

# A CURIOUS CASE OF A CAR'S COE: ANALYSING THE DEMAND PATTERNS OF PRIVATE AND PUBLIC TRANSPORT IN RELATION TO COE PRICES

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**Abstract** - The government has been making a conscientious effort to promote the utilization of the public transport and dissuade the public from driving. Apart from improving the transport network, deterrent measures such as the Certificate of Entitlement (COE), high carpark rates, multi-layered vehicles taxes and Electronic Road Pricing have been implemented.

While the COE has become a natural phase in the purchase of cars in Singapore, its rising prices are increasingly taking out a larger proportion of a car buyer's income. With the recent news on the zero-growth quota on the quantity of cars released for bidding, it has become even more pertinent to assess how this will change the future landscape of vehicle ownership and transportation.

**Index Terms** — COE, transportation, MRT, price sensitivity

## I. Introduction

Ranking 178<sup>th</sup> out of 196 countries at 697 sq. kilometres, Singapore is truly small in land size, despite our land reclamation projects. *“To effectively manage the use of our limited road space, we have implemented the Vehicle Quota System and vehicle ownership taxes.”* The Land Transport Authority (LTA) succinctly explains the purpose of COEs, the main intention is to limit the number of cars on the road, as traffic congestions in a tiny Singapore is detrimental to the economy and productivity levels. Hence, although Singapore also has one of the highest ratios of vehicles per kilometre of road at 281, we are not plagued constantly by traffic congestions faced by neighbouring countries. Our unique combination of incentives and constraints that controls the car population coupled with taxes and fees has helped to allow Singapore's traffic to flow relatively easily. But at what cost did the implementation of COE come with? Is it beneficial to everyone? With this deterrence from cars, is our public transport sufficient? This project was carried out with the intention of giving better insights into how COE affects the demand

patterns of private vehicles. It covers areas such as which brands control the lion's share of the market and provides analysis on these patterns for predictive use in the future. In addition, given the significant amount of revenue which COE premiums and transport-related taxes are providing for the Ministry of Transport, further analysis will be done to determine how much and how efficiently is the revenue being used to improve the transport system.

## II. Exposition

### A. Motivation

The push for more quantifiable analysis in Singapore have made current resources data-rich but information poor. Presently, there are many sources of fragmented datasets on the vehicle population. There is a need for policy makers, industry professionals and the everyday Singaporean to be able to easily access understand the transport landscape before they make informed decisions on policies or drive for change. To be able to do so, they need to be able to access the data from a central location and have the numbers

tell a story in a way which they can easily understand and analyse.

By piecing the parts together, we hope to give a more complete picture of COE and the car markets, ultimately helping our audiences make more informed decisions.

Our country has been and will continue to feel the heat of a growing population coupled with a stunted car population growth rate. The increasing COE prices will not solve the problem. This research paper will discover, explore and discuss the current transport landscape in the country before proposing our suggestions to meet Singaporeans' needs better.

## **B. Objectives and Contributions**

The visualisations the team used were chosen to provide an understanding of car buyers' sensitivity to COE prices based on the brand of the car and market share of these brands over time. After understanding the biology of our car market, we can move on to understanding Singapore's transport expenditure as a proportion of transport tax revenue. Finally, we will cover the relationship between COE prices and public transport ridership.

We mapped several of the time-series visualisations to the timeline of events. The following is a summary of the contributions derived from our project:

- High-end and low-end car brands purchased have different sensitivities to COE prices
- Incomes and the COE price can affect the market share of car brands to a significant amount.
- The expenditure of the government on transport usually falls short of the transport tax revenue it receives.
- COE prices do not seem to directly correlate with public transport ridership, however ridership is very

sensitive to newcomers such as new train lines or ride-hailing companies.

## **C. Paper Outline**

The rest of the paper is organized as follows. Section III describes the data cleaning and software techniques used. Section IV describes the visualisations, discoveries and our analysis. The final conclusions will be made in Section V.

### **III. Data and Software Techniques**

#### **A. Data Preparation**

The project's main source of data came from the Census and Economic Information Centre's (CEIC) database. A smattering of information was also sourced from the Land Transport Authority's (LTA) *DataMall*, the Inland Revenue Authority of Singapore (IRAS) and the government's data repository – *Data.gov.sg*.

**Cleaning & Consolidation:** Results of COE bidding exercise data (Apr 2002 – Present) was consolidated to focus on Cat A, B and E. Furthermore, stacking, concatenation and further calculations (average COE price) was carried out. 1126 rows of data remained which was inner joined with Car Make dataset by date. Car Make dataset also had region manually added. Public transport ridership data was trickier to handle due to disjointed data sets and missing data (SBS/SMRT stopped making the data public), certain figures had to be interpolated for one of the years.

#### **B. The Application**

Data-Driven Document (D3.js) was used to build our visual application as it had the flexibility in visual features. D3.js is a JavaScript library for manipulating documents based on data. The open-source library also provided inspirations to our visualisations. As it served the purpose of the visual we needed (to show a lack of

correlation), one visualisation was created with Tableau.

#### IV. Data Visualisation

The visualisations were used by the team were; a time-series scatterplot, treemap, parallel coordinate charts, an area filled line chart and a trellis plot.

##### A. Ride and Prejudice

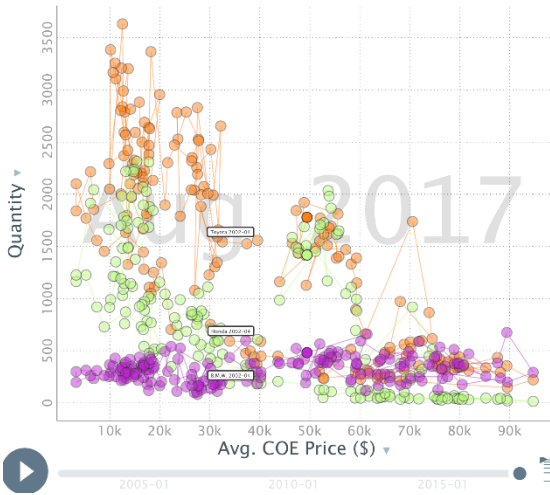


Fig 1: Scatterplot of demand quantity to COE prices of Toyota (orange), Honda (green) and BMW (purple)

The x-axis represents average COE prices (Cat A, B and E divided by 3) and the y-axis represents quantity. Apart from playing the visualization will show the different car brand quantities changing over time, users can also filter for specific car brands.

##### Results and Analysis

The demand for lower end car brands are negatively correlated with COE prices, while higher end car brand quantity is price inelastic.

As COE price increases the proportion of higher end car brands in the market will increase. From this understanding we can further see that the COE bidding system is prejudiced against the lower income bracket in Singapore as higher-income buyers will always be able to afford cars (and buy expensive car brands) while the lower income car buyers are subject to affordability and not necessity of the car.

##### B. The Strange Case of Dr. Japan and Mr. Germany

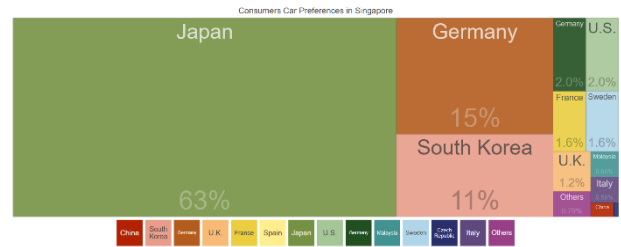


Fig 2: A treemap of the market share of cars by country over time

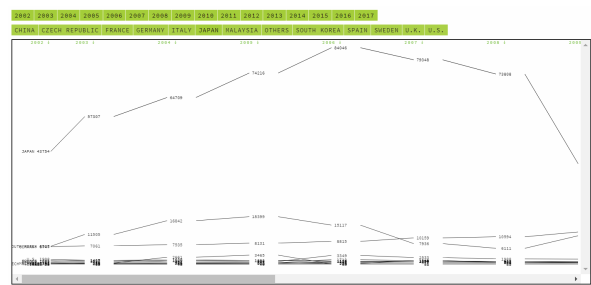


Fig 3.1: Slope graph showing the change in market share of cars by countries over the entire period of 2002-2017.



Fig 3.2: Slope graph showing the Top 10 changes in market share of cars by car brands over the entire period of 2002-2017.

The treemap can be played to show the changes over time, and can also be individually selected to show the brand distribution within the country.

##### Results and Analysis

We found that Japan, specifically Toyota and Honda held the market share from 2002-2009. However, from then till 2013, Japan lost briefly to Germany. In 2014 Japan regained its top position and is holding on to it presently.

Based on our analysis of this pattern, we propose that two reasons contributed to the Germany peak.

First, the global financial crisis in 2008 affected the lower income bracket more severely through wage cuts or unemployment. Being more sensitive to prices (as seen from the first visualisation), purchases of lower end private vehicles fell. Secondly, as COE prices reached its historical highs in 2013, buyers also found that it was more rational to buy higher-end German cars since they were already paying so much for the COE, resulting in a larger market share.

### C. Lès Miserables Budget

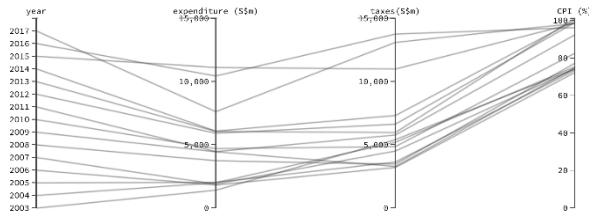


Fig 4: A parallel coordinate chart showing the amount of transport tax collected and the expenditure on transport

Users can select specific years to highlight their paths.

#### Results and Analysis

We found that for most years, expenditure was lower than taxes collected with the downward slopes. The only significant exception was 2006 where expenditure was equal to the amount collected.

Our project advisor gave some insights into this and we propose that this was the result of the election of Prime Minister Lee Hsien Loon into office in 2004. The 2006 expenditure could be the results of increased expenditure into improving transport infrastructure. This lead us to go deeper into our research and question – does the COE system do its job on keeping commuters off the roads? If not, should we be paying so much for the certificate?

### D. A Tale of Two Transports

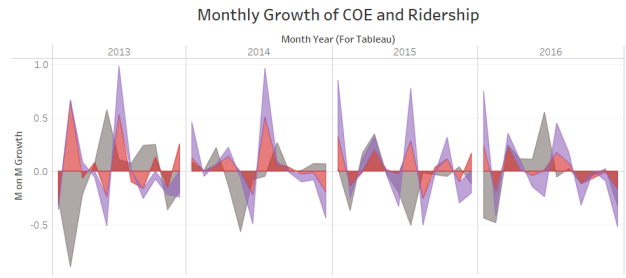


Fig 5: Area-filled line graph showing the correlation between COE price changes and public transport ridership with bus (in purple) and train (red).

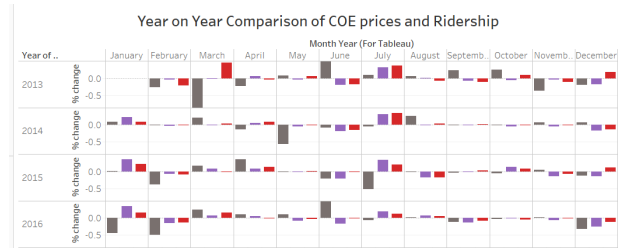


Fig 6: A trellis plot for monthly comparison between years

The values plotted on the graphs were month-on-month growth of COE prices, bus and train ridership. The vizes can be filtered to show only bus or train ridership changes against COE price changes. Filters can also be applied to show different bidding rounds and categories.

#### Results and Analysis

From the first visualisation, we see that there is no discernible correlation between COE prices and ridership. If there were a correlation, when COE prices rose, ridership in public transports should have increased. This indicates that in the short term, perhaps the COE system does not affect ridership.

The second visual answers the natural corresponding question – if not the price of private transport then what affects public transport ridership? A rearrangement of the visual showed a year on year comparison, so that individual months could be compared. Based on our analysis, large scale events such as the opening of new MRT lines, the entrance of UBER and Grab and various other transport related events affected public transport ridership significantly.

## V. Conclusion

Based on the results of the four visualisations, we were able to gain several insights into the effects of the COE on demand patterns in cars and Singapore's transport system:

1. If COE prices continue rising we will see less low-end cars and more high-end cars on our roads. This system only benefits the rich as they would always be able to afford the high COE prices. Whereas those who really need the cars (elderly, children, medical reason etc.) are deprived of a car if they fall within the lower and middle income bracket. Perhaps a COE system tweaked to become ballot based with a token fee would help to address Singaporeans' needs for effectively.
2. Despite significant taxes channelled to invest in transport infrastructure, Singapore's transport system is struggling to support the amount of people commuting with public transport. More should be channelled to public transport be it new MRT lines or creating new direct routes to the city.

### *Future Work*

There are areas where our data visualisation application can be further improved on. With the proliferation of car-sharing services like UBER and GRAB, further analysis on the effects on private car hire could be analysed. Increased access or transparency regarding public transport related data would have allowed us to provide a more accurate analysis. If we had data sets that were specific to the months instead of yearly, we could address such as car brand population specific to COE bidding round and month. Lastly, a central repository of transport related data would make it easier to obtain data sets.

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