D	,056	,014	,349	4,040	,000	1,000	1,000

a. Dependent Variable: MRKT_SHARE

Figure 1.8 Share of Green Product Advertising Vs. Hybrid/EV vehicle introduction

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	,499[a]	,249	,242	,03407	1,677

a. Predictors: (Constant), Gree_intro_D

b. Dependent Variable: Share_GreenAd_exp

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	,045	1	,045	39,033	,000[a]
	Residual	,137	118	,001		
	Total	,182	119			

a. Predictors: (Constant), Gree_intro_D

b. Dependent Variable: Share_GreenAd_exp

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	,003	,004		,703	,483		
	Gree_intro_D	,044	,007	,499	6,248	,000	1,000	1,000

a. Dependent Variable: Share_GreenAd_exp

1.9 Market Share Vs. Share of Green Product Advertising

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	,324[a]	,105	,098	,06814	,203

a. Predictors: (Constant), Share_GreenAd_exp

b. Dependent Variable: MRKT_SHARE

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	,064	1	,064	13,861	,000[a]
	Residual	,548	118	,005		
	Total	,612	119			

a. Predictors: (Constant), Share_GreenAd_exp

b. Dependent Variable: MRKT_SHARE

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statist	
		B	Std. Error	Beta			Tolerance	VI
1	(Constant)	,070	,007		10,561	,000		
	Share_GreenAd_exp	,594	,160	,324	3,723	,000	1,000	

a. Dependent Variable: MRKT_SHARE

1.10 Market Share Vs. (Hybrid/EV vehicle introduction + Share of Green Product Advertising)

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	,389[a]	,152	,137	,06663	,222

a. Predictors: (Constant), Gree_intro_D, Share_GreenAd_exp

b. Dependent Variable: MRKT_SHARE

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	,093	2	,046	10,455	,000[a]
	Residual	,519	117	,004		
	Total	,612	119			

a. Predictors: (Constant), Gree_intro_D, Share_GreenAd_exp

b. Dependent Variable: MRKT_SHARE

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statist	
		B	Std. Error	Beta			Tolerance	VI
1	(Constant)	,062	,007		8,780	,000		
	Share_GreenAd_exp	,367	,180	,200	2,038	,044	,751	
	Gree_intro_D	,040	,016	,249	2,532	,013	,751	

a. Dependent Variable: MRKT_SHARE