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Review

Are sustainable mobility firms reshaping the traditional relationships in the automotive industry value Chain?

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ABSTRACT

The rules of the automotive industry are changing due to sustainable mobility firms linked to essential products and technologies supplied to produce low environmental impact vehicles. Among others, these include batteries and their components (e.g., materials, cells), power electric systems, or technologies for recycling and reuse (e.g., mineral processing, de-pollution waste). Under the global value chain (GVC) approach, the research analyzed these changes through data collected from a survey comparing the relationships established by a sample of 27 sustainable mobility firms and 130 traditional components firms in the Spanish automotive industry value chain. The results indicate that the new players linked to sustainable mobility have greater decision-making power on the value chain in terms of price, product design, and geographical location. Moreover, these firms have broken the traditional asymmetrical dependence on leading buyers. As a result, they lead some of the key products in this industry, and show a high performance that favors a profitable return on investment in sustainable technologies. The main novelty of our findings lies in how to understand the new automotive industry value chain. Although this value chain continues to be governed by the Original Equipment Manufacturers (OEMs), the sustainable mobility suppliers control the main value-added activities and have the power to take relevant decisions in key sustainable technologies.

1. Introduction

The automotive industry is the focus of sustainability policies in the EU as road transport represents one-fifth of the bloc's total CO_2 emissions (European Parliament, 2020). Moreover, sustainable transportation is directly linked to many of the United Nation's Sustainable Development Goals (SDGs) such as SDG7 (clean energy), SDG13 (climate), or SDG12 (sustainable production and consumption) (Onat et al., 2021; Lampón, 2023). In this context, the automotive industry is forced to produce vehicles with low environmental impact to comply with strict emissions legislation (Jiang et al., 2018; Rietmann et al., 2020; Jasiński et al., 2021).

Sustainable development strategies to reduce environmental impact and ensure a response to regulatory requirements not only involve the Original Equipment Manufacturers (OEMs), but also the whole automotive industry value chain (Gunther et al., 2015). The incorporation of battery electric or hydrogen fuel cell vehicles (Van Mierlo et al., 2006; Krings and Monissen, 2020) has implied the need for supplier firms to develop different technologies and products to produce those vehicles. Products such as batteries and their components, hydrogen fuel cells, power control, and energy management systems make up the architecture of low environmental impact vehicles (Chalk and Miller, 2006; Sanguesa et al., 2021). Technologies to recover, recycle and reuse components from battery electric or hydrogen fuel cell vehicles have also become particularly relevant (Jungst, 2001; Elwert et al., 2015; D'Adamo et al., 2022).

From the global value chain (GVC) approach, the development and irruption of new technologies has the capacity to reconfigure the value chain of an industry (Turienzo and Lampón, 2022). In particular, the changes in the automotive industry have been mainly analyzed under the GVC approach, which focuses on the modes of relationships among firms (Sturgeon et al., 2008; Lampón et al., 2022). The traditional automotive industry has been governed by the OEMs that coordinated an extensive network of components suppliers resulting from outsourcing and vertical disintegration processes carried out by them (Frigant and Layan, 2009). This traditional automotive value chain is configured by components suppliers positioned on multiples supply levels and characterized by long-term relationships, an asymmetrical

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power distribution, and a strong dependence of suppliers on buyers (Sturgeon et al., 2008; Sturgeon and Van Biesebroeck, 2011; Lampón et al., 2016).

The relationships established by new sustainable mobility firms in the traditional value chain of the automotive industry have scarcely been studied. On the one hand, it is necessary to go beyond the analyses of most of the previous works, which have focused on the impact that the design and production of low environmental impact vehicles is having exclusively on OEMs (Schöggl et al., 2017; Szász et al., 2021), to look deeper at the changes involving the whole automotive value chain. On the other hand, in previous works that studied this value chain, the relationships established by firms have not been the core of their analyses. Some were focused on competencies of countries and firms (Conde Jussani et al., 2017; Masiero et al., 2017), and others adopted a global production network perspective mainly focused on activity location and supply issues, and the role played by firms and governments in these issues (Bridge and Faigen, 2022). Furthermore, previous studies have not shown consensus on the type of relationships established by firms on the automotive value chain and the impact that this has on their business results (Wiengarten et al., 2010; Marques et al., 2022). Therefore, the following research questions are posed.

RQ1: What are the relationships established by sustainable mobility firms in terms of decision power and dependence on buyers in the automotive industry value chain?
RQ2: What is the impact of these relationships on their performance?

Responding to these questions, the research contributes to the understanding of the relationships established by sustainable mobility firms in the automotive industry and the impact on their performance. Focusing on relationships established by firms in the value chain, our findings make it possible to look beyond the description of how the supply chain is articulated, how activities are dispersed in different locations, or what capabilities are presented in these locations, as previous works have pointed out. Knowledge of the key factors such as the decision power distribution, the dependence in relationships and control of the value-added activities in the value chain allows better interpretation of the real phenomena that are currently taking place in the automotive industry.

The paper is structured in four sections. The first revises the literature related to the GVC approach. The second section develops the research methodology. The third discusses the results and the last section summarizes the conclusions, draws practical implications, and presents further areas for research.

2. Literature review

2.1. The relationships established by sustainable mobility firms in the automotive industry value chain

The GVC approach has been widely used in previous works to analyze the mode of relationships established among firms in the traditional automotive industry value chain (Sturgeon et al., 2008; Sturgeon and Van Biesebroeck, 2011; Lampón et al., 2016, 2018). This traditional value chain is focused on the product (vehicle) and the manufacture of the modules, systems, and components that go to make it up. It is a value chain resulting from outsourcing and vertical disintegration of the OEMs in which the components firms undertake an important part of the activity. Power of decision is concentrated in a few buyers with the capacity to choose and replace their suppliers, and to decide most of the conditions of the supply contracts (Sturgeon and Van Biesebroeck, 2011; Davim, 2018).

Supply chain management in the automotive industry is characterized by a set of logistics and complementary practices that enable a way of managing the value chain (González-Benito et al., 2013; Berger et al., 2018; Moyano-Fuentes et al., 2020). The logistics practices are linked to the operational process of supplying (e.g., frequency of deliveries, stock level, location). The complementary practices affect the mechanisms of the exchange and involvement (e.g., participation in product design), or quality conditions (e.g., supplier selection based on quality and reliability). These practices are included in the supply contracts between buyers and suppliers in this industry, and they define the decision-making power of each firm in the value chain (González-Benito et al., 2013).

The products and technologies supplied by sustainable mobility firms are not the result of an outsourcing process by the OEMs as they are for traditional components (Globisch et al., 2019). Many sustainable mobility firms base their activities on emerging technologies within this industry that are continually evolving and that the OEMs do not know about (Whittle et al., 2019): technologies characterized by stringent requirements in terms of skills which are difficult to acquire. Furthermore, some of these firms come from and operate in industries other than the automotive industry such as energy management or the recycling and reuse of materials (Alesiani and Maslekar, 2014; Sanguesa et al., 2021; D'Adamo et al., 2022).

Therefore, it is difficult for the traditional leaders to participate and have any influence in developing activities far removed from traditional products or production processes in the automotive industry (Sturgeon et al., 2008). This is especially true in decisions over aspects such as product design, production process specifications, or acquisition of assets. At the same time, as far as logistics practices are concerned, the supply mode that is widely implemented in the traditional value chain is mainly characterized by frequent deliveries, minimum stock levels, and particularly geographical proximity (Chun, 2003). In many cases the location of production and the supply of components have traditionally been decided by buyers to meet demanding conditions of nearby delivery (e.g., seats, cockpits) (Tortorella et al., 2018). There is evidence that sustainable mobility firms deliver their products to several geographically dispersed buyers (Turienzo and Lampón, 2022). The authors argue that these firms choose the location for their plants based on technology factors (e.g., locations with presence of universities and research centers) and not based on proximity to buyers. In summary, in this context there are limited elements that the traditional leading buyer firms can use to exert power over these sustainable mobility suppliers as they did with the traditional components suppliers.

In terms of buyer-supplier dependence, various key aspects have been highlighted in the literature (e.g., the availability of supply alternatives, the cost of changing supplier, or dedicated resources) (Manello and Calabrese, 2019; Bodendorf et al., 2022). Sustainable mobility firms base their activity on emerging technologies and these firms have therefore come into the automotive industry's value chain more recently than traditional components firms (De Paulo et al., 2020; Wang et al., 2022). This means buyers have fewer supply alternatives for these technologies. Moreover, some sustainable mobility firms as linked to energy management or to recycling or reusing materials and components operate in industries other than the automotive industry (Mcdonnell and Jackman, 2005; D'Adamo et al., 2022). This feature of diversification in their market allows them to interact with many buyers and they can establish relationships with automotive buyers that are less dependent.

2.2. The impact of the relationships established by sustainable mobility firms on their performance

Among the features of the relationships in the automotive industry value chain that condition the performance of firms, cooperation has attracted the most attention (Nyagaa et al., 2010; Thomas et al., 2018; Davim, 2018; Moyano-Fuentes et al., 2020). Some authors maintain that the traditional automotive value chain follows a cooperation framework and define it by relationships based on trust and a commitment to collaborate in the long term, which involves both parties sharing information (Tortorella et al., 2018). Evidence suggests that even in the relationships established within a cooperation framework, there are some elements of competition (Attias and Mira-Bonnardel, 2017). Competition relationships are established through short-term contracts and penalties for non-compliance are incorporated to guarantee the quality of the supply (Fan and Stevenson, 2018). In this context, some authors have pointed out that performance of firms in the traditional automotive value chain is greater when the relationships have more features of the cooperation-based model (Wiengarten et al., 2010; Marques et al., 2022). Nonetheless, this performance is not equally distributed over the whole value chain; the position firms occupy on the value chain conditions this performance, i.e., the higher the level in the value chain, the better the performance (Lampón et al., 2021).

In terms of the positioning in the value chain, some of the sustainable mobility firms develop key electric vehicle technologies such as power control and energy management systems that are supplied directly to OEMs (Sanguesa et al., 2021). Moreover, an important product such as the battery has a modular architecture made up of components supplied by firms positioned on different levels (Rothgang et al., 2015). Batteries have fewer components than traditional modules, thus a smaller number of suppliers are involved, and therefore a smaller number of supply levels (Lukasiewycz et al., 2016). This means that sustainable mobility firms are positioned on the first levels of supply and this would mean that these firms have better performance.

As a summary, this research does not delve into whether such firms follow a cooperative relationships model (Davim, 2018; Thomas et al., 2018; Moyano-Fuentes et al., 2020) but rather it focuses on the relationships they establish in terms of decision power and dependence. In particular, it is postulated that greater decision-making power and lower dependence on the buyers are aspects that can mean that their performance is better.

3. Research methodology

The research methodology was quantitative. This methodology relies on using numerical data, analyzing them through statistical models, and reporting relationships among the studied variables (Creswell, 2003). Among the advantages of the quantitative approach, the most relevant are that it provides an objective measure of reality and results that can be generalized (Copper and Schindler, 2016).

Research methodology is deployed through a research design that includes the description of the steps taken by the study. The type of development design in our research was cross-sectional. The cross-sectional study compares two different groups within the same parameters (Leedy and Ormrod, 2005). Our research method is proposed because it compares sustainable mobility firms and traditional component firms to analyze key variables in the relationships established in the automotive industry value chain.

The research design includes the characteristics of the scope and boundaries of the study (e.g., sample size, geographical location or setting in which the study takes place), the definition of the variables, and the data collection and analysis (Copper and Schindler, 2016). In terms of scope, our study was carried out in Spain because of the country's relevance within the automotive industry global value chain (Lampón et al., 2016). The variables used in the study were quantitative and their definitions are supported by the existing literature.

To collect data related to the variables, a survey was used. Surveys allow the direct gathering of data from respondents which is not publicly available in other sources of information (Nardi, 2018). Surveys commonly resort to primary information sources to collect the data from companies (Creswell, 2003), as is our case. The final sample of the study consisted of the companies that replied to this survey.

The data analysis was performed through logistic regression (also known as logit model). Logit model is a regression model used when the dependent variable is binary or dichotomous. This model allows a binary outcome to be predicted by analyzing the relationship with multiple independent variables (Hosmer et al., 2013). Thus, the significance of an independent variable in the logit model implies it has an explanatory capacity to characterize the dependent variable (Schneider, 2013), in our case the type of firm (sustainable mobility firm/traditional component firm). Finally, a goodness-of-fit analysis was performed to compare observed and expected values, and to explain whether the developed models fit the set of observations (Smith and McKenna, 2013). In our case, the *McFadden Pseudo-R^2* was used to evaluate the models' goodness-of-fit (McFadden, 1974).

In the following three subsections, the research methodology is developed in depth. The description steps of the research design are detailed with the particular information from the study carried out.

3.1. Data collection and sample

The Spanish automotive industry was chosen to perform the study on. This industry (OEMs and components industry) represents about the 10% of the gross domestic product of the country. A total of seventeen OEM plants are present in Spain and produced 2.220 million vehicles in 2022, of which about 300,000 were electric or hybrid (13.6% of total vehicles produced). The components industry plays an important role in this industry in terms of value of production, which amounted to about 32,000 million euros, placing Spain in third position in Europe, only preceded by Germany and France (ACEA, 2022). It is estimated that the Spanish components industry contributes 75% of the total value of a vehicle and invests 1075 million euros in R&D (3.6% of turnover), where sustainable mobility technologies are an important part of these investments (SERNAUTO, 2021). Different projects related to these sustainable technologies have been deployed, for example, the "*Future: Fast Forward*" project integrates several foreign and Spanish firms to create an entire battery ecosystem, providing essential components for electric vehicles and promoting a circular economy. Moreover, the *PowerCo* firm has started the construction of a lithium battery manufacturing plant to produce batteries at the beginning of 2024, and the *Basquevolt* firm has made the first investment in a prototype production line for a future solid-state lithium battery plant, with the aim of reaching a capacity of 10 GW h in 2027 (FACONAUTO, 2022).

To obtain the traditional components firms operating in Spain, the Amadeus database was used, selecting those with activity code NAICS 3363 (Motor Vehicle Parts Manufacturing). Sustainable mobility firms were identified by using different sources: the new mobility technologies databases (Tracxn, 2021), and sectorial reports and studies (SERNAUTO, 2021). All firms had to meet the one condition of having over 10 employees. 41 sustainable mobility firms and 277 traditional components firms were identified. Thus, the total number of firms forming the universe of study was 318.

A survey was used to collect numerical data; it included a questionnaire with a short number of closed questions. The time to answer the questionnaire was estimated at around 5 min. It was designed to be answered in two ways, by telephone or email. The target respondent was the Chief Executive Officer (CEO) of the firms. The research team carried out a process of validation of the survey (Forza, 2002) by means of a pilot test with eight firms.[1] This pilot test checked the reliability of the questions comprising the questionnaire, and tested and verified the procedure for receiving, completing, and returning it. A first version (draft) of the questionnaire was emailed, together with instructions for filling it out, to four firms. Furthermore, the draft of the questionnaire was also filled out through a telephone call to the other four firms. The research team analyzed the responses from the eight drafts received. The analysis detected problems in the answers related to the question about the *performance* variable. Specifically, there was no response in one of

[1] These eight (four sustainable mobility and four traditional components) firms selected had already participated in other research carried out by the research team. This facilitated the process of interaction between the companies' CEOs and the research team for the validation of the survey.

the questionnaires and the response was incoherent in another. The research team revised the question, and added complementary information[2] to ensure that the question was understood. The modified draft was sent to the eight firms, and the validity of the new responses received was checked.

An external company with extensive experience in this type of fieldwork carried out the survey in order to maximize the response ratio. The fieldwork was done from September to December 2021. The survey was sent to all the firms and 157 valid replies were received (130 traditional components firms and 27 sustainable mobility firms). This supposes a response rate of 49.4% and sample error rate of ± 5.57%. See Table 1, It shows the characterization of the sample of responding firms.

3.2. Variables

3.2.1. Dependent variable

As the methodology is based on comparing sustainable mobility firms and traditional components firms, the variable *firm type* was used, defined as a dummy, assigning value 1 to sustainable mobility firms and 0 to the traditional components firms.

3.2.2. Independent variables

The independent variables used were those that allowed the research questions to be answered. For RQ1, concerning the type of relationships established, two variables were used. The first was *decision power* variable, determined as the average decision power in each of the key elements of supply contracts in the automotive industry (González-Benito and Spring 2000; Johnson et al., 2021), measured using a scale ranging in value from 1 to 3 (see Table 2).

The second variable for RQ1 was *dependence*. Although there are various aspects that can be used to determine this dependence (e.g., supply alternatives, dedicated resources, cost of changing supplier), the *dependence* variable in this research was defined in terms of the dedicated resources, measured as a percentage of turnover from its main buyer (Böhme et al., 2008).

The independent variable used to respond to RQ2 was *performance,* defined in terms of the added value per employee (Fitzgerald, 2007). The formula to calculate the variable was: [Value of production] – [Value of external costs (costs of materials and supplies)]/[Number of employees]. Each element of this formula was desegregated to be obtained from the firm's accounting statements[3] (PGC, 2022). This facilitated the calculation of the variable for the respondents.

3.2.3. Control variable

Supply level was defined as the level of supply on which the firm is positioned. The values for the variable are assigned according to whether it is Tier-1, the firm supplies the OEMs (value = 1); Tier-2, the firm supplies the Tier-1s (value = 2); …; Tier-n (value = n) (Rodríguez-De La Fuente and Lampón, 2020). (see Table 3, it shows the definition of all the dependent, independent and control variables)

Table 1
Characterization of the sample by products and technologies supplied.

	Products and technologies	Number of cases	%
Traditional components firms	Plastic, rubber and composite products	29	22.3%
	Metal components for chassis and bodywork	17	13.1%
	Transmission, suspension, braking systems and parts	15	11.5%
	Modules (seat, cockpit and front end)	14	10.8%
	Textiles (seat covers and internal upholstery)	13	10.0%
	Small metal parts for mechanics	8	6.2%
	Others (view mirrors, belts …)	34	26.1%
Sustainable mobility firms	Batteries or hydrogen storage components (batteries' components, battery-heating system, materials …)	11	40.8%
	Electric power architecture (power unit, energy management system, …)	7	26.0%
	Technologies of recycling and reusing (mineral processing, de-pollution waste, dismantling power electronics components …)	6	22.1%
	Others (optimizing charging software, eco charge systems …)	3	11.1%

Source: own elaboration.

3.3. Data analysis

To analyze data, since the dependent variable shows a binary response (1/0; sustainable mobility firm/traditional components firm), we use logit models to estimate the probability of a positive outcome given a set of regressors (independent variables). This logistic regression allows us to identify the significant independent variables that characterize the type of firm (sustainable mobility firm/traditional component firm). This significance implies that there are significant differences for the variables between the two groups of firms. Additionally, to reinforce the explanation of the differences, a descriptive analysis of the variables for sustainable mobility firms and traditional components firms was presented separately.

Six logistic models were performed. A Main Model that includes the *decision power, dependence, performance,* and *supply level* variables. The other five models (Model 1, Model 2, Model 3, Model 4, and Model 5) include *dependence, performance,* and *supply level* variables and each of the elements that comprise the *decision power* variable (*price*, *quality conditions*, *product design*, *process specifications*, and *location*) respectively. In order to avoid scale issues in the variables, all of them were standardized.[4]

The performance of the logit models was analyzed in terms of goodness of fit (Pseudo-R^2) and its predictive capacity. There are many different ways to calculate Pseudo-R^2 for logistic regression. Mittlbock and Schemper (1996) reviewed twelve different measures, and Menard (2000) considered several others. Among these measures, the *McFadden Pseudo-R^2* (McFadden, 1974) is one of the most commonly used (Louviere et al., 2000; Smith and McKenna, 2013; Hemmert et al., 2016). This is because it reflects both the criterion being minimized in the logistic regression estimation and the variance accounted for by the logistic regression model, and is reported in the statistical software

[2] See note 3 of this document explaining the new concepts incorporated in the initial formula for the calculation of the *performance* variable. These new concepts, also incorporated in the questionnaire, allowed the content of the question about the *performance* variable to be specified in detail.

[3] The Spanish General Accounting Plan (Plan General de Contabilidad) is the legal framework that regulates the accounting of the companies (PGC, 2022). It sets out which accounting statements companies have to present and how they have to present them. Using the standard items of the Spanish General Accounting Plan, the [Value of production] was broken down into [Net sales + Other operating income ± Change in stocks of finished products + Works carried out by the company on its assets]. The [Value of external costs (materials and supplies)] was broken down into [Purchases ± Change in stocks of product in progress + External services expenses].

[4] This process was carried out in order to compare variables that have scales or units with different measurements (Milligan and Cooper, 1988), as in our case. The standardized variable "z" is calculated for each variable x, as z = (x – m)/s. Where "m" is the mean and "s" the standard deviation of variable x.

Table 2
Key elements of supply contracts in the automotive industry.

	No power (value = 1)	Partial power (value = 2)	All the power (value = 3)	Aspects analyzed
Price	The buyer imposes the price	The price is negotiated	The price is imposed by the supplier	Cost structure, productivities
Quality conditions	The buyer imposes the quality conditions	The quality conditions are negotiated	The quality conditions are defined by the supplier	Quality standards, penalties
Product design	The buyer designs the product	The buyer participates in the design	The product is totally designed by the supplier	Features and specifications
Process specifications	The buyer defines the process	The buyer includes some specifications for the process	The process is totally defined by the supplier	Assets, technologies and methods
Location	The buyer decides the location of supplier	The buyer can decide the location of supply	Location is decided by the supplier	Proximity

Source: own elaboration based on González-Benito and Spring (2000) and Johnson et al. (2021).

Table 3
Summary of the variables and definition.

Variable	Definition
Firm type	Dummy, value 1 if the firm is a sustainable mobility firm; value 0 if the firm is a traditional components firm
Decision power	Values from 1 (if the firm does not have decision power) to 3 (if the firm has all the decision power)
Dependence	Revenues from the main buyer as a % of total revenues
Performance	Value added per employee in thousands of euros. Calculated as: = [[Net sales + Other operating income ± Change in stocks of finished products + Works carried out by the company on its assets] – [Purchases ± Change in stocks of product in progress + External services expenses]]/[Number of employees]
Supply level	Level of supply on the automotive industry value chain. Tier-1, the firm supplies the OEMs (value = 1); Tier-2, the firm supplies the Tier-1s (value = 2); …; Tier-n (value = n)

Source: own elaboration.

packages (Smith and McKenna, 2013; Walker and Smith, 2016). The *McFadden Pseudo-R²* is a log-likelihood-based measure, and defined as (McFadden, 1974):

McFadden Pseudo-R^2 = 1 — [deviance of the fitted model / deviance of the null model] = 1 — [log(likelihood for the fitted model) / log (likelihood for the null model)]

If the null model (includes only an intercept as predictor) is less likely and the fitted model is more likely, the second part of the above equation becomes smaller. In a perfect case, this second portion becomes 0 and Pseudo-R^2 value becomes 1 (Smith and McKenna, 2013).

Finally, the *IBM SPSS Statistics*[5] software, version 28, was used to perform the models and to analyze their goodness of fit.

4. Results and discussion

4.1. Results

The results of the logit models are reported in Table 4. The results include the values and signs of regression coefficients, standard errors, and the significance of each variable. Additionally, descriptions of variables for each group of firms are presented in Table 5. In this case, the means, standard deviations, and maximum and minimum values of each variable are shown.

In terms of goodness of fit of the models, the values of the *McFadden Pseudo-R^2* are between 0.735 for the Main Model and 0.554 for the Model 4 (see Table 4). Considering that *McFadden Pseudo-R^2* ranging from 0.200 to 0.400 indicates good model fit, and >0.400 excellent model fit (McFadden, 1979; Louviere et al., 2000; Hemmert et al., 2016), the performed models have an excellent goodness of fit. Moreover, in terms of the predictive capacity (values from 97.5% of the Main Model to 91.7% of the Model 4) (see Table 4), the results confirming the goodness of fit of all the models.

4.2. Discussion

With regard to the first research question (RQ1), the *decision power* variable is highly significant at a confidence level of 99% in the Main Model (Table 4). Furthermore, the mean value of the *decision power* variable for sustainable mobility firms is 2.38 compared to 1.78 for traditional component suppliers (Table 5). These results indicate that suppliers linked to sustainable mobility have greater decision power than traditional component suppliers within the automotive industry value chain. At the same time, the value 2.38 of the *decision power* variable (Table 5) implies that sustainable mobility firms have greater decision-making power than those buying from them. This suggests an important change in power balance respect to the traditional relationships in the automotive value chain, where the traditional leading buyer firms had exerted the power over the component suppliers (Sturgeon et al., 2008; Lampón et al., 2022).

Breaking the *decision power* variable down into its key elements contained in supply contracts, their impact can be analyzed. *Quality conditions* (Model 2) and *process specifications* (Model 4) are not significant. The explanation of the results is different for each one. For *quality conditions*, the lack of significance is due to the globally recognized quality standard for the automotive industry under which all firms operate (De Oliveira et al., 2021), which means there is no difference in the values for both supplier types. For *process specifications*, the lack of significance can be put down to the autonomy suppliers in terms of implementing current advanced production technologies (Szalavetz, 2019; Vasco, 2021). In fact, the mean values for both supplier types are similar and high: 2.44 for traditional suppliers and 2.52 sustainable mobility suppliers (see Table 5).

Price (Model 1) is significant at a confidence level of 99%. Therefore, sustainable mobility suppliers have greater power to set the price of the supplied product or technologies than traditional component suppliers. This result suggests that the information sharing between traditional suppliers and buyers on component cost structures (Tortorella et al., 2018) does not exist for the sustainable mobility suppliers. Thus, it is difficult for buyers to negotiate prices based on costs or even demand an annual reduction based on productivities as happens in the traditional value chain (González-Benito and Spring, 2000). *Product design* (Model 3) is significant at a confidence level of 99%. Furthermore, the mean value for sustainable mobility firms is 2.59 compared to 1.55 for traditional component suppliers (Table 5). This suggests that sustainable mobility suppliers have a high level of decision-making power to define the design of their products. This result was to be expected, as the sustainable mobility suppliers have not resulted from the vertical disintegration of the OEMs. The OEMs have no knowledge of how these sustainable technologies are developed in order to influence their

[5] See the detailed information about the use for logistic regression in IBM SPSS Regression 28. Available at: https://www.ibm.com/docs/en/SSLVMB_28.0.0/pdf/IBM_SPSS_Regression.pdf.

Table 4
Results of the logit models.

Variable	Main Model	Model 1	Model 2	Model 3	Model 4	Model 5
Decision power	3.139** (0.999)					
Price		2.870** (0.848)				
Quality conditions			0.684 (0.364)			
Product design				2.166** (0.630)		
Process specifications					−0.369 (0.393)	
Location						1.289** (0.443)
Dependence	−1.544** (0.591)	−0.771 (0.525)	−1.772** (0.485)	−2.336** (0.710)	−0.066** (0.016)	−0.071** (0.019)
Performance	1.068* (0.474)	1.951** (0.506)	1.466** (0.393)	1.165** (0.464)	0.084** (0.022)	0.073** (0.024)
Supply level	−2.623** (1.010)	−1.786** (0.651)	−1.487** (0.575)	−2.244** (0.876)	−1.434** (0.589)	−1.941** (0.709)
McFadden Pseudo-R^2	0.735	0.679	0.573	0.711	0.554	0.626
Predictive capacity (%)	97.5	96.2	93.6	96.2	91.7	94.3
Number of observations	157 [130 + 27]					

**p < 0.01; *p < 0.05. Standard errors in brackets.
Source: own elaboration.

Table 5
Descriptive statistics of variables.

Variable	Type of firm	Mean	Min.	Max.	S.D.
Decision power	Traditional components firms	1.78	1.0	2.6	0.335
	Sustainable mobility firms	2.38	1.5	3.0	0.279
Price	Traditional components firms	1.68	1.0	1.0	0.574
	Sustainable mobility firms	2.44	2.0	3.0	0.506
Quality conditions	Traditional components firms	1.55	1.0	3.0	0.671
	Sustainable mobility firms	1.85	1.0	3.0	0.534
Product design	Traditional components firms	1.55	1.0	3.0	0.624
	Sustainable mobility firms	2.59	2.0	3.0	0.501
Process specifications	Traditional components firms	2.44	1.0	3.0	0.647
	Sustainable mobility firms	2.52	1.0	3.0	0.643
Location	Traditional components firms	1.69	1.0	3.0	0.788
	Sustainable mobility firms	2.48	1.0	3.0	0.643
Dependence	Traditional components firms	62.18	8.00	100.00	27.928
	Sustainable mobility firms	23.56	5.00	85.00	20.476
Performance	Traditional components firms	36.33	9.96	71.10	11.245
	Sustainable mobility firms	60.74	13.99	95.92	23.073
Supply level	Traditional components firms	2.2	1	4	0.99
	Sustainable mobility firms	1.3	1	3	0.55

Source: own elaboration.

design, unlike the components from traditional suppliers (Frigant and Layan, 2009). *Location* (Model 5) is significant at a confidence level of 99%. This result confirms the capacity of sustainable mobility firms to decide their location, particularly based on technology factors (Turienzo and Lampón, 2022) and not because of their proximity to buyers. This way of locating is very different from the traditional suppliers, where the delivery demands imposed by buyers forces them, in many cases, to locate nearby (Chun, 2003; García-Vázquez et al., 2005).

Regarding the second variable related to the first research question (RQ1), *dependence,* it is highly significant at a confidence level of 99% in the Main Model (Table 4). Moreover, the mean values in terms of the dedicated resources, measured as a percentage of turnover of its main buyer, are 23.56 for sustainable mobility firms and 62.18 for traditional components suppliers (Table 5). These results suggest that, in terms of dependence, the relationships established by sustainable mobility suppliers differs from the traditional relationships characterized by a strong dependence of component suppliers on buyers (Guerrini and Pellegrinotti, 2016). This result can be explained by two motives. On the one hand, some of these sustainable mobility firms operate in different industries; which allows them to be relatively independent from automotive industry buyers. On the other, many of the technologies these firms develop are emerging, and have recently come into the value chain in automotive industry. This means there are fewer suppliers of these technologies available and, therefore, there are fewer supply alternatives for buyers.

With regard to the second research question (RQ2), the *performance* variable is significant at a confidence level of 95% in the Main Model (Table 4). The average for the *performance* variable, in terms of thousands of euros per employee, is 60.74 for sustainable mobility firms and 36.33 for traditional components firms (Table 5). This implies a high performance for sustainable mobility firms compared to traditional components firms. This result suggests that the relationships established by sustainable mobility firms in the automotive value chain, in which they have a high level of decision-making power and low dependency on the buyer, imply better performance. Finally, the control variable, *supply level,* is significant at a confidence level of 95% in the Main Model. Moreover, the mean value of this variable for sustainable mobility firms is 1.3 (Table 5). This highlights that the sustainable mobility firms are practically Tier-1, supplying their products and technologies to the OEMs. These results point out those sustainable mobility suppliers are positioned on higher supply levels than traditional components suppliers and confirm previous works that suggest that the higher position in the value chain, the better the performance (Lampón et al., 2021).

5. Conclusions

In terms of theoretical contribution, the results point out that the GVC approach remains valid for identifying the key elements that explain the relationships between firms that have traditionally been a part of the automotive value chain and new players, particularly sustainable mobility firms. The findings show that these new players linked to essential products and technologies supplied to produce low environmental impact vehicles, such as batteries and their components, or technologies for recycling and reusing, have a high power of decision and have changed the asymmetrical dependence on traditional leading buyers in the automotive industry value chain. Moreover, the impact of this type of relationships established by sustainable mobility firms, characterized by a high level of decision-making power and low dependence on buyers, have meant high levels of performance for them, regardless of the extent of the cooperation in these relationships they establish within the value chain. The findings represent a novelty with respect to previous works on how to understand the automotive industry value chain. Our research highlights that a part of this value chain is not the result of a vertical disintegration processes carried out by OEMs, and although it continues to be governed by these OEMs, the suppliers take decisions in key sustainable technologies.

There is a strong connection between our findings and the current firms' strategic processes within the Spanish automotive industry. Firstly, although the OEMs' assembly plants in Spain produce around 300,000 electric and hybrid vehicles, there are no battery manufacturers located in the country. This suggests a relevant decision power, as identified in our research, in terms of geographical location of some of the sustainable mobility firms with regard to OEMs, which tend to prefer to be sourced in proximity. On the other hand, a reduction in the number of employees is being observed in the OEMs' assembly plants located in Spain. This is to be expected because the labor required for the final assembly of electric vehicles is lower than for combustion engine vehicles (ILO, 2020; Bushey, 2022), but also because of the significant added value that is in the hands of suppliers sourcing essential components for the electric vehicles, as highlighted by our findings.

Our research has several implications, especially for governments and society. From the governmental perspective, industrial policies in countries where the automotive industry has a strong presence must focus not only on the attraction of foreign sustainable mobility firms, but also, and mainly, on the deployment of domestic sustainable mobility firms in a territory. This not only favors the development of high added-value activities in these countries and the reduction of supply costs derived from the proximity to the OEMs' assembly plants, but also provides the countries with a leading position within the global automotive industry value chain. Leadership is created by the decision power of these firms in the development of essential sustainable mobility technologies for low environmental impact vehicles. There seems to be a glimpse of these policies in the Spanish industry. In fact, the first projects for battery manufacturing plants in Spain are being accompanied by important direct aids from public administrations. The firm *PowerCo* has received 95 million euros for the construction of its plant to supply lithium batteries at the beginning of 2024, and the Spanish-owned firm *Basquevolt* has received 19 million euros, 50% of its initial investment for the production of solid-state lithium batteries in 2025.

This research also contributes to current social debate about sustainable development in mobility. A part of society agrees with the initiatives that help to mitigate climate change. However, for some of those people, accessibility to environmentally friendly mobility technologies is difficult, mainly due to their high costs. Our results show that firms developing these technologies have a relatively high level of performance in terms of value added, and therefore a profitable return on investment in these technologies. The good performance of these firms may be a key aspect in the future innovation and development of cheaper sustainable mobility technologies to make them accessible to a greater part of the society.

Our research presents some limitations mainly derived from the empirical study. Firstly, the analysis was only carried out in the Spanish automotive industry, which may have specifics that condition the results. Secondly, although the sample error rate is acceptable, the number of sustainable mobility firms in the sample analyzed is relatively small. To overcome these limitations, it would be convenient to perform a future analysis including more countries with a relevant presence in the automotive industry. This will allow a greater number of sustainable mobility firms to be analyzed, and avoid the possible bias linked to the geographical delimitation of the study when generalizing the results. In this respect, a core-periphery model is used in this industry to characterize the geographical organization of value chain activities (Lung, 2004; Mordue and Sweeney, 2020; Pavlínek, 2022). With this in mind, the countries selected for this new analysis should belong to all the categories included in this model. That is, core countries (e.g., Japan, USA, Germany, France), semi-peripheral countries (e.g., Canada, Belgium, Sweden) and peripheral countries (e.g., Mexico, Romania, Hungary).

On the other hand, our research design adopted a cross-sectional approach to compare two groups of firms within the same parameters. This design has not adopted a longitudinal approach, and the findings obtained are a static picture of the time at which the empirical study was carried out. This is a limitation caused by the novelty of certain sustainable mobility technologies in the automotive industry. Decisions are still pending on new technologies that will improve battery capacity, or facilitate recycling and reuse of materials. It is therefore necessary to address future research with a longitudinal approach to analyze whether the new relationships with firms linked to sustainable mobility technologies that will be adopted by the industry will follow the same model identified in this research.

Finally, the traditional automotive industry value chain has been the result of a process of vertical disintegration and outsourcing undertaken by the OEMs. Our findings suggest that future lines of research are opened up given the decision-making power acquired by sustainable mobility suppliers. It would be of interest to analyze whether this disintegration process by the OEMs is ongoing or whether, conversely, they are going to start a reverse process of vertical integration through in-house development of product and technologies that are being supplied to produce low environmental impact vehicles.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The data that has been used is confidential.

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