BART Rolling Stock ABS Issuance

Executive Summary

MFE 230M

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"You know, it does look like NASA" - Richard Nixon, 1972

1 Background

Since having wowed Richard Nixon in 1972, BART continues to be the most important public transportation system in the Bay Area. Given its significant history and high ridership, maintenance and renewal is required constantly. Recently, BART proposed an expansion plan that will stretch the Fremont line to downtown San Jose. Phase I of this plan resulted in the extension to Warm Springs, the station became fully operational in 2017. Phases II and III are still under construction and are scheduled to be delivered in 2029 to 2033.

In addition, BART also has car replacements scheduled, as a significant chunk of its rolling stock ("cars on the railroad") is becoming obsolete and has reached the end of useful life [1]. By February 2020, BART anticipates having enough new cars to remove the least reliable legacy cars from service. Moreover, BART is targeting to relieve transbay traffic pressure. Currently, BART operates 23 trains per hour in each direction through the Transbay Tube between San Francisco and Oakland during peak hours and it is planning on increasing train frequencies as well as train lengths so that the overall capacity can be increased by approximately 45%.

With scarcity in rolling stock looming on the horizon, BART is in need of 1200 cars total, of which it is contractually bound to buy 775 from Bombardier Transportation. For the remaining 445 cars BART is still looking for a total of $1.566 billion of funding [2].

Traditionally, BART projects are funded with general obligation bonds ("GO bonds") [3]. GO bonds have many shortcomings. For example, the borrower is obligated to make bond payments by any means necessary, it cannot earmark a subset of its revenues for this purpose. Contrast this with revenue bonds, wherein the most common practice is to contractually dedicate a certain portion of revenues to fulfilling payments due. For large scale infrastructure projects that generate their own dedicated and estimable cash flows, issuing revenue bonds remains a common go-to. Additionally, GO bonds in cases where the community is sufficiently and significantly enmeshed are issued after a community vote, a cumbersome and lengthy process. Revenue bonds are different however, the approval by the board of the issuing authority is enough. Most of BART's current obligations are met with GO bonds (though there are revenue bonds issued on the sales tax chunk of their revenues).

The most recent of the issues was the Measure RR bond (a 3.5 billion USD bond issue that will take place over several years [4]) which was marginally approved (70% community vote [5]) by the community to shore up maintenance efforts all across the aging system. BART authorities promised that they would not use the funds raised to meet operational costs, of which labor is by far the biggest portion. BART has reneged on this promise however, and has been eating up previous debt service allocations to fund labor costs and this has led to discussions of voter deceit [6].

BART finds itself in a position where issuing GO bonds is not really a feasible option, given the above discussion. The proposal that follows suggests an alternative funding opportunity for BART's rolling stock expansion plans. The idea is for BART to issue an Asset-Backed-Security (ABS) backed by lease payments for rolling stock purchases. A Special Purpose Entity will be setup which does all the purchasing of the rolling stock. The initial funding is obtained through the issuance of revenue bonds by the SPV. Rolling stock purchased is then leased out to BART, which is obligated to pay amortised lease payments to this entity. Lease payments are driven solely from a determined share of projected ridership revenues, this is discussed more in the 'Security Design' section that follows.

2 Security Design

2.1 Assumptions

In order to simplify the design the of the security, a number of assumptions are made. First, it is assumed that the 445 cars are purchased now instead of in series in the future (immediate purchase at t = 0). This makes calculating lease payments easier, and can easily be extended to a case where the SPV purchases rolling stock on an ongoing basis. Second, because lease payments are driven by ridership revenue, forecasts for fare and ridership patterns are required. It is assumed that new stations opened will follow trends similar to those seen in historical data, because the model is built from this. Third, BART's expansion plans are assumed to be as per their declared short-term capital improvement program. Essentially this means that projections for stock requirements and assumptions for ridership have a basis in BART's announced plans. The assumption is that there are no significant deviations from this setup. The final and most essential assumption is that BART is prohibited from using a significant proportion of its ridership revenue to fund labour costs. Contractually it is obligated to meet non-labour operational costs only first from ridership revenue, and hand whatever is remaining to the issued tranches. Analysis of historical data suggests that 40% of ridership revenue is sufficient to fund non-labour expenses in each month, which leaves the remaining 60% free to be distributed to the tranches. There are two reasons why this assumption makes sense, first, based on BART's own estimates of revenues projected over the duration of the issue period there is enough to fund labor from other revenue sources like financial aid and taxes, and second, to generate legitimate demand for issued tranche bonds, it is felt that this restriction needs to be built into the contract given the fact that BART reneged on its promise to not fund labor costs from the Measure RR issue.

2.2 Design Details

With all the assumptions laid out, the design for the ABS is as follows:

Tranches	A1	A2	M1	M2	M3	R
Principal ($M)	313,200	313,200	313,200	313,200	313,200	0
Coupon Rate (%)	2.7	2.8	3.0	3.2	3.4	-

Table 1: Principal and coupon rate for issuing bonds.

The principal is equivalent in all tranches with a total capital issue of $1.566 billion, which is the amount of funding needed by BART. Issuance is at par and the coupon rates are

determined as a base rate of 2.65% plus a spread. Spreads depend on the seniority of tranches - junior tranches have higher spreads to compensate for the higher risk. Weighted average coupon rate comes out to be around 3%, which is approximately the same yield as on existing AA corporate bond issues (akin to ratings on prior issues by BART.)
Since lease payments are driven by fare revenue, fare revenue is estimated by using the fact that revenue = average fare · ridership. The main task here then is to forecast these 2 variables in the next 15 years which is the bond maturity period as well as the period of requirement for the rolling stock here.

3 Forecast

3.1 Ridership

For ridership, historical data [7] was used from the stations currently operational. In order to catch the trend and seasonality accurately, data from newly opened stations was excluded and it was assumed that they will preserve the same pattern. Figure 1 shows a short-term downward trend and a clear seasonal pattern for old stations.

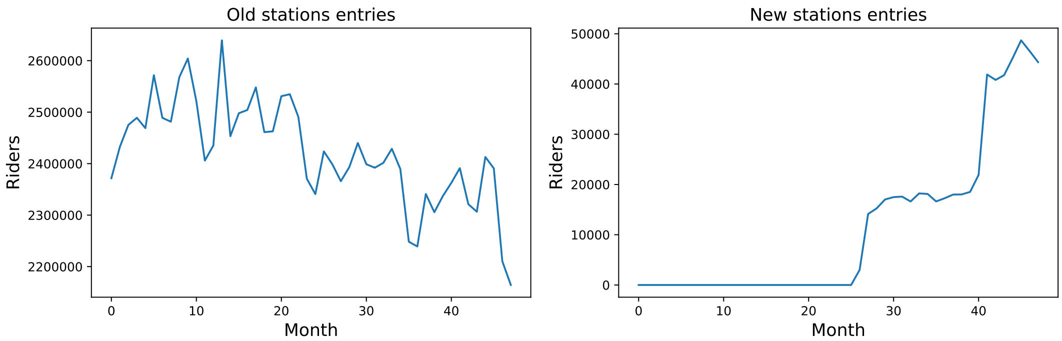

Figure 1: Riders entering old and new stations

It was decided to model ridership difference of old entries, therefore the model is over a de-trended series. To this difference it was fitted a SARIMA(p=2, d=0, q=0; P=1, D=1, Q=0), i.e. an additional seasonal 12 month difference in the SARIMA model was taken and other AR components were included both in the regular and seasonal lag. With such a model, seasonality and all the significant autocorrelated terms were captured. Figure 2 shows that the residual has no significant autocorrelation and the QQ plot and the histogram in the same figure shows that a normal distribution is a reasonable assumption.

The outcome is a downward trend, which is in the opposite direction as the prediction given on the official BART website. The downward trend is plausible in the short term, as BART has shown decreasing ridership over the past few years. However, with the expansion plan, ridership is expected to increase sometime in the long term. Hence, the 2 models were combined by placing a weight on the official ridership prediction that is lower for recent years and higher in the further future.

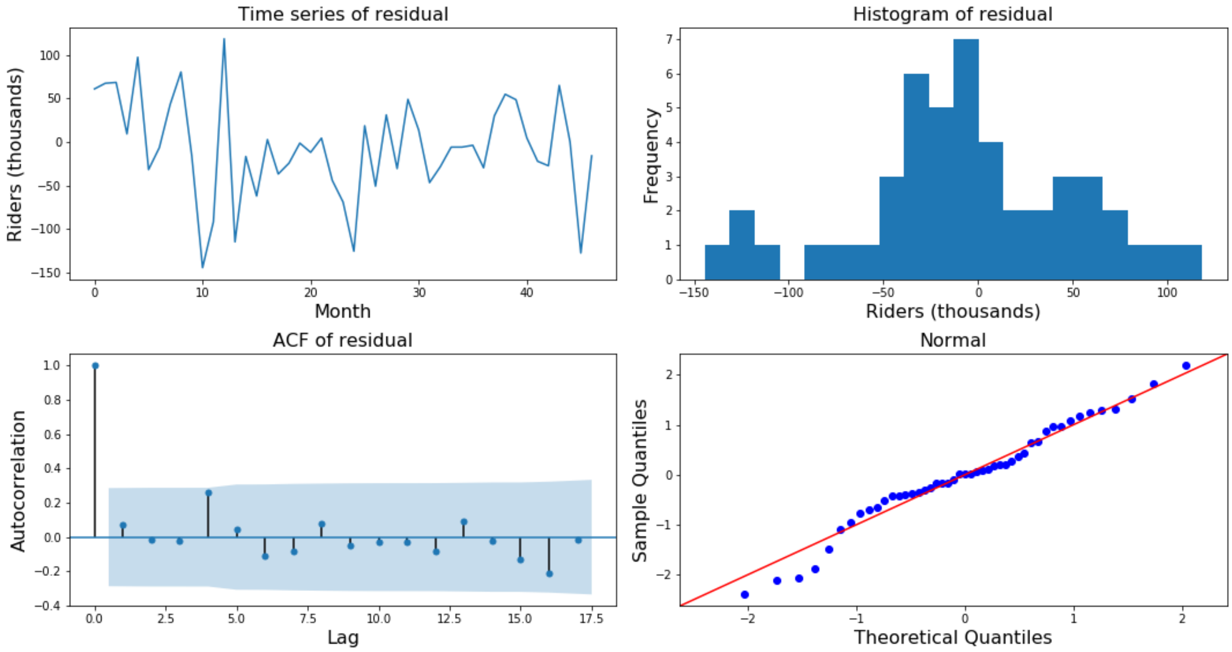

Figure 2: Residual outputs

This final result shows decline in the recent future that eventually starts to increase as it can be seen from the orange line in Figure 3. For years after 2028, the forecast remains constant since there is no clear long-term trend for the time series. This final prediction is the expected value. The SARIMA model naturally allows to model this as a stochastic process. Random normal innovations are drawn on top of the expected prediction of the SARIMA model for the difference. This gives the behaviour of a random walk with expected path equal to the forecast. Figure 3 shows two simulated paths for the ridership.

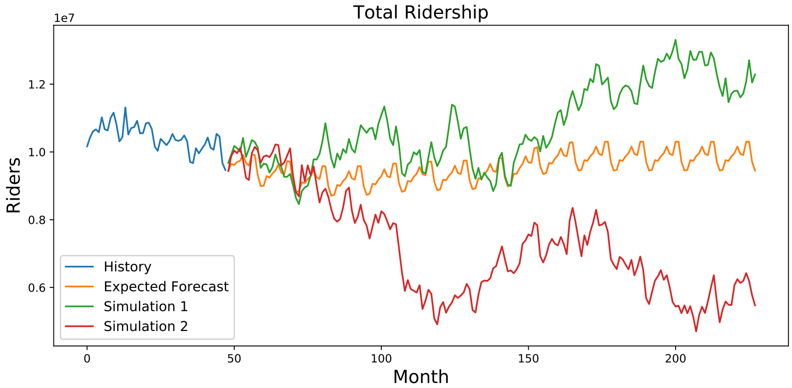

Figure 3: Expected forecast and sample simulations

3.2 Fares

Fare data from 2008 and onward is then used to forecast ridership revenues. Data available includes current fare data for every pair of stations ([2], page 16) as well as the average daily number of travellers between each pair of stations on a monthly basis [7]. From that information, and from average fare increase over time (available from 2016), past fares are inferred. Putting all this information together, several metrics were obtained - average fare over time, average revenue from short and long rides, and proportion of short rides. Any ride that costs $4 (with discounting applied for earlier years where rides were less expensive) or less in 2018 is classified a “short ride”. Note that this empirical threshold can potentially be moved around, notably to estimate the impact of the opening of new stations on further ends of the line, like Antioch or Warm Springs recently.

When looking at average fare paid by customers, as expected, due to the underlying fare prices increase, the trend is upwards sloping. A strong seasonal component is also observed, and an odd/even year difference as well which will be useful for the forecast below.
However when looking at revenue from rides over time, this revenue has been stalling for a few years now: average fare increases, but number of customers decreases. This trend starts being true for short rides too. The increasing proportion of short rides does not help at getting more revenues either.

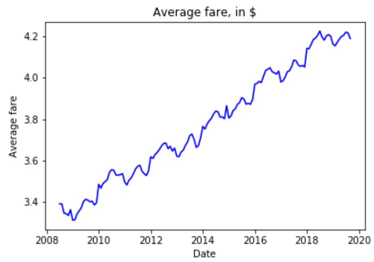

Figure 4: Average fare over time

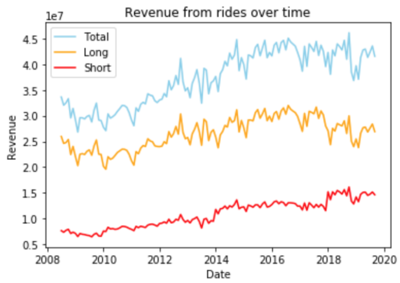

Figure 5: Fares revenues over time

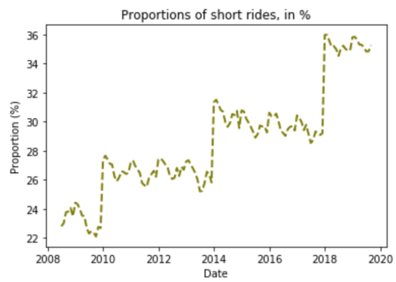

Figure 6: Proportion of short rides over time

In order to model evolution of fares in time, average fare -paid by customers- is considered, which increases on a year to year basis. A clear pattern is visible: a 2-3% increase on even years and a 0-1% increase on odd years. In order to simulate fares increase for the period 2019-2029, a 1000 samples are drawn for each year from the according historical distribution.

4 Results

The results were largely in-line with expectations as input parameters were optimized. The first expected result was that the tranches would be paid off in order of priority, and that the full balance on all tranches would be paid off by the expiration of our product.

Furthermore, the residual between the total principal amount, and the sum of Tranche prices is a negligible -$3.38, therefore issuance of the bonds give exactly the proceeds required to buy the cars.

Tranches	A1	A2	M1	M2	M3
Avg. Price ($)	317,774,516	316,524,017	312,945,757	310,326,329	308,429,385
Std. Dev. ($)	3,124,211	2,524,332	3,262,457	3,368,751	3,785,663
Err. ($)	3,124,211	2,524,332	3,262,457	3,368,751	3,785,663

Table 2: Average Price Summary for Tranches

	Duration	Convexity
A1	1.30	2.17
A2	2.74	8.70
M1	3.47	14.29
M2	3.90	18.54
M3	4.17	21.73

Table 3: Duration and Convexity

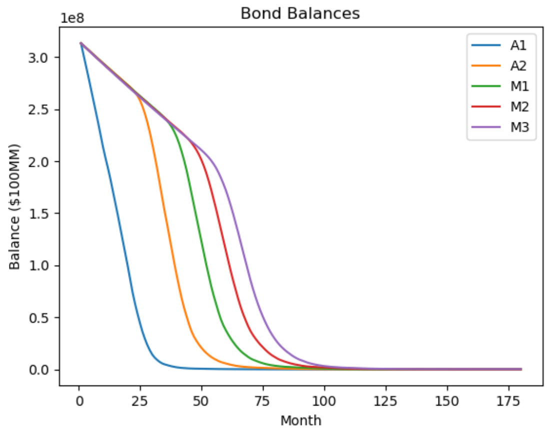

Figure 7: Bond Balances Evolution through Time

$$\begin{aligned}
Residual &= 1,566,000,000 - \sum(\text{Average Prices}) \\
&= 1,566,000,000.00 - 1,566,000,003.38 \\
&= -\$3.38
\end{aligned}$$

5 Conclusion

The proposal detailed above suggests the issuance of an Asset Backed Security (ABS) to fulfil funding needs of BART rolling stock, till the period of 2033. Several key assumptions were laid out, and a model to forecast ridership revenue was described.

There are several pros and cons of a potential ABS issue. Advantages include the ease of issuance due to the fact that there is no community voting needed, unlike general obligation bonds. BART is able to now attract a variety of potential investors, due to the differing characteristics of the issued tranches. The R bond could be used as a hedge against the agency problem that might be associated with such an issue, for instance, opposition from labor unions could be mitigated by offering it as a performance incentive.

The primary disadvantage of such an issue is borne of the duration of forecast. Predicting month-by-month ridership data as above is not insensitive to shocks. This model could potentially be made more robust by breaking down assumptions further, and considering factors such as the demographics of the area, BART management styles, etc. The assumption about contractually ensuring that part of ridership revenues are used to pay debt obligations before labor costs might also find substantial resistance from labor unions. It is felt that it will be key that representation and participation of labor is ensured to allow for smooth issuance of ABS structures such as the one proposed.

References

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