MARUTI Udyog's role in the growth of the Indian auto parts industry
--2014 financial data and quantitative evaluation based on SHAP analysis--

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1. Introduction

The rapid development of the automobile industry in India accelerated with the start of production by MARUTI Udyog (Suzuki India Limited, hereafter MARUTI) in 1982 [1], [2], [3], [4]. Since then, the company has consistently maintained the top market share and has shown a competitive edge. This study focuses on the "systematic development and structured training of local component suppliers" as the secret to this success. In other words, MARUTI does not regard Indian parts suppliers as mere subcontractors, but provides education and support from a long-term perspective, and has implemented a philosophy of "mutual prosperity for oneself and others" in which both parties pursue mutual development.

The objective of this research is to use machine learning regression models (XGBoost) and SHAP (SHapley Additive exPlanations) to quantitatively identify the main factors that influence a company's Market Capital Growth Rate (MCGR). In particular, we examine the factors that enabled MARUTI to maintain its dominance in the Indian market from multiple perspectives around 2014, as global automakers accelerated their expansion into other Asian markets. The discussion in this paper is structured as follows.

- Section 2: Analysis of factors contributing to the development of the global automobile manufacturing industry

  This quantitative analysis of various financial indicators' impact and contribution to MCGR is based on 2014 managerial data for 65 of the world's leading car manufacturers. The rapid growth in the Indian and Chinese markets in 2014 was remarkable [5]. Therefore, the characteristics of these companies are extracted and analysed. The results show that companies with high MCGR have supply chain management capabilities and new product development capabilities that work together to improve MCGR.
- Section 3: Analysis of the development mechanism of the Indian automobile manufacturing industry
  Following the previous section, we survey existing studies limited to India and develop hypotheses on the impact of MARUTI on growth of the Indian auto parts industry and the competitive advantage of MARUTI. In addition, financial and other data of Indian automobile manufacturers from 2011 to 2014 are analysed. The results of the investigation indicate that Maruti's sustained ability to resist competitive pressures from new market entrants around 2014 can be largely attributed to its long-term partnerships with component suppliers, which were grounded in a spirit of mutual prosperity. This cooperative framework is strongly suggested to have played a pivotal role in

enhancing the company's competitiveness in developing low-cost vehicles.

The final section, Section 4, is a summary.

2 Analysis of development factors in the global automotive manufacturing industry

This section presents a quantitative analysis of the impact and contribution of various financial indicators to MCGR based on 2014 managerial data for 65 of the world's major automobile manufacturers, using regression analysis and other techniques.

2.1 data

This study analyses the global automotive manufacturing industry. Data were obtained from the ORBIS database of Bureau van Dijk (BvD) for companies falling under the industry code '2910 (Manufacture of motor vehicles)'. The selection of the analysed companies was limited to those with sales of USD 200,000,000 (USD 200 million) or more in 2011 to exclude companies of highly different sizes. In Figure 1, companies that exceeded the criteria indicated by the red line (located on the left) (see Figure 1) were selected. The 65 companies include TESLA. The base year for the analysis in this paper is 2011, with a view to analysing time series data over a more extended period. Still, the quantitative analysis uses financial data from 2014, when a particularly significant change was observed.

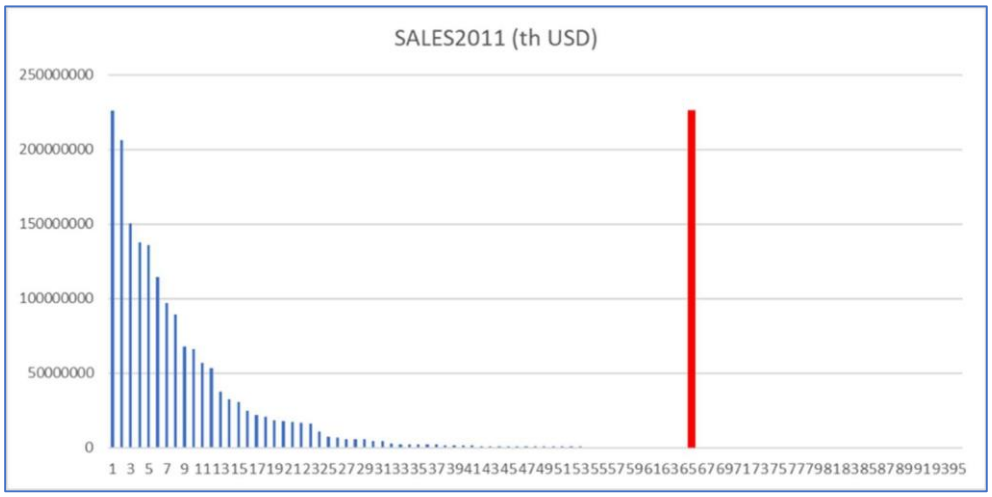

Figure 1: Automobile manufacturing companies' sales in 2011 (sorted in descending order)

2.2 Data and interpretation methods for regression analysis

This section describes the data used in the regression and the SHAP approach to regression methods and their interpretation.

Target and explanatory variables

In this paper, regression analysis was used. The target variable for this analysis is the Market Capital Growth Rate (MCGR) as an indicator of the expansion of a company's market value. Market capitalisation is the share price multiplied by the number of shares outstanding, and a high MCGR

indicates that the company's expectations in the stock market have risen and its market valuation has expanded rapidly. It should be interpreted as an overall 'expected value' indicator rather than a direct indicator of operational performance.

The following five financial indicators were employed as explanatory variables. Originally, labour productivity was to be included as an indicator, but due to the high missing rate of data on the number of employees, it was unavoidably excluded from this study. In addition to the growth rate of sales, the amount of sales itself was also included as an explanatory variable.

1. Inventory Turnover Ratio (INV)
2. Net Sales, SALES
3. Sales Growth Rate (SGR)
4. Profit Ratio (PROF)
5. Fixed Asset Turnover Ratio (FA)

Each indicator was defined using annual data as follows.

$$MCGR = (MC\ 2014 - MC\ 2013) / MC\ 2013$$

$$INV = Costs\ of\ Goods\ Sold\ 2014 / Inventory\ 2014$$

$$SGR = (Net\ Sales\ 2014 - Net\ Sales\ 2013) / Net\ Sales 2013$$

$$PROF = PLBT\ 2014 / Net\ Sales\ 2014$$

$$FA = Net\ Sales / Fixed\ Assets\ 2014$$

Regression analysis methods and the significance of SHAP values

This study employed an XGBoost regressor based on gradient boosting decision trees [6] as a regression model to explain the objective variable, the market capitalisation growth rate (MCGR). Unlike linear models, it has a complex shape. First, the model f(X) is constructed using XGBoost, and then the contribution of each explanatory variable to its predictions is calculated as a SHAP (Shapley Additive exPlanations) value. It is a method based on the Shapley value in game theory [7], [8], [9], [10], which decomposes the predicted results of the target value of a machine learning model into the contributions of individual explanatory variables. While the interpretation of regression coefficients in conventional linear regression only shows the average trend of the model as a whole, the use of SHAP values takes into account company characteristics. It has a great strength in that it allows quantitative evaluation of "which factors contributed most significantly to improving MCGR for each company" [11], [12], [13], [14]. [12], [13].

2.3 Analysis based on SHAP values

In this section, we report the results of our analysis using SHAP values. Figure 2 shows a stacked bar chart of the SHAP values of the major firms in 2014. The deviation of each company's market capitalisation growth rate (MCGR) from the average (Figure 2) is calculated using the five INV_shapvalue, SALES_shapvalue, SGR_shapvalue, PROF_shapvalue and FA_shapvalue The SHAP values are decomposed into five SHAP values (see Figure 3) SHAP values also take negative values as they represent deviations from the mean. Therefore, the sum of the five SHAP values for each company is the deviation of the MCGR. The shape of Figure 2 is thus close to that of

Figure 3.

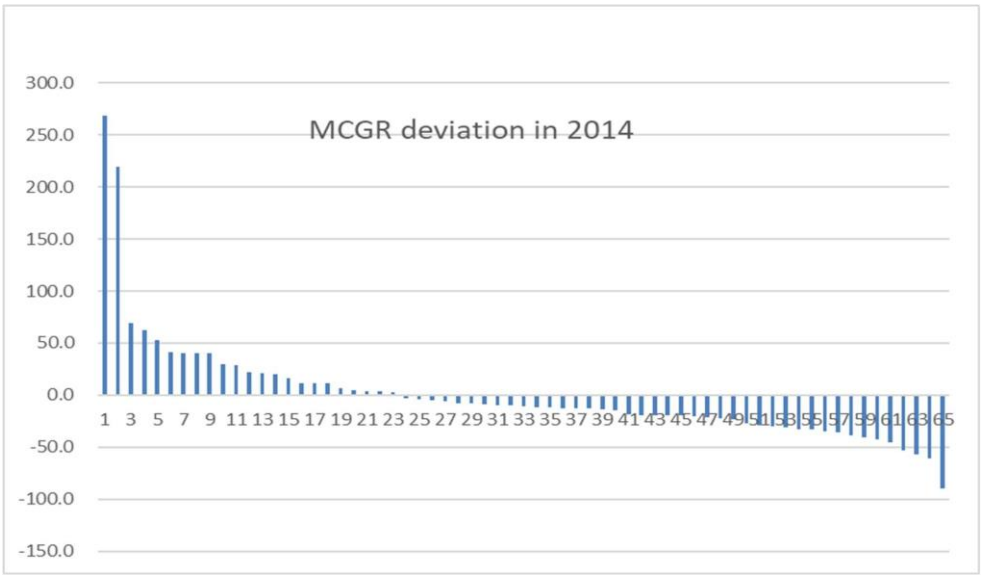

Figure 2: Deviation of the MCGR from the mean in 2014

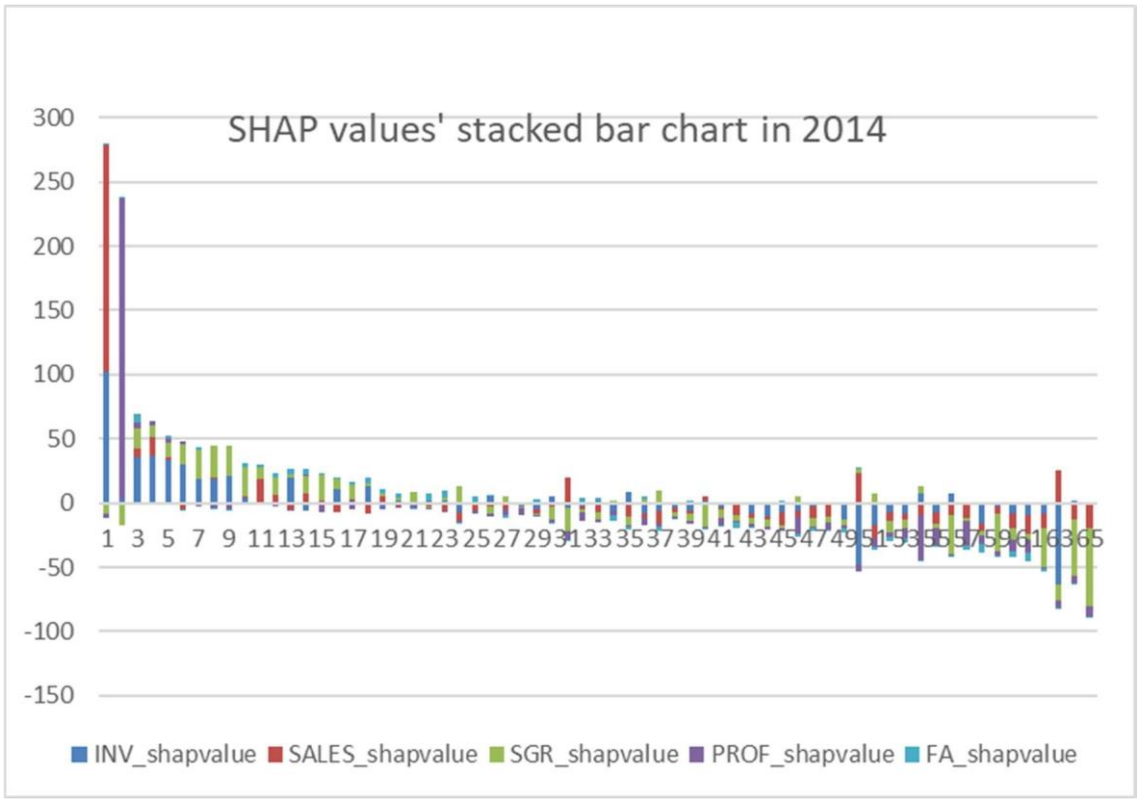

Figure 3: SHAP values for the individual companies in 2014 (stacked bar chart)

The next step is to analyse which explanatory variables contribute more to the MCGR using correlation coefficients. Table 1 shows the correlation coefficients between each variable. In Table 1, both the raw explanatory variables and the SHAP values of the explanatory variables are shown for comparison. In the correlation coefficients with the MCGR, accuracy is increased by using the SHAP values instead of the raw explanatory variable values (see Table 1). For example, for INV, -0.09 increased to 0.71: the correlation coefficient between INV_shapvalue and MCGR is the highest at 0.71, indicating that INV is the most influential explanatory variable on MCGR (Table 1). The correlation coefficient between SALES_shapvalue and MCGR is then high at 0.68, suggesting that inventory turnover and sales strongly contribute to MCGR. SGR_shapvalue showed only a weak correlation of 0.33 (see Table 1).

Table 1: Correlation coefficients between variables

	MCGR	INV	SALES	SGR	PROF	FA
MCGR	1.00					
INV	−0.09	1.00				
SALES	−0.09	−0.06	1.00			
SGR	0.08	0.00	−0.09	1.00		
PROF	−0.03	0.15	−0.02	0.07	1.00	
FA	−0.01	0.19	−0.15	0.22	0.02	1.00
INV_shapvalue	0.71	−0.01	0.01	0.14	0.04	0.04
SALES_shapvalue	0.68	−0.06	−0.15	−0.10	0.02	−0.07
SGR_shapvalue	0.33	−0.01	−0.03	0.59	0.12	0.23
PROF_shapvalue	0.57	−0.08	−0.04	−0.17	−0.17	−0.08
FA_shapvalue	0.35	−0.15	−0.01	−0.04	0.06	−0.21

Figure 4 shows a scatter plot of INV_shapvalue(horizontal axis) and MCGR(vertical axis). The distribution trend of the blue points visually confirms a strong positive correlation (0.71) between the two. This tendency was particularly pronounced for Indian companies (prefix "IN:") and Chinese companies (prefix "CN:"). Most of the major automobile manufacturers are clustered around the centre of Figure 4, suggesting that it is difficult for companies that are already large-capitalised to increase their MCGR rapidly and that medium-capitalised companies are more likely to grow quickly. For example, RICO AUTO and MARUTI (India), Chinese manufacturers and TESLA have increased their MCGR response to high INV_shapvalue. TESLA in this period shows an exponential surge in electric vehicle (EV) production, with increases of 24,000 units (2013) and 34,000 units (2014) [14], followed by an exponential surge in 2014, which can be considered the dawn of the rapid growth of TESLA .

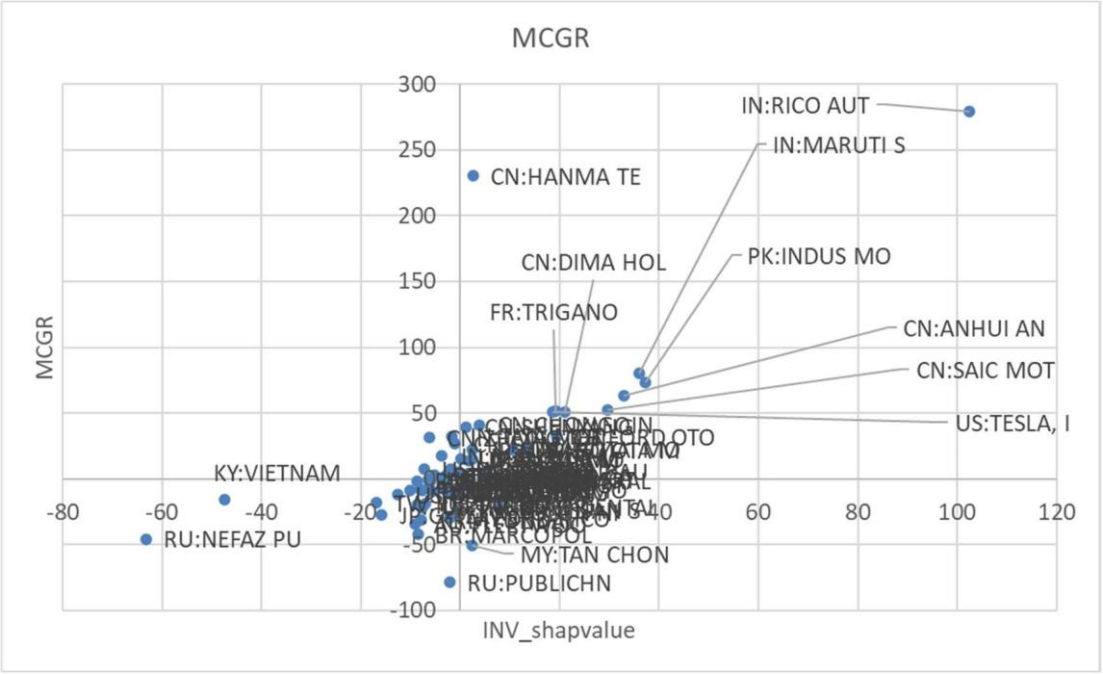

Figure 4: Scatterplot of INV_shapvalue (horizontal axis) and MCGR (vertical axis) (2014).

Morita and Machuca proposed the concept of "ambidextrous management". They stated that "companies that sustain sales growth SGR and supply chain (SC) enhancement/improvement (kaizen) in parallel achieve sustained high earnings performance (EBIT)" [15]. Tushman et al. define supply chain management competence as "explicit (operational) competence", sales growth as Tushman et al. consider supply chain management capability as "explicit (operational) competence" and sales growth "innovative (innovative) competence", and point out the importance of balancing the two in growth strategies [16], [17], [18], [19]. On the other hand, it has been reported that in the automotive industry after 2020, SGR, which indicates new product development competence, is the primary growth driver [20], [21]. Other studies have shown that the sales growth rate (SGR) is the primary driver of growth in the automotive manufacturing industry after 2020 [22], [23]. SGR can be seen as an indicator of new product development capability, and its SGR contribution increases significantly, especially when EVs increase their market share. A typical company is TESLA from 2020 onwards. On the other hand, inventory turnover (INV) was the main factor in the current data analysis for the 2014 rapid growth phase. This result is discussed, including the clustering results in the next section.

2.4 Clustering by SHAP values

The 64 companies are then clustered according to the similarity of the distribution of SHAP values. Clustering is an unsupervised learning method that automatically groups unlabelled data based on feature similarity [24]. Its purpose is to identify potential data structures and patterns and group similar data. In this case, the objective is to find a group of companies with a rapidly growing MCGR. For this purpose, six values were used as data for each company: MCGR, INV_shapvalue, SALES_shapvalue, SGR_shapvalue, PROF_shapvalue and FA_shapvalue. The k-means method was used as the clustering method and Euclidean distance was used as the distance [24]. The number of clusters k was determined as 4 from the elbow method [25], [26]. The results of

clustering by the k-means method are shown in Figure 5. The RICO A UTO in India has created a cluster (cluster 1) by itself (see red dot in Fig. 5), HANMA in China is also a single cluster (cluster 2) (see yellow-green dots in Figure 5). The remaining 62 firms were in the cluster with black dots (cluster 3, circled by red lines) and the cluster with blue dots (cluster 0) in Figure 5.

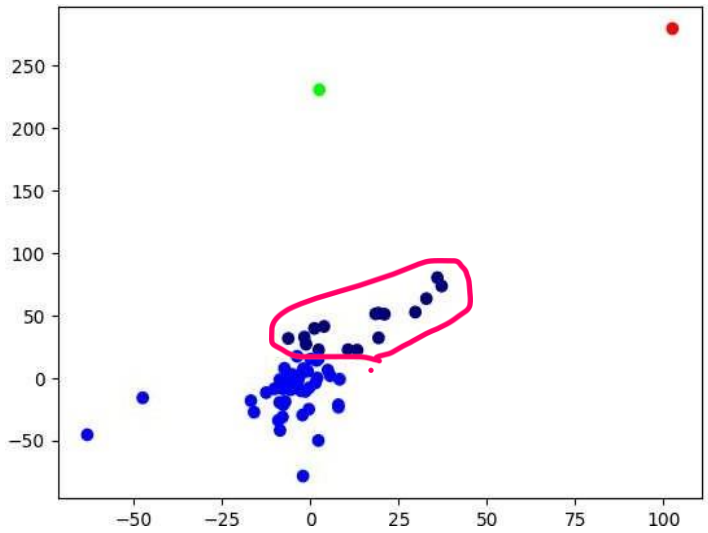

Figure 5: Results of clustering 65 companies using SHAP values with k=4 on a scatterplot of INV_shapvalue (horizontal axis) and MCGR (vertical axis)

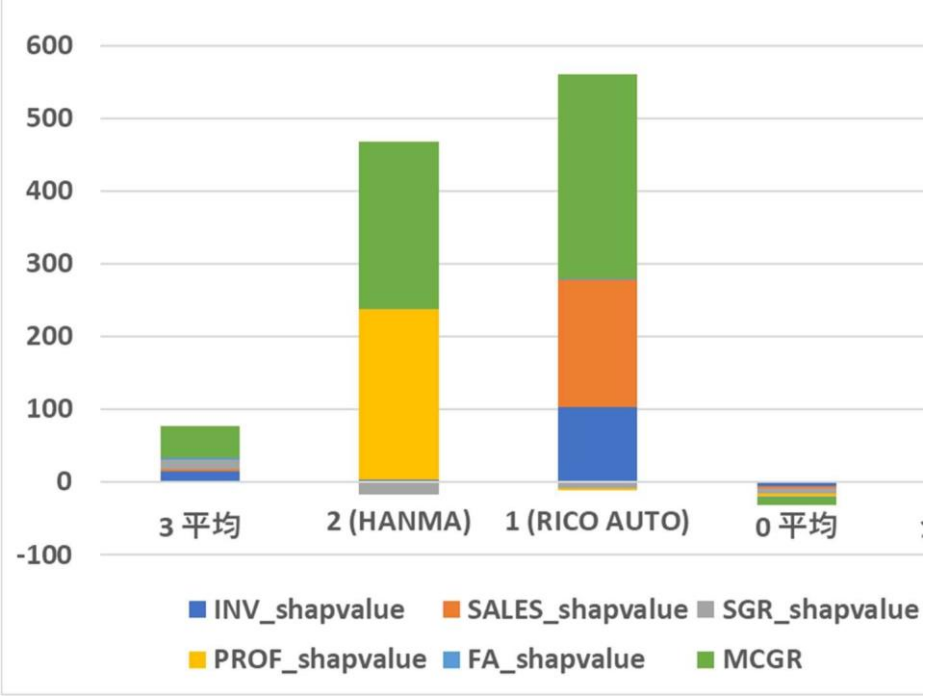

Figure 6: Stacked bar chart of SHAP means by cluster 2014.

Figure 6 shows the averages of the six variables for the four clusters. It can be seen that the strength of RICO AUTO is SALES_shapvalue, followed by INV_shapvalue. These two factors improve the MCGR; in H, PROF_shapvalue is the main factor in HANMA.

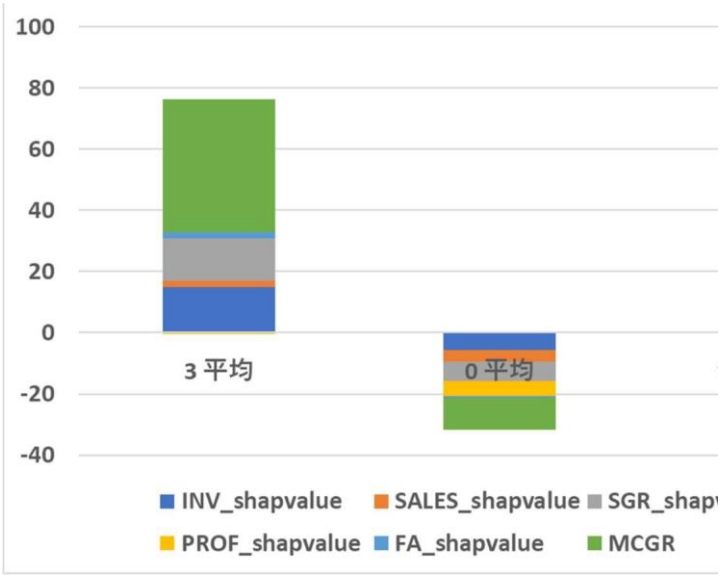

Figure 7: Stacked bar chart of SHAP means for clusters 3 and 0 (2014).

Figure 7 shows an enlarged view of cluster 3 and cluster 0. Cluster 0 has all SHAP values negative and below average, with cluster 3 being the cluster with the higher MCGR. In cluster 3, all SHAP values are positive and higher than the average of the 64 companies; the SHAP values of INV and SGR are balanced and significant; the SHAP values of SALES, PROF and FA are large. The SHAP values of SALES, PROF and FA are almost zero. The distribution of individual SHAP values for the companies in cluster 3 is shown in Figure 8. The contribution ratios by company show that the ratio of INV_shapvalue is higher than SGR_shapvalue for MARUTI, INDUS, A NHUI and SAIC, suggesting that the high inventory turnover ratio is the main factor for the improvement of MCGR. On the other hand, TRIGANO, TESLA and DIMA have a balanced contribution from INV and SGR. For TESLA, both INV and SGR made a high contribution as of 2014, although the weight of SGR_shapvalue increased after 2020. In summary, despite differences in the SHAP distribution characteristics of the companies, it was confirmed that for the top seven companies (MARUTI to DIMA), the INV_shapvalue and SGR_shapvalue contributions were almost balanced. This is in line with Morita et al. This indicates Morita et al.'s "ambidextrous hypothesis" and means that INV and SGR work in tandem to support high MCGR. A significant advantage of SHAP analysis is that the characteristics of each company can be visualised.

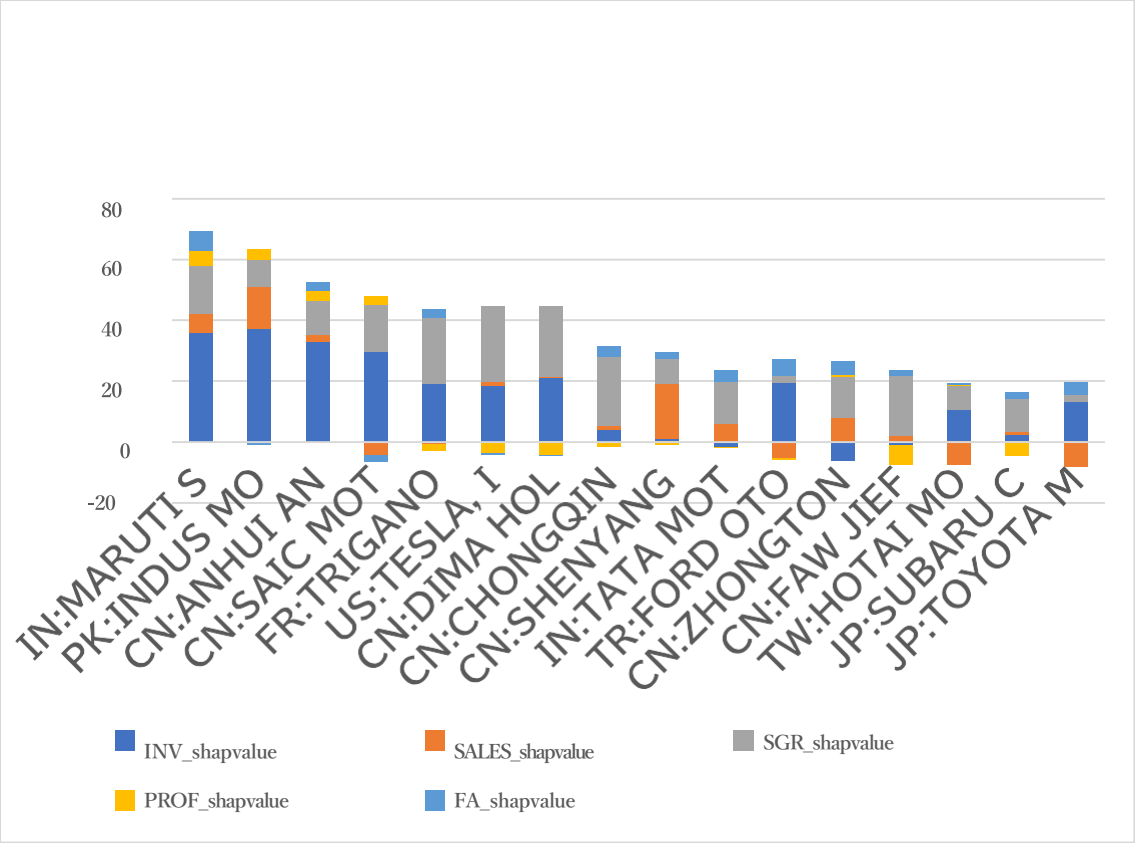

Figure 8: Distribution of individual SHAP values for companies in cluster 3

Table 1 shows that INV_shapvalue had the highest correlation coefficient with MCGR at 0.71, SALES_shapvalue at 0.68 and SGR_shapvalue at 0.33. AThis is the result before clustering: the reason for the highest correlation with SALES_shapvalue is that the RICO AUTO has an extremely high MCGR and SALES_shapvalue. The presence of RICO AUTO raises the overall SALES_shapvalue. Therefore, the overall contribution of SGR_shapvalue was more minor at 0.33. After clustering, the SGR_shapvalue increased when the analysis was restricted to the clusters of the top MCGR firms. In this study, the clustering based on the SHAP value enabled us to clarify the characteristics of each company, which are challenging to grasp only from the overall trend. As a result, we confirmed that the theory that the manufacturing industry with a well-balanced high SGR and INV maintains higher performance is valid. As a result, it was confirmed that the theory that manufacturing industries with higher SGR and INV in balance maintain higher performance is valid.

2.5 Analysis and discussion of growth enterprises

In this section, we analyse the trends in the global automobile manufacturing industry during this period, starting with the companies with the highest MCGR values. Table 2 shows the top 20 companies in terms of MCGR together with their sales (in thousands of dollars) and MCGR (%). While many companies have relatively small sales, TOYOTA, followed by SAIC, and TATA, has the largest sales.

Table 1: MCGR. Enterprises in the TOP 20 of 2014

2014	SALES (th USD)	MCGR (%)
IN: RICO AUT.	207610	280
CN: HANMA TE.	772456	231
IN: MARUTI S.	7901321	80
PK: INDUS MO.	577516	73
CN: ANHUI AN.	784468	63
CN: SAIC MOT.	100071037	53
FR:TRIGANO.	1177129	52
US: TESLA, I.	3198356	51
CN: DIMA HOL.	1084774	51
CN: CHONGQIN.	1824371	41
CN: SHENYANG.	815593	40
IN: TATA MOT.	41943307	33
TR: FORD OTO.	5137912	32
CN: ZHONGTON.	577528	32
CN: FAW JIEF.	4889723	27
TW: HOTAI MO.	5056420	23

JP:SUBARU C	23960645	22
JP:TOYOTA M	226746495	22
IN: MAHINDRA.	10203185	17
JP:ISUZU MO.	15647673	15

Table 2 shows that the company with the highest MCGR is the Indian auto parts supplier RICO A UTO (henceforth RICO). India's MARUTI is also third. MARUTI was the first company to achieve automobile industrialisation in India, and its production started in 1983. RICO has a powerful alliance with MARUTI and is a member of the MARUTI Group. The history of RICO can be seen in "1985-86: Focus - Hero Honda & MARUTI Suzuki, 1990-92: Focus - MARUTI Suzuki" [27], [28]. As of 2014, many major companies such as TATA, NISSAN and TOYOTA are listed as partners, but it is assumed that MARUTI was the most critical contractor in the company's early days.

MARUTI has fostered many Indian component manufacturers, including Jay Bharat MARUTI Limited and Krishna MARUTI Limited, both of which bear the corporate name 'MARUTI' and are joint ventures and subsidiaries of MARUTI Suzuki India Ltd. Major Indian component manufacturers such as Samvardhana Motherson Sumi Systems (formerly Motherson Sumi) and Sundram Fasteners also have extensive business relationships with MARUTI Suzuki. These are examples of the results of MARUTI Udyog's efforts to develop parts suppliers. Table 2 shows the top 20 MCGR companies 2014, including TATA and Mahindra & Mahindra, both leading Indian conglomerates. The positive impact that MARUTI has had on the development of component suppliers in India is thought to have had a significant ripple effect on these companies, as the development of high-quality parts suppliers is expected to expand the scope of business with other vehicle manufacturers and propagate superior technical capabilities and codes of conduct throughout the industry. As evidence of the impact of MARUTI, the Government of India's conferment of the National Order of Padma Vibhushan on Mr. Osamu Suzuki (former Chairman of Suzuki Motor Corporation), who passed away in December 2024, is evidence of its high appreciation of his achievements [29]. Prime Minister Narendra Modi also said in his eulogy: 'He has a deep affection for India and has revolutionised the Indian automobile market'. This shows the extent of its influence.

Expanding the perspective from India to Southeast Asia, around 2014 the automobile manufacturing industry in Southeast Asian countries has grown considerably [29]. One of the reasons for this is that the Japanese automobile industry introduced Japanese-style management and other factors to Southeast Asian countries in a retrospective period and fostered local parts manufacturers [30]. In 2014, the market share of Japanese manufacturers in Southeast Asian countries was high: 92% in Indonesia, 87% in Thailand, 76% in the Philippines, 53% in Viet Nam and Malaysia 41%, and in India MARUTI alone 45% [31]. For Suzuki, the parent company of MARUTI, the production of MARUTI in India (production started in 1983) is a significant source of revenue for the company. For Suzuki, the period of no competition lasted for a long time. Due to political instability, major global manufacturers did not enter the market [32]. After that, around 1995, Volkswagen AG (VW) went on the offensive in China and Toyota in South-East Asia [33], [34]. As a result, according to Nakanishi, in 2012, the market shares of the Toyota Group and the VW Group were 17% and 3% respectively in Asia and elsewhere, but in China the situation reversed, with the Toyota Group at 4% and the

VW Group at 14%. As for the company's presence in India, HONDA CARS INDIA LIMITED was established in 1995, HYUNDAI MOTOR INDIA LIMITED was established in 1996, TOYOTA KIRLOSKAR MOTOR PRIVATE was founded in 1997 [32]. Features common to Japanese manufacturers in Southeast Asian countries are (1) a product strategy centred on small cars and (2) the adoption of Japanese-style management methods and production control methods [2], [4], [35]. In particular, it is important to note that in the early stages of production, the company focused on small cars that were easy for local people to purchase, a strategy that directly led to an increase in regional GDP. When automobile manufacturing was launched in Southeast Asian countries, it was effective to start with small cars and compact cars.

China also experienced rapid growth in automobile manufacturing over the same period, with SAIC Motor Corporation Limited (Shanghai Automotive Group) and FAW (First Automotive Works, China First Automobile Group) having emerged. These two companies strengthened their market competitiveness through joint ventures with foreign companies [36]. SAIC was responsible for producing and selling Western brand vehicles, with Shanghai Volkswagen (established in 1984) and Shanghai General Motors (established in 1997) at its core. FAW, on the other hand, played an essential role in the Chinese market through FAW-Volkswagen, established in 1991, and FAW-Toyota, established in 2003, producing Volkswagen and Toyota brand cars [36]. Thus, in the case of China, there is a historical background in which economic partnerships with German companies have been strengthened, especially since the 1970s. The following section analyses why MARUTI continued to maintain a dominant market share in India, considering these differences in background.

3. Analysis of the development mechanism of the Indian automobile manufacturing industry

This section explores the success factors of MARUTI, targeting India.

3.1 Data analysis of the Indian automobile manufacturing industry

In this section, the data analysis focuses on Indian firms.

In the previous section, the regression analysis results were interpreted by SHAP values. Out of 65 firms, four Indian firms were included - MARUTI, TATA, MAHINDRA and RICO AUTO. These SHAP values extracted from Figure 3 are illustrated in Figure 9: the MCGR of RICO AUTO is very high, with SALES contributing the most considerable SHAP value, followed by the SHAP value of INV. We speculate that the SHAP value of SGR is around the average of the 65 companies (almost zero) because RICO is a component manufacturer. For clarity, Figure 10 shows the SHAP values of the three Indian companies, excluding RICO AUTO.

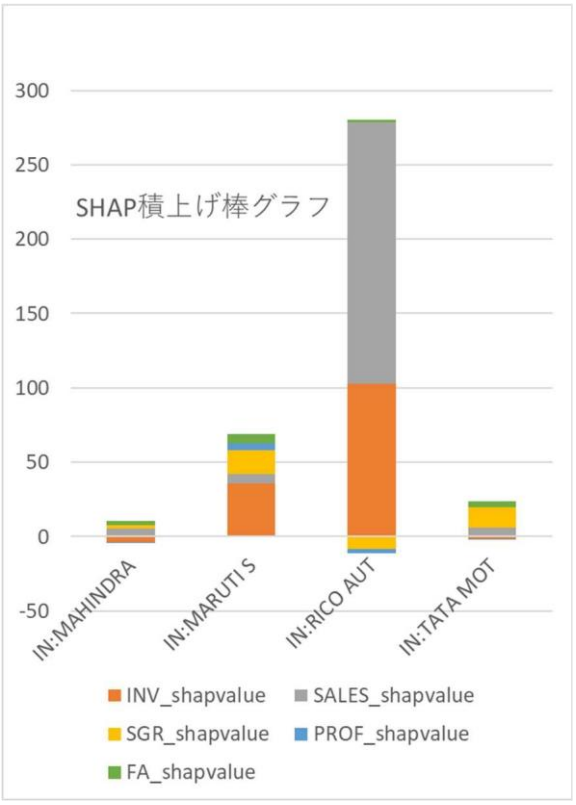

Figure 9: Stacked bar chart of SHAP values for four Indian companies (2014).

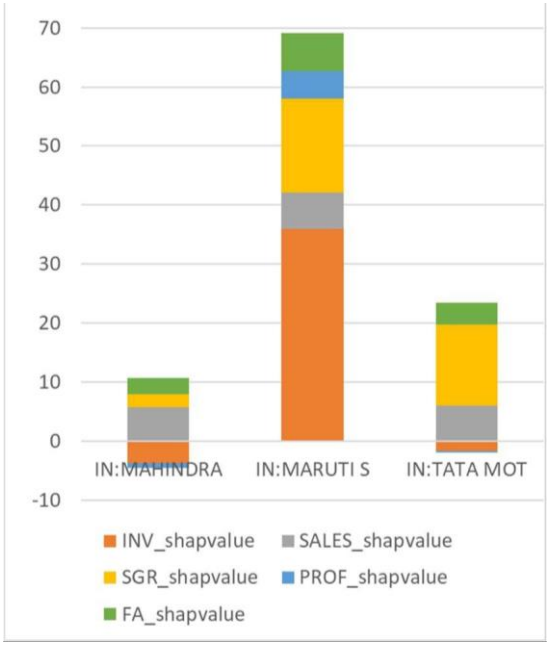

Figure 10: Stacked bar chart of SHAP values for three Indian companies (2014).

MARUTI has the highest MCGR; MARUTI has the highest INV contribution, followed by a high SGR SHAP value, indicating a good balance between INV and SGR. This is characteristic of high-performing firms; TATA is SGR-driven, indicating that INV is slightly below the 65-company average; MAHINDRA has a higher SALES has the highest SHAP value, FA and SGR are similar and INV is below the average. These results indicate that MARUTI represents a high-performing company type among the three companies, with a balanced contribution from INV and SGR, with INV in particular leading the contribution.

The following section analyses the situation of the Indian automobile manufacturing industry from 2011 to 2015 using the management indicators of these three companies and others. Data were retrieved from ORBIS WEB. Due to the large number of missing values in the 2011-2015 data for Indian firms, missing values were not interpolated and left blank. In addition to the representative firms MARUTI, TATA and MAHINDRA, there are many global firms. However, the available indicator for the international firms in this period was only Profit/Loss Before Tax (PLBT). All figures such as SALES are in thousands of dollars (thousand USD).

The PLBT trends in Figure 11 show that TATA, MARUTI and MAHINDRA are by far the three companies with the highest profits relative to other group companies, with some of them recording losses TATA is the company with the largest PLBT. At the same time, MARUTI increased its market share from 41.4% to 51.8% from 2011 to 2018 and TATA decreased from 12.3% to 6.4% [37]. The growth of MARUTI since 2011 shows that MARUTI has steadily taken advantage of India's expanding demand [37].

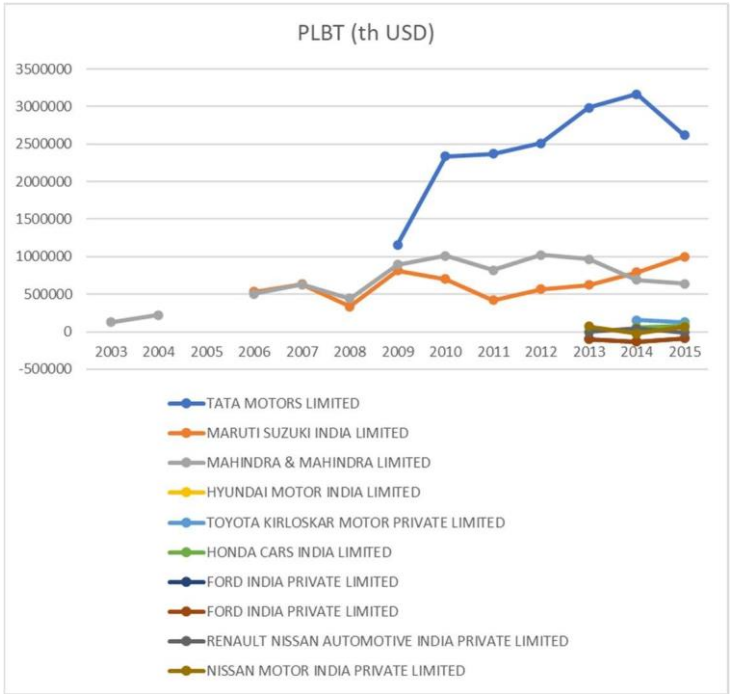

Figure 11: Trends in PLBT of three Indian companies

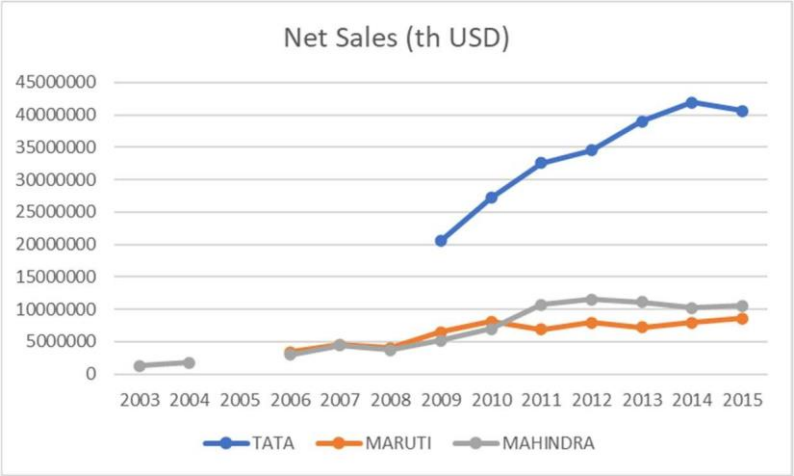

Figure 12: Net Sales of the three Indian companie

The characteristics of key management indicators for the three representative companies are examined (see Figures 11 to 14). In terms of Net Sales and PLBT (Profit Before Tax), TATA records the highest values. However, regarding profit rate (calculated as PLBT ÷ Net Sales -1), MARUTI has maintained the highest level since 2014, showing a steady, nearly linear increase from 2011 onward. MARUTI also consistently exhibits a very high inventory turnover ratio (INV), as shown in Figure 14. In the SHAP value distribution comparison in Figure 10, MARUTI's INV_SHAP value is significantly higher, while the other two companies fall below the average. This is likely due to MARUTI's high inventory turnover ratio, which can be attributed to the strengths of Japanese-style supply chain management practices.

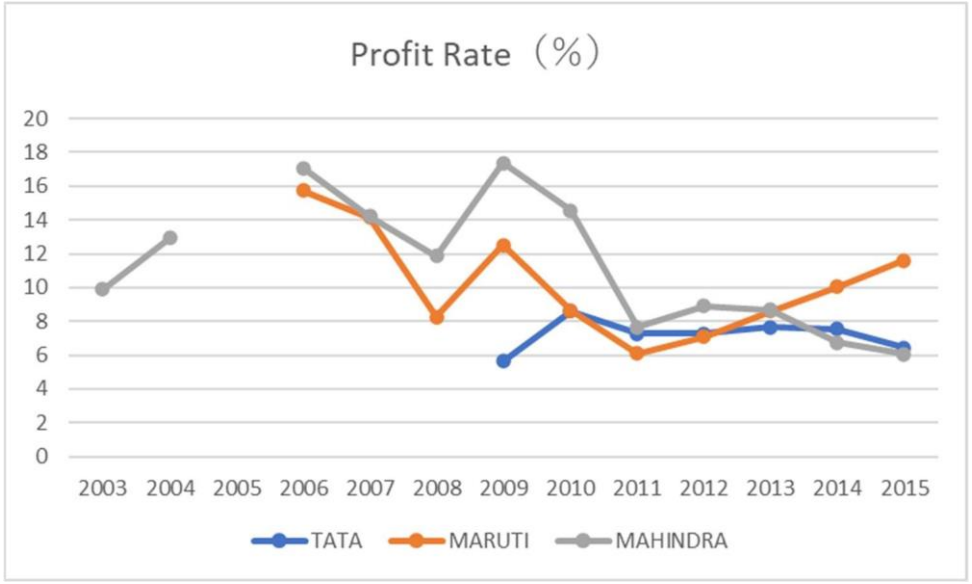

Figure 13: Profit rates of the three Indian companies.

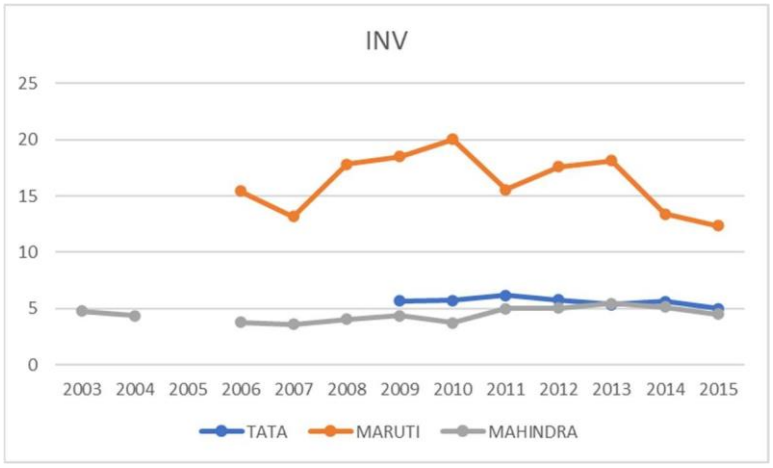

Figure 14: Inventory turnover ratio of the three Indian companies.

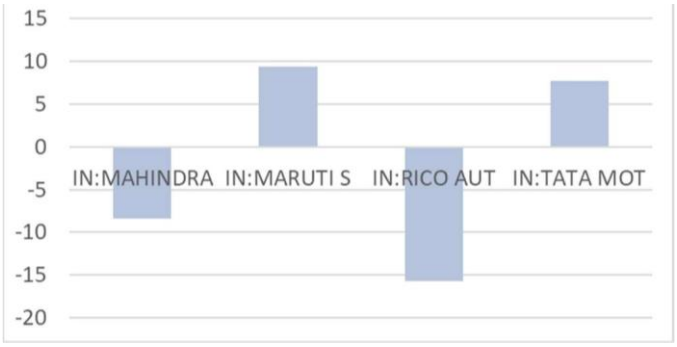

Figure 15: Sales growth rate (SGR) of the three Indian companies in 2014 (%)

Next, we examine the Sales Growth Rate (SGR) contribution as revealed by the SHAP values. One of the key advantages of SHAP is that, while the raw data for SGR shows little difference between MARUTI and TATA (with MARUTI being slightly higher, as seen in Figure 15), SHAP takes into account the unique characteristics of each company (i.e., the values of other explanatory variables). As a result, in the case of MARUTI, the ratio of the INV_SHAP value is overwhelmingly higher than that of the SGR_SHAP value (see Figure 10). In contrast, for TATA, the SGR_SHAP value represents the highest contribution. Even when the raw SGR values are similar across companies, the SHAP value ratios vary because they are derived by incorporating each company's unique characteristics. This ability to account for company-specific features makes SHAP an excellent method for interpreting AI-generated results. In the future, we intend to conduct a time-series analysis of SHAP values from 2011 onward, to examine how these contributions have evolved.

3.2 Existing studies of the Indian automobile manufacturing industry

This study will conduct a survey focusing on MARUTI's initiatives in the development and education of

component manufacturers.

MARUTI's impact on the development of Indian component suppliers has been significant. MARUTI has substantially impacted the development of automotive component suppliers in India. At the time of Udyog's establishment, R.C. Bhargava stated, "We adopted a policy of nurturing existing local companies already engaged in the automotive sector to become MARUTI's parts suppliers" [4]. This approach was characterized not by the simple transfer of Japanese technology, but by MARUTI's efforts to increase the local content ratio within India. The Udyog actively outsourced to domestic component manufacturers in its core manufacturing area [37], treating these suppliers not merely as subcontractors but as long-term partners [1]. In 1982, MARUTI formulated a comprehensive plan for developing component manufacturers. This initiative's distinguishing feature was its foundation in mutual, long-term partnerships between MARUTI and its suppliers. Later, the United Nations Industrial Development Organization (UNIDO) highly praised MARUTI's program, recognizing it as a model broadly applicable to manufacturing industries in developing countries [4].

Ashizawa interviewed with the president of the Indian component supplier, Imperial Auto Industries Ltd., on February 16, 2011, in which he inquired about the role played by MARUTI [38]. The answer was: 'Since Suzuki of Japan came to India, the idea of cars in India has changed drastically. Until then, it was taken for granted that car parts were defective to some extent. Even so, they were sold as cars with impunity. But after Suzuki's arrival in India, the idea of car function and quality changed drastically. The idea that there should be no defective parts and that they should not be sold is now firmly established in India" [38], showing that MARUTI has also changed the mindset of suppliers not directly involved in training and development. Imperial Auto Industries has dealings with many assembly manufacturers and suppliers in India and abroad but has no powerful relationship with MARUTI. Therefore, we believe that the words of the company's president can be trusted as the opinion of an impartial Indian supplier.

We now turn to the historical development of MARUTI. Around 1984, several Japanese automobile manufacturers other than Suzuki attempted to enter the Indian market. For instance, Toyota established DCM Toyota Ltd. as a joint venture with Delhi Cloth & General Mills Co. Limited (DCM), and Mazda launched Swaraj Mazda through a joint venture with Punjab Tractors and Sumitomo Corporation, initiating technical collaborations. However, following the 1985 Plaza Accord, the resultant appreciation of the Japanese yen led to the rise of domestic manufacturers such as TATA, forcing many Japanese firms to withdraw from India. MARUTI alone managed to maintain its top share in the Indian domestic market, unaffected by the strong yen, thanks to its consistent efforts to increase the local content ratio. This outcome can be attributed mainly to the high level of localization in MARUTI's component procurement [39].

Around 2010, major global automakers once again sought to enter the Indian market. Govindarajan observed that when global companies rely on resources from developed countries to target emerging markets, it results in increased prices and a poor fit with local consumer needs. Therefore, it is essential to create new products specifically for emerging markets [37], [40]. In line with this theory, many major automakers introduced strategic models tailored for India. For example, Toyota launched the Etios in 2010; other

examples include Honda's Brio, Amaze, and Jazz, as well as Hyundai's i20 and Eon, and Nissan's Go [37]. Despite this influx of competitors, MARUTI retained its leading market share, driven by Swift's large-scale success. The Swift triggered a pricing revolution in India's compact car segment, with a starting price of 390,000 rupees (approximately 670,000 yen at the time) and even the core price range staying around 450,000 rupees (770,000 yen) [33]. Nakanishi analyzed this low pricing and concluded that it was enabled by MARUTI's exceptionally high level of domestic sourcing, which allowed it to achieve price points inaccessible to global brands [33].

Ueno and Sato identified a relationship between Suzuki's lightweight technology—an asset originating in Japan—and consumer benefits such as low purchase and maintenance costs [37]. They attribute Suzuki's competitive advantage to the strategic use of home-country resources and the incremental adaptation of those resources to the Indian market over time. Indeed, Suzuki's lightweight technologies are highly advanced. However, whether this alone sufficiently explains why Toyota and Honda failed to overtake MARUTI's market share remains questionable. We argue that there may be success factors beyond technological superiority.

In their study, Ueno and Sato sought explanations by comparing vehicle specifications [37]. Yet, it is doubtful whether specifications alone can fully account for the outcome. Even if the optimal specs aligned with the local customer preferences are identified, the ability to realize those specs at a low cost is a separate issue—and likely a significant implementation barrier. In many cases, maintaining cost competitiveness requires sacrificing certain features. As Nakanishi argues, the primary reason MARUTI was able to fend off its competitors lies in its high level of localization in component sourcing [33].

3.3 Partnerships with Indian component manufacturers

Next, we examine the educational initiatives undertaken by MARUTI in India. As former MARUTI President R.C. Bhargava has emphasized, sustained education is essential for cultivating competitiveness [2], [4]. The main targets of this education included: (1) factory workers, (2) executives and managers (to promote mindset reform), (3) dealership and service personnel, and (4) component suppliers. MARUTI sent personnel ranging from managers to labor union leaders to Japan for training, where the curriculum encompassed technical knowledge and Japanese culture, customs, and management systems [4]. Among these four categories of educational recipients, we believe the training and developing component suppliers were likely the most challenging. Unlike in-house employee education, training local suppliers requires first establishing mutual trust.

To this end, MARUTI digitalized the exchange of goods and payments with suppliers and developed a transparent, fair, and prompt payment system, thereby steadily and systematically building trust [4]. This proactive commitment to "prompt payment" exemplifies the attentive, small-business-like care extended to partners—a reflection of the philosophy of former Chairman Osamu Suzuki, who often referred to himself as a "small business owner" [41]. His personal approachability and the spirit of "partnership" were embodied in these practices. It is fair to say that MARUTI's high degree of localization in component sourcing resulted from its long-standing efforts to educate and foster its suppliers. In India, the simple picture that investing money and time in education will lead to success is not the case.

When considered in depth, we believe that MARUTI's true strength lies in its code of conduct, which, as Bhargava and the late Osamu Suzuki put it, "positioned itself as a long-term partner, not a subcontractor". Indian people consider the MARUTI brand their national car, manufactured by India for the Indian people [33]. It can be regarded as the result of the steady partnerships that MARUTI has built with consumers and component suppliers over time.

The following hypotheses are therefore formulated.

Hypothesis 1: Despite the successive entries of major global automobile manufacturers into the Indian market during the 2010s, the primary reason MARUTI was able to maintain its top market share lies in its long-term commitment to nurturing and educating local Indian component suppliers—not as short-term subcontractors, but as long-term business partners. From this case, it can be argued that a code of conduct that emphasizes mutual prosperity with the host country for manufacturers entering emerging markets is essential for achieving long-term and sustainable growth.

The concept of *mutual prosperity* (自他共栄) was promoted alongside "maximum efficient use of energy" (精力善用) by Jigorō Kanō, the founder of judo [42]. Even in relationships that are often viewed as adversarial—such as between labor unions and management, or between parent companies and subcontractors—it is vital for all parties to share the understanding that mutual success ultimately contributes to the achievement of individual goals and career development. While this ethical principle is difficult to quantify, and therefore not readily captured through data analysis, case-based evidence can provide insight.

In India, Suzuki has embodied this philosophy through various initiatives, such as the operation of the Suzuki Innovation Centre (SIC) in collaboration with the Indian Institute of Technology Hyderabad (IITH), and the establishment and support of impact investment funds targeting social-issue-driven startups [43]. In particular, through efforts led by *Next Bharat Ventures* (NBV), Suzuki has supported the discovery and development of social entrepreneurs and has collaborated in implementing their solutions, aiming to simultaneously generate employment and raise incomes [44]. These initiatives promote the sustainable growth of local communities and can be seen as foundational to Suzuki's long-term growth strategy.

In January 2025, Shirota and Chakraborty visited SIC at IITH and conducted field interviews on support programs for social entrepreneurs in the agriculture and supply chain sectors. Although these grassroots activities are challenging to measure using quantitative indicators, they left a strong impression as tangible expressions of the growing culture of mutual prosperity locally.

Additionally, MARUTI has implemented renewable energy initiatives at its Manesar plant in Haryana, including introducing a biomass gas generation facility that utilizes waste materials. The facility produces approximately 0.2 tons of biogas daily using food waste from the factory cafeteria and napier grass cultivated on-site [44]. In January 2025, Shirota visited the Manesar plant and observed the biogas generation process. The produced biogas is primarily used as cooking fuel in the factory cafeteria, serving as a renewable alternative to fossil fuels. The by-product of the biogas process is repurposed as organic fertilizer, which is then used for greening activities on the factory premises. Some biogas is also stored in tanks and used to power vehicles.

Through such initiatives, MARUTI presents a model of sustainable manufacturing that integrates SDG-oriented renewable energy use with tangible contributions to the local community.

3.3 Small business competitive strategy through human resource training

Suzuki is called a small giant [33], and this section analyses the success factors of MARUTI from the aspect of education and the strategy of a company with limited capital to develop competitiveness and become a large capital company through education. The following sections discuss the issues.

Education is essential in management strategy. Matsuhashi et al. concluded in the management strategy of a football team that "investing in player development in the academy can be an effective means for small capitalised teams to be competitive (in terms of points won, winning percentage, etc.) with large capitalised teams" [45], [46], [47]. We consider this to be a generalisable theory. Even small capitalised enterprises can develop competitiveness against large capitalised enterprises if they invest in education and develop excellent human resources. Enterprises dedicated to such education can incrementally transition to large capitalised enterprises. Figure 16 shows the strong football teams in the transition state from small to medium size to large by the symbols [46]. The method of analysis by SHAP-values is also utilised in this analysis, as in the present paper. Matsuhashi uses the SHAP value of academy operating costs as a core indicator of educational achievement.

Matsuhashi developed an indicator of educational achievement using the SHAP value of academy operating costs as a core measure. Establishing appropriate KPIs (Key Performance Indicators) is essential in corporate management strategy. Shirota considers utilizing SHAP values as a core element in developing such KPIs a practical approach [48].

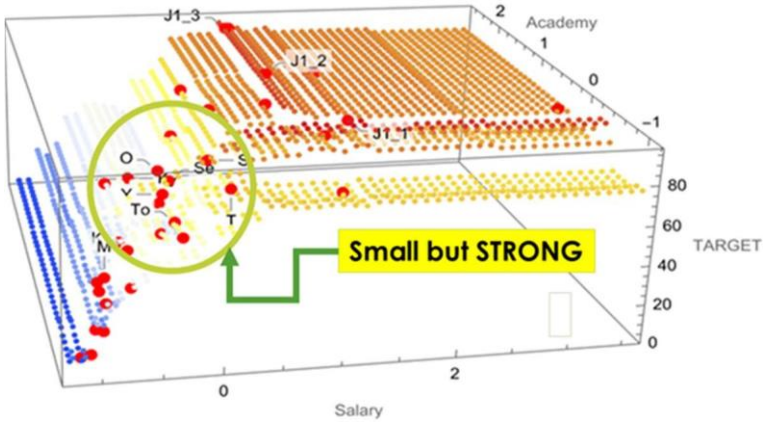

Figure 16: Small but strong football teams may be in the transition process of maturing into large teams

This study focuses on the concept of *educational capability* as the driving force behind the exceptional performance of companies like Suzuki (the parent company of MARUTI), which, despite being smaller than major global players in terms of sales and employee numbers, has been referred to as a “small giant” [33] and has astonishingly captured and maintained a top market share in India. When combined with our previous hypothesis, this capability can be described as *education based on the spirit of mutual prosperity*. At the time, Suzuki had already established efficient and low-cost production technologies for compact cars. Under the exceptional leadership of the late Chairman Osamu Suzuki, the company did not regard local staff and component suppliers merely as labor or subcontractors but as long-term business partners. Through the implementation of continuous training and development programs, Suzuki succeeded in achieving productivity and quality

performance that rivaled that of larger corporations [33].

This case offers an important lesson: even small enterprises can achieve performance equal to or surpassing that of large corporations—and open new paths for growth—if they are deeply committed to investing in and cultivating human resources. Particularly in the context of manufacturing expansion into emerging markets, it is evident that the development of local human capital is the key to sustaining competitive advantage during technology transfer and localization.

This insight is summarized in the following hypothesis:

Hypothesis 2: Small enterprises may not be able to compete with large corporations in terms of capital strength, but through investment in and commitment to human resource development, they can build competitiveness and potentially grow to a scale comparable to that of large enterprises.

We also attempted to collect data on educational costs and time investment. However, during our analysis, it became clear that obtaining quantitative data—such as the amount of investment in educational programs and the time devoted to them—is not easy. At present, it is not easy to mathematically demonstrate the effectiveness of education. Therefore, this paper positions the case of MARUTI as a "notable success story in which educational capability has driven corporate growth," and in future research, we intend to further investigate the correlation between educational investment and corporate performance through qualitative data and case-based analysis.

4. Conclusion

This study conducted quantitative and qualitative analyses of the role Maruti Udyog (now Maruti Suzuki India Limited) played in the remarkable development of the Indian automobile industry. Focusing mainly on managerial data from 2014, the study evaluated the factors influencing the Market Capital Growth Rate (MCGR) using an XGBoost regression model and SHAP analysis. The results revealed that MARUTI's sustained competitive advantage in the Indian market can be attributed to a balanced contribution of Inventory Turnover Ratio (INV) and Sales Growth Rate (SGR). Furthermore, this study highlights MARUTI's long-term strategic perspective in fostering local component suppliers—not as mere subcontractors but as strategic partners. It concludes that this management philosophy of *mutual prosperity* (自他共栄) enabled a high localization rate of components within India, thereby facilitating the development of competitively priced products.

This research proposes two hypotheses. Hypothesis 1 attributes MARUTI's ability to maintain the top market share in India to the long-term partnerships it built with Indian suppliers, grounded in the spirit of mutual prosperity. As supporting evidence, the study discusses MARUTI's initiatives such as installing biomass gas generation facilities and utilizing renewable energy, as well as its social contribution activities through the cultivation of social entrepreneurs—positioning MARUTI as a model of sustainable corporate management.

Hypothesis 2 offers implications for small enterprises. Specifically, it suggests that small firms can enhance their competitiveness and gradually expand in scale through sustained investment and commitment to human resource development, eventually evolving into large-scale enterprises. By positioning *educational capability* as a core component of management strategy, the study provides theoretical and practical insights for growth strategies in small and medium-sized enterprises.

Overall, this study comprehensively examines the success factors behind MARUTI's performance and suggests that its strategies are universal and applicable to other emerging markets.

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References.

[1] R. C. Bhargava, The MARUTI story: how a public sector company put India on wheels HarperCollins Publishers India, 2013.

[2] R. C. Bhargava, Getting Competitive:Practitioner's Guide for India HarperBusiness, 2020.

[3] R. C. Bhargava, Impossible to Possible: MARUTI's Incredible Success and How It Can Change India (English Version) Bloomsbury India, 2024.

[4] R. C. Bhargava (Bhargava), Suzuki's India strategy: the miracle business strategy that took Suzuki to the top with 'Japanese-style management' KADOKAWA(Chukei Publishing), 2006.

[5] Yukari Shirata, Tamaki Sakura, and B. Chakraborty, "A time-series analysis of stock price growth in the global automobile manufacturing industry in 2014," The Gakushuin Economic Review, vol. 59, no. 2, pp. 141-160, 2022.

[6] XGBoostDevelopers, "XGBoost Decumentation (Revision 534c940a.)," 2022. [Online]. Available: https://xgboost.readthedocs.io/en/stable/

[7] L. S. Shapley, "A value for n-person games, Contributions to the Theory of Games, 2, 307-317," Princeton University Press. Princeton, NJ, USA, 1953.

[8] A. E. Roth, The Shapley value: essays in honour of Lloyd S. Shapley Cambridge University Press, 1988.

[9] A. E. Roth, "Introduction to the Shapley value," The Shapley value, pp. 1-27, 1988.

[10] E. Winter, "The shapley value," Handbook of game theory with economic applications, vol. 3, pp. 2025-2054, 2002.

[11] S. M. Lundberg and S.-I. Lee, "Consistent feature attribution for tree ensembles," arXiv preprint arXiv:1706.06060, 2017.

[12] S. M. Lundberg and S.-I. Lee, "A unified approach to interpreting model predictions," Advances in neural information processing systems, vol. 30, 2017.

[13] S. M. Lundberg, G. G. Erion, and S.-I. Lee, Consistent individualized feature attribution for tree ensembles," arXiv preprint arXiv:1802.03888, 2018 .

[14] Nakanishi, T., CASE revolution: cars that survive in the MaaS era Nikkei BP, Tokyo, 2020.

[15] M. Morita and J.A. Machuca, Integration of product development capability and supply chain capability: the driver for high performance adaptation," International Journal of Production Economics, vol. 200, pp. 68-82, 2018.

[16] M. J. Benner and M. L. Tushman, "Exploitation, exploration, and process management:.

The productivity dilemma revisited," Academyof management review, vol. 28, no. 2, pp. 238-256, 2003.

[17] C.A. O'Reilly and M. L. Tushman, "The ambidextrous organisation," Harvard business review, vol. 82, no. 4, pp. 74-83, 2004.

[18] C.A. O'reilly Iii and M. L. Tushman, "Ambidexterity as a dynamic capability: resolving the innovator's dilemma," Research in organisational behaviour, vol. 28, pp. 185-206, 2008.

[19] D. Lavie, U. Stettner, and M. L. Tushman, "Exploration and exploitation within and across organisations," The Academyof Management Annals, vol. 4, no. 1, pp. 109-155, 2010.

[20] Y. Shirota, K. Kuno, and H. Yoshiura, "Time Series AnalysisSHAP Values by Automobile Manufacturers Recovery Rates," IC Deep Learning Technology, China and Online, 2022.

[21] K. Kuno and Y. Shirota, "Time Series Analysis of Shapley Values in Machine-Learning Regression," IEICE Technical Report; IEICE Tech. Rep. ., 2022.

[22] M. Fujimaki, E. Tsujiura, and Y. Shirota, " Manufacturers Stock Price Recovery Analysis at COVID-19 Outbreak," 6 th World Conference on Production and Operations Management - P&OM Nara 2022 EurOMA (European Operations Management), Nara, Japan, pp. Decision Science Institute Best Paper, 2022.

[23] Y. Shirota and B. Chakraborty, "Impactof Supply Chain Competence on Market Capital Growth in Automobile Manufacturers," 2023 14th IIAI International Congress on Advanced Applied Informatics (IIAI-AAI) IEEE, pp. 438-441, 2023.

[24] C. M. Bishop and N. M. Nasrabadi, Pattern recognition and machine learning Springer, 2006.

[25] M. Syakur, B. Khotimah, E. Rochman, and B. D. Satoto, "Integration k-means clustering method and elbow method for identification of the best customer profile cluster," IOP conference series: materials science and engineering IOP Publishing, pp. 012017, 2018.

[26] F. Liu and Y. Deng, "Determine the number of unknown targets in the open world based on the elbow method," IEEE Transactions on Fuzzy Systems, vol. 29, no. 5, pp. 986 -995, 2020.

[27] RicoAutoIndustries, "Rico Auto Industries," 2016. [Online]. Available Available: https://new.ricoauto.in/

[28] RicoAutoIndustries, "RICO Annual Report 2015-16, Key Milestones," 2016. [Online]. Available:

[29] NHK, "India announces award of National Order of Merit to Suzuki's late Osamu Suzuki," 27 Jan 2025. [Online]. [Online]. https://www3.nhk.or.jp/news/html/20250127/k10014704591000.html

[30] Y. Shirota, M. Sekine, and B. Chakraborty, "The Rise of India's Automotive Supplier

Industry and MARUTI's Influence -A SHAP-Based Analysis Using 2014 Financial Data -," IEICE Technical Report IEICE Tech. Rep. 2025.

[31] Nakanishi, T., A book to understand the present and future of the automobile industry. Yosen-sha, 2015.

[32] Nomura, T., "The rapidly growing Indian automobile market: the challenge of Suzuki, the dominant player on the board, and Toyota, the pursuer," Journal of Business and Economics, vol. 67, pp. 1-39, 2016.

[33] Nakanishi, T., Osamu-ism "Small Giant" Suzuki's Management, Nikkei Newspaper, 2015.

[34] Nakanishi, T., Toyota vs. VW: The most powerful company aiming for supremacy in 2020, Nikkei BP Marketing, 2013.

[35] Bhaskar Chatterjee, Japanese-style management in India: the success of MARUTI and Suzuki, Simar Press, 1993.

[36] Nakanishi, T., Automobile (2nd ed.) Nikkei BP Marketing, 2010.

[37] M. Ueno and T. Sato, "Suzuki's competitiveness in India: exploring corporate strategy and competitiveness through product characteristics analysis," RIEB Discussion Paper Series, no. DP2019-J06, Institute of Economic and Business Research, Kobe University, pp. 1-29, 2019.

[38] Shigemitsu Ashizawa, "Competitiveness of component suppliers in the Indian automobile industry: a case analysis of three companies," Discussion Paper.

Series: the Bulletin of the Faculty of Business Administration, Tamagawa University, vol. 2012, no. 18, pp. 1-13, 2012.

[39] Ota, Shino, "Strength of the Japanese Automobile Industry from the Indian Automobile Market," Machinery and Information Industry Current Analysis Report, Japan Society for the Promotion of Opportunity, 2010.

[40] V. Govindarajan and J. Euchner, "Reverse innovation: an interview with Vijay Govindarajan," Research technology management, vol. 55, no. 6, pp. 13-17, 2012. 2012.

[41] Suzuki, Osamu, I am a father of small and medium-sized enterprises Nikkei BP Marketing, 2009.

[42] Kiribuchi, Teruki, Biography of the World. Kano, Jigoro Gyosei, 1980.

[43] Japan External Trade Organisation (JETRO), "Suzuki establishes social impact investment fund in India," 2024. [Online]. Available: www.jetro.go.jp/biznews/2024/07/170a774a9321fb40.html

[44] Suzuki Motor Corporation, "By Your Side Suzuki New Medium-term Business Plan (FY2025-2030)," 2025/2/20. [Online]. Aavailable:www.suzuki.co.jp/ir/library/forinvestor/pdf/0220_s.pdf

[45] Seiji Matsuhashi and Yukari Shirata, "Discovering corporate growth patterns by Shapley values: A case study of academy development in the J-League," IEICE, Information-Based Information Theory and Machine Learning (IBISML), 22-23 December 2022, Kyoto, Japan. 2022.

[46] S. Matsuhashi and Y. Shirota, "Football Teams Sustained Growing by Academy Training.

- Proposal of Shapley-based Measurement -," DBKDA 2023 IARIA XPS Press, Barcelona. pp. 13-18, 2023.

[47] S. Matsuhashi and Y. Shirota, "Critical Factors in Doubling Revenue for Soccer Teams:A Comprehensive Study," IEEE IC of Optimization Techniques for Learning (ICOTL 2023) IEEE, Madanapalle, India (Hybrid Mode), pp. 1-5, 2023.

[48] Yukari Shirata, "The strongest DB lecture: how to use Shapley values in machine learning regression," in Japan Data Base Society , 2023. [Online]. Available: https://dblectures.connpass.com/event/274198/