SCAI Special Session

Shapley Value Technology for Business Data Analysis

- **Yukari Shirota (Gakushuin University)**
- **Basabi Chakraborty (Madanapalle Institute of Technology and Science)**
- **Junichi Tomita (Toyo University)**

- Machine learning technologies REGRESSION and SHAP have been more and more used.
- The analysis target includes economic, managerial, financial, social, and environmental data. However, in some conferences concerning economics, there is not enough discussions on the data analysis technologies.
  Especially concerning the latest machine learning analysis methods, there is quite few comments because the audience have not enough knowledge on the machine learning technologies.
  This special session focuses on the machine learning based regression analysis. In almost all fields in business data analysis, regression analysis is used. As the technology for interpretation of the regression result, Shapley values are essential and has been widely used.

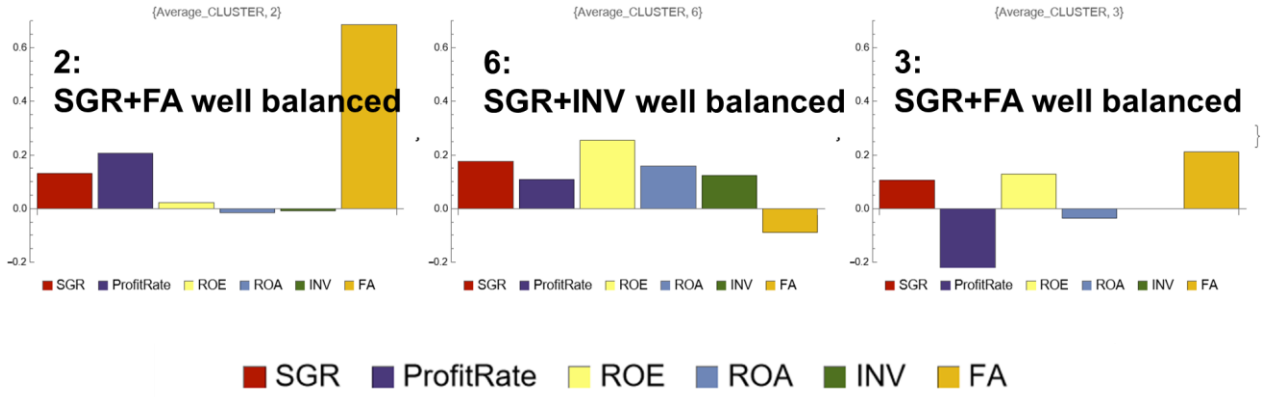
Contents

1. The Network Structure of Open Innovation and the Creativity in Semiconductor Manufacturing Equipment Industry (Junichi Tomita, Yukari Shirota, Eishi Fukushima and Masahide Terahata)
2. Impact Analysis of Supply Chain Competence on Market Capital Growth in Automobile Manufacturers (Yukari Shirota and Basabi Chakraborty)
3. Relationship Analysis Between Stock Prices and Financial Statements in the Automobile Industry (Kenji Yamaguchi)
4. Analyzing Relationship between Companie's SDGs Activities and Financial Information using SHAP (Kouta Ohi, Takako Hashimoto, Yukari Shirota, Kaya Akagi, Takao Terano and Ryohei Egusa)
5. Gender Equality Level Analysis in Indonesia by Shapley Values (Takako Hashimoto, Yukari Shirota, and Riri Fitri Sari)

IIAI AAI 2023

Special Session "Shapley Value Technology for Business Data Analysis"

Impact Analysis of Supply Chain Competence on Market Capital Growth in Automobile Manufacturers



2023/07/08

Prof Yukari Shirota (Gakushuin University)

Prof Basabi Chakraborty (Madanapalle Institute of Technology and Science, India)

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2. Method: Xgboost and SHAP
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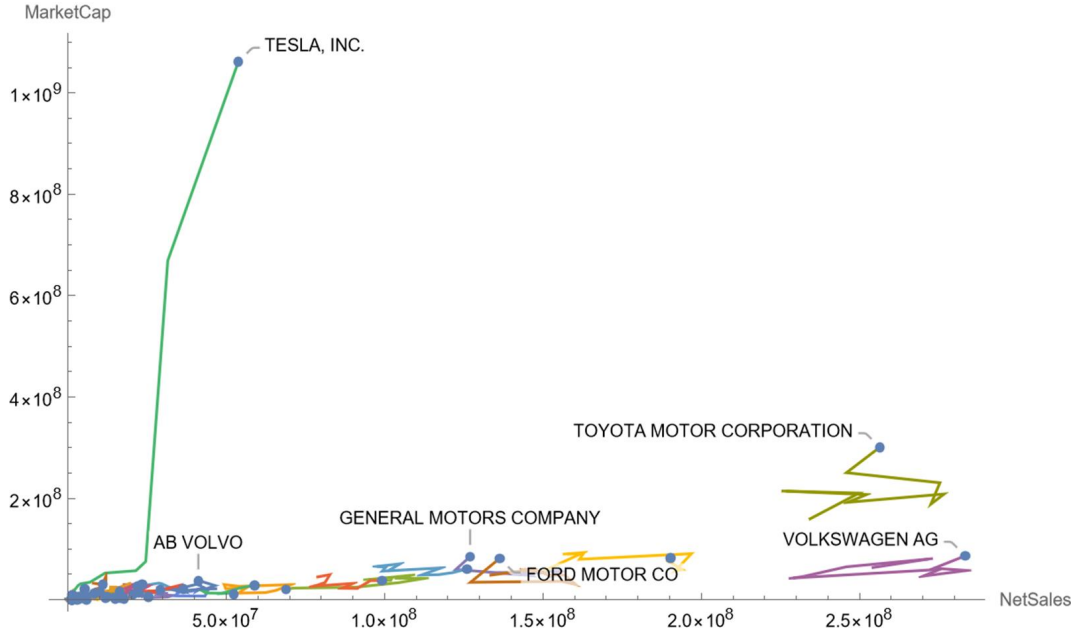
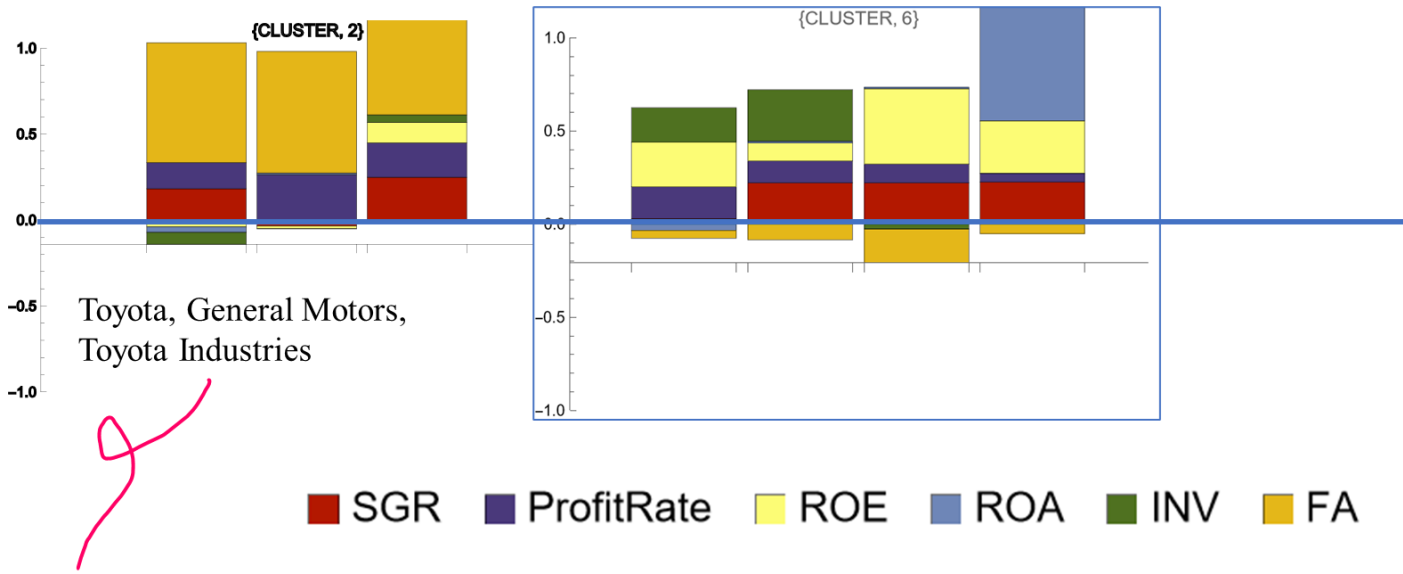


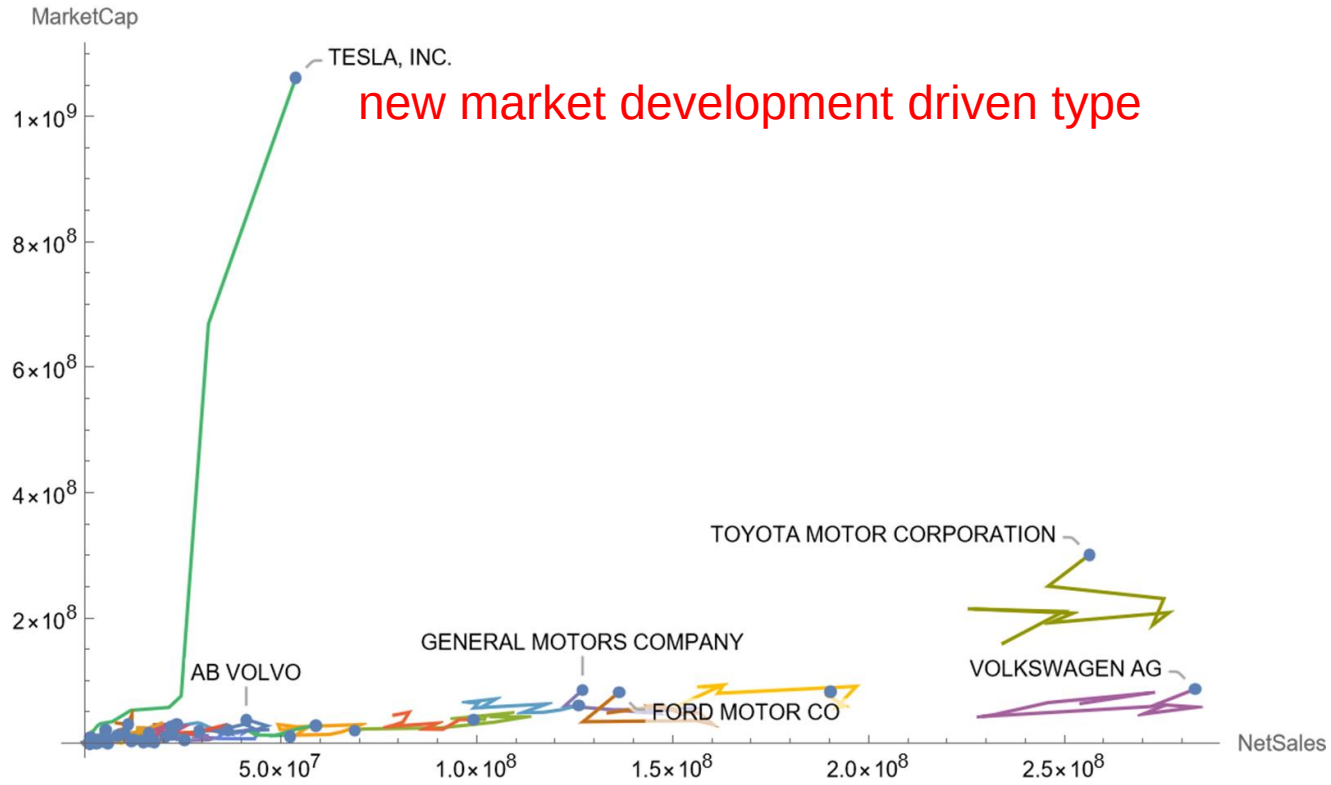


Research Objective

- **Morita's theory:**
  The important factors for manufacturers are the competence of supply chains and the new market development required for the long-run sustenance of high business performance;
  They are supposed to lead to high stock prices [1].
- **In such a long-run company, which factor is the main, a supply chain competence driven type or a new market development driven type?**
- **[1] Morita, M. and J.A. Machuca, *Integration of product development capability and supply chain capability: The driver for high performance adaptation.* International Journal of Production Economics, 2018**

Research Objective

- **What's dominant for Market Capital growth ?**
- **MC = stock price x total number of outstanding shares**
  Stock price movement is directly reflected to MC.
- **In automakers,**
  Tesla is the largest, and
  Toyota is the 2nd.
- **How about**
  long-run companies ?



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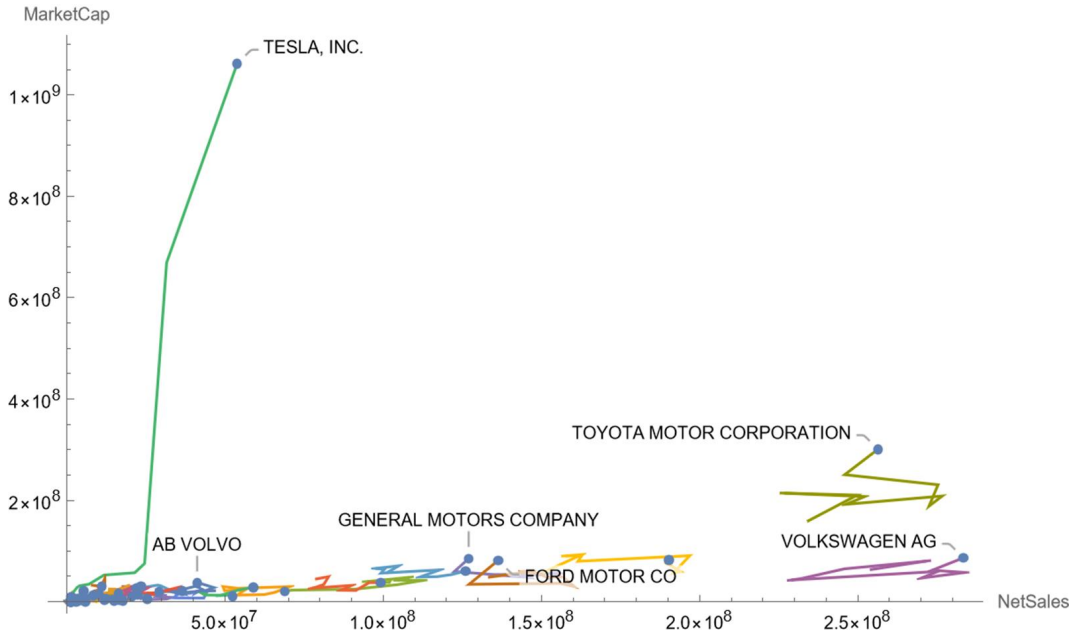
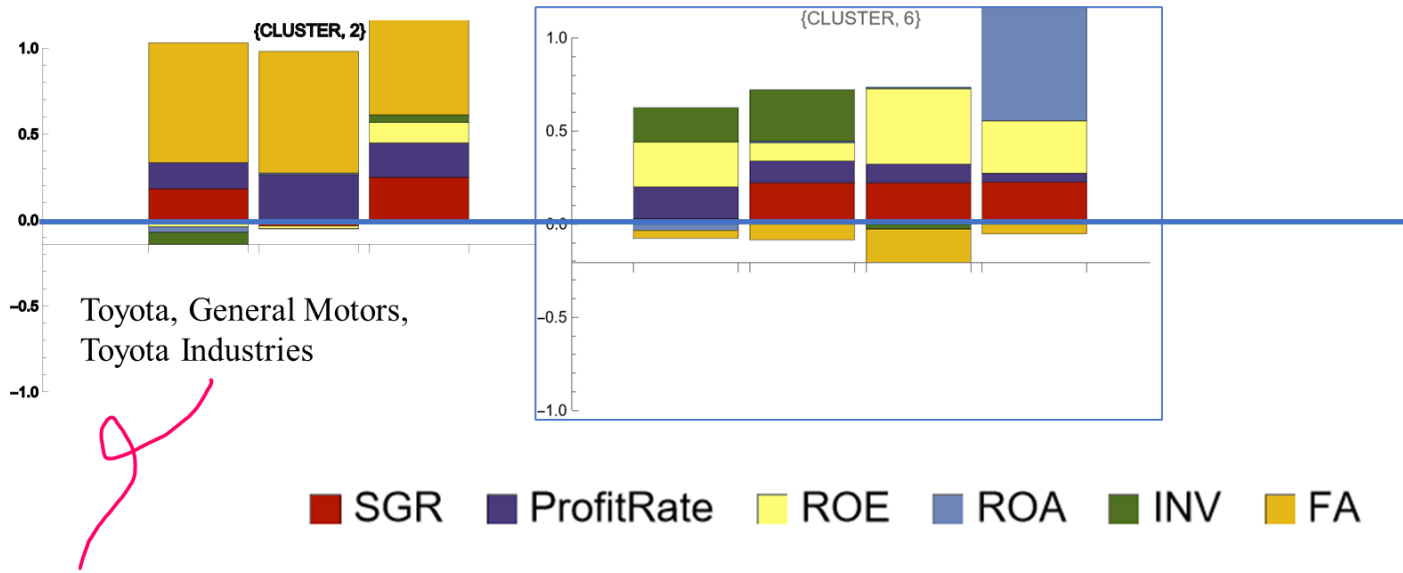




Regression

- **Target variable is the MC growth rate from 2011 December to 2021 December.**
- **6 explanatory variables**

✓**Sales growth ratio (SGR) : new market development.**

✓**Inventory turnover (INV) and Tangible fixed assets turnover (FA) : supply chain competence.**

✓**Profit rate**

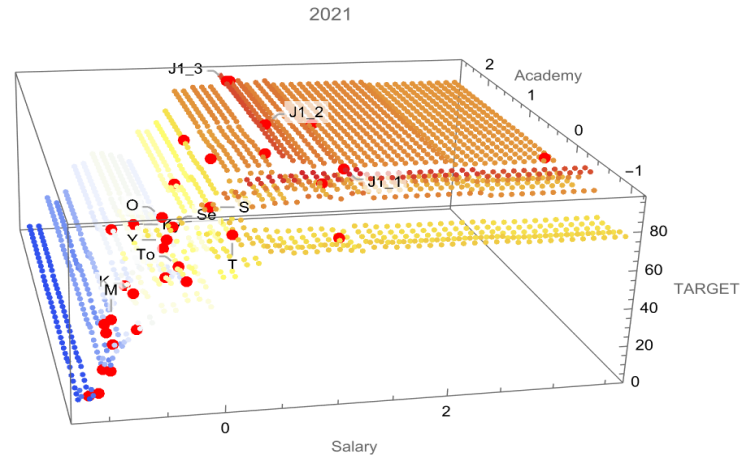
✓**ROE (Return on Equity)**

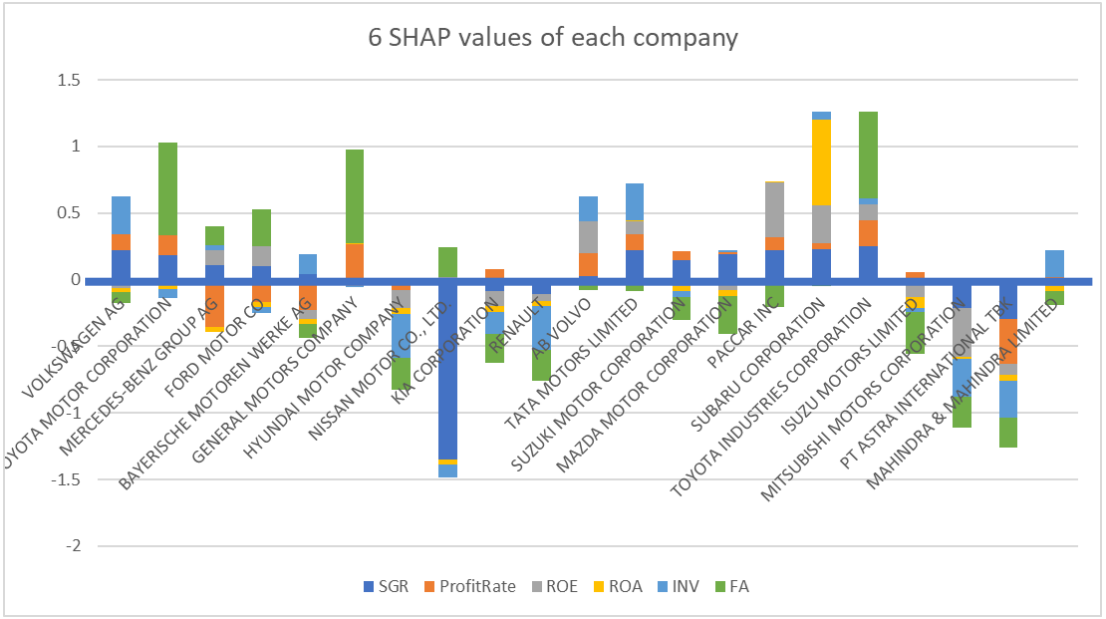
✓**ROA (Return on Assets) which are profitability-related factors.**

- **For the explanatory variable values, the average values of 10 annual data from 2012 to 2021 are used, from the web-based data base ORBIS by Bureau Van Dijk.**

Regression + SHAP approach

- Regression by XGBoost
- Resultant regression model
- SHAP values using the regression model
- Original Shapley values are customized and called SHAP in machine learning regressions
- Deviation of target value can be divided to 6 SHAP values.





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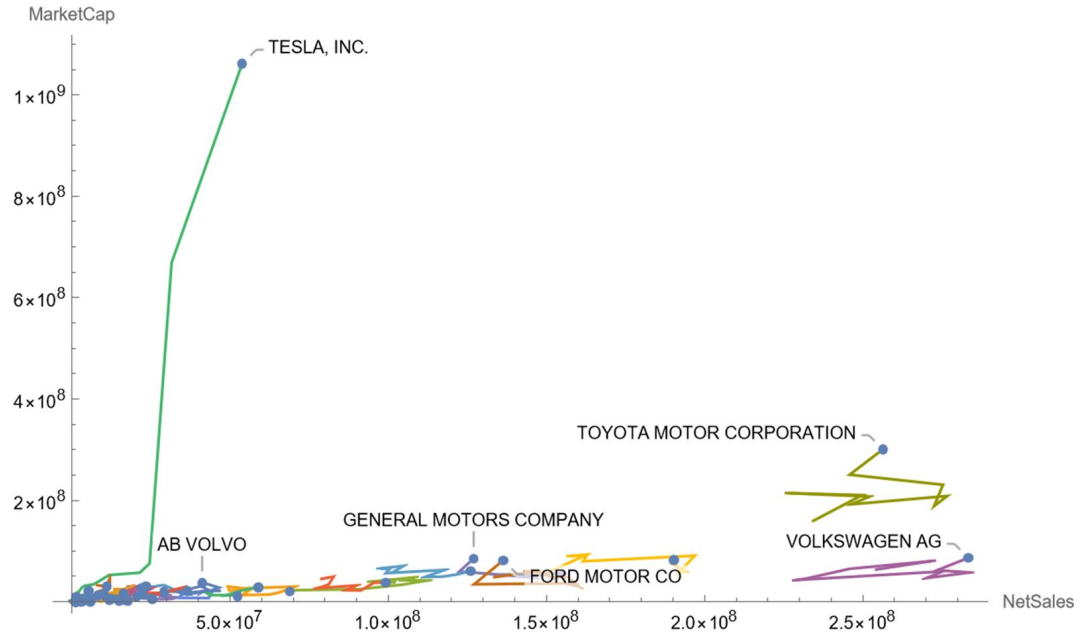
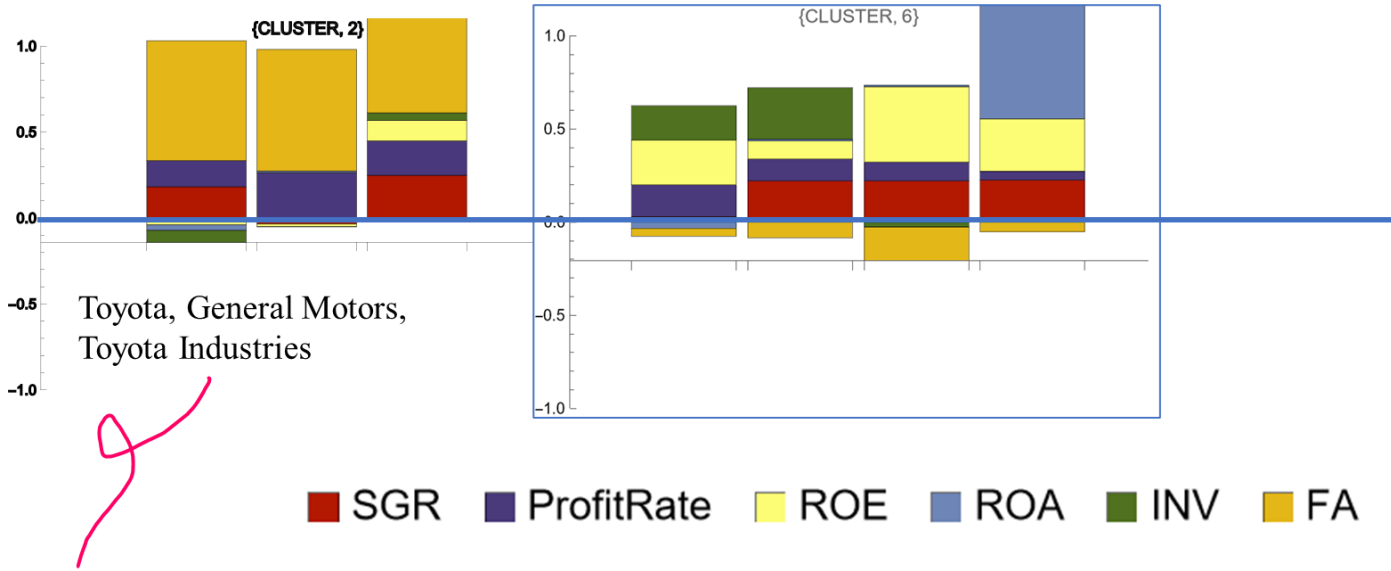
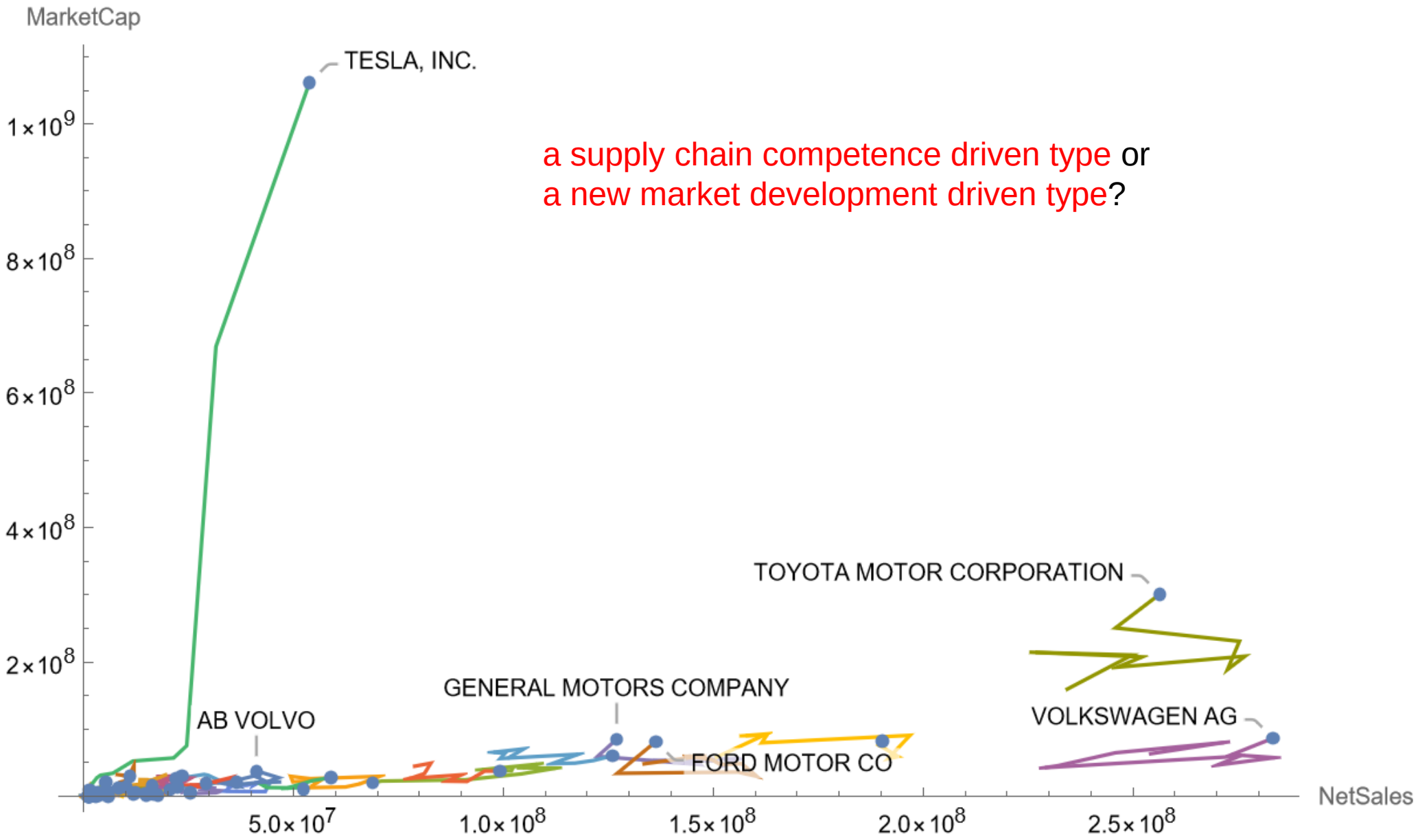


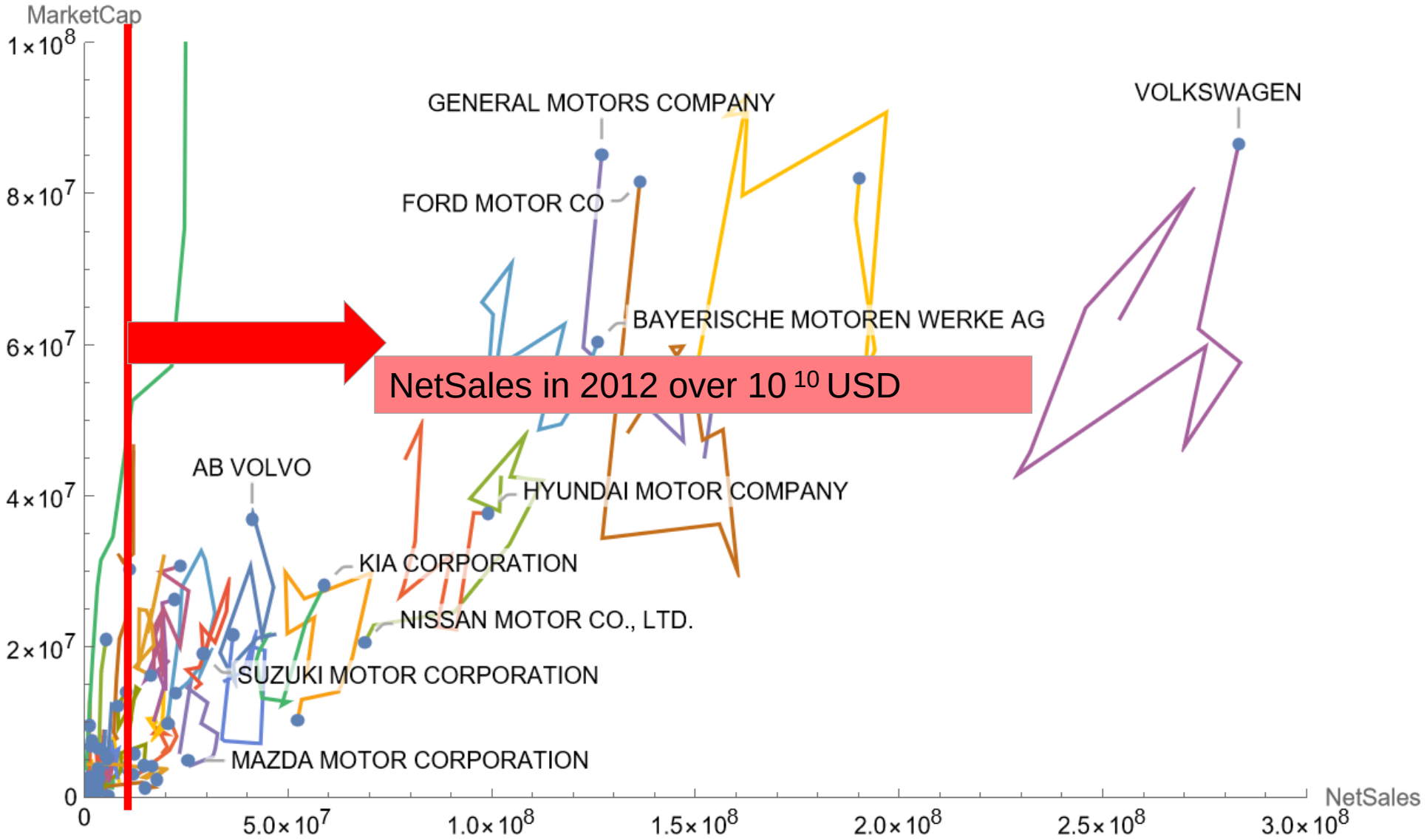


NetSales～MarketCap. (2012 to 2021)



a supply chain competence driven type or
a new market development driven type?

Focus on largest 21 companies only



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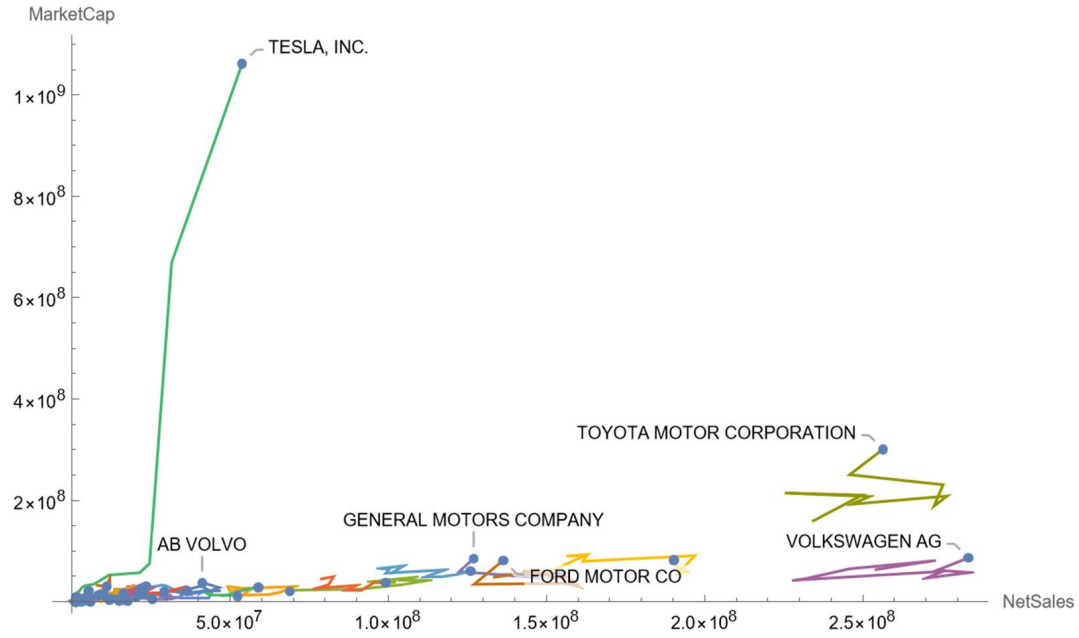
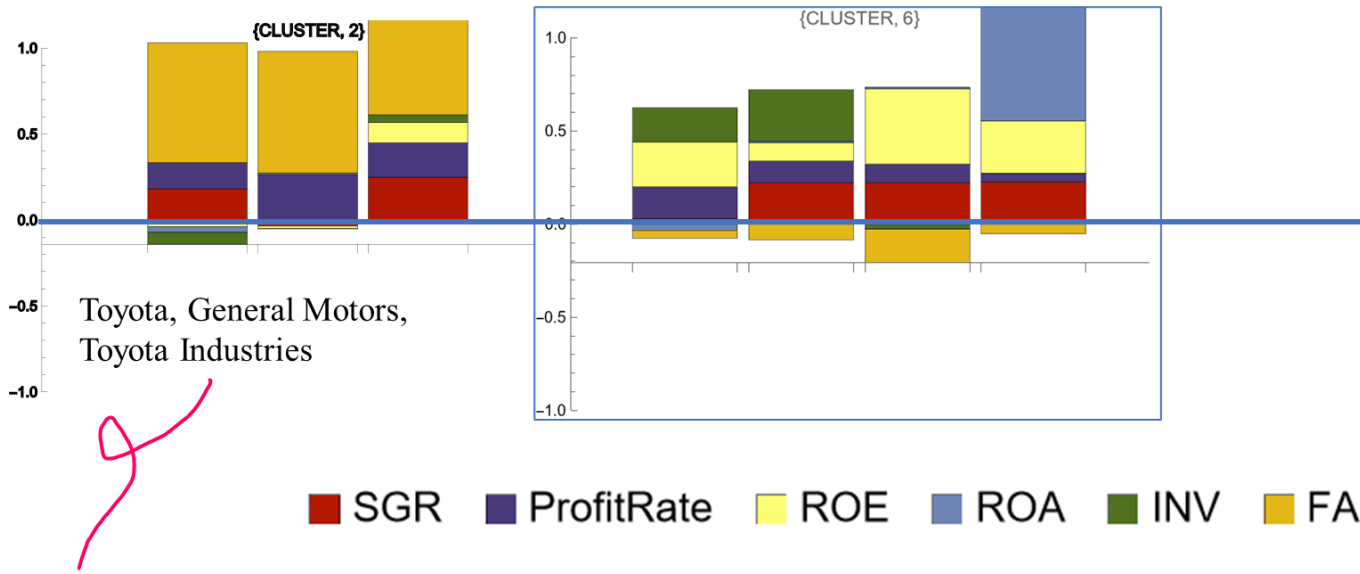
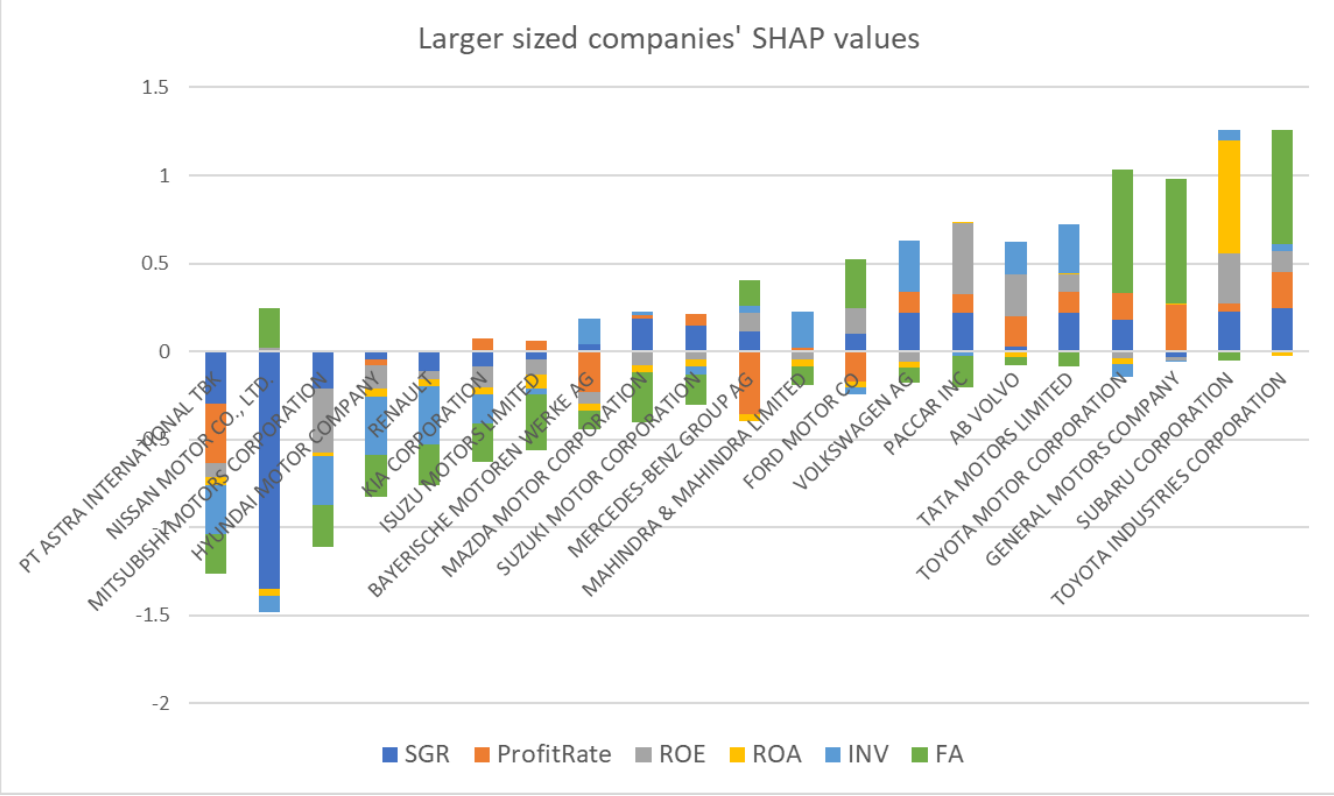




Larger sized 21 companies' SHAP values

- **Deviation of target value can be divided to 6 SHAP values.**
- **SHAP reflects company's characteristics**



Correlation Coefficients between SHAP values and target values

Dominant factor has the high correlation with target values

1. **SGR_SHAP**
2. **INV_SHAP**
3. **ROE_SHAP**

As a whole, the most dominant one is SGR and the 2nd is INV.

	MarketCGR
SGR	0.66
ProfitRate	0.52
ROE	0.62
ROA	0.42
INV	0.64
FA	0.57

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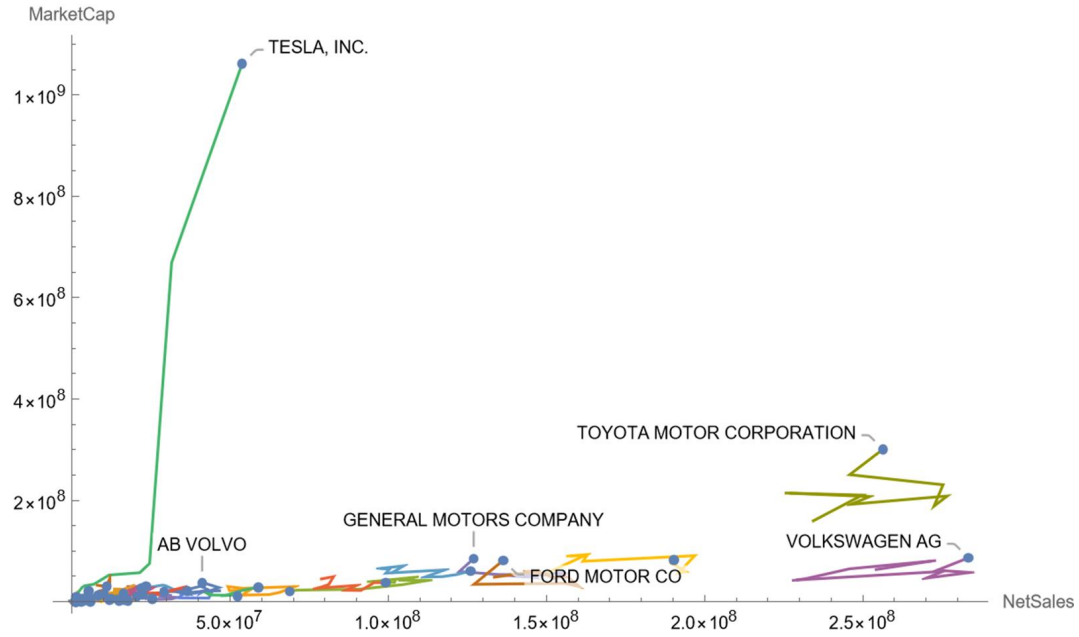
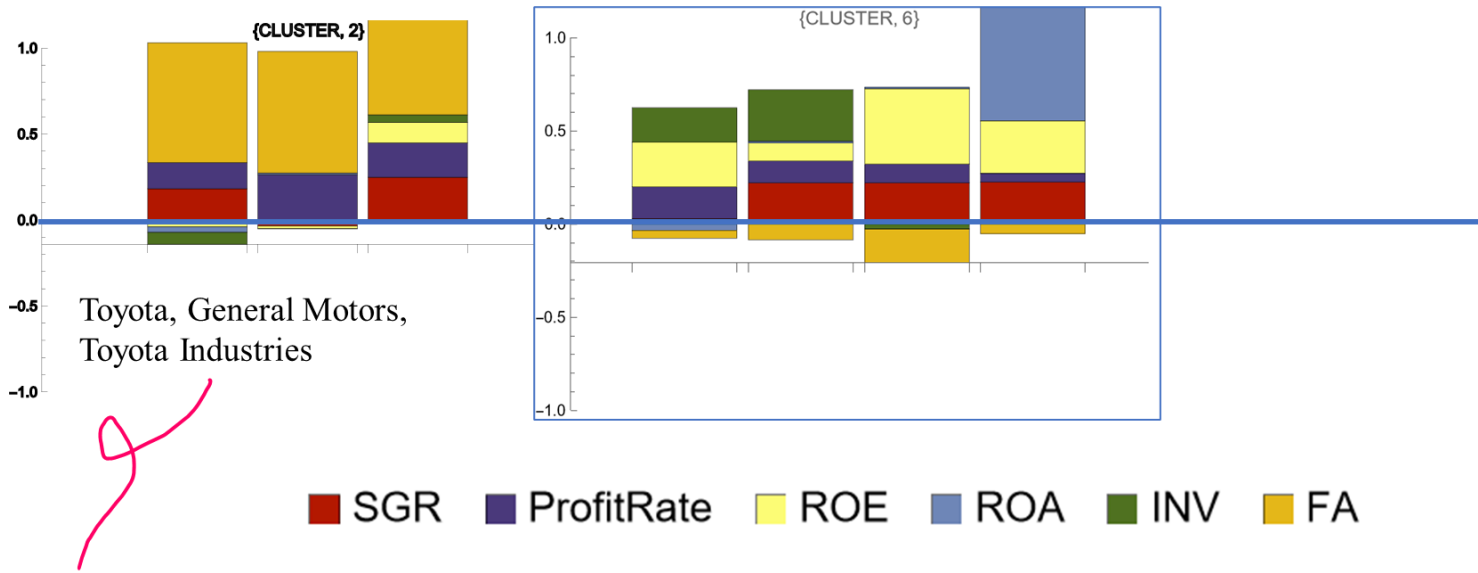
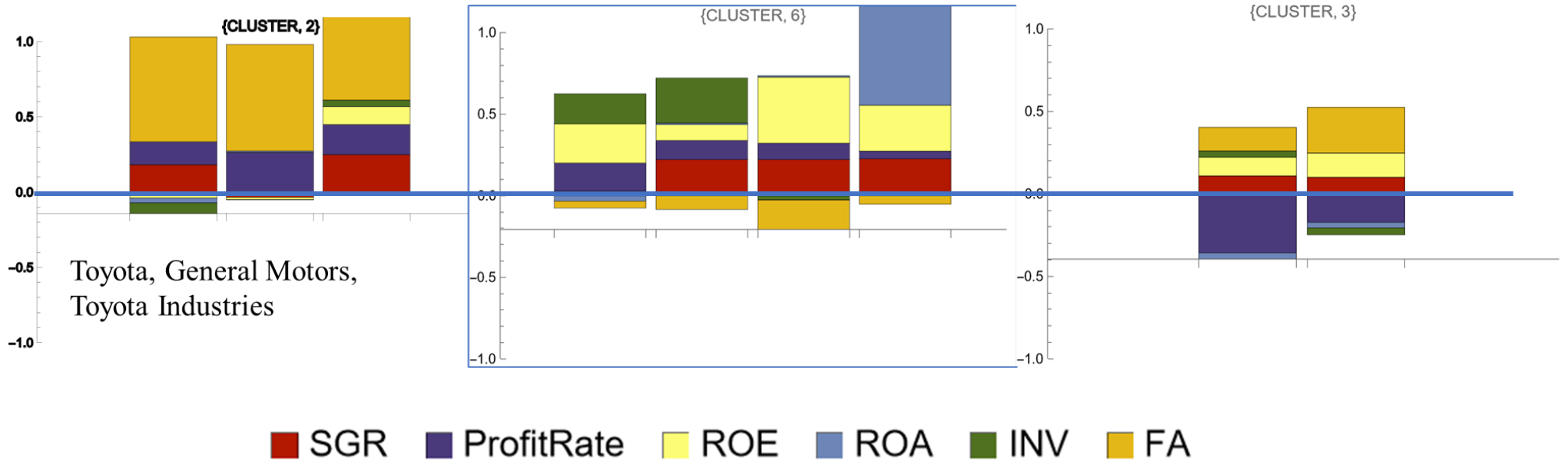


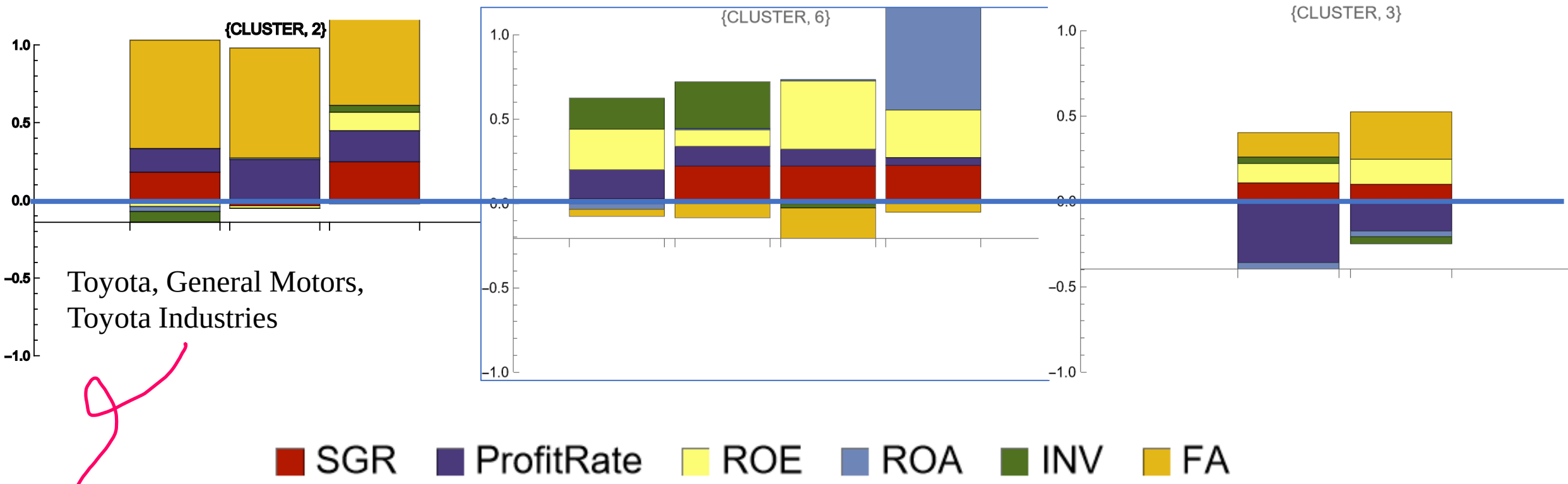


A long-run company is a supply chain competence driven type or a new market development driven type?

- To extract the features,
  clustering of the 6 SHAP values+TARGET value
- k-Means algorithm with k=6



Top high growth clusters: 2, 6, 3

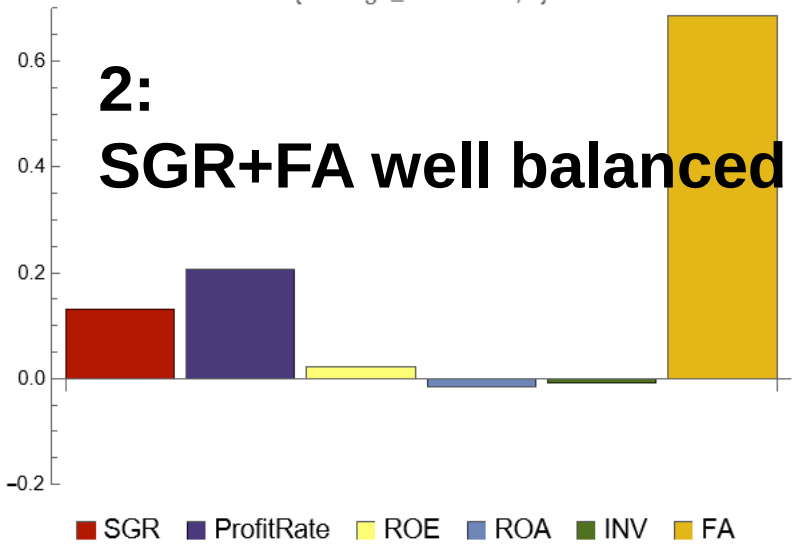


SHAP_FA is much larger.

This seems that these companies leverage well their tangible fixed assets.

Top high growth clusters: 2, 6, 3
Average of cluster members

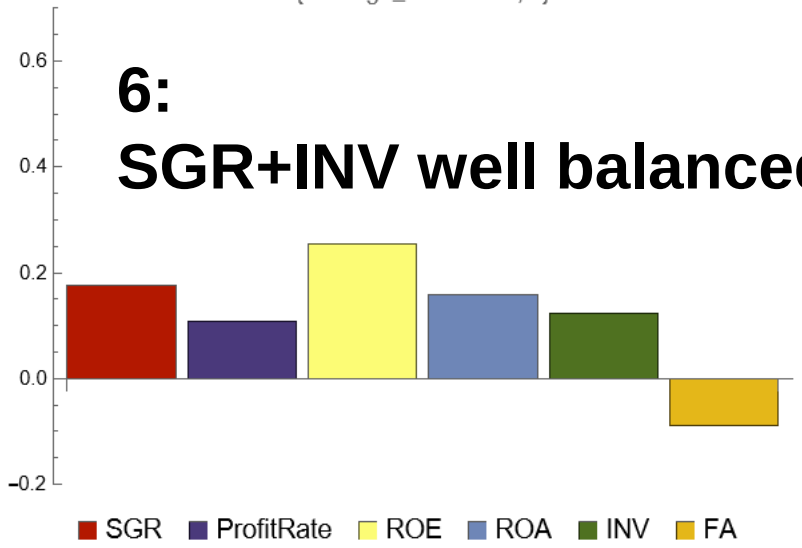
{Average_CLUSTER, 2}



2:
SGR+FA well balanced

,

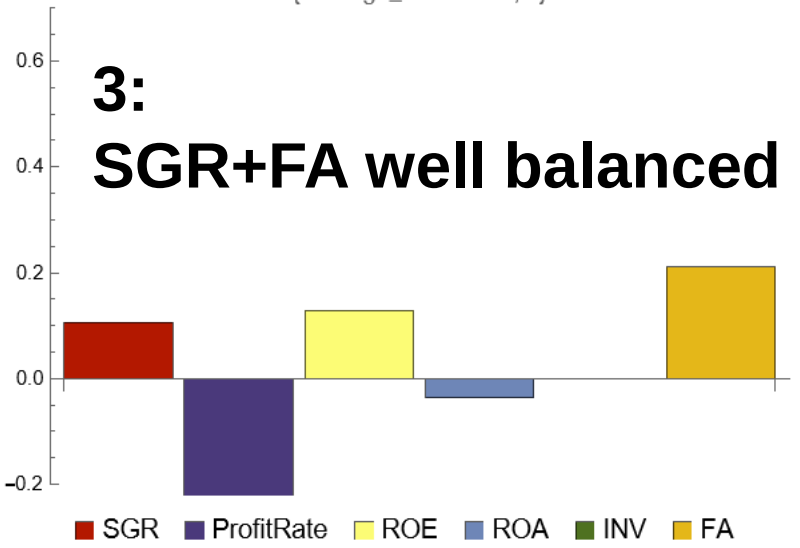
{Average_CLUSTER, 6}



6:
SGR+INV well balanced

,

{Average_CLUSTER, 3}



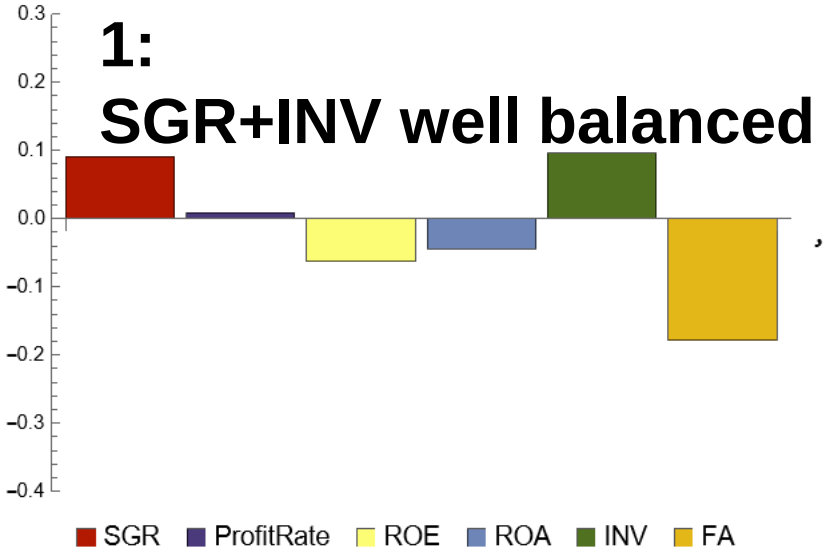
3:
SGR+FA well balanced

}

SGR ProfitRate ROE ROA INV FA

Lower clusters: 1, 4, 5

{Average_CLUSTER, 1}



1:
SGR+INV well balanced

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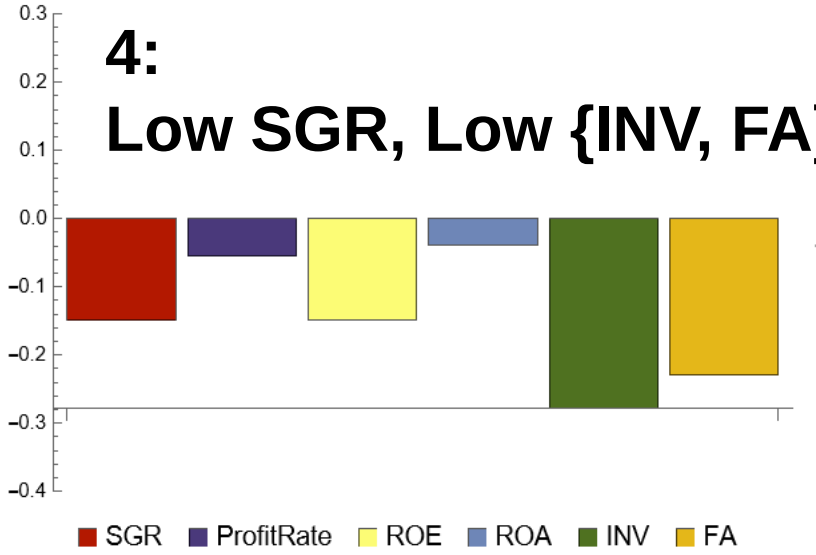
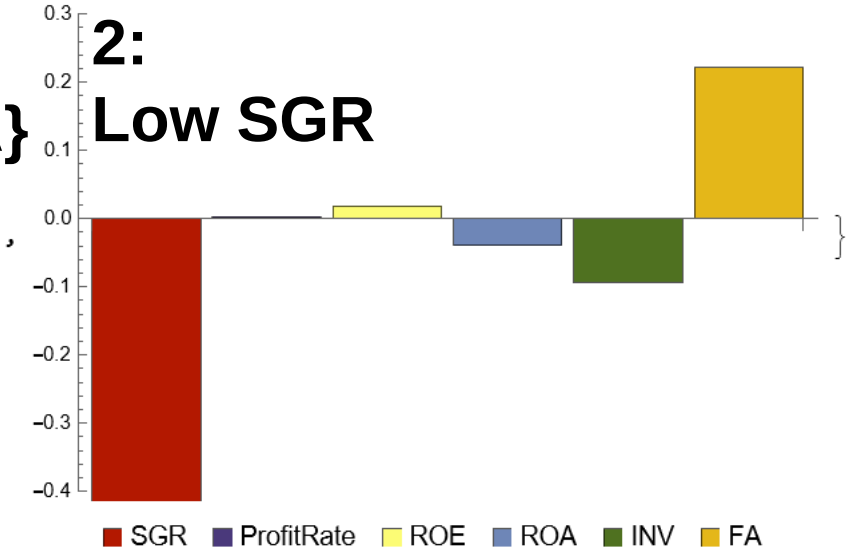
{Average_CLUSTER, 4}



4:
Low SGR, Low {INV, FA}

,

{Average_CLUSTER, 5}



2:
Low SGR

}

SGR ProfitRate ROE ROA INV FA

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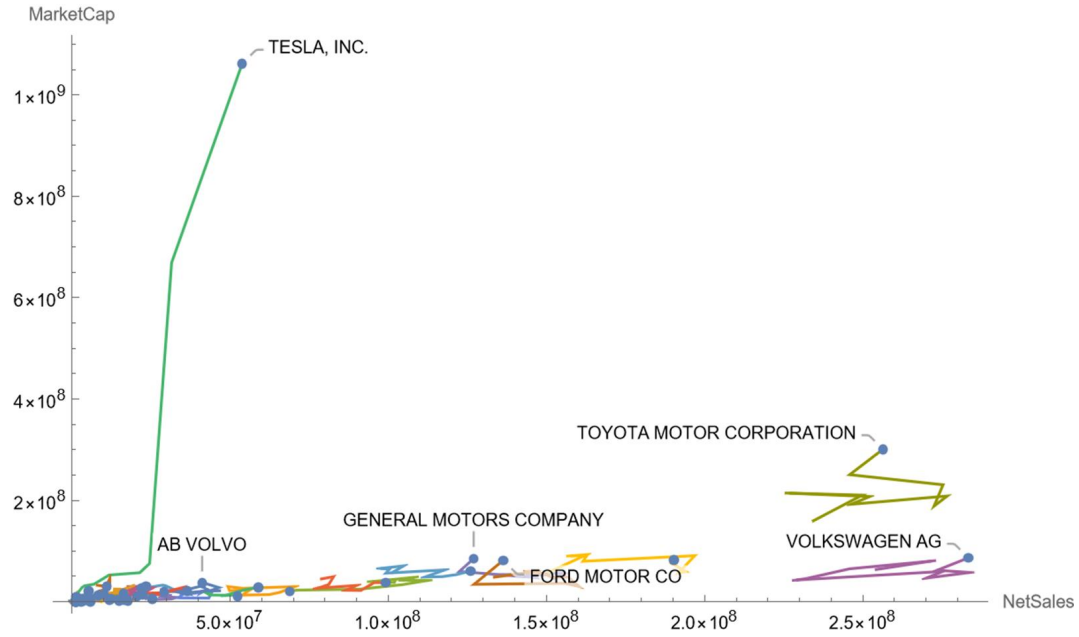
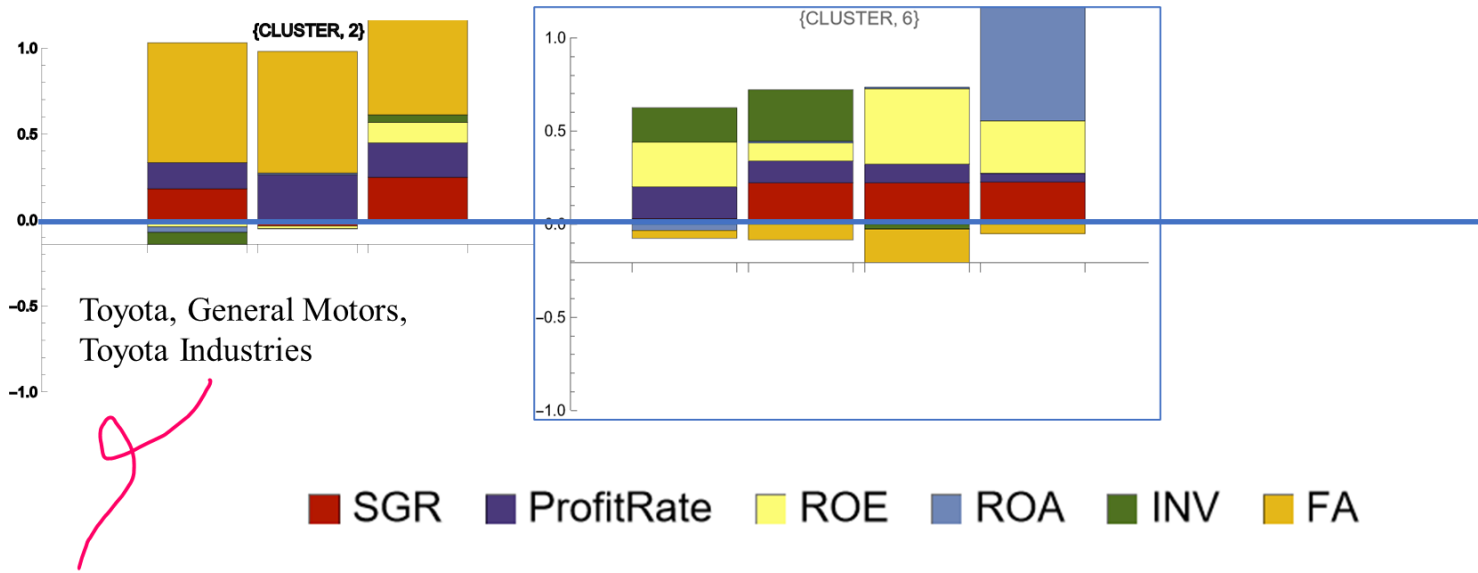
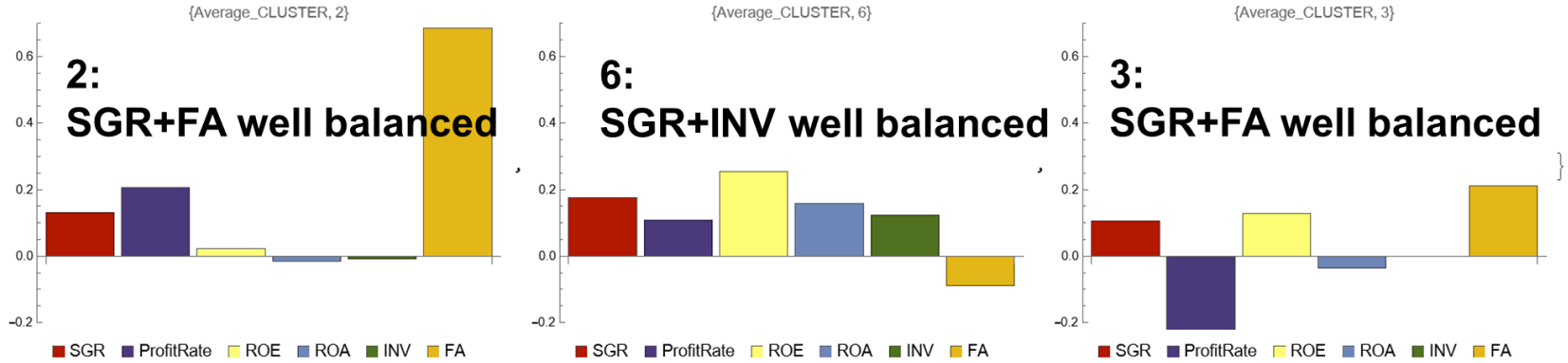




Conclusions

- Long-run automakers' Market Capital growth rate
- Higher growth company is SCM-driven or SGR-driven ?
- Data from 2011 Dec. to 2021 Dec. (10 years)
- Method: Regression → SHAP →clustering of SHAP values
- Affirmative that higher growth companies are well balanced
- Top 3 companies leverage well their tangible fixed assets