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Automaker Platform Strategies and Battery Sourcing in the Electric Vehicle Industry

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Sommario

L'industria automobilistica sta vivendo un'era di grande incertezza e cambiamento dovuti all'introduzione dei veicoli elettrici sul mercato, fenomeno che ha portato i produttori di auto a cambiare il proprio modo di produrre e approvvigionare componenti. Lo studio si focalizza sulle piattaforme elettriche dedicate e sulle batterie, individuando per queste tre principali strategie adottate: la produzione propria, la creazione di joint ventures e l'outsourcing. Al fine di capire se esista un nesso tra le strategie adottate per le due componenti, è stato creato un database di 57 produttori di auto studiati secondo diverse variabili, che includono le strategie adottate per le piattaforme e le batterie, la distribuzione geografica, la dimensione di impresa, la natura di incombenti o nuovi entranti. Dall'analisi statistica è emerso che la strategia adottata per le piattaforme EV non consente di prevedere quale strategia sarà adottata per la batteria. D'altra parte, le caratteristiche dell'azienda possono incidere sulla scelta: l'analisi suggerisce che è più probabile che un soggetto nuovo entrante nel mercato delle auto elettriche produca batterie in-house rispetto ad un incombente.

Abstract

The automotive industry is experiencing an era of great uncertainty and change due to the introduction of electric vehicles on the market, which has led car manufacturers to change their way of producing and sourcing components. This study focuses on dedicated electric platforms and batteries, identifying the three main strategies adopted by automakers: own production, creation of joint ventures and outsourcing. In order to understand whether there is a link between the strategies adopted for the two components, a database of 57 car manufacturers has been created, including variables that describe the strategies adopted for platforms and batteries, geographical distribution, size, and nature of incumbent vs new entrant. From the statistical analysis it is found that the strategy adopted for the EV platforms does not allow to predict which strategy will be adopted with regard to the battery. On the other hand, the characteristics of the company do affect the choice: the analysis suggests that a new entrant to the electric car market is more likely to produce batteries in-house than an incumbent.

1. Introduction

The objective of this thesis is to study the strategies adopted by car manufacturers regarding dedicated EV platforms and batteries and understand whether there is a link between the strategies chosen.

This research is the result of a joint project between the University of Pisa and the University of Klagenfurt. I was awarded an ERASMUS + scholarship to carry out my thesis at Alpen Adria University of Klagenfurt, which started in person but then had to continue in home-working mode due to the Covid emergency.

2. Literature Review

To set the context, an extensive review of the literature[1] was made regarding the automotive sector and more specifically the evolution of the platform, from the standard and integral design to the modular one dedicated for electric cars.

2.1 The evolution of the automotive industry

The automotive sector has undergone numerous structural changes over the years and Original Equipment Manufacturers (OEMs) have led the change in the architecture of the industry, assuming more or less strong competitive positions and collaborating with suppliers to reach, at the end of the 90s, a new strategic vision based on modularity and outsourcing.

The automotive industry is an integral component of the global economy. It encompasses every aspect of the value chain, from raw materials to design and development, manufacturing, sales and service. All of these areas of value creation are undergoing significant innovative change as a result of environmental and competitive forces (Holweg, 2008). The development of new forms of propulsion, as an alternative to combustion engines, has been capturing public attention for long time and consumer perception of hybrid or electric vehicles is changing. Electric vehicles are currently considered a key element in the automotive industry to contribute to sustainable development.

The development of electric cars began in the 1990s when the economic and environmental crisis accelerated the change.

[1] Please consult the thesis for the references to the articles mentioned. I have examined >100 academic and non academic sources.

More and more car manufacturers have introduced cars with electric propulsion into their production, to achieve the goal of zero emissions (Dijk and Yarime, 2010).

The advent of hybrid-electric vehicles is an example of a technological competition driven by the incumbents. Technological discontinuities can lead to the consolidation of industries and the introduction of new technologies within existing capabilities (Bergek et al., 2013).

2.2 The platform strategy

The product platform concept was introduced in the automotive industry around the 1960s and quickly became a key approach in all product innovation processes. The main advantage is the ability to create different types of models from the same platform. The adoption of a standard platform allows automakers to obtain greater flexibility between the plants, allowing to move production from one plant to another, and a significant reduction in costs due to the sharing of material, technological and intellectual resources (Muffatto, 1999).

In the last decade, starting around 2010, the platform strategy has been revised and a new type of platform has been introduced in the automotive sector: the modular one (Sehgal and Gorai, 2012). The increase in product customization and variety and the need to keep production volumes high without increasing costs, has pushed car manufacturers to increasingly use modularity as a strategy to efficiently organize complex products and processes (Baldwin and Clark, 2003). The trend in the last three years is to build electric-only platforms. This is the opposite of the traditional and still widely used strategy of building cars with several different powertrain options (including hybrid or electric) on the same platform of the internal combustion engine.

3. Research Setting

The research focuses on two main components of an electric car: the EV dedicated platform and the battery.

I examine exclusively fully electric propulsion cars because the modular platform dedicated to electric cars is the real revolution and therefore has led to substantial changes. In fact, the platform for hybrid cars did not involve major structural changes as it was an adaptation of the platform already used for cars with combustion engines. The platform dedicated to electric cars, on the contrary, has an adaptable, scalable, modular and upgradeable design in the shape of a skateboard, in which both the battery and the motor are placed in a lower position. By reading articles, papers, website pages, reports and press releases, I came to

identify, for each producer, the main strategies that automakers are adopting with regard to EV platforms, namely: own production, joint ventures and outsourcing. The same strategies have been identified for the batteries, again for each producer. Both the EV platform and the battery are two components of an electric car of strategic importance and above all of recent introduction.

The formulation of my research question started from these concepts and the interest went towards identifying a link between the strategies chosen for the two aforementioned components to understand whether there is a connection. *Based on the choice made regarding the sourcing of platforms, is it possible to understand what strategy will be adopted towards batteries? Will the same or different strategies be used? Which variables influence the choice?*

4. Methodology and Data

The answer to my research question was sought by building a database that compared the strategies of the two components with other variables describing automakers.

The basis on which to build my dataset are the procurement strategies that the automakers have developed for both the electrical modular platforms and batteries until nowadays, as documented in a variety of sources.

The dataset was complemented with data from two existing databases.

The first consists of a collection of data from 2000 to 2015 that describes all the alliances that have formed over time in the automotive market while the second, whose source is Bloomberg New Energy Finance, refers exclusively to the category of suppliers, describing all the supply agreements over time, from 2000 to 2017, between suppliers themselves or between car manufacturers and suppliers. Other data come from the Orbis database.

4.1 Database Creation

In order to obtain consistency in the data analysis, data cleaning and data integration were carried out.

Since my analysis focuses on fully electric propulsion vehicles, I selected only those firms that produce BEVs (Battery Electric Vehicles) from the database regarding the alliances and removed the ones that produce vehicles other than passenger cars (as they are outside my field of interest). The final list of car manufacturers, belonging to different geographical areas,

includes 57 companies. However, the list does not include all the automakers on the market that produce electric cars, but only those that use EV platforms.

The database includes the following variables:

- Platform-related strategies
- Battery-related strategies
- Country of origin of the car manufacturer: classification made according to an assessment of the macro-environmental variables that characterize each geographical area, namely political, social, technological, and economic scenarios
- Number of battery suppliers
- Name and country of origin of main battery suppliers
- Company size[2]: small, medium or large
- Automaker's characteristic of being Incumbent or EV New Entrant: to understand which automakers were born with the aim of producing electric vehicles or which ones have adapted to the new demands of the market
- Year of foundation of the company
- Number of EV platforms used
- Year of introduction of the EV platform: to identify the date at which the EV platform was put into production (i.e. to understand which of the car manufacturers reacted more quickly to market changes and decided to innovate their production)
- Subjects with which car manufacturers develop JVs, OEM or supplier
- Investments in research and development[2]: disruptive innovations such as electric vehicles require investments in technological innovation and research to be used to improve products or production processes or create new ones
- Battery supplier sector focus[2]: supplier characteristic of focusing on a single sector or being multi-sector corporations.
- Characteristic of the battery supplier of belonging to a supplier association

[2] These data were obtained from the Orbis Database

4.2 Descriptive Analysis

Once the database was created, a descriptive analysis was developed.

The following two figures illustrate the strategies of the platforms and batteries in comparison. The aspect on which to focus attention is the different use of outsourcing that car manufacturers make.

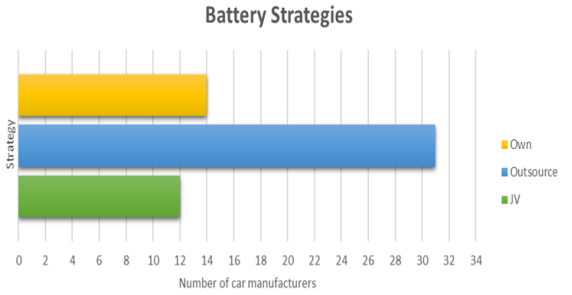

Figure 1

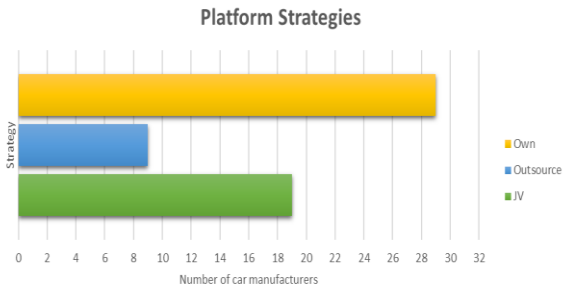

Figure 2

By comparing the two strategies, it is possible to observe an opposite attitude towards batteries and platforms. In fact, there is a large use of outsourcing in batteries, in contrast to platforms. On the other hand, for platforms, in-house production is preferred.

Subsequently, a comparison was made between the two strategies to understand, within the database, how the different battery strategies vary depending on the chosen platform strategy and these results were summarized in a heat map (Table 1).

EV Platform Strategy	Battery Strategy		
	JV	Outsource	Own
JV	7	10	2
Outsource	1	6	2
Own	4	15	10

Table 1. Heat map of configuration of strategies

There are three combinations that stand out and are therefore more popular:

1. Own production of both the platform and the battery
2. The platform's own production and battery outsourcing
3. The combined production of the platform through joint ventures and the external purchase of the battery.

4.3 Statistic Analysis

Simple descriptive statistics does not allow to understand what type of strategy will be adopted for the battery conditional on the strategy for the platform.

In order to identify if there are factors that influence the choice in a statistically significant way, a correlation matrix was built in order to examine the sign of the relation, and then a regression model was developed using the statistical software STATA.

First of all, a model was created in order to define the variables (Table 2).

Battery Strategy = (Platform Strategy) *α + (Geographical Area) *β * + (Company Size) *γ + (Incumbent or EV New Entrant) *δ + (Platform Year of Introduction) *η + (Automaker Foundation) * ϑ + ε

Table 2. Outline of the regression model

Among all the variables analyzed in the dataset, only those that had available values for each of the car manufacturers in the list were included in the statistical model.

The table below summarizes all the studied variables.

VARIABLE	ROLE	TYPE OF OUTCOME	MEASUREMENT
Battery Strategy	Dependent Variable	Binary	1 = Own 0 = Outsource
Platform Strategy	Independent Variable	Binary	1 = Own 0 = Outsource
Europe	Control Variable	Binary	1 = automaker ∈ to Europe 0 = automaker ∉ to Europe
Asia	Control Variable	Binary	1 = automaker ∈ to Asia 0 = automaker ∉ to Asia
USA	Control Variable	Binary	1 = automaker ∈ to USA 0 = automaker ∉ to USA
Company Size	Control Variable	Binary	1 = Large Company 0 = Medium/Small Company
Incumbent or EV New Entrant	Control Variable	Binary	1 = Incumbent 0 = EV New Entrant
Platform Year of Introduction	Control Variable	Integer	/
Automaker Foundation	Control Variable	Integer	/

Table 3. Variables of the model

All independent variables were then transformed into quantitative variables by means of binary transformations (dummies).

Both the dependent and the independent variables were transformed into binary variables, except for the ones relating to the year of introduction of the electric platforms and the automaker foundation which remained unchanged.

Unlike the descriptive analysis, for the statistical analysis the variables related to the strategies were decreased from three to two, thus making them binary.

As far as battery strategies and platforms are concerned, the distinction that will be taken into consideration from now on will be between OWN and OUTSOURCE as the available data did not show a variability that would allow to keep all three variables.

The data relating to the JV and Outsourcing were merged into a single variable (Outsource) to be contrasted with the "Own" variable. Although the variables related to the strategies are categorical in nature, it was not possible to perform a logistic multinomial regression due to the small number (57 instances) of data available for processing, which did not allow to reach statistically significant values.

4.3.1 Correlation

A correlation matrix was created and studied to understand the two-by-two correlation between variables, focusing on the correlation with the dependent variable (Table 4).

		1	2	3	4	5	6	7	8	9
1	Battery Strategy	1								
2	Platform Strategy	0.2346	1							
3	Europe	0.0301	0.1591	1						
4	Asia	0.0291	-0.1217	-0.7803*	1					
5	Usa	-0.0893	-0.0600	-0.3550*	-0.3077*	1				
6	Company Size	-0.4131*	-0.2316	-0.2485	0.1939	0.0882	1			
7	Incumbent or EV New Entrant	-0.4735*	-0.2960*	0.0799	0.0235	-0.1566	0.5833*	1		
8	Platform Year of Introduction	0.0942	-0.0055	-0.0462	0.0297	0.0260	0.3194*	0.3070*	1	
9	Automaker Foundation	0.0443	0.2495	-0.1600	0.2020	-0.0585	-0.2393	-0.4112*	-0.3599*	1

* $p < 0.05$

Table 4. Correlation matrix

Values marked with an asterisk are statistically significant results.

There is a statistically significant correlation between "Battery Strategy" and "Company Size" and between "Battery Strategy" and "Incumbent or EV New Entrant" which means that the size of the company and the fact of being an EV new entrant in the electric car market are associated to the choice to produce batteries internally. The correlation is negative, so it means, respectively, that the smaller a company and the more it has entered the market as EV New entrant, the more likely it is to produce batteries internally.

The correlation between the battery strategy and the platform strategy is low. Therefore, it is assumed, to be confirmed with the regression analysis, that there is no link between the choices made for the two components.

The correlation matrix serves as a descriptive matrix to understand which variables are expected to have statistical significance in the regression.

4.3.2 Regression analysis

The analysis performed used a logistic regression ("logit" command) starting from a binary outcome and the results are shown in Table 5.

The variable USA exhibited perfect multicollinearity, so it was omitted. The data on the size of the company is not relevant in the regression phase since the dataset indicates that there is a preponderance of large companies which therefore are not helpful to the analysis. Furthermore, the low number in the dataset prevented the estimation of a statistically significant coefficient for this variable.

	MODEL Battery Strategy
Platform Strategy	**.6335508**
	(.8439441)
Europe	**1.215085**
	(1.510501)
Asia	**1.885881**
	(1.478014)
Incumbent or EV New Entrant	**-4.056038 ***
	(1.757836)
Platform Year of Introduction	**.4770967**
	(.2497219)
Automaker Foundation	**-.0158123**
	(.012474)
Pseudo R2 = 0.2553	
_cons	**-932.5863**
	(506.2998)
Standard Errors between parentheses	
**** p<.05***	

Table 5. Logistic Regression

The values in bold are the coefficients for the logistic regression equation and predict the dependent variable on the basis of the independent variable.

The model built and developed therefore shows that, among all variables that have been checked, the only significant one is whether the company is a New Entrant or Incumbent. And in particular, the regression confirms the hypothesis that New Entrants in the electric car market prefer a proprietary battery strategy.

4.3.3 Findings

The findings from the regression model offer several interesting insights.

First, the platform strategy does not affect the choice. It is possible to argue that the strategies related to the platform and the strategies of battery sourcing are two strategies taken independently. Automakers first decide about the internal integration of the platform, and then address the compatibility with the production of batteries, selecting various options.

Second, the only statistically significant variable is "Incumbent or EV New Entrant". This means that a new entrant on the electric car market is more likely to produce battery in-house compared to an incumbent. This is an interesting finding, suggesting that incumbent manufacturers are at risk of disruption if the technology of batteries will be subject to significant improvements, but these are appropriated primarily by those that vertically integrate the production.

In these early years of the all-electric revolution new entrants stimulate disruptive innovation and propose themselves as battery producers.

Incumbents, on the other hand, react by continuing to keep core competencies in-house but looking outside the company for the skills necessary for the construction of a strategically important component such as the battery. This happens because they are restricted by their existing assets that reflect past investments and therefore not able to support new large investment into production facilities. The large car manufacturers that have a strong competitive position in established technology are not motivated to radically innovate as competence destroying innovations such as that of the battery could jeopardize the competitiveness in the market.

The results were also analysed from the point of view of cognitive distance. The cognitive distance between an automaker and a battery manufacturer is enormous.

However, for an incumbent or a new entrant this problem could be of a different entity, in particular for an incumbent it could be a problem as the knowledge bases are always very slow to change and very difficult to modify while for a new entrant this phenomenon could be less severe and intrusive. In fact, the characteristics of the new entrants that produce own batteries, show that those who decided to enter the electric car market already had previous knowledge in the production of batteries and technological components.

5 Conclusions

The research conducted in this thesis focused on three alternative sourcing trends that are occurring in the automotive sector at a time of radical innovation, focusing on the fact that the trends of the past that identified the exclusive preference of outsourcing for components are no longer so clear-cut.

The data collected and their subsequent analysis suggest there is no statistically significant relation between the strategies for the two components. Therefore, knowing which strategy has been adopted by the automakers regarding the platforms, it is not possible to predict

which path will be taken for the battery. Similarly, the geographic origin of the automaker does not affect the choice.

The electric car industry has not yet reached stability and there is still a long way to go. Fully electric cars are an innovation introduced very recently, unlike, for example, hybrid cars which have a longer history, therefore a further evolution of internal dynamics within companies is expected.

The distinction between Incumbent and New Entrant is the variable that in this thesis project has turned out to be the most significant. Contrary to expectations, EV New Entrants, compared to incumbents, are looking for a proprietary solution regarding batteries and this constitutes a new interpretation in the evolution of the automotive industry as new entrants are pioneers of this new technology.

5.1 Future Research Perspectives

An extension of this research might benefit from additional data. It would be interesting to build a database by interviewing key decision makers within companies, for instance corporate R&D managers to understand what percentages of research and development expenses are destined for platforms and batteries.

It would also be very interesting to discover in the future what consequences and results the joint venture strategies have brought in order to understand if the collaborations continued over time or they dissolved. And it would be useful to investigate whether the joint production between automakers and battery manufacturers continued or the automakers decided to continue autonomously once the skills and knowledge have been acquired.