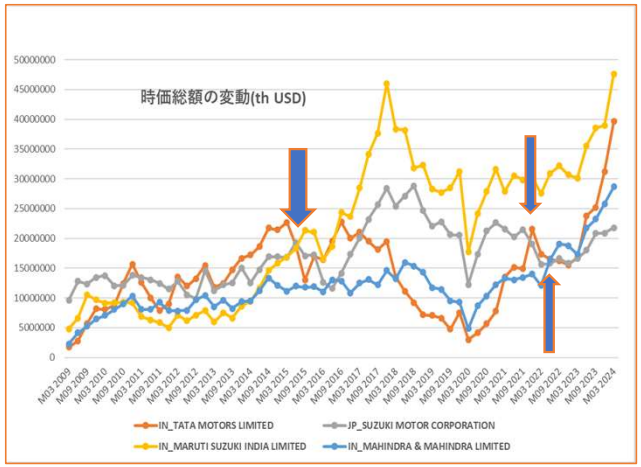
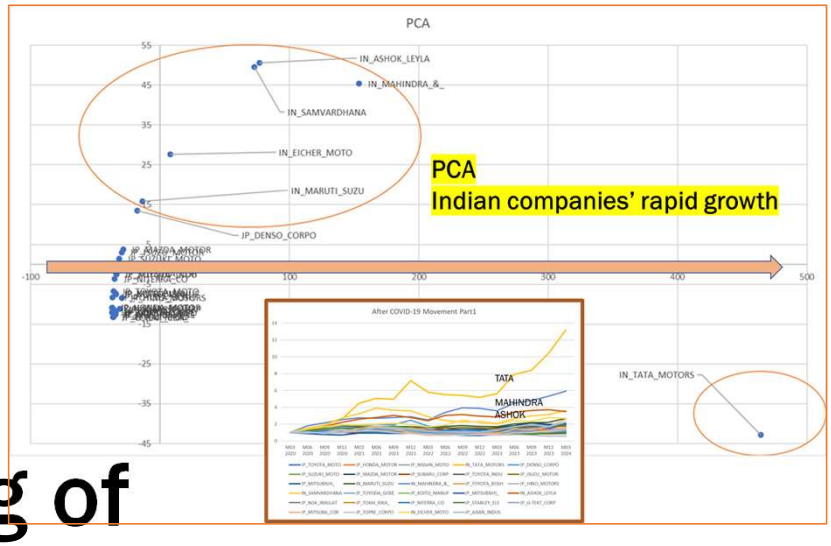


WebDB夏のシンポジウム
2024年9月

インド自動車企業の
株価変動パターン分析



Time Series Clustering of India Automakers Market Capital Movement

Basabi Chakraborty
(Madanapalle Institute of Technologies and Science, MITS)
Yukari Shirota (Gakushuin University)
Bonthala Sreekanth (MITS)

時系列データ（株価）変動パターンの分析手法

以下が参考になります

- 白田：株価クラスタリングのチュートリアルビデオ
  T2：株価分析のための時系列データクラスタリング入門（最強データベース講義 DEIM Version）（mp4とpdf) DEIM 2023 T2

フルペーパ　リンク

- Basabi Chakraborty, Bonthala Sreekanth, Yukari Shirota: “Analysis of Indian Automakers’ Resilience after COVID-19 ―Comparison between Indian and Japanese Automakers―”,『学習院大学　経済論集』第61巻　第3号（2024年11月）

- 学習院大学　経済論集

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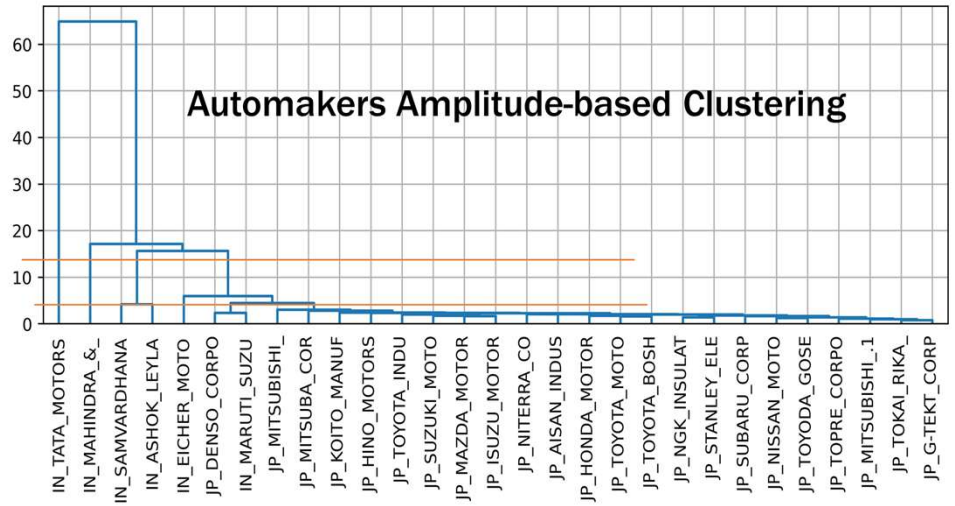
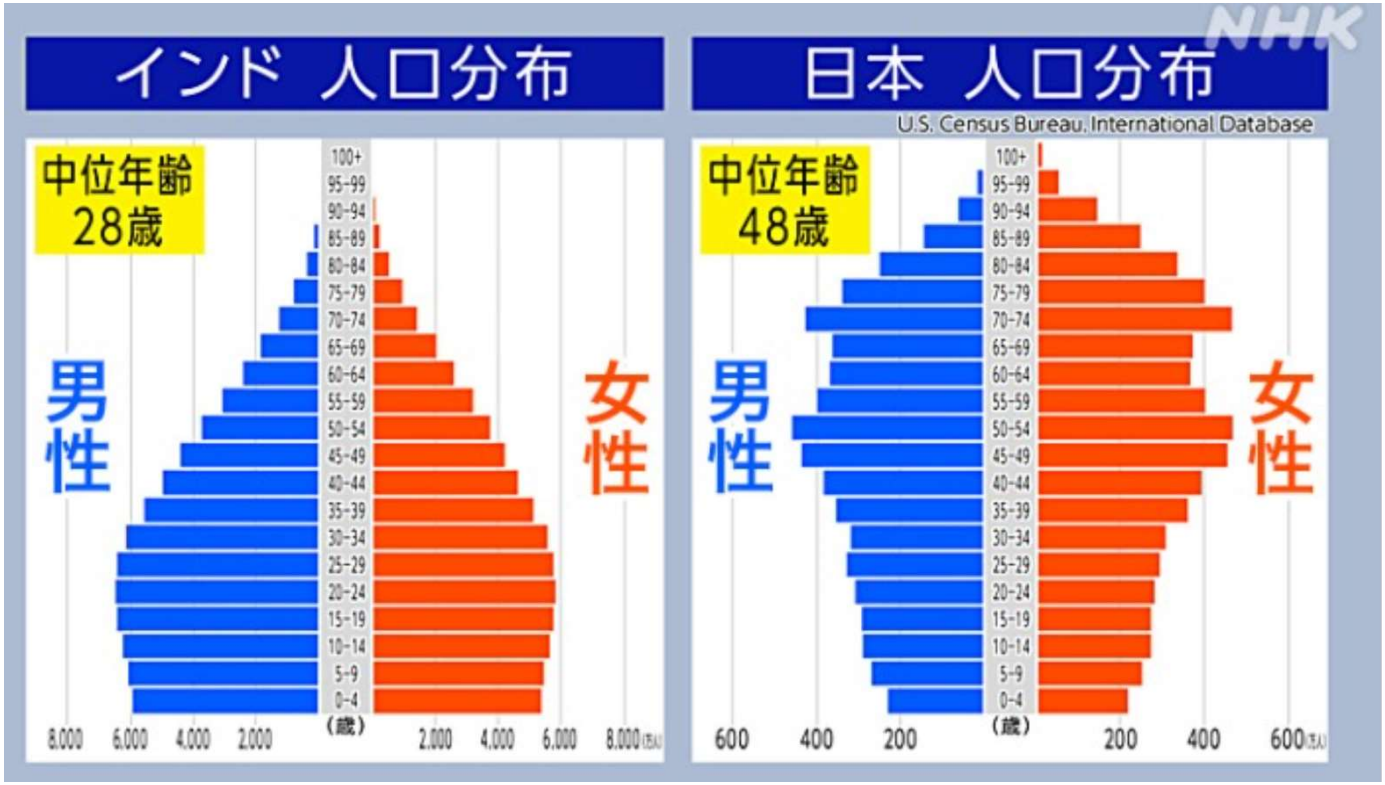


India GDP Progress and Industrious Growth

- Population bonus
- GDP No 5 → 4
- New cars sales amount No 3 2022 (Japan 4th)
- IIT (Google CEO)

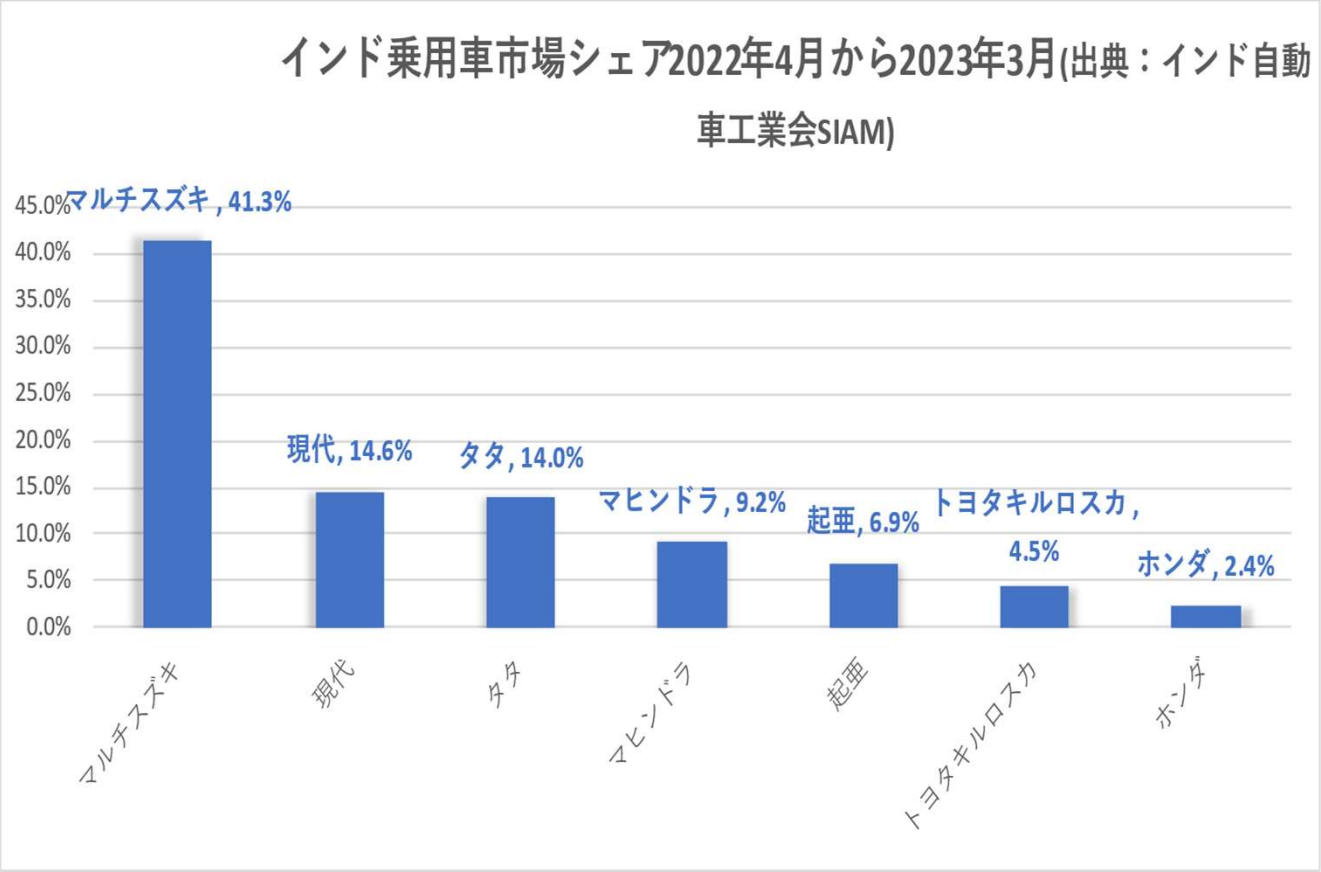


NHK: 1からわかる！なぜインドは世界3位の経済大国に？人口14億を原動力に成長のワケ｜NHK就活応援ニュース
https://www3.nhk.or.jp/news/special/news_seminar/jiji/jiji141/

インド乗用車市場シェア2022年度

インドの独自性

- マルチスズキ
- 小型車　税制優遇
- 高い車が売れない
- インドのニーズに合致した車が売れる



Maruti Suzuki India

- 1981年，マルチスズキの元となった，スズキの合弁会社設立
  地場**官営**企業　マルチ・ウドヨグ
- 1982年，スズキが出資し**半官半民**合弁企業
- 2006年，インド政府が全株式を売却し完全民営化
  民営合弁企業となった.
- 2007年，Maruti Suzuki Indiaに社名変更して現在に至る
  スズキの出資率 58.2%

研究目的
マルチスズキを軸にインドの自動車製造業社の時価総額の伸びを分析する

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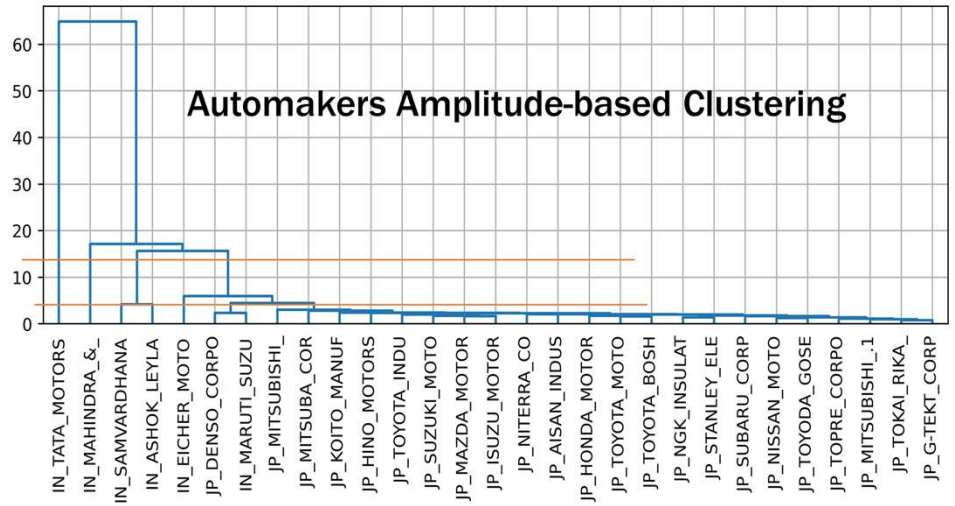
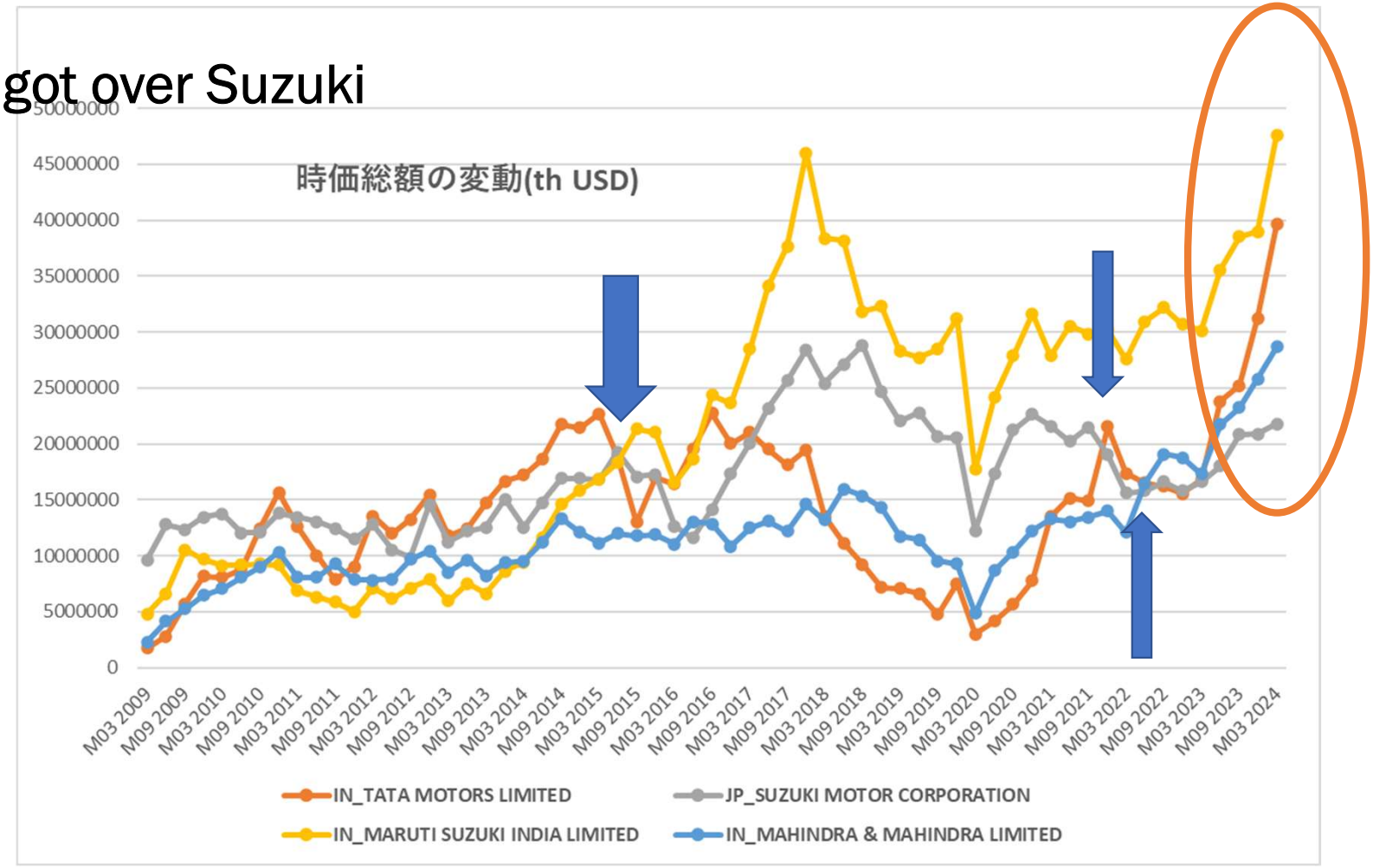


インド6社と日本23社
インドとのグローバルな動きの比較のため

- 2009年から2024年の四半期ごとの時価総額
- 時価総額＝株価×発行株数

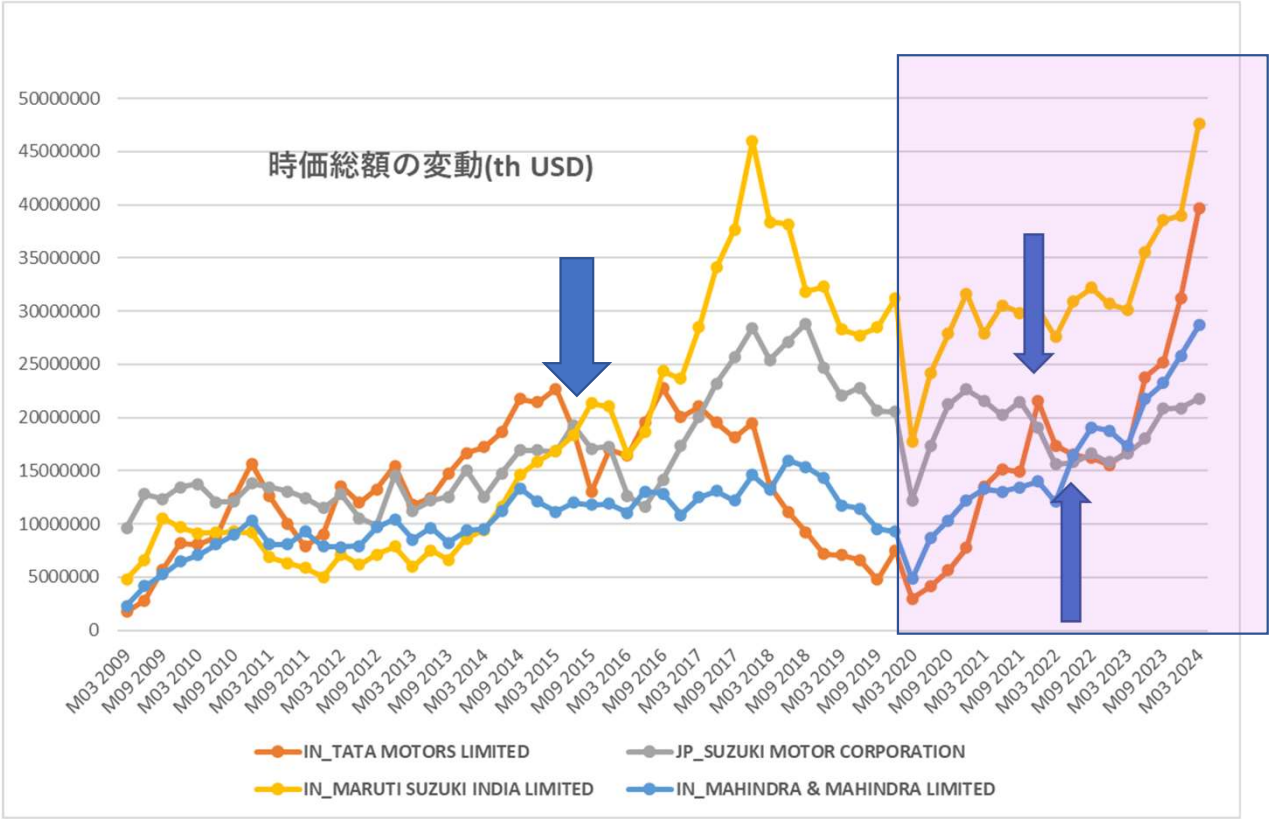
MC Movement 2009～2024

- Maruti Suzuki got over Suzuki



COVID-19 Effect and Its After Period

- Resilience after decline by COVID
- India and Japan 29 automakers



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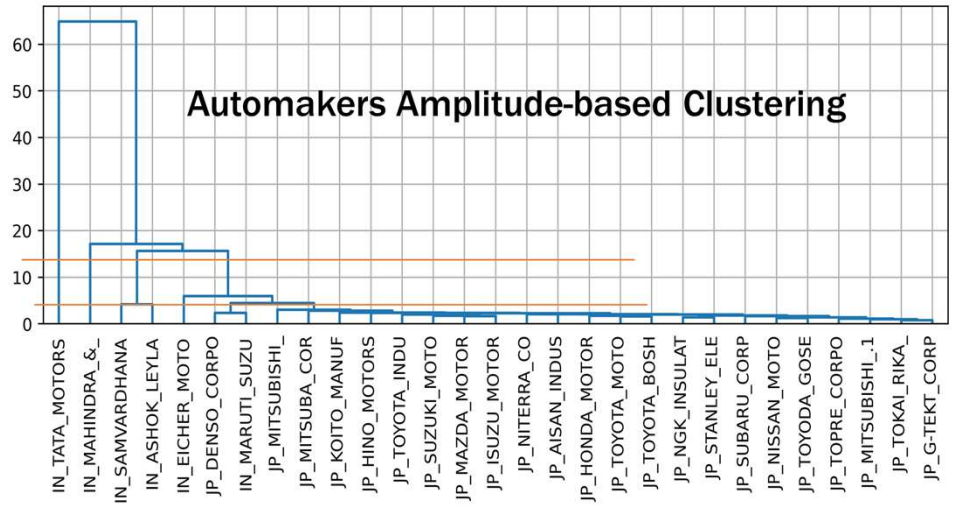
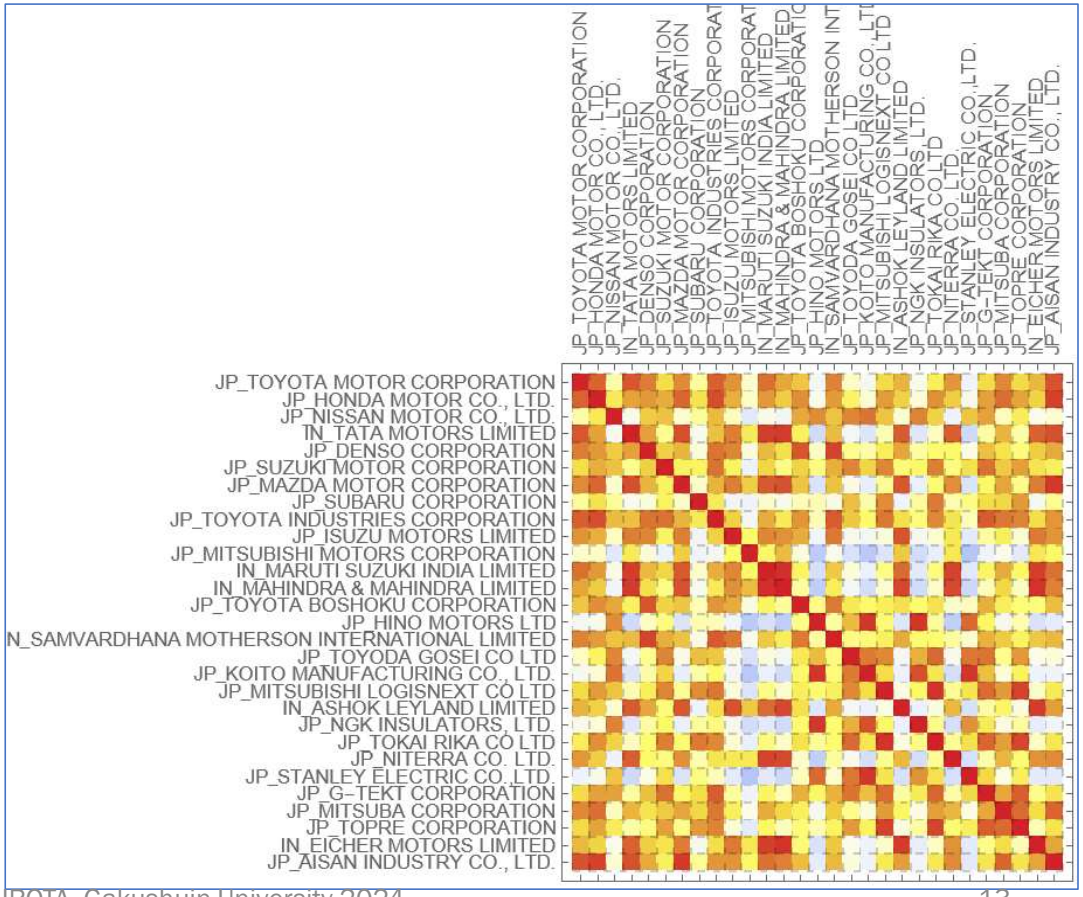
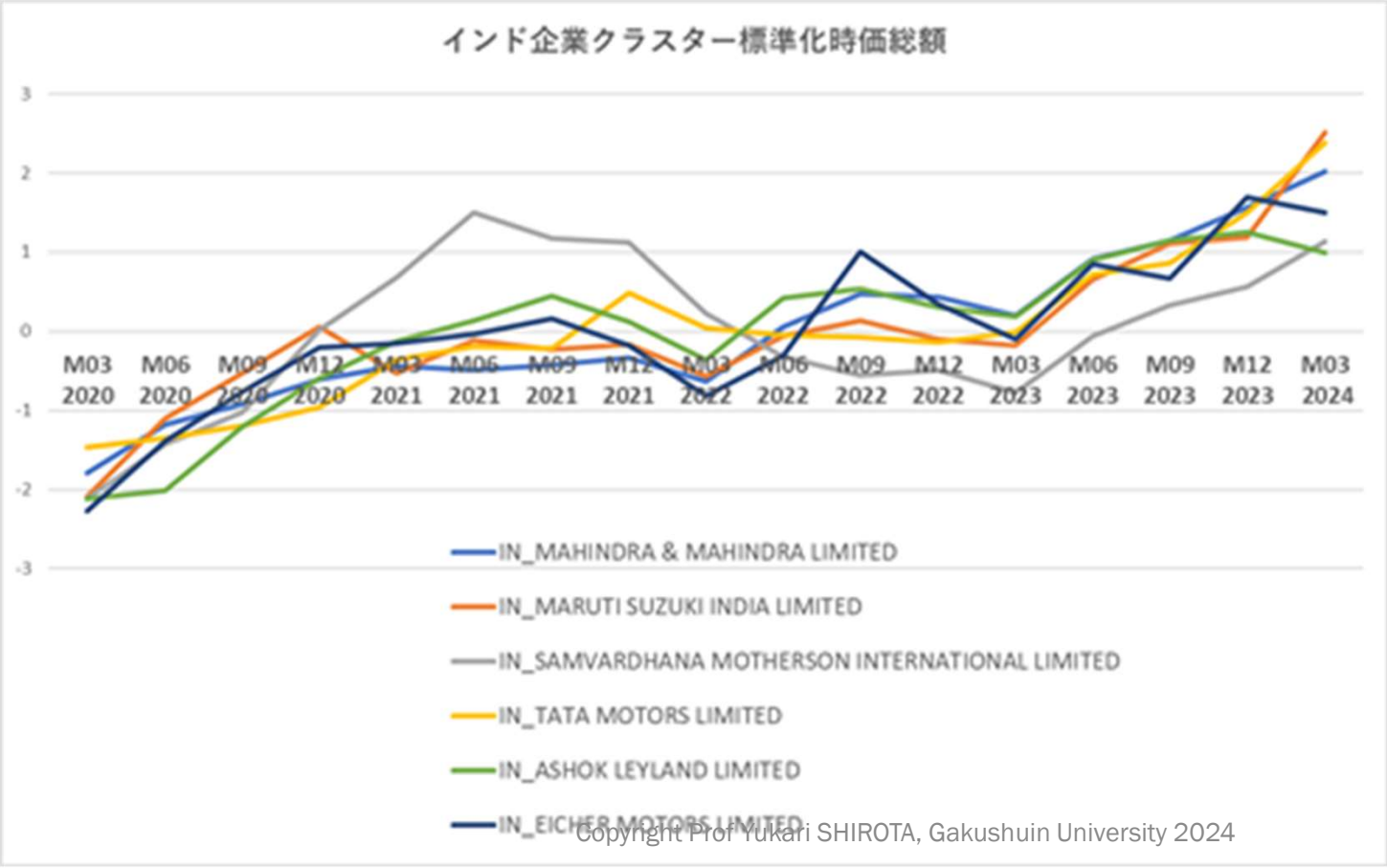


Hierarchical Clustering by Correlation Coef.-based Distance

- Correlation coefficient matrix
- $\boldsymbol{d_{i,j} = \sqrt{\frac{1}{2}(1 - \rho_{i,j})}}$
- $\boldsymbol{\tilde{d}_{i,j} = \sqrt{\sum_{n=1}^{N}(d_{n,i} - d_{n,j})^2}}$
- Distance of distance defined



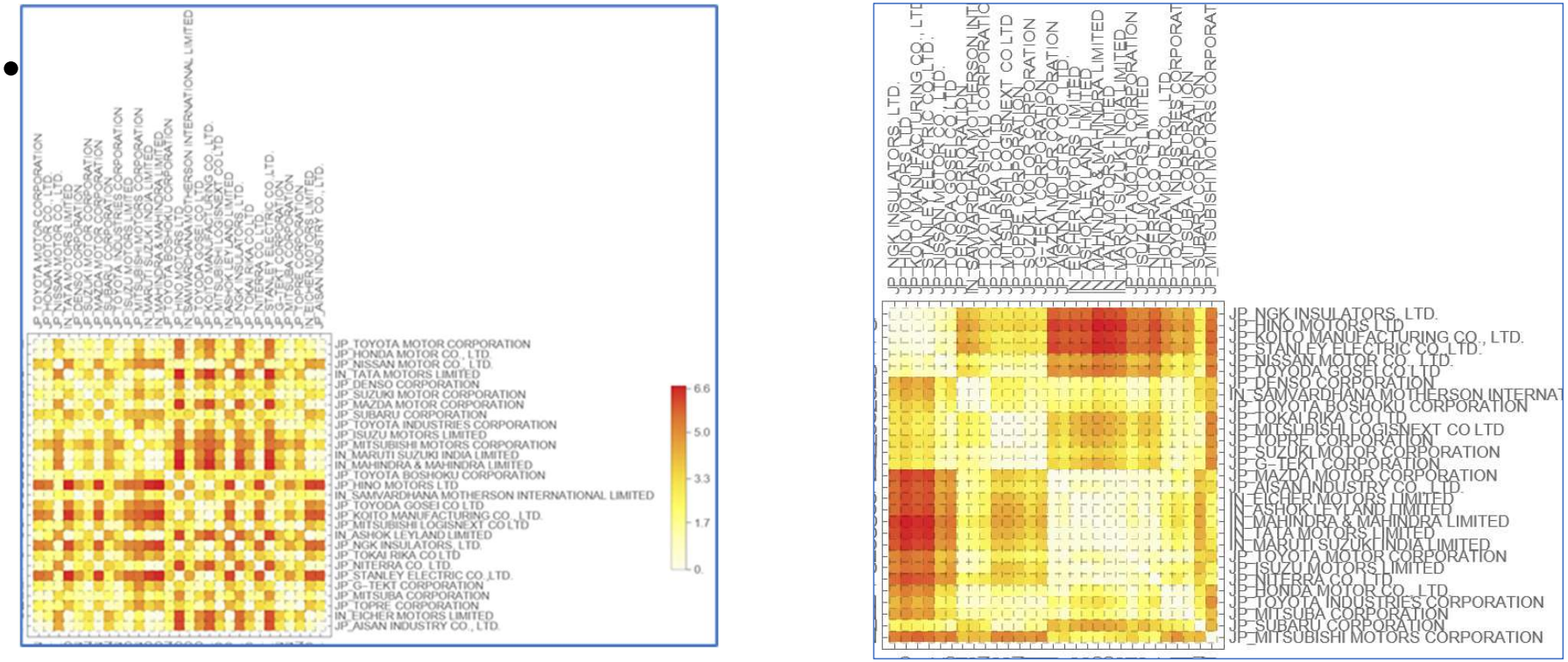
相関係数を使うと，データ標準化したことと同じ　→　伸びの分散は削除された



Hierarchical Clustering by Correlation Coef.-based Distance

Distance of distance matrix

After Quasi-Diagonalization



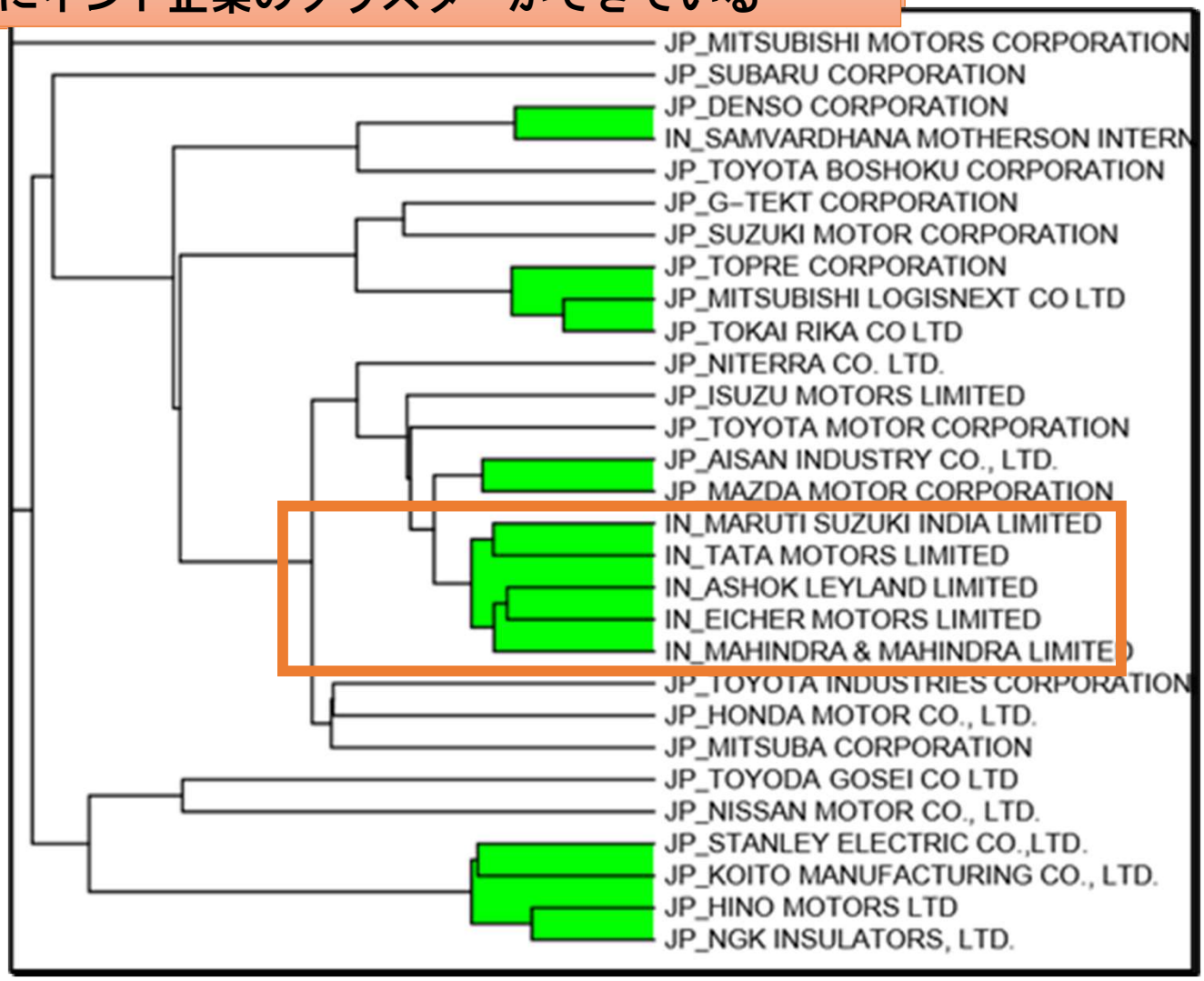
Dendrogram

India cluster found

- Maruti Suzuki
- Tata
- Mahindra&Mahindra
- Ashok Leyland
- Eicher Motors

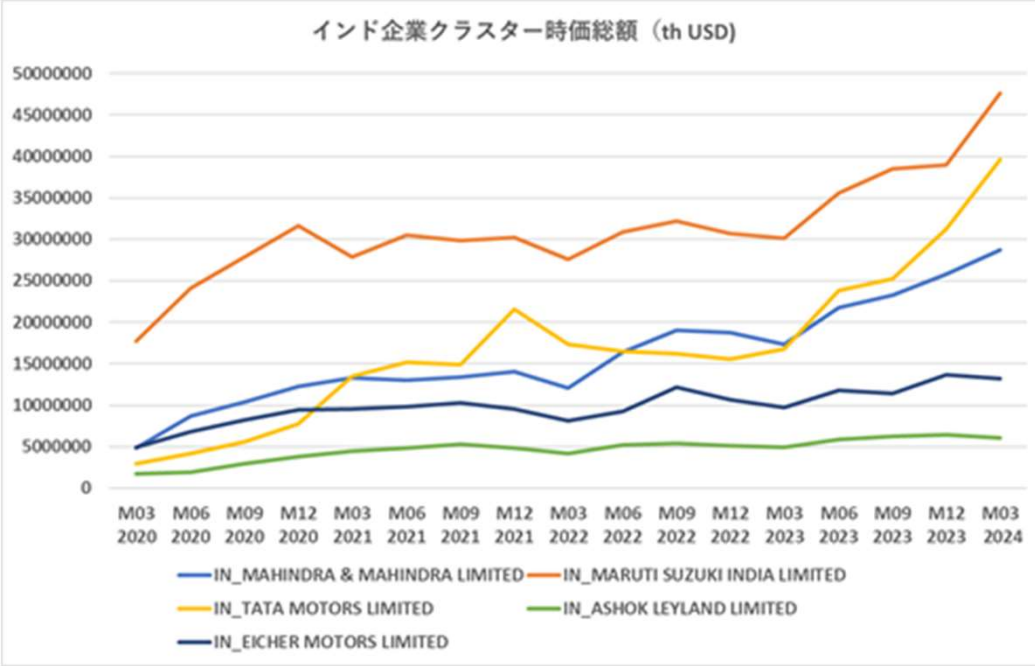
Clear separated from Japanese makers

明確にインド企業のクラスターができている

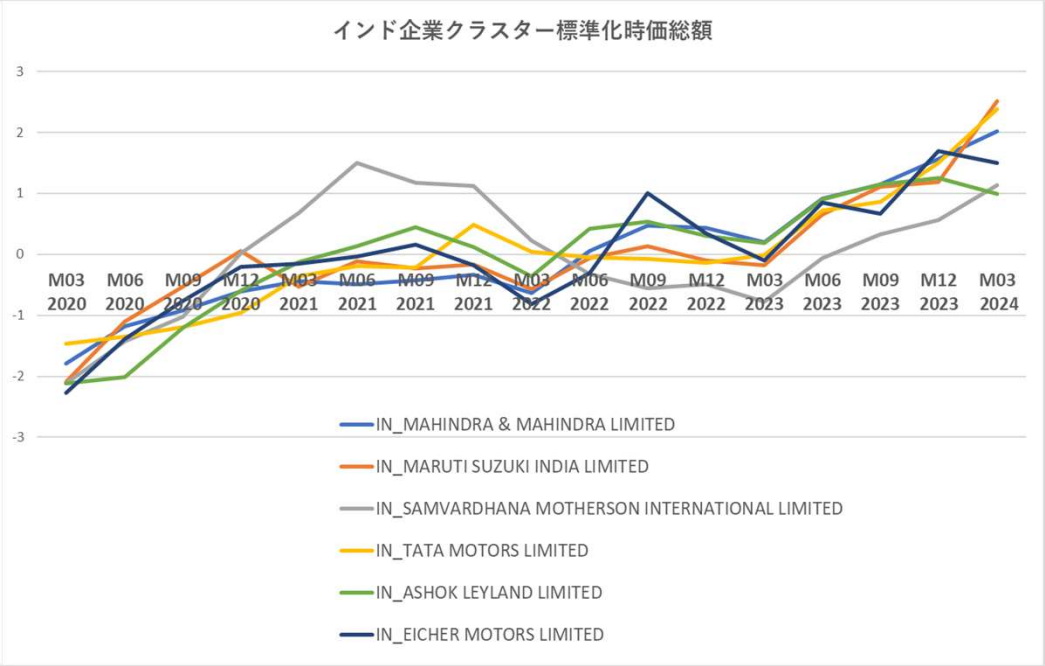


Indian 6 Automakers M.C. Movement after COVID-19: Whole trend is “rapid growth”

Raw Market Capital Movement



Standardized movement



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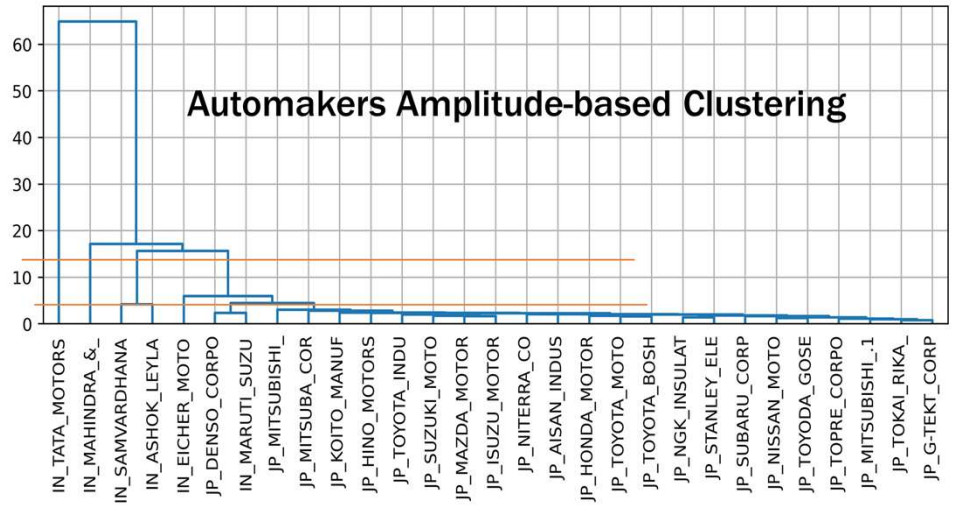
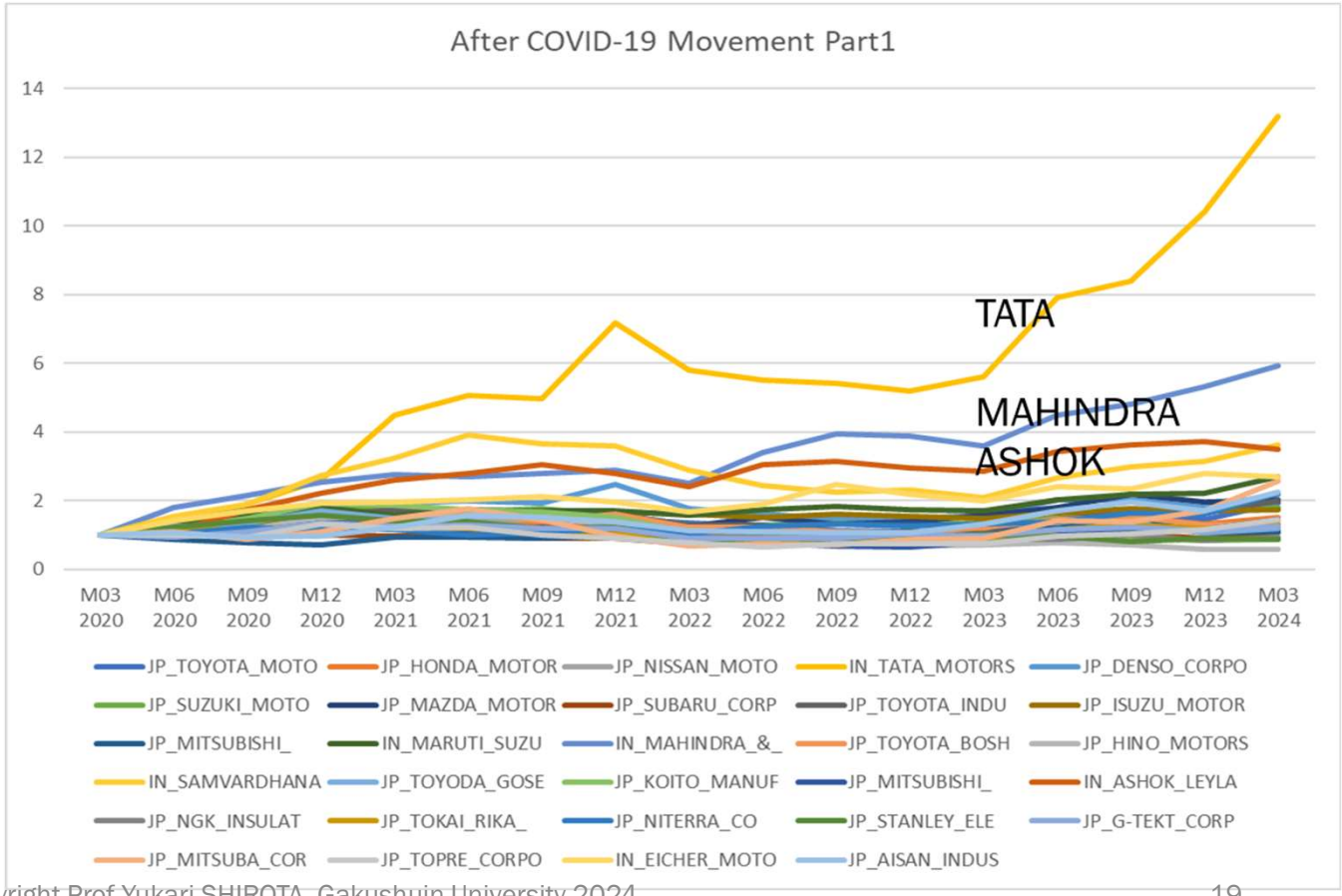


Amplitude-based clustering
Similar movement patterns

- Amplitude
- Indexed by ’20 March as 1
- Tata→ Mahindra→ Ashok
- Maruti Suzuki is low



Amplitude-based clustering Algorithm (1) Hierarchical clustering

Euclidean distance between i, j

- $ED_{i,j} = \sqrt{\sum_{k=1}^{T}\left(G_{i,k} - G_{j,k}\right)^2}$

$G_{j,k}$ is the index data of j-th company on k-th day.

T is the number of days.

Euclidean distance of distance

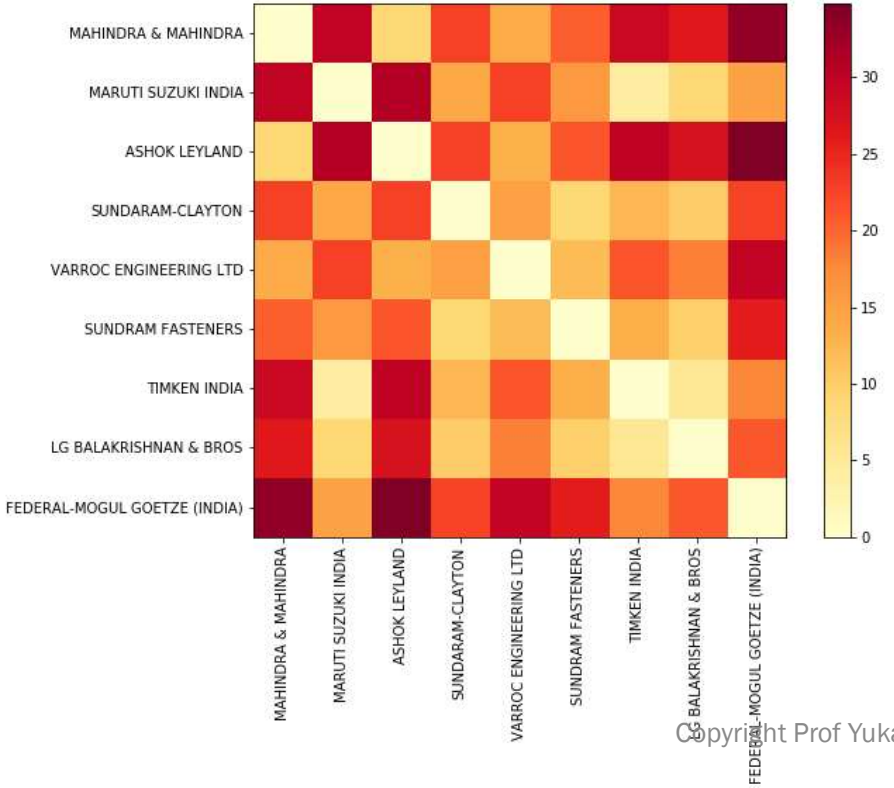
- $\widetilde{ED}_{i,j} = \sqrt{\sum_{n=1}^{N}\left(ED_{n,i} - ED_{n,j}\right)^2}$

N is the number of companies.

Q: How about just using Euclidean distances ?
A: Cannot obtain the good result.
Distance of distance includes the whole company data

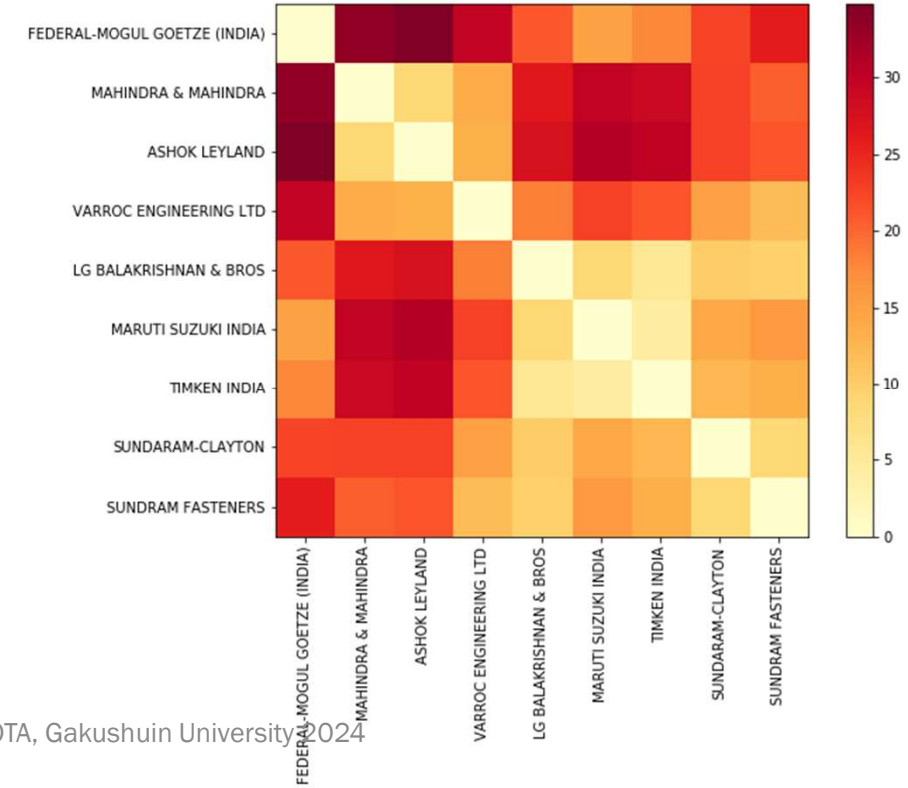
Amplitude-based clustering Algorithm (2) Serialization (Quasi-Diagonalization)

BEFORE



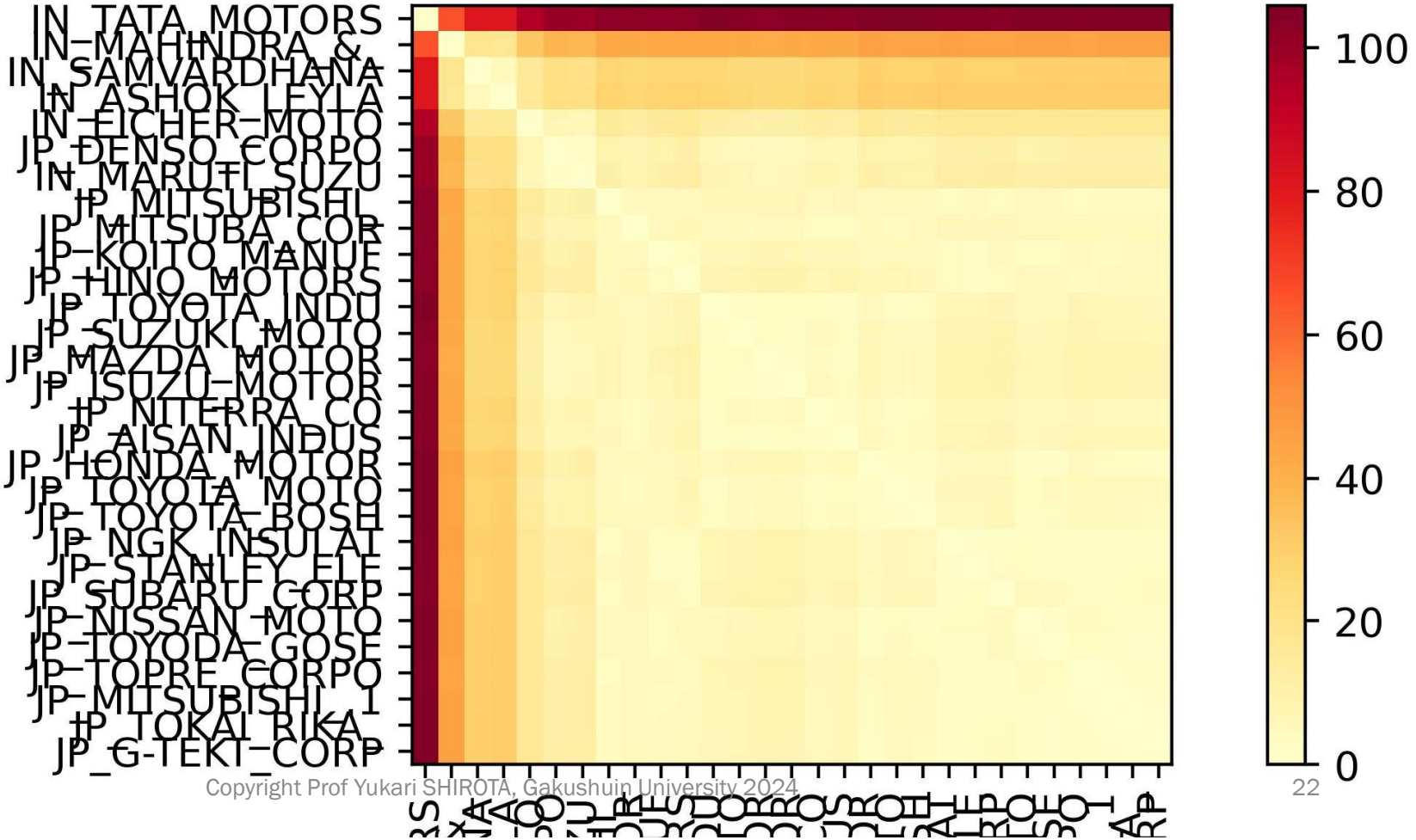
AFTER

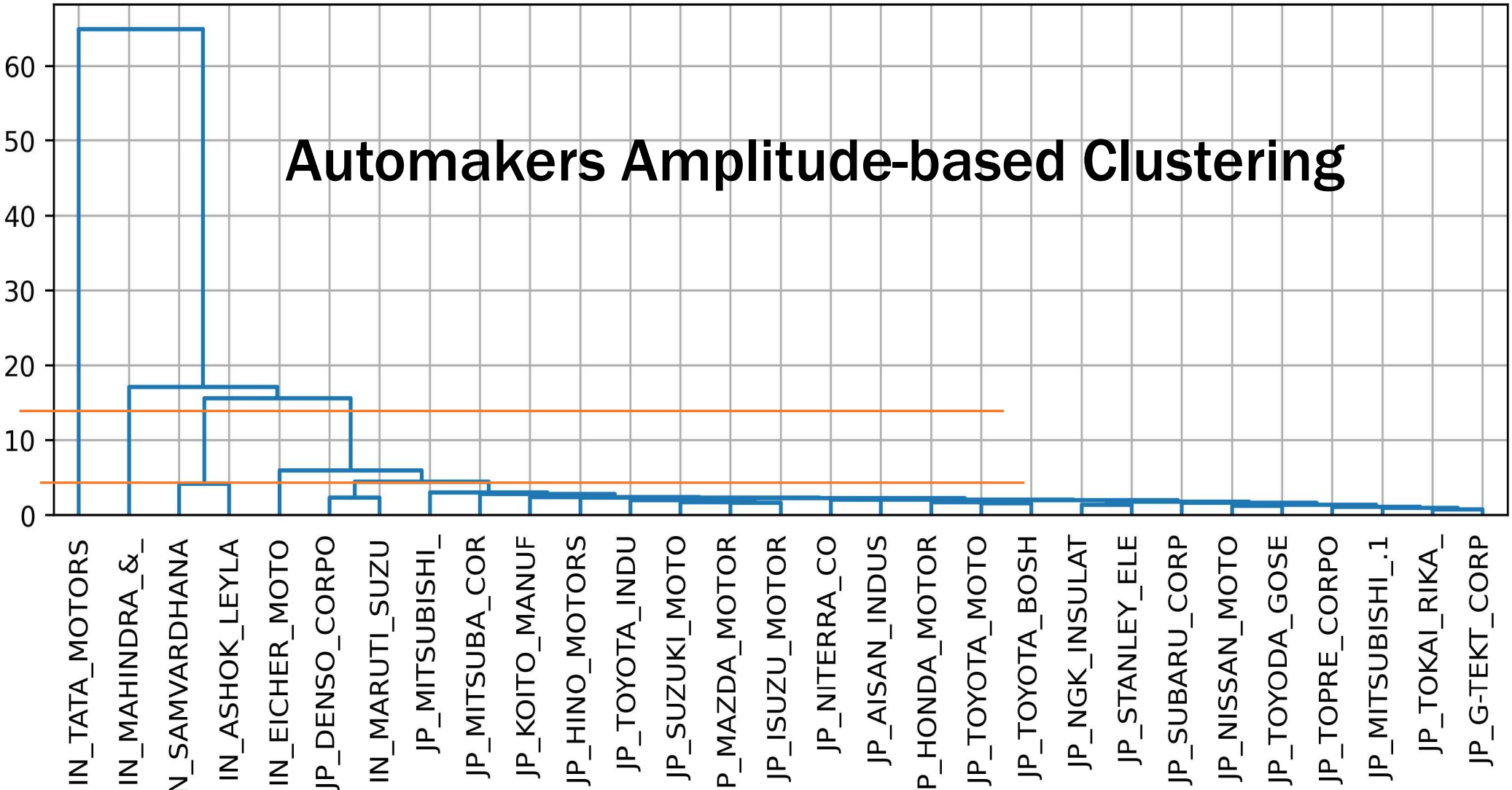
Change the company order for diagonalization

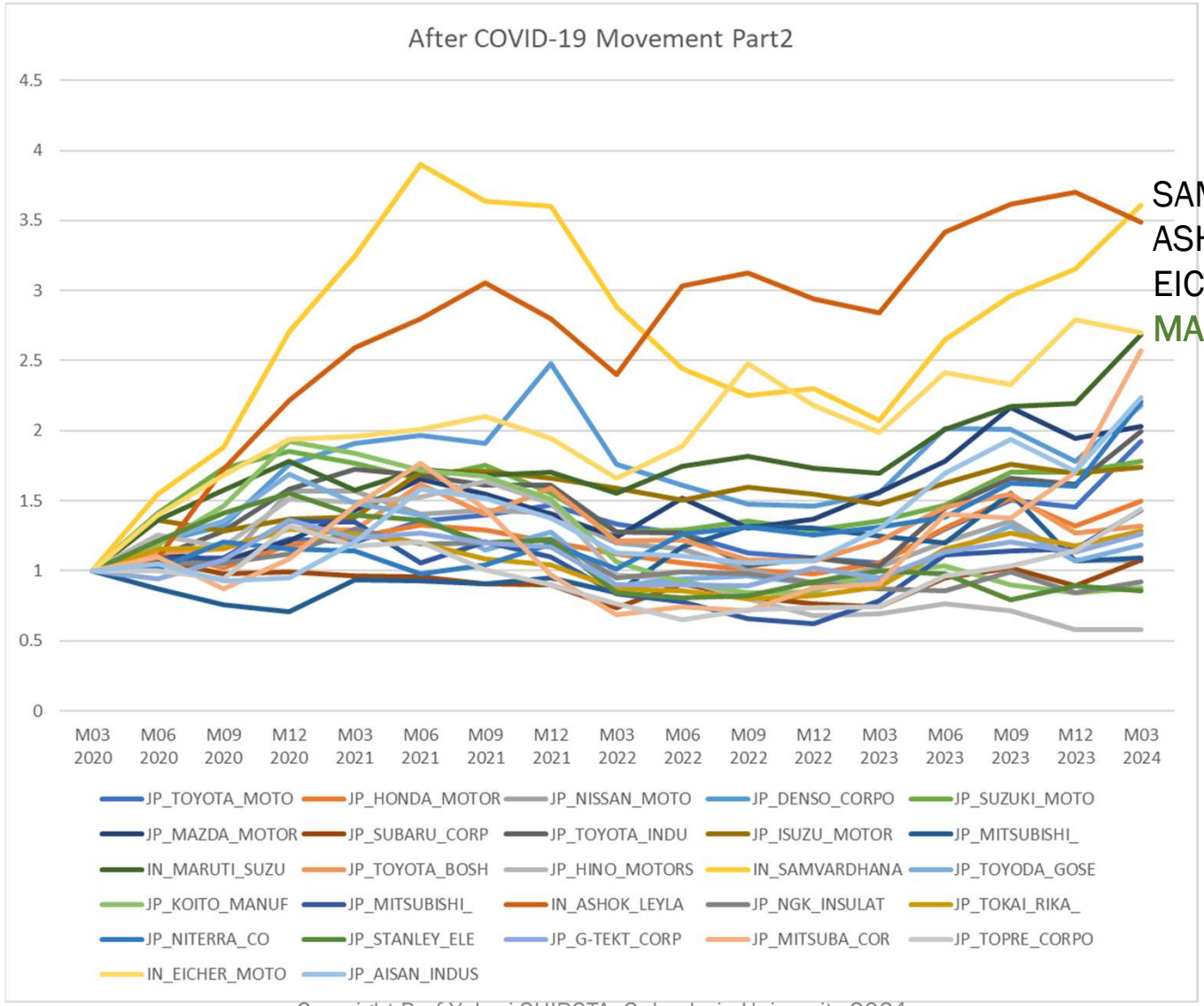


Automakers Amplitude-based Clustering

- Distance of distance matrix



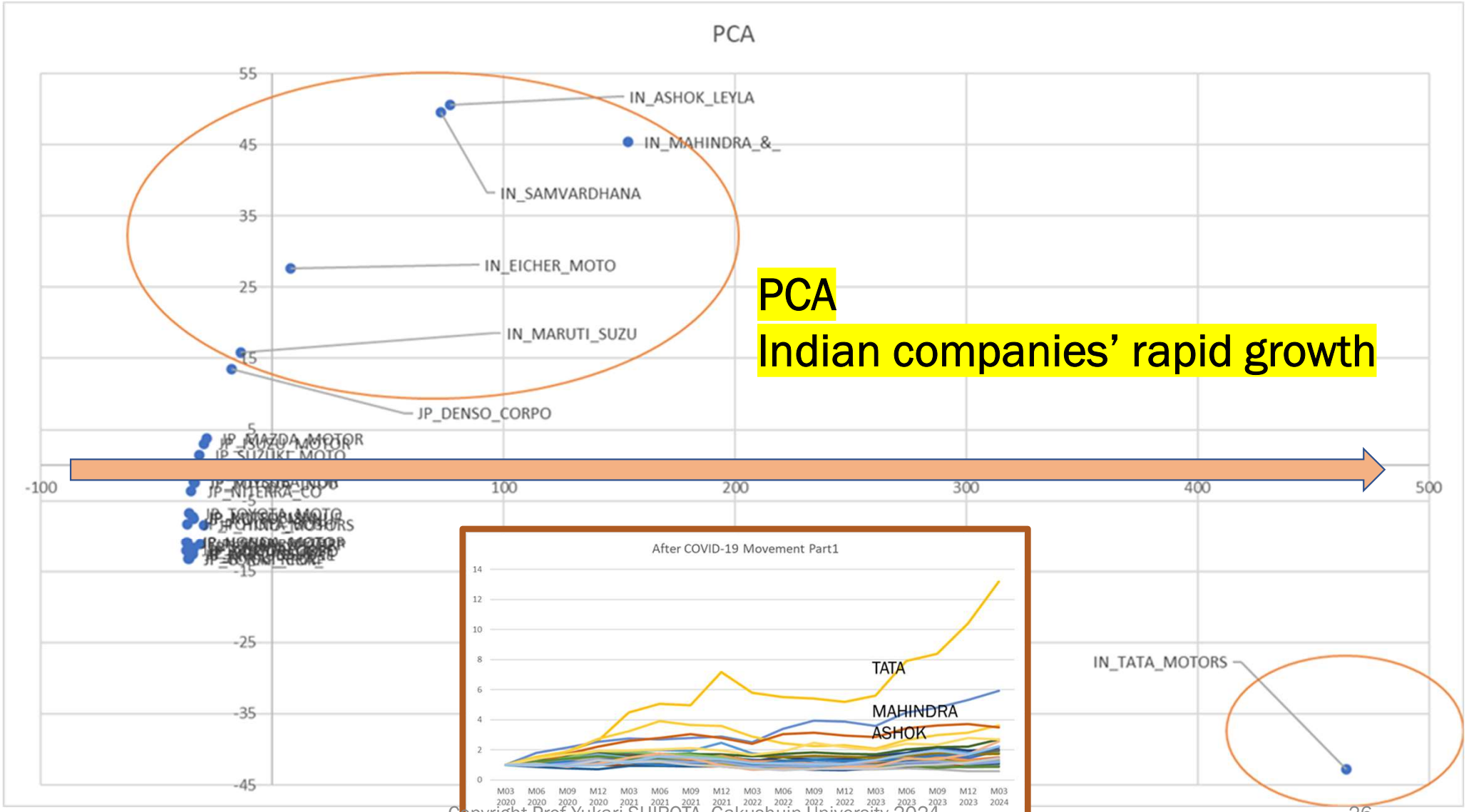




SAMVARDHANA
ASHOK
EICHER
MARUTI SUZUKI

次元圧縮により主成分軸を求める

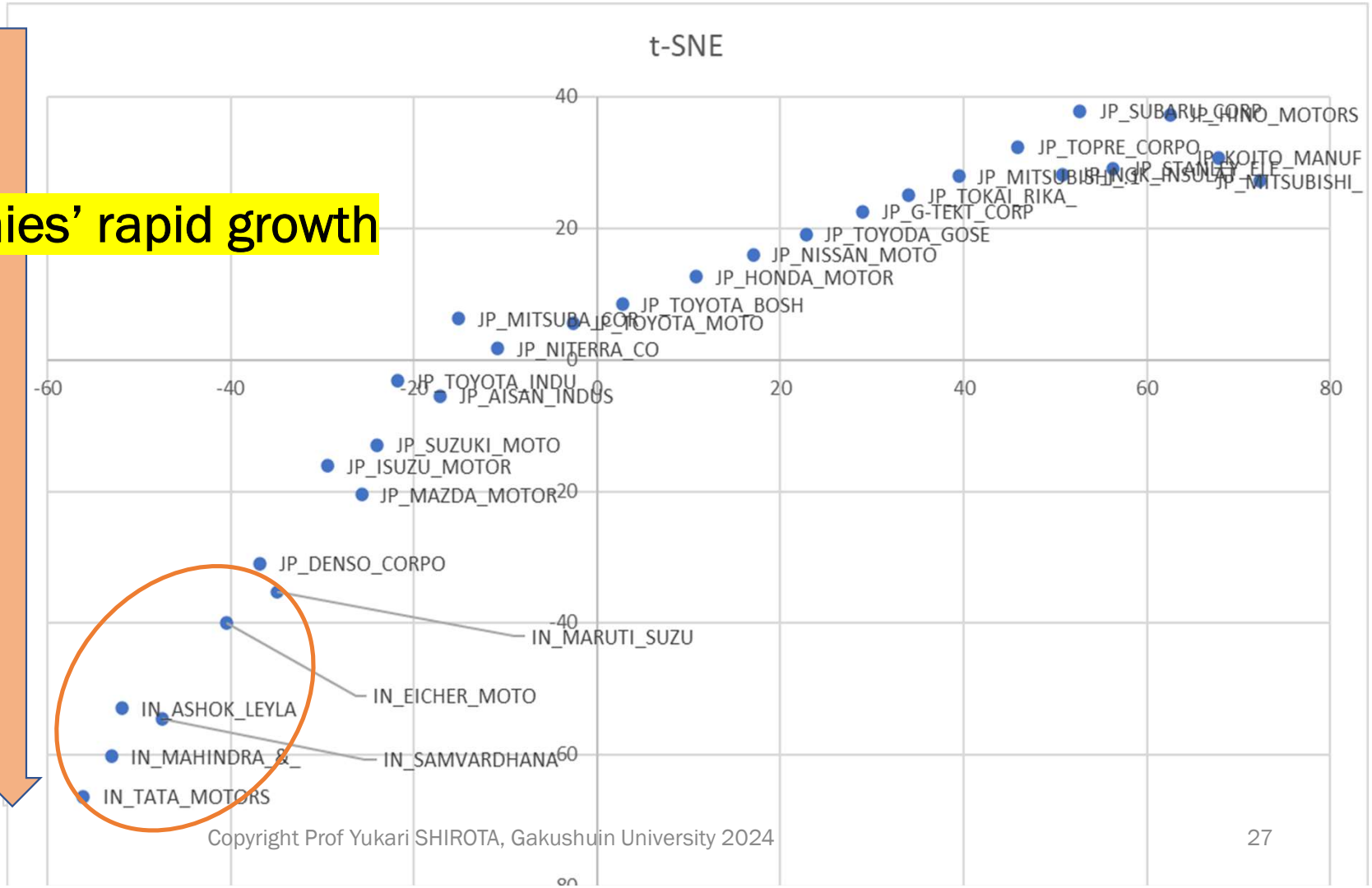
- 距離行列に次元圧縮を行うことで、主成分軸を求める
  - PCA
  - SVD
  - t-SNE
  - UMAP



t-SNE perplexity=4

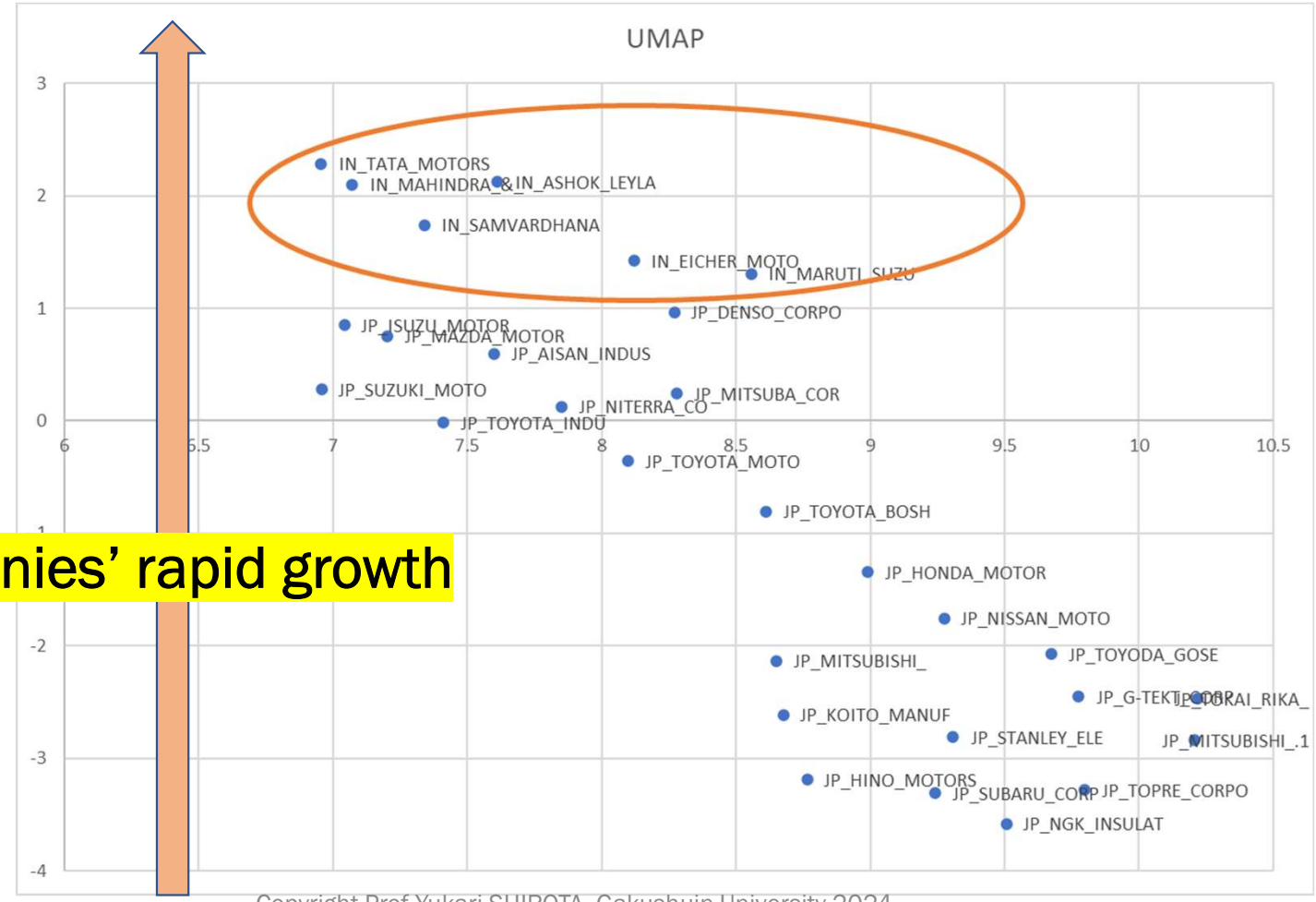
Indian companies' rapid growth

- Indians' rapid growth



UMAP

- Indians' rapid growth



Indian companies' rapid growth

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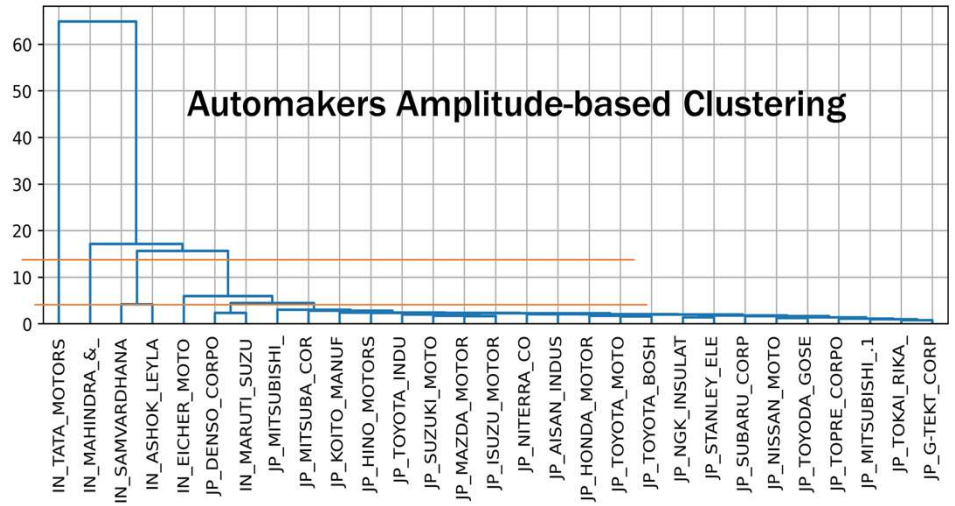
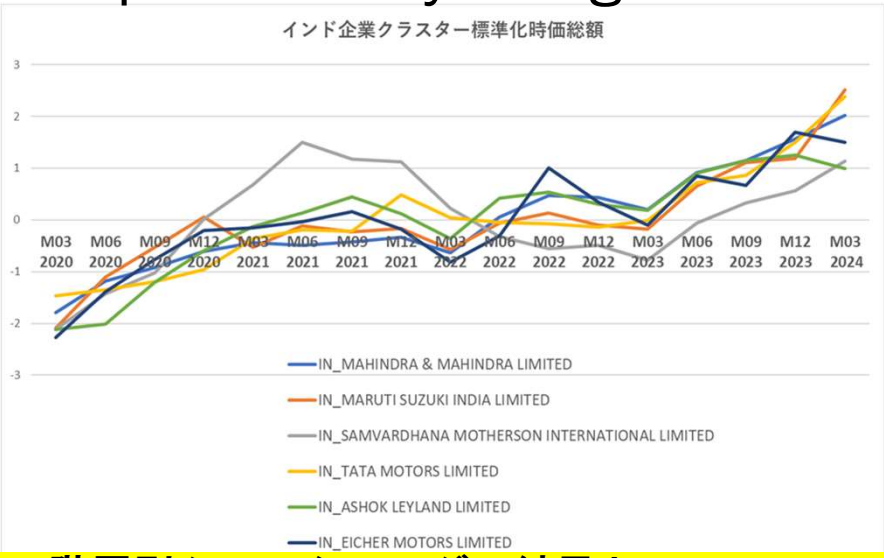


Evaluation

Standardization of the data

HRP

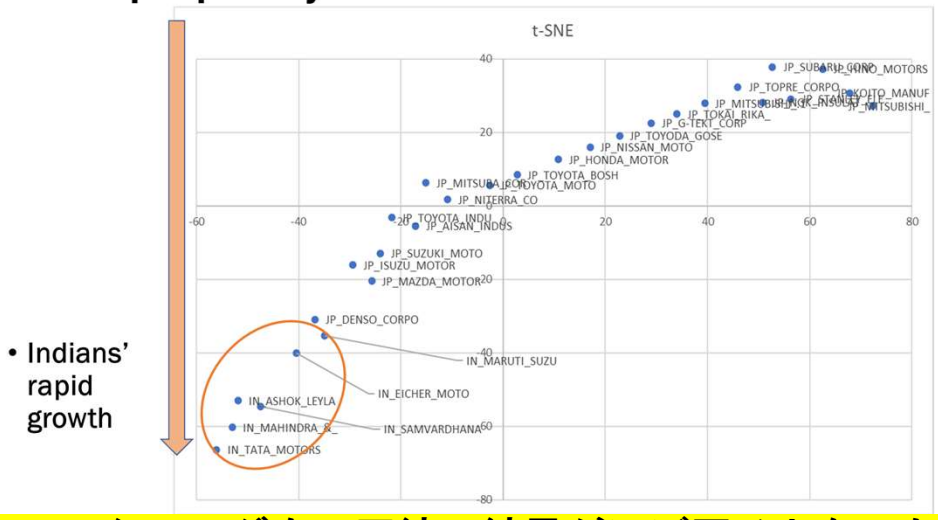
- India’s 5 companies show a rapid recovery and growth.



Amplitude-based clustering

Non-Standardized data used

t-SNE perplexity=4



HRP階層型クラスタリングの結果と、Amplitude-basedクラスタリング次元圧縮の結果がほぼ同じとなった

Evaluation

- After COVID-19, India's 5 companies show a rapid recovery and growth.
- The growth pattern has similarities, compared to that of Japan's companies.

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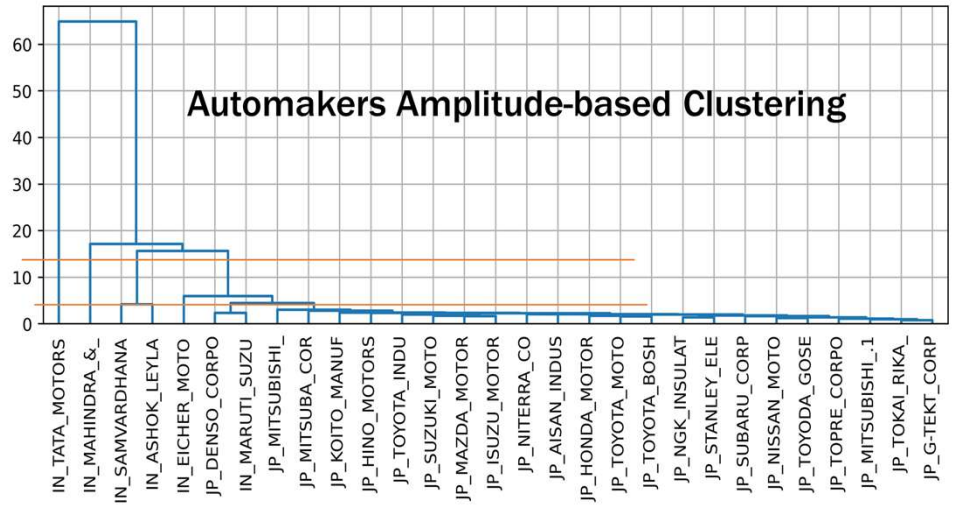

Conclusions

- Indian automakers' market capital movement analysis
- 6 Indian and 23 Japanese automakers
- Period: 2020 March to 2024 March
- Clustering result clarified the rapid growth of Indian companies compared to that of Japan's companies
- The driving force of Indian companies are Population bonus, GDP growth, increase in purchasing power and Indian government's manufacturing promotion policy