Abstract

Our objective for the group project is how spectrum allocation was affected by the release of smartphones, that is, the release of the **Apple iPhone** which was around **2007**. IPhone was the first smartphone and we can see how the valuation of spectrums were changed by the progression of technology in the smartphone industry.
We used the USA's spectrum allocation from the year 2000-2016 to accurately depict the growth of valuation of spectrum over the years.

Data Visualisation

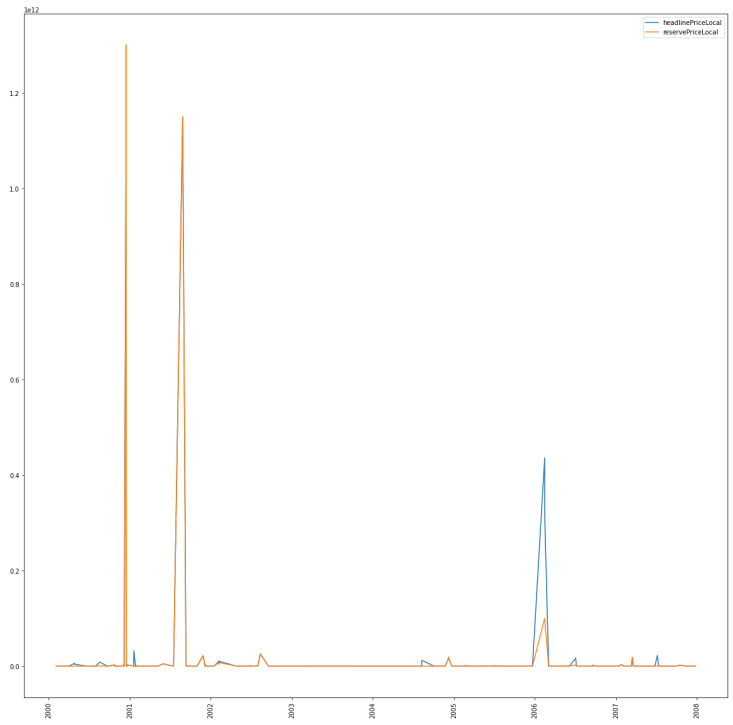

Fig: Winning and reserved bid prices over the years(before smartphone popularity)

Around 2001, 3G spectrum was released, and it can be seen with the yellow coloured spikes (reserve price) of the spectrum. However, we can see that the blue spikes are significantly lower, which implies that the spectrum was sold at a much lower price than expected. The next spike which we see is around 2006 which was a year before the release of the Apple iPhone. The headline price is significantly higher than the reserve price of the auction, which could be hypothesized by the rumours around the release of the Apple iPhone which Apple had started to develop in 2004.

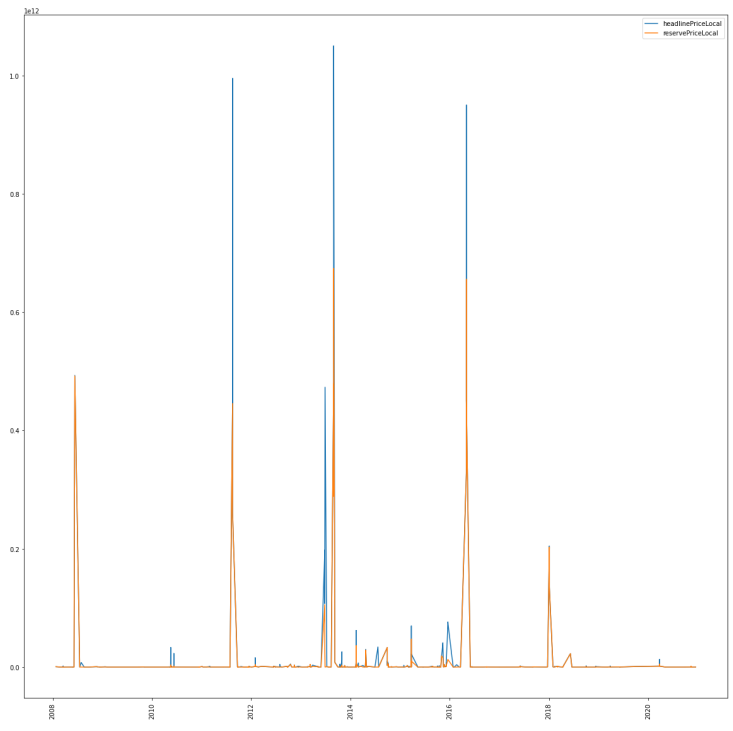

Fig: Winning and reserved bid prices over the years(after smartphone popularity)

In the USA, Verizon released the first ever 4G LTE network in the year 2010, and iPhone 5(first iPhone to support 4G LTE) was released in the year 2013. And we can see that there is a spike in the year just before 2013. It can be hypothesized that whenever there has been a **significant upgrade in the networking technologies**, and there is a popular smartphone which has an **imminent release**, the price of the spectrum will increase drastically.

We also looked upon the frequency bandwidth of the spectrum sold, however, the data we found was so garbled that it could not be shown in any kind of visualisation.

Submitted by: **Group-7** Submission Date: May 17th, 2021.

Regression and hypothesis testing

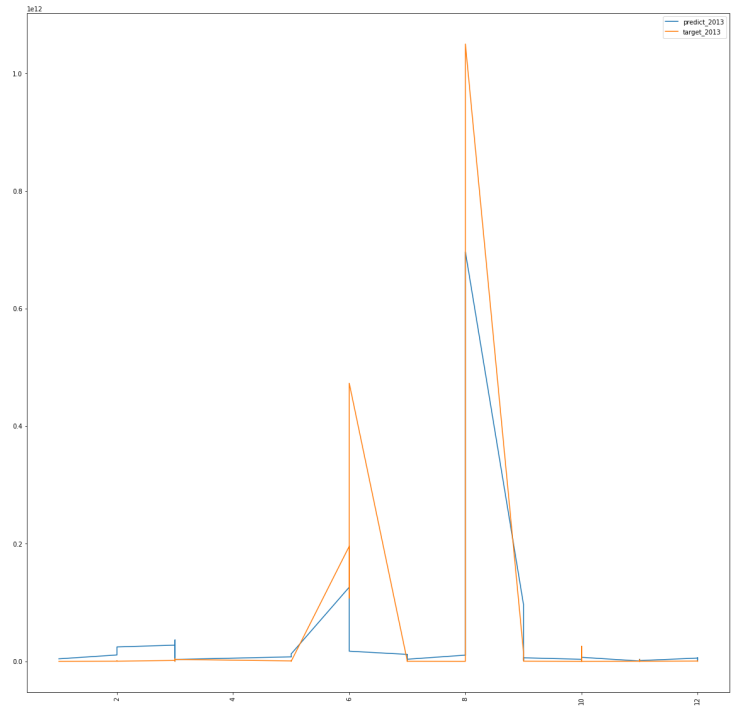

Fig: Predicted and ground truth winning bid price value for the year 2013

In this we implemented a simple Linear Regression model which was trained on the data-set of all spectrum auctions that occurred in the USA from 2008 to 2012 and we predicted the auction headline price winners in 2013 since iPhone 5 (first iPhone to support 4G) was released in the year 2013.

During the training of the model, we also took care of the parameters such as block frequency, amount of spectrum(paired and unpaired), frequency band, previous winners, reserve price, license duration, population covered in that state etc.

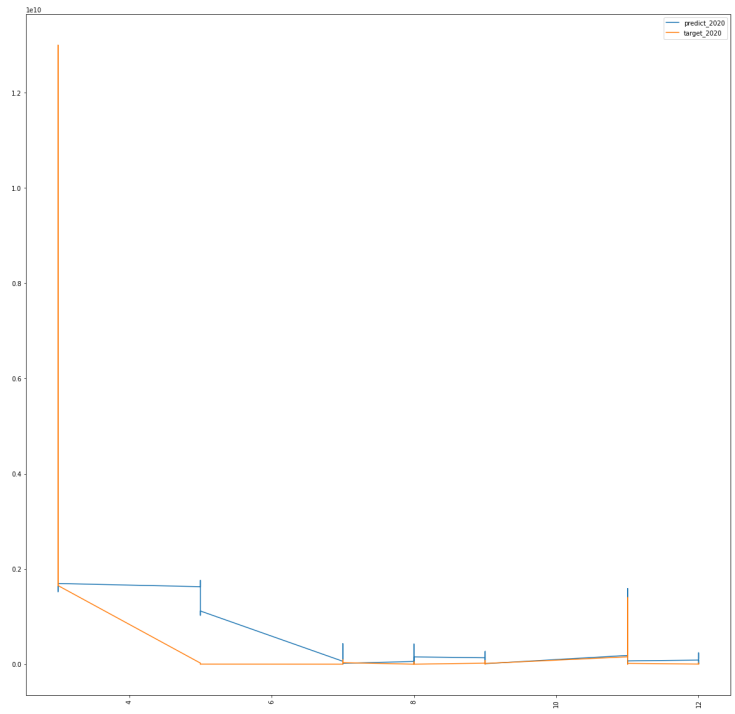

Fig: Predicted and ground truth winning bid price value for the year 2013

We again implemented a linear regression model which was trained on the data-set of all spectrum auctions that occurred in the USA from 20012 to 2019 and we predicted the auction headline price winners in 2021 since iPhone 12 (first iPhone to support 5G) was released in the year 2020.

Inferences drawn and Scope of Improvement

- There is a correlation between increased price spikes in headline price and imminent release of popular smartphones which support the latest technological development. This also is supported by intuition. We also observed that the frequency band allocated and amount of spectrum also changes in accordance.
- One limitation is to exactly predict in which auction would the price spike occur. As of now, we can roughly estimate when a price spike would occur, but the exact date is as of not predicted. The reason can also be attributed to the limitation of data-set, as these price spikes also depend on the rumours around the market at that time as well.
- As scopes of improvement, we can try and improve upon this endeavor, by maybe cleaning the data-set and trying out more complex predicting models as well. Not only that, we can also study for various other regions as well. As of now we only studied spectrum auction in the USA.