# APPENDIX

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## Section 1: Data on FasTrak utilization and toll booth configuration

**Table 1.1.** Peak Period FasTrak utilization, late 2002 - early 2003.

| Bridge | ETC/FasTrak Dedicated Lane | ETC Mixed Mode Lanes | Total Peak FasTrak Use (% of peak traffic) | All Day FasTrak Use (% of all-day traffic) |
|---|---|---|---|---|
| Antioch Bridge | 17% | 1% | 18% | 17% |
| Bay Bridge Morning | 15% | 11% | 26% | 20% |
| Bay Bridge Evening | 15% | 10% | 25% | 20% |
| Benicia Bridge | 28% | 1% | 29% | 25% |
| Carquinez Bridge | 27% | 1% | 28% | 22% |
| Dumbarton Bridge | 37% | 1% | 38% | 25% |
| Richmond-San Rafael Bridge | 29% | 1% | 21% | 32% |
| San Mateo-Hayward Bridge | 26% | 4% | 30% | 22% |
| **Grand Total** | **22%** | **6%** | **28%** | **23%** |

**Table 1.2.** Toll Booths at Bay Area Toll Bridges as of 2006

| Bridge | Cash/FasTrak Booths | FasTrak-only Booths | Total Toll Booths |
|---|---|---|---|
| Antioch | 2 | 1 | 3 |
| Benicia-Martinez | 8 | 1 | 9 |
| Carquinez | 9 | 3 | 12 |
| Dumbarton | 4 | 2 | 6 |
| Richmond-San Rafael | 6 | 1 | 7 |
| San Francisco-Oakland Bay | 15 | 7 | 22 |
| San Mateo-Hayward | 8 | 2 | 10 |
| **Total** | **52** | **17** | **69** |

**Table 1.3.** Toll Booths at Bay Area Toll Bridges as of 2016-2017

| Bridge | Cash/FasTrak Booths | FasTrak-Only Booths | Total Toll Booths |
|---|---|---|---|
| Antioch | 1 | 2 | 3 |
| Benicia-Martinez | 7 | 4 | 9 |
| Carquinez | 5 | 7 | 12 |
| Dumbarton | 4 | 3 | 7 |
| Richmond-San Rafael | 3 | 4 | 7 |
| San Francisco-Oakland Bay | 11 | 9 | 20 |
| San Mateo-Hayward | 5 | 5 | 10 |
| **Total** | **36** | **34** | **70** |

**Table 1.4.** FasTrak Utilization Rates on State-Owned Bridges during Weekday Peak Hours (2016-2017). By 2017, FasTrak usage on all state-owned bridges averaged about 69% of toll-paying (excluding HOVs) during weekday peak hours.

| Facility | Total Peak FasTrak Use |
|---|---|
| Antioch Bridge | 54% |
| San Francisco-Oakland Bay Bridge | 73% |
| Benicia Bridge | 67% |
| Carquinez Bridge | 61% |
| Dumbarton Bridge | 69% |
| Richmond-San Rafael Bridge | 71% |
| San Mateo-Hayward Bridge | 71% |
| **All Bridges (based on aggregated traffic)** | **69%** |

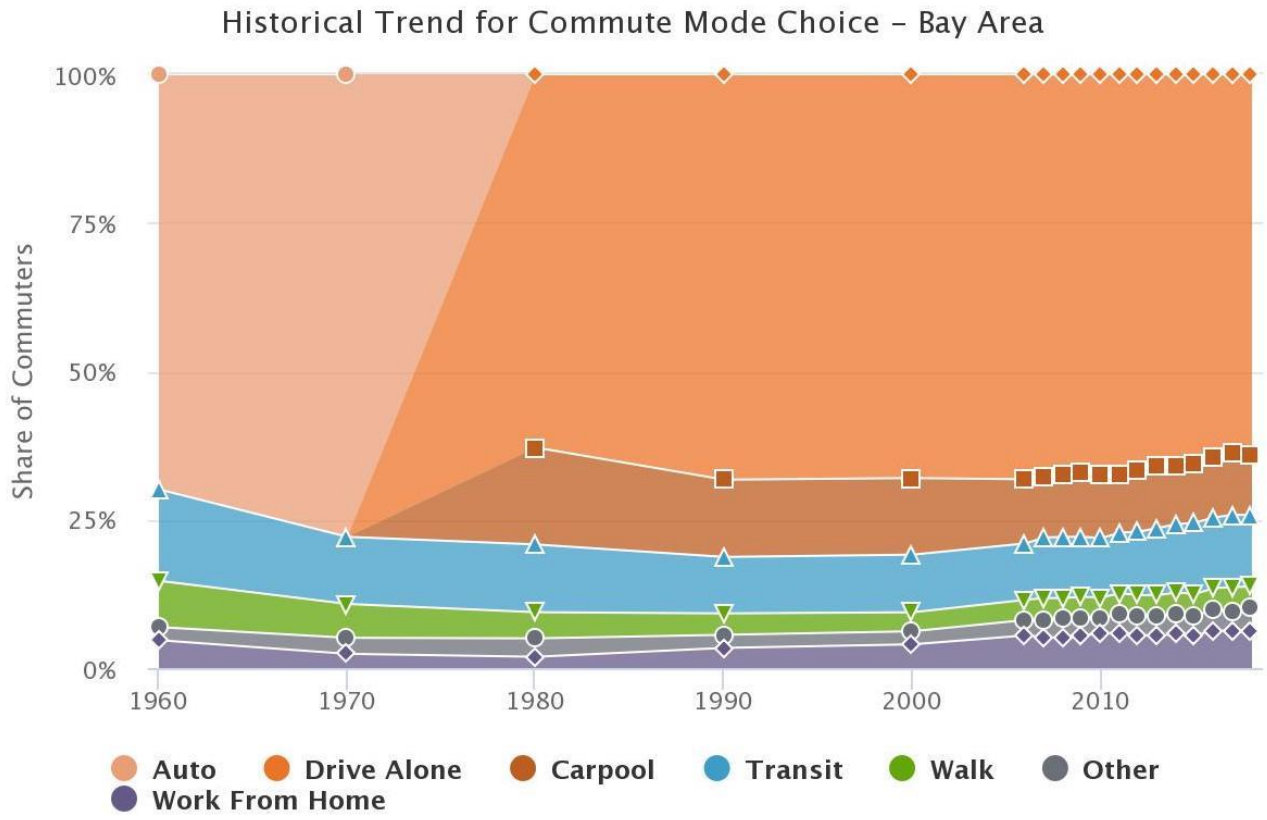
**Table 1.5.** Summary of lane distribution on San Francisco Oakland Bridge

| San Francisco Oakland Bridge | | | | | | |
|---|---|---|---|---|---|---|
| | **2005** | **2006** | **2007** | **2010** | **2013** | **2015** |
| **Cash/ETC** | 13 | 12 | 11 | 12 | 10 | 9 |
| **FasTrak** | 5 | 6 | 7 | 4 | 6 | 7 |
| **Carpool** | 4 | 4 | 4 | 4 | 4 | 4 |

**Table 1.6.** Summary of lane distribution on other Bay Area bridges

| | San Mateo Bridge | | Richmond Bridge | | Dumbarton Bridge | | Carquinez Bridge | | Benicia Bridge | | Antioch Bridge | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2007 | 2015 | 2007 | 2015 | 2007 | 2014 | 2007 | 2015 | 2007 | 2015 | 2010 | 2015 |
| **Cash / ETC** | 6 | 5 | 1 | 3 | 4 | 4 | 5 | 7 | 7 | 8 | 1 | 1 |
| **FasTrak** | 2 | 3 | 2 | 1 | 1 | 2 | 3 | 3 | 1 | 2 | 0 | 1 |
| **Carpool** | 2 | 2 | 4 | 3 | 1 | 1 | 4 | 2 | 4 | 2 | 2 | 1 |

**Figure 1.1: Historical Trend for Commute Mode Choice, Bay Area, 1960-2020, Source: Vital Signs, MTC**



## Section 2: Electronic Toll Collection Systems in the United States

While trying to improve the utilization of the FasTrak on all seven state-owned toll bridges, it was imperative to assess similar systems to note their accomplishments. The success of ETC systems is evident in the use of E-Z Pass throughout the East Coast, I-Pass in Illinois, SunPass in Florida, and FasTrak on the Golden Gate Bridge. Green et al. (1999) developed a conjoint technique for a marketing research project for E-ZPass to analyze consumers' needs and preferences in the E-Z Pass Strategic Plan. The conjoint analysis helped the marketing research team determine the design configuration most desirable to those surveyed, thereby bringing the customer's voice into the decision-making process as early as possible (Vavra et al. 1999). Another crucial factor that made E-ZPass successful was the permanent discount offered to users, an incentive that motivated commuters to start using the system.

| Electronic Toll Collection Systems and Locations |
|---|
| C-Pass in Key Biscayne, Florida |
| Cruise Card in Atlanta, Georgia |
| E-PASS in Orlando, Florida (Interoperable with SunPass) |
| EXpressToll in Colorado |
| EZ TAG in Texas (Interoperable with TxTAG) |
| E-ZPass in Maine (Interoperable with E-ZPass) |
| E-ZPass in the U.S. Northeast |
| Fast Lane in Massachusetts (Interoperable with E-ZPass) |
| FasTrak in California |
| I-Pass in Illinois (Interoperable with E-ZPass) |
| K-Tag in Kansas |
| LeeWay in Lee County, Florida (Interoperable with SunPass) |
| MnPass in Minnesota |
| O-PASS in Osceola County, Florida (Interoperable with SunPass) |
| PalmettoPass in South Carolina |
| Pikepass in Oklahoma |
| Smart Tag in Virginia (Interoperable with E-ZPass) |
| SunPass in Florida |
| TollTag in Texas (Interoperable with TxTAG) |
| TxTAG in Texas |

Agencies using the E-Z Pass Electronic Toll Collection System in the United States

| Agencies Using EZ-Pass |
|---|
| Atlantic City Expressway (New Jersey) |
| Burlington County Bridge Commission (New Jersey/Pennsylvania) |
| Delaware Department of Transportation (includes Delaware Turnpike and State Route 1) |
| Delaware River Joint Toll Bridge Commission (New Jersey/Pennsylvania) |
| Delaware River and Bay Authority (Delaware/New Jersey) |
| Delaware River Port Authority (New Jersey/Pennsylvania) |
| Maryland Transportation Authority |
| Maine Turnpike Authority |
| New Hampshire Department of Transportation |
| New Jersey Turnpike Authority (includes Garden State Parkway) |
| New York State Thruway Authority |
| New York State Bridge Authority |
| Peace Bridge Authority (New York, US/Ontario, Canada) |
| Pennsylvania Turnpike Commission |
| Port Authority of New York and New Jersey |
| MTA Bridges & Tunnels (New York) |
| West Virginia Turnpike |
| Massachusetts Port Authority |
| Massachusetts Turnpike Authority |
| Chicago Skyway (Illinois) |
| Illinois State Toll Highway Authority |
| Dulles Greenway (Virginia) |
| Pocahontas Parkway Association (Virginia) |
| Richmond Metropolitan Authority (Virginia) |
| Virginia Department of Transportation |

**Table 2.1** Electronic Toll Collection Usage Rates at Other Toll Agencies in 2006

| Agency | ETC System | Facility | ETC Usage Rates | Begin Use Date | Automobile Cash Toll | ETC Toll |
|---|---|---|---|---|---|---|
| Florida Department of Transportation | SunPass | Alligator Alley | 25.9% | 10/16/1999 | $2.50 | $2.00 |
| | | Bee Line East Expressway | 41.2% | 1/26/2001 | $0.25 | $0.25 |
| | | Pinellas Bayway System | 46.1% | 1/6/2000 | $1.35 | $1.35 |
| | | Selmon Crosstown Expressway | 51.6% | 9/30/2000 | $2.25 | $1.75 |
| | | Garcon Point Bridge | 26.7% | 5/14/1999 | $3.00 | $3.00 |
| | | Mid-Bay Bridge | 56.3% | 5/15/1999 | $2.50 | $1.50 |

| Agency | ETC System | Facility | ETC Usage Rates | Begin Use Date | Automobile Cash Toll | ETC Toll |
|---|---|---|---|---|---|---|
| | | Sunshine Skyway Bridge | 30.1% | 8/19/2000 | $1.00 | $0.75 |
| Metropolitan Transportation Authority New York City (Bridges and Tunnels) | E-ZPass | Verrazano-Narrows Bridge | 71.5% | Mid 1990's | $4.50 | $4.00 |
| | | Triborough Bridge | | | | |
| | | Bronx-Whitestone Bridge | | | | |
| | | Throgs Neck Bridge | | | | |
| | | Queens Midtown Tunnel | | | | |
| | | Brooklyn Battery Tunnel | | | | |
| | | Henry Hudson | | | $2.25 | $1.75 |
| | | Marine Parkway-Gil Hodges Memorial Bridge | | | $2.25 | $1.50 |
| | | Veterans Memorial Bridge | | | | |
| Port Authority of New York and New Jersey (Bridges and Tunnels) | E-ZPass | George Washington Bridge<br>Lincoln Tunnel<br>Holland Tunnel<br>Goethals Bridge<br>Outerbridge Crossing<br>Bayonne Bridge | 70.0% | Mid 1990's | $6.00 | $4.00 Off-peak Hrs.<br>$5.00 Peak Hrs. |
| Illinois Tollway | I-Pass (inter-operable with E-ZPass) | North South Tollway<br>Tri-State Tollway<br>Ronald Reagan Memorial Tollway<br>Northwest Tollway | 75.0% | 6/15/1905 | $0.80 to $1.00 per mile | $0.40 to $0.50 per mile |
| Delaware River Port Authority | E-ZPass | Benjamin Franklin Bridge<br>Walt Whitman Bridge<br>Commodore Barry Bridge<br>Betsy Ross Bridge | | 12/18/1999 | $3.00 | $18 for 18 crossings in single month |
| Delaware River Joint Toll Bridge Commission | E-ZPass | Trenton Morrisville Toll Bridge | 51% | 6/1/2003 | $0.75 | 20% discount |

| Agency | ETC System | Facility | ETC Usage Rates | Begin Use Date | Automobile Cash Toll | ETC Toll |
|---|---|---|---|---|---|---|
| | | New Hope Lambertville Toll Bridge | 54% | | | |
| | | I-78 Toll Bridge | 47% | | | |
| | | Easton-Phillipsburg Toll Bridge | 49% | | | |
| | | Portland-Columbia Toll Bridge | 53% | | | |
| | | Delaware Water Gap Toll Bridge | 47% | | | |
| | | Milford Montague Toll Bridge | 50% | | | |

## Section 3: Forecasting during Phase 1

The publicly available quarterly usage rates for FasTrak from Quarter 2 of 2002 to Quarter 4 of 2005 provided the data to forecast FasTrak usage rates until Quarter 2 of 2008.

**Table 3.1.** Data on FasTrak usage during peak hours, 2002-2005

| Quarter | All State Owned Bridges | Antioch (PM peak) | Benicia-Martinez (PM peak) | Carquinez (PM peak) | Dumbarton (AM peak) | Richmond-San Rafael (AM peak) | SF-Oakland Bay (PM peak) | San Mateo-Hayward (AM peak) |
|---|---|---|---|---|---|---|---|---|
| Qtr 1 2002 | 25.36% | 18.62% | 29.65% | 28.07% | 36.92% | 30.18% | 21.76% | 26.62% |
| Qtr 2 2002 | 25.86% | 17.78% | 28.37% | 27.75% | 37.07% | 29.03% | 22.41% | 26.61% |
| Qtr 3 2002 | 26.75% | 17.52% | 28.64% | 27.81% | 36.81% | 28.83% | 23.61% | 28.02% |
| Qtr 4 2002 | 28.20% | 18.43% | 29.40% | 28.19% | 37.88% | 30.90% | 25.50% | 30.33% |
| Qtr 1 2003 | 30.17% | 21.48% | 31.91% | 29.86% | 39.87% | 32.63% | 28.12% | 31.99% |
| Qtr 2 2003 | 29.99% | 20.68% | 31.22% | 29.49% | 39.47% | 31.95% | 27.96% | 32.38% |
| Qtr 3 2003 | 28.27% | 18.85% | 28.17% | 26.28% | 37.47% | 29.67% | 26.69% | 30.58% |
| Qtr 4 2003 | 29.33% | 19.83% | 28.76% | 27.17% | 37.84% | 30.52% | 28.29% | 31.18% |
| Qtr 1 2004 | 30.47% | 21.00% | 29.94% | 28.37% | 38.95% | 31.76% | 29.28% | 32.50% |
| Qtr 2 2004 | 30.87% | 20.42% | 31.06% | 28.48% | 39.16% | 30.82% | 29.48% | 33.84% |
| Qtr 3 2004 | 38.22% | 25.97% | 37.26% | 35.35% | 49.70% | 36.57% | 35.89% | 42.92% |
| Qtr 4 2004 | 36.51% | 31.53% | 42.44% | 34.92% | 43.11% | 40.44% | 36.66% | 38.36% |
| Qtr 1 2005 | 36.88% | 33.20% | 42.97% | 34.82% | 43.94% | 41.15% | 37.27% | 39.02% |
| Qtr 2 2005 | 36.62% | 31.55% | 41.87% | 33.75% | 43.58% | 42.71% | 36.05% | 38.01% |
| Qtr 3 2005 | 37.56% | 31.06% | 41.51% | 34.06% | 42.26% | 42.06% | 38.22% | 37.78% |
| Qtr 4 2005 | 39.56% | 31.37% | 42.21% | 34.72% | 42.68% | 44.10% | 41.72% | 38.74% |

The temporary discount given during Quarter 3 of 2004 was an outlier which shifted the data set from its natural path. The discount's approximate effect was added to each of the quarterly FasTrak data points before the quarter when the discount was offered. A difference of 2.5% in the usage between Quarter 2 of 2005 and Quarter 3 of 2005 resulted, and this difference was used to calculate the usage for Quarter 3 of 2004 had the discount not occurred. The quarterly usage rate for Quarter 2 of 2004 was adjusted to 37.25%, which was 2.5% below the quarterly usage rate for Quarter 3 of 2004. The difference between the actual and adjusted figures for Quarter 2 of 2004 was added to the actual FasTrak rates for Quarter 1 of 2002 through Quarter 2 of 2004.

The selected models used diagnostic measures like the Akaike Information Criterion (AIC) and Schwarz Information Criterion (SIC). Both these criteria evaluate models based on their in-sample fit while

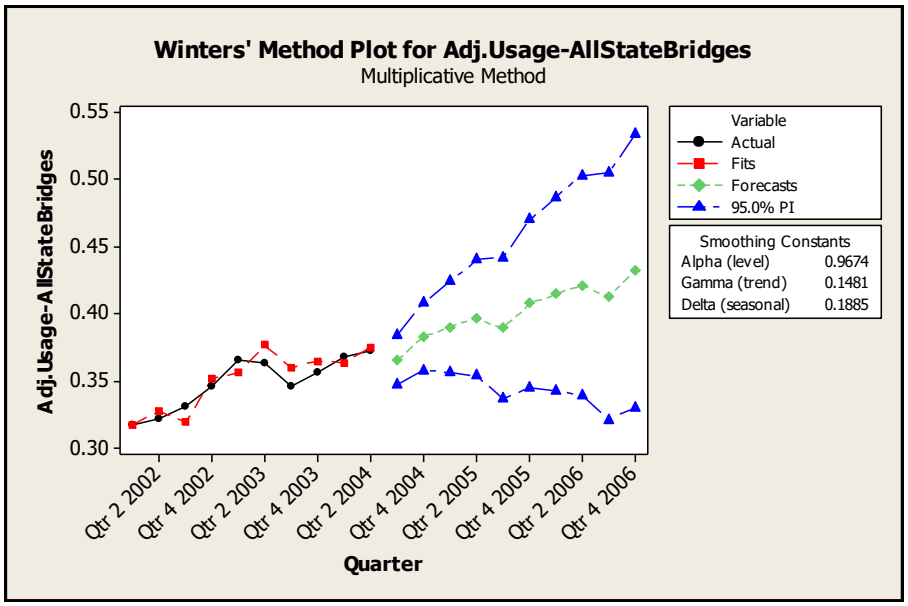
considering the number of estimated parameters, or the parsimony of the different models. The forecasting techniques were then analyzed to identify the best forecasting method (the one with the least errors, and therefore the most accurate). The data from Quarter 1 of 2002 through Quarter 2 of 2004 were analyzed using the different forecasting models and the models were used to calculate the forecasted FasTrak usage rates from Quarter 3 of 2004 to Quarter 4 of 2006. Table 3.2 presents the forecast accuracy metrics for each method using the Mean Absolute Percentage Error (MAPE), Mean Absolute Deviation (MAD), and the Mean Squared Difference (MSD). The Winters method emerged as the best method for forecasting. The analysis was conducted with MINITAB and EViews software.

**Table 3.2.** Forecasting Methods and Accuracy Metrics

| Forecasting Method | Mean Absolute Percentage Error (MAPE) | Mean Absolute Deviation (MAD) | Mean Squared Difference (MSD) |
|---|---|---|---|
| Single Exponential Smoothing | 2.22991 | 0.00810 | 0.00009 |
| Quadratic Trend | 2.71052 | 0.01008 | 0.00023 |
| Winters' | 3.22857 | 0.01174 | 0.00019 |
| Linear Trend | 3.31366 | 0.01204 | 0.00024 |
| Multiplicative Decomposition | 3.38389 | 0.01220 | 0.00023 |
| Additive Decomposition | 3.46173 | 0.01248 | 0.00024 |
| Growth Curve | 3.64253 | 0.01328 | 0.00030 |
| 4-Quarter Moving Average | 3.64514 | 0.01371 | 0.00030 |
| S-Curve Trend | 3.77418 | 0.01313 | 0.00032 |
| Double Exponential Smoothing | 4.32945 | 0.01585 | 0.00046 |

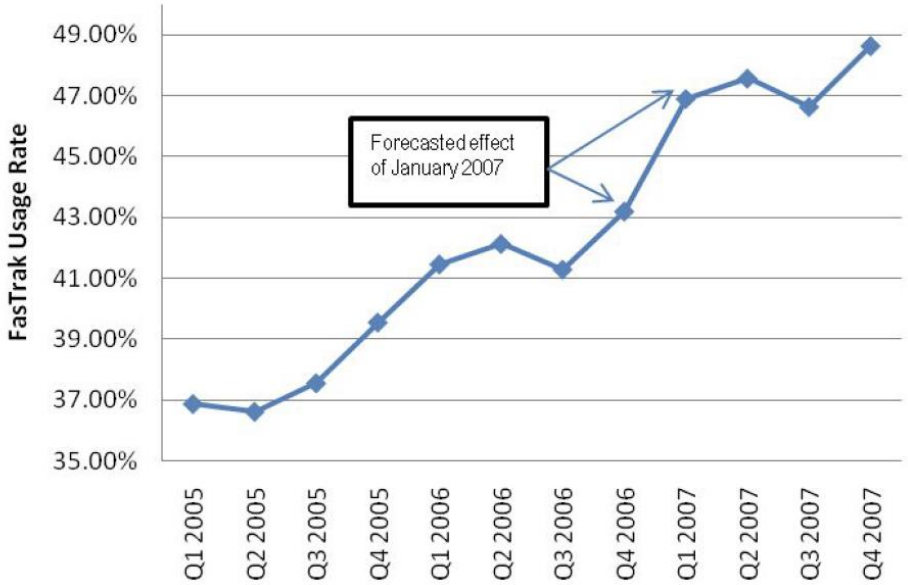
The forecasting accuracy results suggest that the Single Exponential Smoothing method had the least MAPE, MAD, and MSD for Quarter 3 of 2005 through Quarter 4 of 2005. However, these results can be misleading since this method calculates its forecast for each quarter based on the previous quarter's actual value and the previous quarters' forecast, making this method suitable for short-term forecasts but not long-term forecasts. The Quadratic Trend model also had a low MAPE but was not appropriate because the FasTrak usage rates had been slowly increasing and were not expected to decrease. Thus, the Winters forecasting method was chosen to forecast. It had the third-lowest MAPE, MAD and MSE and reflected the upward trend, confirming its appropriateness as a long-term forecasting method for this data. It also provides relevance to seasonality and trends since it decomposes data into trend and seasonal components. Figure 3.1. graphs the forecasts of FasTrak usage on all state-owned toll bridges through 2006; it clearly indicates an upward trend.

**Figure 3.1**. Winters method forecast of quarterly FasTrak usage from first quarter of 2002 through fourth quarter of 2006




There is a spike in usage between Quarter 2 of 2004 and Quarter 3 of 2004 due to the discount, representing an increase in the usage rate by 7.35 percentage points. A forecast using Winters method assumes that the scheduled discount in January 2007 would result in a 3% increase in usage. This assumption is justified based on the intuition that the discount in January 2007 is only a one-month discount compared to a full quarter in 2004, and therefore the increase will not be as high as 7.35%. However, taking a literal split (3 months to 1 month) will be inaccurate since the intensity of a one-month discount is more than that of a discount spread over a quarter. Therefore, only a mid-range of approximately 3% is appropriate for this situation. Thus, a 3% spike in usage was utilized in the Winters model to predict the forecast of FasTrak usage through 2007 and to include the effects of the planned FasTrak discount of January 2007. The results in Figure 3.2 clearly indicate that by Quarter 4 of 2007, FasTrak usage increases to approximately 49%.

**Figure 3.2**. Forecast of FasTrak usage rates on all state-owned toll bridges from 2005 through 2007.




The same forecasting method was applied for all state-owned toll bridges, with the increase in usage (January 2007) for all bridges except Benicia-Martinez assumed to be 3%. We estimated the Benicia-Martinez Bridge usage rate increase to be 4% since open road tolling of FasTrak Express lanes was introduced. Figure 3.3 shows the resulting forecasts.

**Figure 3.3.** Forecasts of FasTrak Usage Rates on All State-owned Toll Bridges, 2006-07.

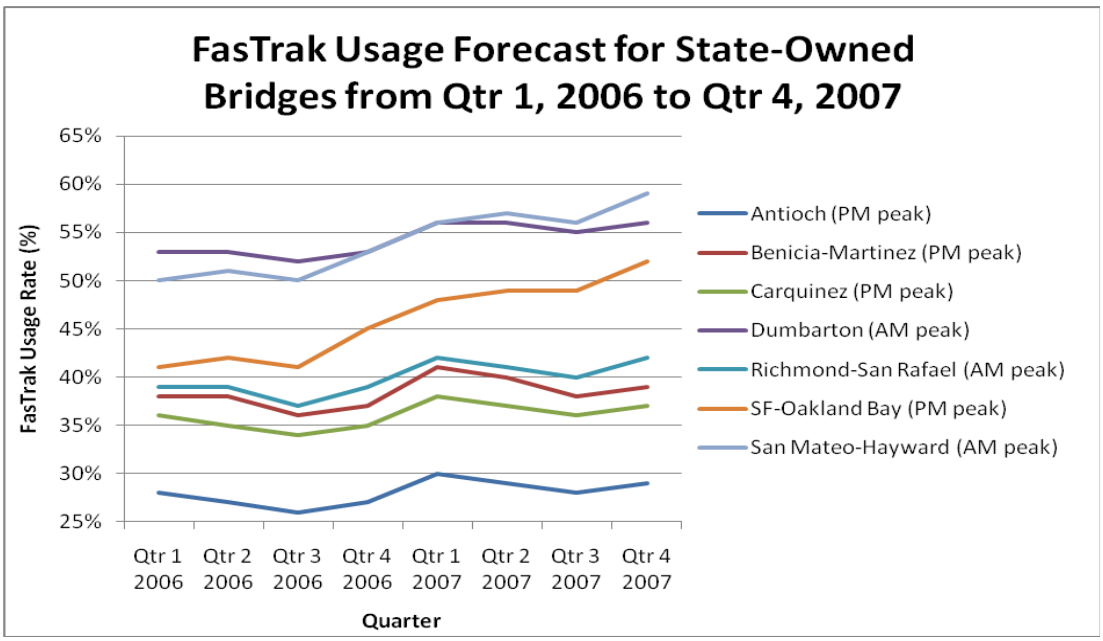


**Table 3.3.** Actual Peak-hour FasTrak usage on State-owned bridges used for comparison with the Forecasted FasTrak usage

| Quarter | All State-owned Bridges | Antioch | Benicia-Martinez | Carquinez | Dumbarton | Richmond-San Rafael | SF-Oakland Bay | San Mateo-Hayward |
|---|---|---|---|---|---|---|---|---|
| 2006 avg. | 41% | 34% | 44% | 37% | 44% | 44% | 45% | 42% |
| 2007 avg. | 46% | 39% | 51% | 42% | 48% | 51% | 51% | 47% |
| 2008 avg. | 48% | 41% | 56% | 42% | 49% | 54% | 53% | 50% |

A detailed forecasting graphical Analysis from 2004-2008 is presented in the below figures.

1. Figure 3.4 shows a comparison of the actual usage rates and the forecasts for each of the state-owned bridges for 2007-2008, based on the disaggregated data for each bridge.
2. Figure 3.5 shows the forecasted FasTrak quarterly usage from 2004-2006 and 2006-2008.
3. Figure 3.6 presents the results of stability tests using cumulative sum (CUSUM) test analysis, which identifies systematic changes in the regression coefficients and tests for parameter instability.

The data from tables 3.1 and 3.3 above are used for comparing the actual usage with the forecasted FasTrak quarterly usage from 2007-2008 (Figure 3.4), from 2004-2006 (Figure 3.5) and from 2006-2008 (Figure 3.6). The forecasts in each case coincide with actual data or come close to actual data at least once in the forecasting horizon. There are overestimates for a few bridges in the last quarter because the data have a quarterly frequency and the forecasting accuracy worsens as the forecasting horizon increases. The actual data show a plateau in FasTrak usage rates.

**Figure 3.4**: Comparison of Actual Data and Forecasts for All State-owned Bridges (2007-2008).

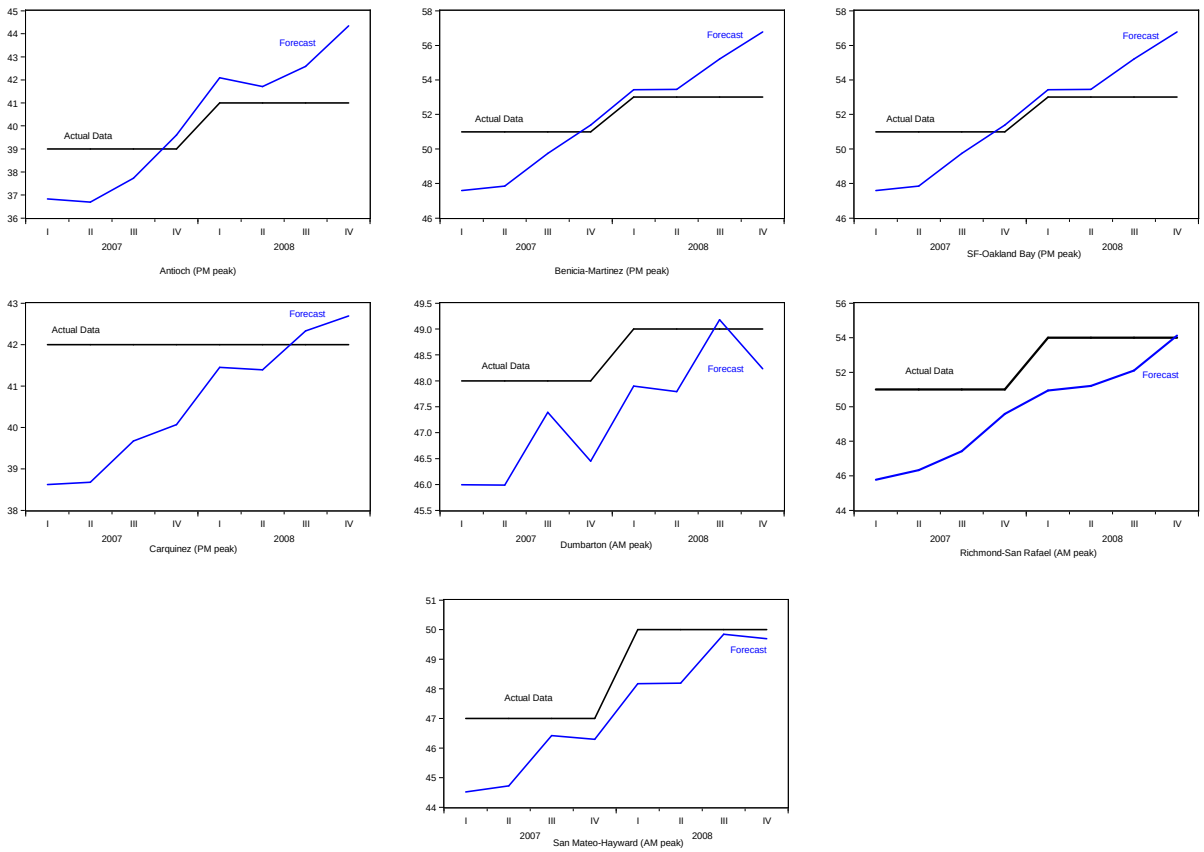
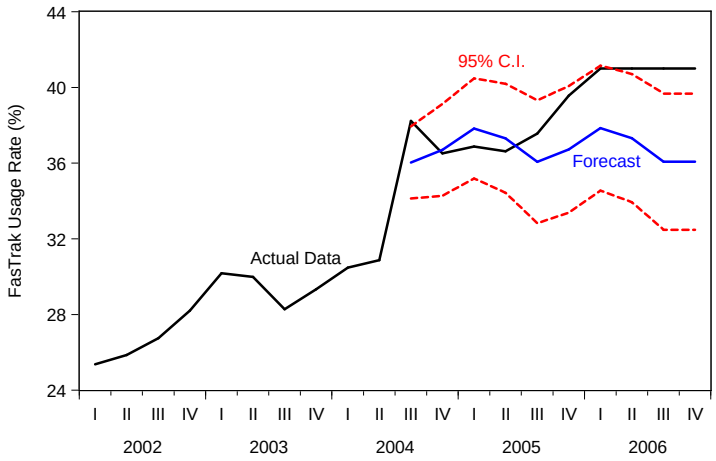
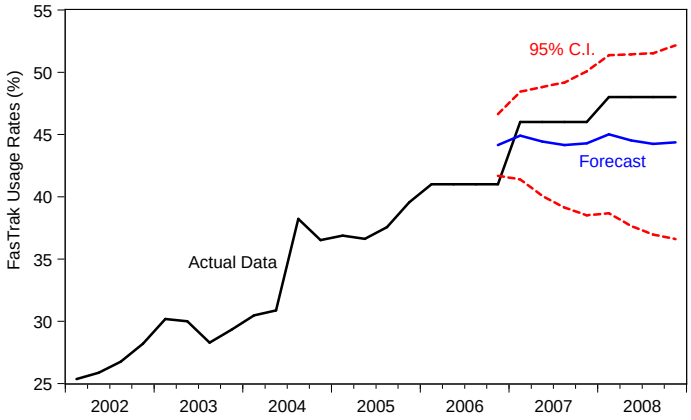



Figure 3.5 presents the forecast of FasTrak usage rates for all state-owned bridges from 2004 to 2006 and from 2006 to 2008, respectively. The figures show that for both forecasting horizons, the 95% confidence intervals associated with the forecasts contain the actual data.

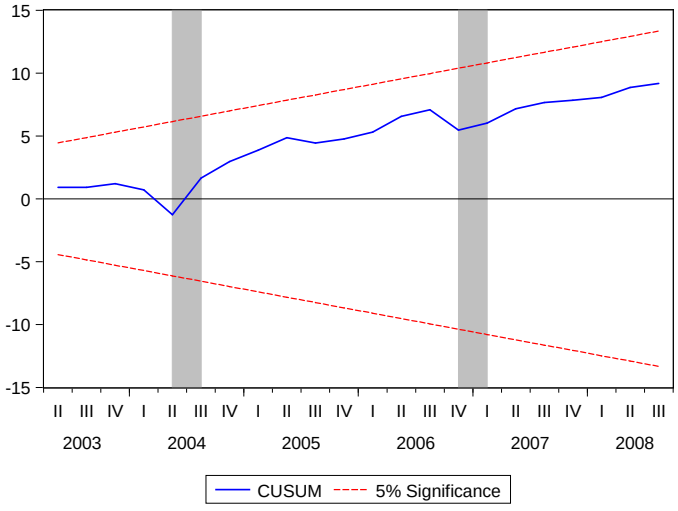
**Figure 3.5**: Forecast of FasTrak Usage Rates from 2004-2006 and 2006-09






Next, stability tests using cumulative sum (CUSUM) test analysis were performed. These tests identify systematic changes in the regression coefficients and tests for parameter instability. The plots indicate the absence of any instability of the coefficients because the plots of the CUSUM statistics fall inside the critical bands of the 5% confidence intervals of parameter stability.

**Figure 3.6**: Parameter stability test using CUSUM analysis.



## Section 4: Data used for forecasting in Phase 2

Tables used for data analysis for all state-owned bridges in Phase 2 are presented here, organized into daily traffic by hour from January 1, 2006, to November 28, 2014. We collected a large amount of data for all seven bridges from January 2006 to December 2014 (a total of 470 weeks), including hourly traffic throughout the day on all lanes (i.e., Carpool, Cash/ETC and FasTrak). A plaza ID represents each bridge, and each lane has a number. The analysis used data on FasTrak lane utilization during peak hours (5 am to 10 am, and 3 pm to 7 pm) during weekdays, as this research is focused on achieving 70% FasTrak utilization during peak hours. The data tables for each of the seven bridges that are used in the models for Phase 2 forecasting are below. Pivot tables in Excel were used to create these data tables from original data.

## Tables for San Francisco-Oakland Bridge

### Tables for San Francisco-Oakland Bridge Data Daily by Hour

| Date | Day | 0000-0100 | 0100-0200 | 0200-0300 | 0300-0400 | ... | 2100-2200 | 2200-2300 | 2300-2400 | Total Volume |
|---|---|---|---|---|---|---|---|---|---|---|
| 1/1/06 | Sun. | 2,093 | 2,801 | 2,003 | 1,375 | ... | 3,873 | 3,673 | 2,615 | 87,306 |
| 1/2/06 | Mon. | 1,463 | 962 | 703 | 769 | ... | 3,924 | 3,401 | 2,219 | 84,558 |
| 1/3/06 | Tues. | 1,437 | 977 | 717 | 1,015 | ... | 3,395 | 3,025 | 2,002 | 120,784 |
| 1/4/06 | Wed. | 1,209 | 849 | 690 | 981 | ... | 3,807 | 3,493 | 2,038 | 124,915 |
| 1/5/06 | Thurs. | 1,215 | 822 | 592 | 945 | ... | 4,026 | 3,940 | 2,876 | 129,857 |
| 1/6/06 | Fri. | 1,446 | 914 | 679 | 981 | ... | 4,625 | 4,530 | 3,326 | 134,467 |
| 1/7/06 | Sat. | 1,812 | 1,240 | 975 | 835 | ... | 5,540 | 5,681 | 4,033 | 120,260 |
| . | . | . | . | . | . | . | . | . | . | . |
| . | . | . | . | . | . | . | . | . | . | . |
| 7/27/14 | Sun. | 2568 | 1599 | 1236 | 1122 | ... | 5946 | 4814 | 2912 | 124,641 |
| 7/28/14 | Mon. | 1499 | 897 | 814 | 1310 | ... | 4288 | 3660 | 2013 | 131,660 |
| 7/29/14 | Tues. | 1163 | 738 | 738 | 1207 | ... | 3826 | 3466 | 2019 | 132,479 |
| 7/30/14 | Wed. | 1356 | 796 | 825 | 1333 | ... | 4391 | 3727 | 2321 | 132,891 |
| 7/31/14 | Thurs. | 1323 | 802 | 798 | 1385 | ... | 4314 | 4050 | 2785 | 135,990 |

### Tables for San Francisco-Oakland Bay Bridge by peak hour by lane

| Lane ID | Date | Week | Day | 0500-0600 | 0600-0700 | | 1600-1700 | 1700-1800 | 1800-1900 | Peak Summary | Lane Type |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1/2/06 | 1 | Mon. | 39 | 52 | ... | 259 | 234 | 198 | 1401 | Carpool |
| 2 | 1/2/06 | 1 | Mon. | 75 | 113 | ... | 222 | 257 | 215 | 1629 | Carpool |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 3 | 1/2/06 | 1 | Mon. | 133 | 152 | … | 258 | 252 | 247 | 1807 | Cash/ETC |
| … | … | … | … | … | … | … | … | … | … | … | … |
| 17 | 1/2/06 | 1 | Mon. | 91 | 133 | … | 236 | 239 | 183 | 1480 | Cash/FT |
| 18 | 1/2/06 | 1 | Mon. | 4 | 11 | … | 33 | 24 | 26 | 168 | FasTrak |
| 19 | 1/2/06 | 1 | Mon. | 26 | 62 | … | 142 | 139 | 103 | 807 | FasTrak |
| 20 | 1/2/06 | 1 | Mon. | 83 | 166 | … | 278 | 235 | 256 | 1756 | FasTrak |
| 21 | 1/2/06 | 1 | Mon. | 40 | 66 | … | 84 | 87 | 62 | 614 | Carpool |
| 22 | 1/2/06 | 1 | Mon. | 109 | 227 | … | 263 | 236 | 197 | 1834 | Carpool |
| 1 | 1/3/06 | 1 | Tues. | 115 | 363 | … | 188 | 207 | 192 | 2818 | Carpool |
| 2 | 1/3/06 | 1 | Tues. | 248 | 507 | … | 201 | 207 | 212 | 3700 | Carpool |
| 3 | 1/3/06 | 1 | Tues. | 305 | 327 | … | 300 | 348 | 277 | 2583 | Cash/ETC |
| 4 | 1/3/06 | 1 | Tues. | 162 | 350 | … | 254 | 229 | 203 | 2118 | Cash/ETC |
| … | … | … | … | … | … | … | … | … | … | … | … |
| 17 | 11/28/14 | 470 | Fri. | 223 | 321 | … | 595 | 504 | 432 | 3709 | FasTrak |
| 18 | 11/28/14 | 470 | Fri. | 136 | 153 | … | 331 | 275 | 205 | 1854 | FasTrak |
| 19 | 11/28/14 | 470 | Fri. | 73 | 97 | … | 150 | 115 | 64 | 928 | Carpool |
| 20 | 11/28/14 | 470 | Fri. | 128 | 240 | … | 335 | 258 | 214 | 2282 | Carpool |

**San Francisco-Oakland Lane Changes Over Time**

| Effective Until | 6/26/05 | 1/22/06 | 9/2/07 | 3/7/10 | 8/25/13 | 1/1/15 |
|---|---|---|---|---|---|---|
| **1** | Carpool | Carpool | Carpool | Carpool | Carpool | Carpool |
| **2** | Carpool | Carpool | Carpool | Carpool | Carpool | Carpool |
| **3** | Cash/ETC | Cash/ETC | Cash/ETC | Cash/ETC | Cash/ETC | Cash/ETC |
| **4** | Cash/ETC | Cash/ETC | Cash/ETC | Cash/ETC | Cash/ETC | Cash/ETC |
| **5** | FasTrak | FasTrak | FasTrak | Cash/ETC | Cash/ETC | Cash/ETC |
| **6** | Cash/ETC | Cash/ETC | Cash/ETC | Cash/ETC | Cash/ETC | Cash/ETC |
| **7** | Cash/ETC | Cash/ETC | Cash/ETC | Cash/ETC | FasTrak | FasTrak |
| **8** | Cash/ETC | Cash/ETC | Cash/ETC | Cash/ETC | FasTrak | FasTrak |
| **9** | Cash/ETC | Cash/ETC | FasTrak | FasTrak | FasTrak | FasTrak |
| **10** | FasTrak | FasTrak | FasTrak | FasTrak | FasTrak | FasTrak |
| **11** | FasTrak | FasTrak | FasTrak | FasTrak | FasTrak | FasTrak |
| **12** | Cash/ETC | Cash/ETC | Cash/ETC | Cash/ETC | Cash/ETC | Cash/ETC |
| **13** | Cash/ETC | Cash/ETC | Cash/ETC | Cash/ETC | Cash/ETC | Cash/ETC |
| **14** | Cash/ETC | Cash/ETC | Cash/ETC | Cash/ETC | Cash/ETC | Cash/ETC |
| **15** | Cash/ETC | Cash/ETC | Cash/ETC | Cash/ETC | Cash/ETC | Cash/ETC |
| **16** | Cash/ETC | Cash/ETC | Cash/ETC | Cash/ETC | Cash/ETC | Cash/ETC |
| **17** | Cash/ETC | Cash/ETC | Cash/ETC | Cash/ETC | Cash/ETC | FasTrak |
| **18** | Cash/ETC | FasTrak | FasTrak | FasTrak | FasTrak | FasTrak |
| **19** | FasTrak | FasTrak | FasTrak | Not Used | Carpool | Carpool |
| **20** | FasTrak | FasTrak | FasTrak | Not Used | Carpool | Carpool |
| **21** | Carpool | Carpool | Carpool | Carpool | Not Used | Not Used |
| **22** | Carpool | Carpool | Carpool | Carpool | Not Used | Not Used |

## San Francisco-Oakland Bridge Peak Data Summary

| Week | Carpool | Cash/ ETC | FasTrak | Not Used | Grand Total |
|---|---|---|---|---|---|
| 1 | 63,256 | 136,444 | 115,081 | | 314,781 |
| 2 | 75,597 | 149,446 | 121,144 | | 346,187 |
| 3 | 70,588 | 146,880 | 118,706 | | 336,174 |
| 4 | 79,764 | 141,073 | 129,644 | | 350,481 |
| 5 | 75,953 | 136,188 | 126,921 | | 339,062 |
| 6 | 81,389 | 139,273 | 130,670 | | 351,332 |
| 7 | 79,419 | 141,343 | 134,509 | | 355,271 |
| 8 | 73,843 | 138,545 | 123,665 | | 336,053 |
| ... | ... | ... | ... | | ... |
| 468 | 68,281 | 76,792 | 199,144 | | 344,217 |
| 469 | 72,175 | 74,340 | 197,089 | | 343,604 |
| 470 | 50,247 | 76,636 | 159,998 | | 286,881 |
| **Grand Total** | **32,387,999** | **53,910,291** | **65,786,704** | **3,546,400** | **155,631,394** |

# Tables for Carquinez Bridge

## Carquinez Bridge Daily Data by Hour

| Date | Day | 0000 - 0100 | 0100 - 0200 | 0200 - 0300 | 0300 - 0400 | . | 2100 - 2200 | 2200 - 2300 | 2300 - 2400 | Total Volume |
|---|---|---|---|---|---|---|---|---|---|---|
| **11/1/05** | Tuesday | 942 | 665 | 627 | 548 | ... | 1948 | 1942 | 1336 | 58803 |
| **11/2/05** | Wednesday | 955 | 483 | 424 | 345 | ... | 1852 | 2112 | 1606 | 58144 |
| **11/3/05** | Thursday | 1035 | 564 | 407 | 330 | ... | 2363 | 1939 | 1541 | 60092 |
| **11/4/05** | Friday | 1065 | 538 | 465 | 400 | ... | 3714 | 2610 | 2270 | 64753 |
| **11/5/05** | Saturday | 1582 | 1055 | 839 | 670 | ... | 2644 | 2518 | 2216 | 64634 |
| **11/6/05** | Sunday | 1641 | 1007 | 967 | 677 | ... | 2634 | 1947 | 1232 | 57326 |
| **11/7/05** | Monday | 914 | 461 | 363 | 286 | ... | 1924 | 1471 | 1220 | 55261 |
| **...** | **...** | **...** | **...** | **...** | **...** | **...** | **...** | **...** | **...** | **...** |
| **11/26/14** | Wednesday | 1098 | 696 | 447 | 386 | ... | 3068 | 2504 | 1825 | 67048 |
| **11/27/14** | Thursday | 1322 | 768 | 646 | | ... | 3556 | 2978 | 2078 | 64381 |
| **11/28/14** | Friday | 1234 | 634 | 383 | 300 | ... | 2161 | 2011 | 1512 | 54108 |
| **11/29/14** | Saturday | 1074 | 655 | 533 | 412 | ... | 2037 | 1905 | 1702 | 49651 |
| **11/30/14** | Sunday | 1214 | 759 | 604 | 338 | ... | 1912 | 1359 | 1034 | 44368 |

## Carquinez Bridge Daily Data by Peak Hour by Lane

| Lane ID | Date | Week Counter | Peak Sum | Lane Type |
|---|---|---|---|---|
| **1** | 11/1/05 | 1 | 1,104 | Carpool |
| **2** | 11/1/05 | 1 | 1,778 | Cash/ETC |
| **3** | 11/1/05 | 1 | 2,383 | Cash/ETC |
| **4** | 11/1/05 | 1 | 2,271 | Cash/ETC |
| **…** | **…** | **…** | **…** | **…** |
| **8** | 11/1/05 | 1 | 4,392 | FasTrak |
| **9** | 11/1/05 | 1 | 1,740 | FasTrak |
| **10** | 11/1/05 | 1 | 1,809 | Cash/ETC |
| **11** | 11/1/05 | 1 | 1,095 | Carpool |
| **12** | 11/1/05 | 1 | 1,496 | Cash/ETC |
| **1** | 11/2/05 | 1 | 892 | Carpool |
| **2** | 11/2/05 | 1 | 1,815 | Cash/ETC |
| **…** | **…** | **…** | **…** | **…** |
| **12** | 11/30/14 | 480 | 660 | Cash/ETC |

**Carquinez Bridge Peak Data Summary**

| Week | Carpool | Cash/ETC | FasTrak | Grand Total |
|---|---|---|---|---|
| 2 | 33,459 | 47,805 | 57,246 | 150,049 |
| 3 | 44,998 | 53,050 | 54,188 | 157,883 |
| 4 | 50,645 | 54,007 | 42,679 | 148,882 |
| 5 | 52,196 | 47,000 | 51,733 | 144,327 |
| 6 | 45,594 | 50,980 | 54,821 | 154,795 |
| 7 | 48,994 | 51,097 | 54,930 | 155,460 |
| **…** | **…** | **…** | **…** | **…** |
| 477 | 16,047 | 79,473 | 92,633 | 188,153 |
| 478 | 15,193 | 74,602 | 92,459 | 182,254 |
| 479 | 14,870 | 77,798 | 79,792 | 172,460 |
| 480 | 798 | 9,731 | 8,178 | 18,707 |
| **Grand Total** | **12,518,690** | **27,013,905** | **31,822,307** | **71,354,902** |

**Carquinez Bridge Lane Changes Over Time**

| Effective Until | 8/10/07 | 6/21/10 | 1/1/15 |
|---|---|---|---|
| 1 | Carpool | Carpool | Carpool |
| 2 | Cash/ETC | FasTrak | FasTrak |
| 3 | Cash/ETC | FasTrak | FasTrak |
| 4 | Cash/ETC | FasTrak | FasTrak |
| 5 | Carpool | Carpool | Carpool |
| 6 | Carpool | Cash/ETC | Cash/ETC |
| 7 | FasTrak | Cash/ETC | Cash/ETC |
| 8 | FasTrak | Cash/ETC | Cash/ETC |
| 9 | FasTrak | Cash/ETC | Cash/ETC |
| 10 | Cash/ETC | Cash/ETC | Cash/ETC |
| 11 | Carpool | Carpool | Cash/ETC |
| 12 | Cash/ETC | Cash/ETC | Cash/ETC |

# Tables for San Mateo Bridge

## San Mateo Bridge Daily Data by Hour

| Date | Day | 0000 - 0100 | 0100 - 0200 | 0200 - 0300 | 0300 - 0400 | ... | 2100 - 2200 | 2200 - 2300 | 2300-2400 | Total Volume |
|---|---|---|---|---|---|---|---|---|---|---|
| 12/1/05 | Thursday | 283 | 197 | 193 | 1,375 | ... | 1,085 | 783 | 685 | 47,221 |
| 12/2/05 | Friday | 313 | 194 | 200 | 769 | ... | 1,310 | 1,364 | 865 | 51,056 |
| 12/3/05 | Saturday | 461 | 304 | 278 | 1,015 | ... | 1,605 | 1,451 | 1,079 | 41,653 |
| 12/4/05 | Sunday | 614 | 407 | 292 | 981 | ... | 1,355 | 945 | 528 | 36,646 |
| 12/5/05 | Monday | 299 | 189 | 171 | 945 | ... | 1,021 | 728 | 468 | 48,162 |
| 12/6/05 | Tuesday | 264 | 161 | 179 | 981 | ... | 1,118 | 824 | 485 | 49,308 |
| 12/7/05 | Wednesday | 251 | 168 | 178 | 835 | ... | 1,198 | 1,195 | 522 | 49,719 |
| ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 11/26/14 | Wednesday | 343 | 204 | 226 | 483 | ... | 1,182 | 882 | 658 | 51,007 |
| 11/27/14 | Thursday | 424 | 240 | 219 | 320 | ... | 2,994 | 2,657 | 1,851 | 41,521 |
| 11/28/14 | Friday | 1,003 | 417 | 293 | 406 | ... | 1,263 | 1,055 | 663 | 39,538 |
| 11/29/14 | Saturday | 367 | 245 | 208 | 304 | ... | 1,515 | 1,279 | 848 | 36,404 |
| 11/30/14 | Sunday | 487 | 322 | 210 | 297 | ... | 1,338 | 951 | 567 | 32,806 |

## San Mateo Bridge Daily Data by Peak Hour by Lane

| Lane ID | Date | Week Counter | Peak Sum | Lane Type |
|---|---|---|---|---|
| 1 | 12/1/05 | 1 | 5,331 | Carpool |
| 2 | 12/1/05 | 1 | 6,139 | Carpool |
| 3 | 12/1/05 | 1 | 4,768 | FasTrak |
| 4 | 12/1/05 | 1 | 2,381 | Cash/ETC |
| 5 | 12/1/05 | 1 | 2,508 | FasTrak |
| 6 | 12/1/05 | 1 | 2,275 | Cash/ETC |
| 7 | 12/1/05 | 1 | 1,763 | Cash/ETC |
| ... | ... | ... | ... | ... |
| 8 | 11/28/14 | 475 | 1,482 | Cash/ETC |
| 9 | 11/28/14 | 475 | 950 | Cash/ETC |
| 10 | 11/28/14 | 475 | 1,388 | Cash/ETC |

## San Mateo Bridge Peak Data Summary

| Week | Carpool | Cash/ETC | FasTrak | Grand Total |
|---|---|---|---|---|
| 2 | 61,530 | 53,911 | 38,213 | 153,654 |

| | | | | |
|---|---|---|---|---|
| 3 | 61,437 | 53,097 | 38,512 | 153,046 |
| 4 | 54,719 | 47,814 | 34,722 | 137,255 |
| 5 | 41,662 | 38,639 | 26,735 | 107,036 |
| 6 | 51,422 | 43,449 | 32,895 | 127,766 |
| 7 | 60,739 | 50,735 | 38,939 | 150,413 |
| … | … | … | … | … |
| 474 | 27,865 | 47,896 | 95,324 | 171,085 |
| 475 | 22,469 | 40,546 | 66,227 | 129,242 |
| **Grand Total** | **15,505,295** | **21,103,407** | **32,918,079** | **69,526,781** |

**San Mateo Bridge Lane Changes Over Time**

| Effective Until | 7/8/07 | Lane Type |
|---|---|---|
| 1 | Carpool | Carpool |
| 2 | Carpool | Carpool |
| 3 | FasTrak | FasTrak |
| 4 | Cash/ETC | FasTrak |
| 5 | FasTrak | FasTrak |
| 6 | Cash/ETC | Cash/ETC |
| 7 | Cash/ETC | Cash/ETC |
| 8 | Cash/ETC | Cash/ETC |
| 9 | Cash/ETC | Cash/ETC |
| 10 | Cash/ETC | Cash/ETC |

## Tables for Richmond Bridge

**Richmond Bridge Daily Data by Hour**

| Date | Day | 0000-0100 | 0100-0200 | 0200-0300 | 0300-0400 | … | 2100-2200 | 2200-2300 | 2300-2400 | Total Volume |
|---|---|---|---|---|---|---|---|---|---|---|
| 12/1/05 | Thursday | 248 | 145 | 114 | 114 | … | 832 | 683 | 628 | 31,770 |
| 12/2/05 | Friday | 288 | 157 | 116 | 143 | … | 1,017 | 1,122 | 789 | 37,599 |
| 12/3/05 | Saturday | 447 | 265 | 196 | 134 | … | 1,002 | 1,181 | 802 | 31,089 |
| 12/4/05 | Sunday | 478 | 273 | 182 | 119 | … | 961 | 778 | 473 | 26,790 |
| 12/5/05 | Monday | 254 | 143 | 130 | 117 | … | 813 | 680 | 377 | 34,628 |
| 12/6/05 | Tuesday | 181 | 149 | 124 | 122 | … | 967 | 781 | 394 | 35,936 |
| 12/7/05 | Wednesday | 205 | 128 | 96 | 137 | … | 1,023 | 1,150 | 484 | 36,095 |
| … | … | … | … | … | … | … | … | … | … | … |
| 11/26/14 | Wednesday | 410 | 241 | 198 | 231 | … | 1,137 | 905 | 734 | 40,780 |
| b11/27/14 | Thursday | 453 | 264 | 184 | 238 | … | 2,139 | 1,578 | 957 | 36,697 |
| 11/28/14 | Friday | 400 | 213 | 139 | 168 | … | 980 | 938 | 587 | 35,575 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 11/29/14 | Saturday | 302 | 186 | 138 | 151 | … | 1,205 | 991 | 793 | 31,808 |
| 11/30/14 | Sunday | 488 | 321 | 229 | 125 | … | 1,065 | 746 | 525 | 28,150 |

**Richmond Bridge Daily Data by Peak Hour by Lane**

| Lane ID | Date | Week Counter | Peak Sum | Lane Type |
|---|---|---|---|---|
| 1 | 12/1/05 | 1 | 2016 | Carpool |
| 2 | 12/1/05 | 1 | 2174 | FasTrak |
| 3 | 12/1/05 | 1 | 2158 | Carpool |
| 4 | 12/1/05 | 1 | 2313 | Carpool |
| 5 | 12/1/05 | 1 | 7869 | FasTrak |
| 6 | 12/1/05 | 1 | 1125 | Carpool |
| 7 | 12/1/05 | 1 | 1194 | Cash/ETC |
| … | … | … | … | … |
| 8 | 11/28/14 | 475 | 1610 | Cash/ETC |
| 9 | 11/28/14 | 475 | 1512 | Cash/ETC |
| 10 | 11/28/14 | 475 | 1064 | Cash/ETC |

**Richmond Bridge Peak Data Summary**

| Week | Carpool | Cash/ETC | FasTrak | Grand Total |
|---|---|---|---|---|
| 2 | 43951 | 7066 | 56000 | 107017 |
| 3 | 43216 | 8008 | 55653 | 106877 |
| 4 | 39904 | 6866 | 47826 | 945 |
| 5 | 33086 | 5969 | 38216 | 77271 |
| 6 | 36657 | 6595 | 48026 | 91278 |
| 7 | 41958 | 6992 | 54412 | 103362 |
| … | … | … | … | … |
| 474 | 47513 | 23381 | 42591 | 113485 |
| 475 | 37970 | 23063 | 32793 | 93826 |
| **Grand Total** | **19831103** | **9993994** | **18409869** | **48234066** |

**Richmond Bridge Lane Changes Over Time**

| Effective Until | 8/18/07 | 6/9/15 | 1/1/15 |
|---|---|---|---|
| 1 | Carpool | Carpool | Carpool |
| 2 | FasTrak | FasTrak | FasTrak |
| 3 | Carpool | Carpool | FasTrak |
| 4 | Carpool | Cash/ETC | Cash/ETC |
| 5 | Carpool | Carpool | Carpool |
| 6 | Carpool | Carpool | Cash/ETC |
| 7 | Cash/ETC | Cash/ETC | Cash/ETC |

# Tables for Antioch Bridge

## Antioch Bridge Data Daily by Hour

| Date | Day | 0000 - 0100 | 0100 - 0200 | 0200 - 0300 | 0300 - 0400 | ... | 2100 - 2200 | 2200 - 2300 | 2300 - 2400 | Total Volume |
|---|---|---|---|---|---|---|---|---|---|---|
| 12/1/05 | Thursday | 42 | 27 | 13 | 34 | ... | 137 | 93 | 134 | 6,154 |
| 12/2/05 | Friday | 40 | 16 | 22 | 37 | ... | 231 | 142 | 63 | 7,968 |
| 12/3/05 | Saturday | 80 | 41 | 32 | 30 | ... | 181 | 174 | 58 | 6,765 |
| 12/4/05 | Sunday | 102 | 41 | 36 | 23 | ... | 173 | 117 | 68 | 5,408 |
| 12/5/05 | Monday | 39 | 19 | 15 | 29 | ... | 144 | 94 | 77 | 6,703 |
| 12/6/05 | Tuesday | 33 | 17 | 21 | 22 | ... | 128 | 96 | 75 | 7,038 |
| 12/7/05 | Wednesday | 42 | 26 | 20 | 30 | ... | 131 | 124 | 123 | 7,033 |
| ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 11/26/14 | Wednesday | 44 | 24 | 24 | 37 | ... | 198 | 123 | 83 | 8,137 |
| 11/27/14 | Thursday | 47 | 22 | 29 | 35 | ... | 501 | 287 | 148 | 9,816 |
| 11/28/14 | Friday | 95 | 48 | 27 | 22 | ... | 143 | 139 | 67 | 7,007 |
| 11/29/14 | Saturday | 46 | 38 | 20 | 20 | ... | 172 | 111 | 86 | 5,260 |
| 11/30/14 | Sunday | 43 | 38 | 21 | 23 | ... | 103 | 75 | 38 | 4,362 |

## Antioch Bridge Data Daily by Peak Hour by Lane

| Lane ID | Date | Week Counter | Peak Sum | Lane Type |
|---|---|---|---|---|
| 1 | 12/1/05 | 1 | 1,364 | Carpool |
| 2 | 12/1/05 | 1 | 1,146 | Cash/ETC |
| 3 | 12/1/05 | 1 | 1,159 | Carpool |
| 1 | 12/1/05 | 1 | 1,556 | Carpool |
| 2 | 12/1/05 | 1 | 1,656 | Cash/ETC |
| 3 | 12/1/05 | 1 | 1,252 | Carpool |
| 1 | 12/1/05 | 1 | 1,453 | Carpool |
| ... | ... | ... | ... | ... |
| 1 | 11/28/14 | 475 | 1,489 | Cash/ETC |
| 2 | 11/28/14 | 475 | 1,104 | FasTrak |
| 3 | 11/28/14 | 475 | 397 | Carpool |

### Antioch Bridge Peak Data Summary

| Week | Carpool | Cash/ETC | Grand Total |
|---|---|---|---|
| 2 | 14,102 | 7,551 | 21,653 |
| 3 | 15,296 | 7,807 | 21,664 |
| 4 | 12,509 | 6,895 | 19,404 |
| 5 | 11,105 | 6,370 | 17,475 |
| 6 | 11,621 | 6,248 | 17,869 |
| 7 | 13,735 | 7,188 | 20,923 |
| .. | …… | …… | …… |
| .. | …… | …… | …… |
| 474 | 9,387 | 7,544 | 16,931 |
| 475 | 10,031 | 6,866 | 16,897 |
| Grand Total | 3,807,548 | 16,69,172 | 8,364,911 |

### Antioch Bridge Lane Changes Over Time

| Effective Until | 6/9/10 | 1/1/15 |
|---|---|---|
| 1 | Carpool | Cash/ETC |
| 2 | Cash/ETC | FasTrak |
| 3 | Carpool | Carpool |

## Tables for Dumbarton Bridge

### Dumbarton Bridge Data Daily by Hour

| Date | Day | 0000 - 0100 | 0100 - 0200 | 0200 - 0300 | 0300 - 0400 | … | 2100 - 2200 | 2200 - 2300 | 2300 - 2400 | Total Volume |
|---|---|---|---|---|---|---|---|---|---|---|
| 1/1/06 | Sunday | 417 | 519 | 364 | 210 | … | 545 | 445 | 318 | 14,181 |
| 1/2/06 | Monday | 202 | 112 | 92 | 83 | … | 523 | 411 | 269 | 14,949 |
| 1/3/06 | Tuesday | 159 | 104 | 88 | 107 | … | 540 | 448 | 272 | 31,392 |
| 1/4/06 | Wednesday | 144 | 96 | 107 | 148 | … | 556 | 510 | 273 | 32,928 |
| 1/5/06 | Thursday | 144 | 89 | 101 | 137 | … | 531 | 564 | 395 | 33,597 |
| 1/6/06 | Friday | 132 | 109 | 101 | 168 | … | 622 | 599 | 426 | 33,765 |
| 1/7/06 | Saturday | 236 | 190 | 156 | 129 | … | 679 | 632 | 510 | 20,541 |
| … | … | … | … | … | … | … | … | … | … | … |
| 11/26/14 | Wednesday | 107 | 92 | 95 | 222 | … | 498 | 462 | 250 | 31,800 |
| 11/27/14 | Thursday | 147 | 105 | 89 | 87 | … | 1171 | 1017 | 648 | 17,927 |
| 11/28/14 | Friday | 339 | 168 | 111 | 127 | … | 602 | 500 | 322 | 19,012 |
| 11/29/14 | Saturday | 171 | 140 | 93 | 96 | … | 654 | 595 | 388 | 17,636 |
| 11/30/14 | Sunday | 230 | 133 | 96 | 79 | … | 558 | 401 | 217 | 15,029 |

## Dumbarton Bridge Data Daily by Peak Hour by Lane

| Lane ID | Date | Week Counter | Peak Sum | Lane Type |
|---|---|---|---|---|
| 1 | 1/2/06 | 1 | 700 | Cash/ETC |
| 2 | 1/2/06 | 1 | 951 | Cash/ETC |
| 3 | 1/2/06 | 1 | 1,304 | Cash/ETC |
| 4 | 1/2/06 | 1 | 759 | Cash/ETC |
| … | … | … | … | … |
| 5 | 11/28/14 | 475 | 2,417 | FasTrak |
| 6 | 11/28/14 | 475 | 1,473 | FasTrak |
| 7 | 11/28/14 | 475 | 1,263 | Carpool |

## Dumbarton Bridge Peak Data Summary

| Week | Carpool | FasTrak | Cash/ETC | Grand Total |
|---|---|---|---|---|
| 1 | 20781 | 37100 | 38709 | 96590 |
| 2 | 24175 | 46081 | 46390 | 116646 |
| 3 | 22804 | 42852 | 44147 | 109803 |
| 4 | 24715 | 46747 | 47180 | 117642 |
| 5 | 24535 | 46670 | 45509 | 116714 |
| 6 | 14930 | 46773 | 46442 | 108145 |
| … | … | … | … | … |
| 467 | 18799 | 68194 | 62508 | 129404 |
| 468 | 18151 | 67562 | 59485 | 125319 |
| 469 | 18742 | 68130 | 60307 | 128278 |
| 470 | 12599 | 43786 | 50898 | 86621 |
| **Grand Total** | **9471680** | **25070131** | **16932869** | **51474680** |

## Dumbarton Bridge Lane Changes over time

| Effective Until | 7/17/14 |
|---|---|
| 1 | Cash/ETC |
| 2 | Cash/ETC |
| 7 | Cash/ETC |
| 4 | Cash/ETC |
| 5 | FasTrak |
| 6 | FasTrak |
| 7 | Carpool |

# Tables for Benicia Bridge

## Benicia Bridge Data Daily by Hour

| Date | Day | 0000-0100 | 0100-0200 | 0200-0300 | 0300-0400 | … | 2100-2200 | 2200-2300 | 2300-2400 | Total Volume |
|---|---|---|---|---|---|---|---|---|---|---|
| 12/1/05 | Thursday | 456 | 258 | 178 | 218 | … | 1594 | 1176 | 755 | 46,334 |
| 12/2/05 | Friday | 486 | 261 | 190 | 240 | … | 2045 | 1508 | 1291 | 52,911 |
| 12/3/05 | Saturday | 823 | 450 | 339 | 242 | … | 1793 | 1710 | 1301 | 46,537 |
| 12/4/05 | Sunday | 875 | 519 | 352 | 239 | … | 1488 | 951 | 673 | 36,988 |
| 12/5/05 | Monday | 398 | 197 | 168 | 194 | … | 1441 | 1022 | 632 | 47,422 |
| 12/6/05 | Tuesday | 456 | 218 | 164 | 171 | … | 1605 | 1148 | 714 | 49,587 |
| 12/7/05 | Wednesday | 444 | 227 | 178 | 198 | … | 1603 | 1308 | 892 | 49,832 |
| … | … | … | … | … | … | … | … | … | … | … |
| 11/26/14 | Wednesday | 548 | 328 | 255 | 264 | … | 2334 | 1682 | 1134 | 64,843 |
| 11/27/14 | Thursday | 829 | 432 | 355 | 273 | … | 3538 | 2370 | 1720 | 57,605 |
| 11/28/14 | Friday | 1001 | 455 | 333 | 273 | … | 1866 | 1497 | 1009 | 53,214 |
| 11/29/14 | Saturday | 547 | 409 | 254 | 242 | … | 1770 | 1526 | 1215 | 46,330 |
| 11/30/14 | Sunday | 685 | 510 | 284 | 214 | … | 1469 | 1015 | 663 | 41,076 |

## Benicia Bridge Data Daily by Peak Hour by Lane

| Lane ID | Date | Week Counter | Peak Sum | Lane Type |
|---|---|---|---|---|
| 1 | 12/1/05 | 1 | 1668 | Cash/ETC |
| 2 | 12/1/05 | 1 | 1703 | Cash/ETC |
| 3 | 12/1/05 | 1 | 1970 | Carpool |
| 4 | 12/1/05 | 1 | 2405 | Carpool |
| 5 | 12/1/05 | 1 | 2453 | Carpool |
| 6 | 12/1/05 | 1 | 9311 | FasTrak |
| 7 | 12/1/05 | 1 | 2123 | Cash/ETC |
| … | … | … | … | … |
| 8 | 11/28/14 | 475 | 0 | Vio Shoulder |
| 9 | 11/28/14 | 475 | 1064 | Carpool |
| 10 | 11/28/14 | 475 | 1 | Vio Shoulder |

## Benicia Bridge Peak Data Summary

| Week | Carpool | Cash/ETC | FasTrak | Grand Total |
|---|---|---|---|---|
| 1 | 14384 | 18812 | 18245 | 51441 |
| 2 | 37667 | 50786 | 48220 | 136673 |

| | | | | |
|---|---|---|---|---|
| 3 | 38923 | 51178 | 48933 | 139034 |
| 4 | 46324 | 5969 | 41430 | 125387 |
| 5 | 40051 | 44332 | 34224 | 118607 |
| 6 | 36124 | 44490 | 41759 | 122373 |
| … | … | … | … | … |
| 474 | 330 | 24150 | 0 | 113485 |
| 475 | 325 | 29660 | 0 | 93826 |
| **Grand Total** | **5093911** | **18011406** | **4380072** | **66524968** |

**Benicia Bridge Lane Changes Over Time**

| Effective Until | 8/25/07 | 1/1/15 |
|---|---|---|
| 1 | Cash/ETC | Cash/ETC |
| 2 | Cash/ETC | Cash/ETC |
| 3 | Carpool | Carpool |
| 4 | Carpool | Cash/ETC |
| 5 | Carpool | Cash/ETC |
| 6 | FasTrak | Cash/ETC |
| 7 | Cash/ETC | Cash/ETC |
| 8 | Cash/ETC | Cash/ETC |
| 9 | Cash/ETC | Cash/ETC |
| 10 | Via Shoulder | Via Shoulder |
| 11 | Via Shoulder | Via Shoulder |
| 12 | Cash/ETC | FasTrak |
| 13 | Cash/ETC | FasTrak |
| 14 | Via Shoulder | Via Shoulder |
| 15 | Via Shoulder | Via Shoulder |
| 16 | Via Shoulder | Via Shoulder |
| 17 | Carpool | Carpool |
| 18 | Via Shoulder | Via Shoulder |
| | | |

The tables below show how the distribution of the three lanes (Cash/ETC, FasTrak, Carpool) has changed over time across all seven Bay Area bridges.

## Summary of lane distribution on San Francisco Oakland Bridge at Different Time Intervals

| San Francisco Oakland Bridge | | | | | | |
|---|---|---|---|---|---|---|
| | **2005** | **2006** | **2007** | **2010** | **2013** | **2015** |
| **Cash/ETC** | 13 | 12 | 11 | 12 | 10 | 9 |
| **FasTrak** | 5 | 6 | 7 | 4 | 6 | 7 |
| **Carpool** | 4 | 4 | 4 | 4 | 4 | 4 |

## Summary of lane distribution on other Bay Area bridges at Different Time Intervals

| | **San Mateo Bridge** | | **Richmond Bridge** | | **Dumbarton Bridge** | | **Carquinez Bridge** | | **Benicia Bridge** | | **Antioch Bridge** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **2007** | **2015** | **2007** | **2015** | **2007** | **2014** | **2007** | **2015** | **2007** | **2015** | **2010** | **2015** |
| **Cash / ETC** | 6 | 5 | 1 | 3 | 4 | 4 | 5 | 7 | 7 | 8 | 1 | 1 |
| **FasTrak** | 2 | 3 | 2 | 1 | 1 | 2 | 3 | 3 | 1 | 2 | 0 | 1 |
| **Carpool** | 2 | 2 | 4 | 3 | 1 | 1 | 4 | 2 | 4 | 2 | 2 | 1 |

## Section 5: Forecasting post 2014

FasTrak usage rates were forecast using the TBATS model described in the main paper for the remaining six State-owned bridges (2010-2016). Figures 5.1-5.6 depict the actual data (black) and the forecasts (blue). There are three panels for each bridge that correspond to FasTrak usage rates for all lanes (Carpool, Cash/ETC, FasTrak only). The 80% (dark) and 95% (light) confidence intervals are plotted alongside the two-year forecasts. The complex seasonality TBATS model is able to pick up trends and seasonal patterns in data quite well for long-term forecasting. Peaks are observed in the summer months and troughs during winter.

**Figure 5.1**: Corresponds to the Antioch Bridge. The mean of forecasts for the carpool lane is around 12%, whereas the mean of the forecasts for Cash/ETC and FasTrak lanes are around 46% and 44%. FasTrak-only lane data was only available in late 2010.

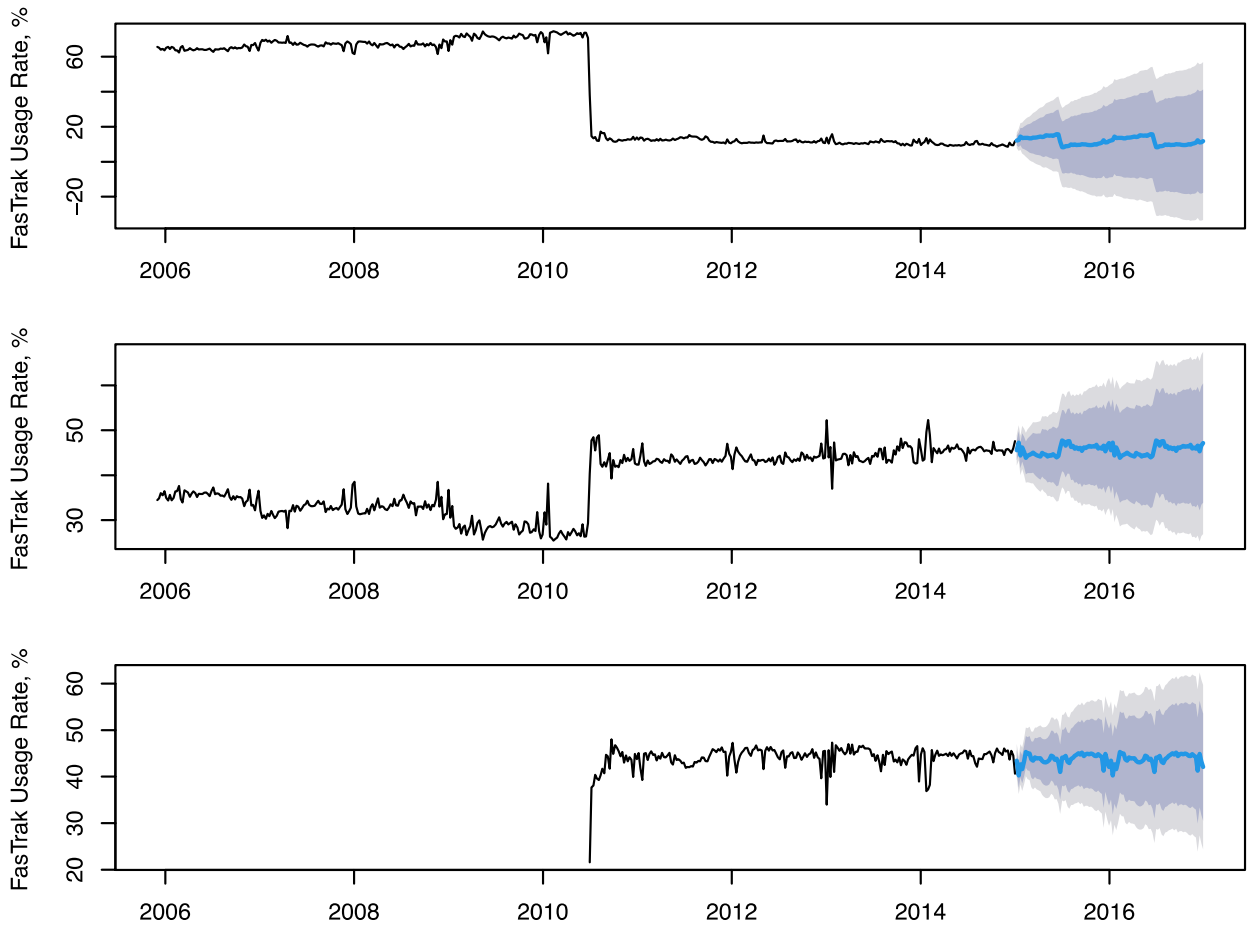


**Figure 5.2**: Corresponds to the Benicia Bridge. The mean of forecasts for the carpool lane is around 4.3%, whereas the means of the forecasts for the Cash/ETC and FasTrak lanes are around 33% and 67%, respectively.

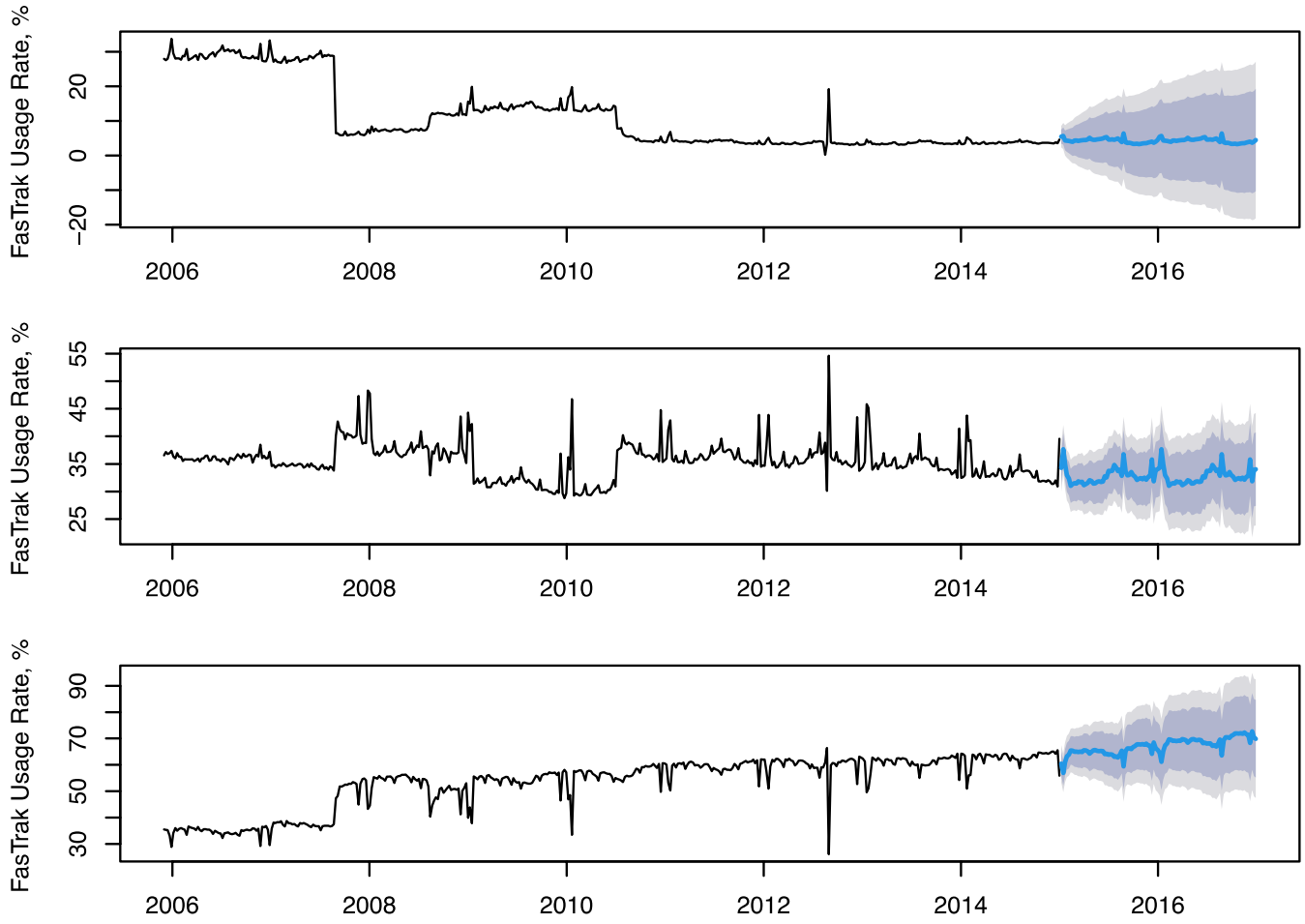


**Figure 5.3**: Corresponds to the Carquinez Bridge. The mean of forecasts for the carpool lane is around 5%, whereas the means of the forecasts for the Cash/ETC and FasTrak lanes are around 48% and 47%, respectively.

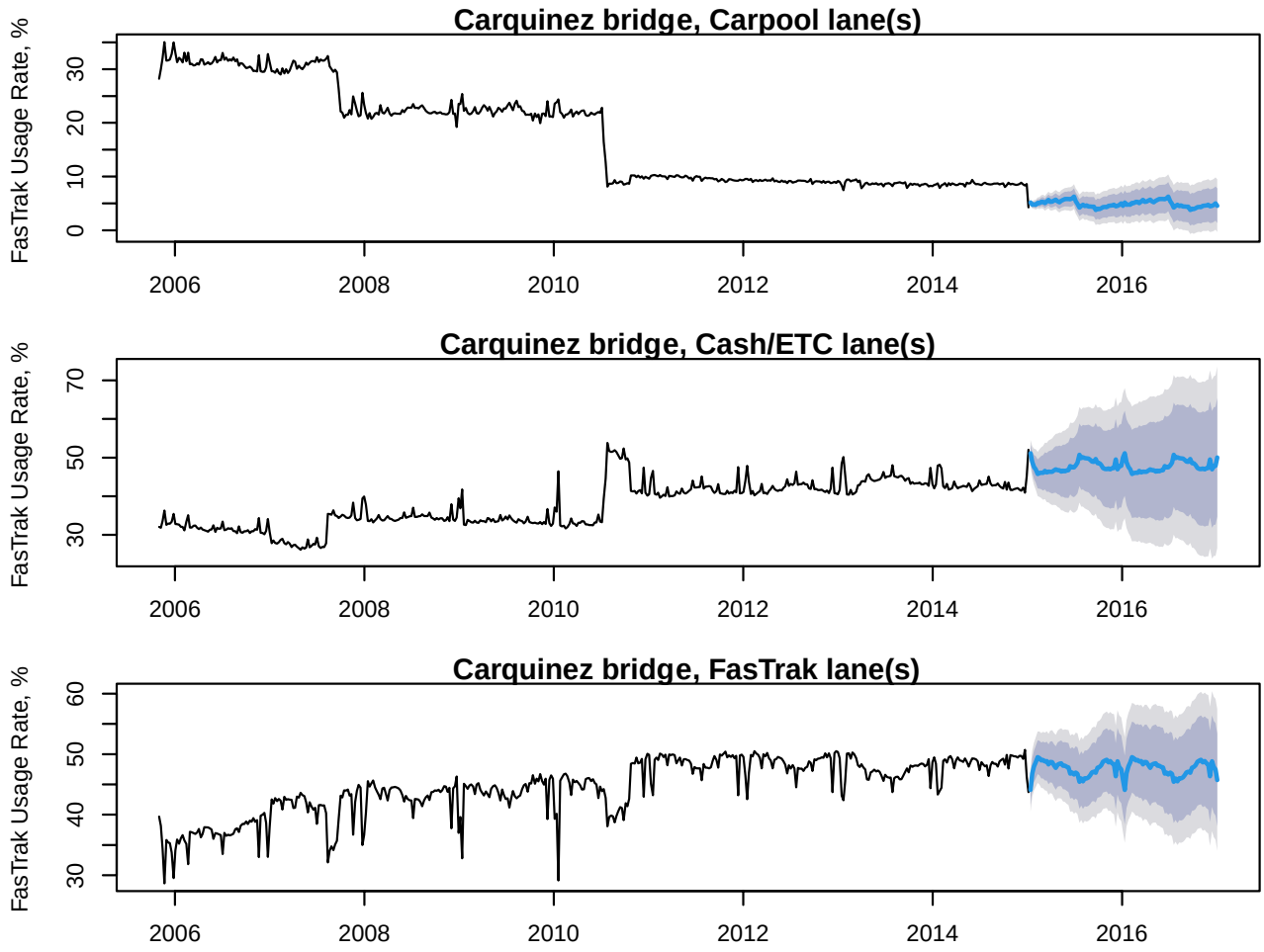


**Figure 5.4**: Corresponds to the Dumbarton Bridge. The mean of forecasts for the carpool lane is around 15%, whereas the means of the forecasts for the Cash/ETC and FasTrak lanes are around 33% and 53%, respectively.

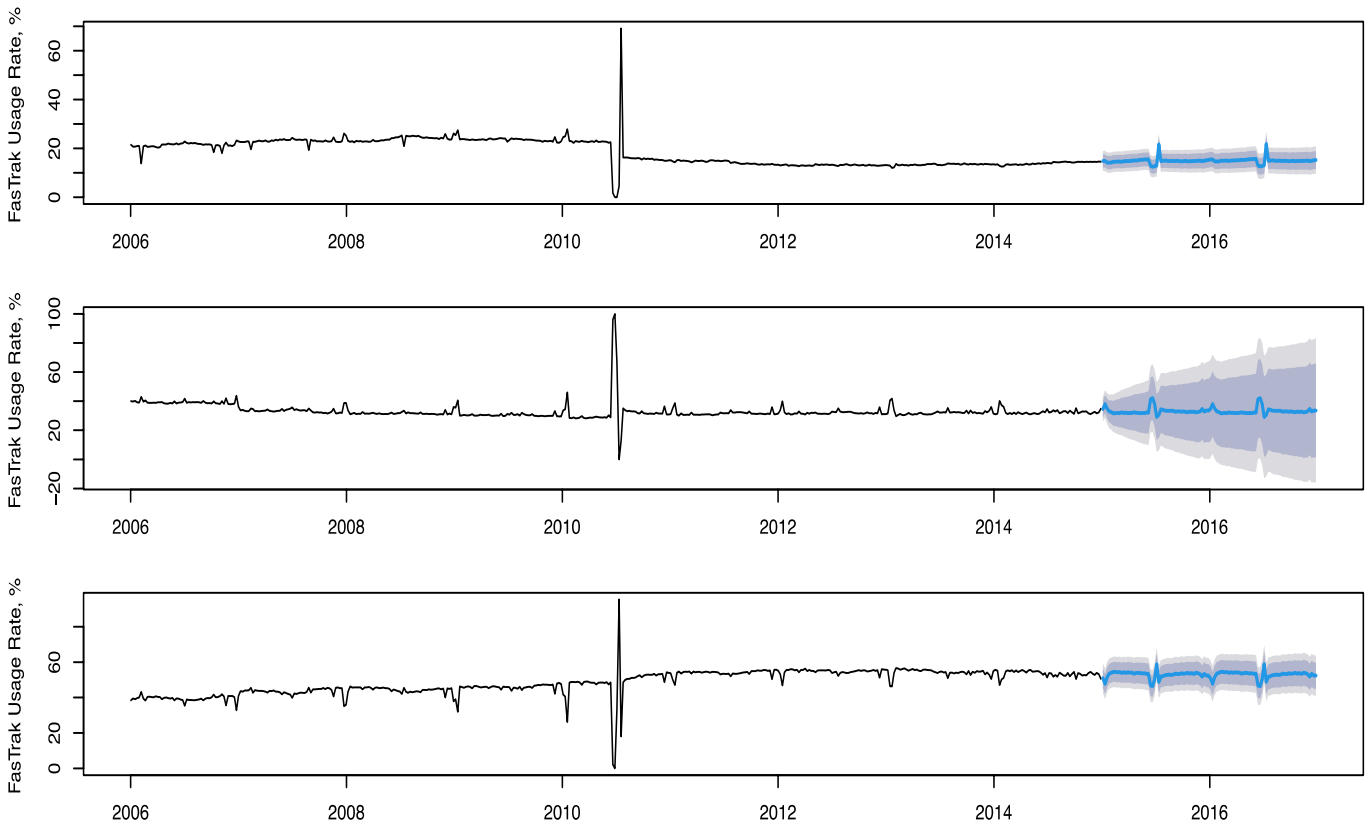


**Figure 5.5**: Corresponds to the Richmond Bridge. The mean of forecasts for the carpool lane is around 41%, whereas the means of the forecasts for the Cash/ETC and FasTrak lanes are around 23% and 36%, respectively.

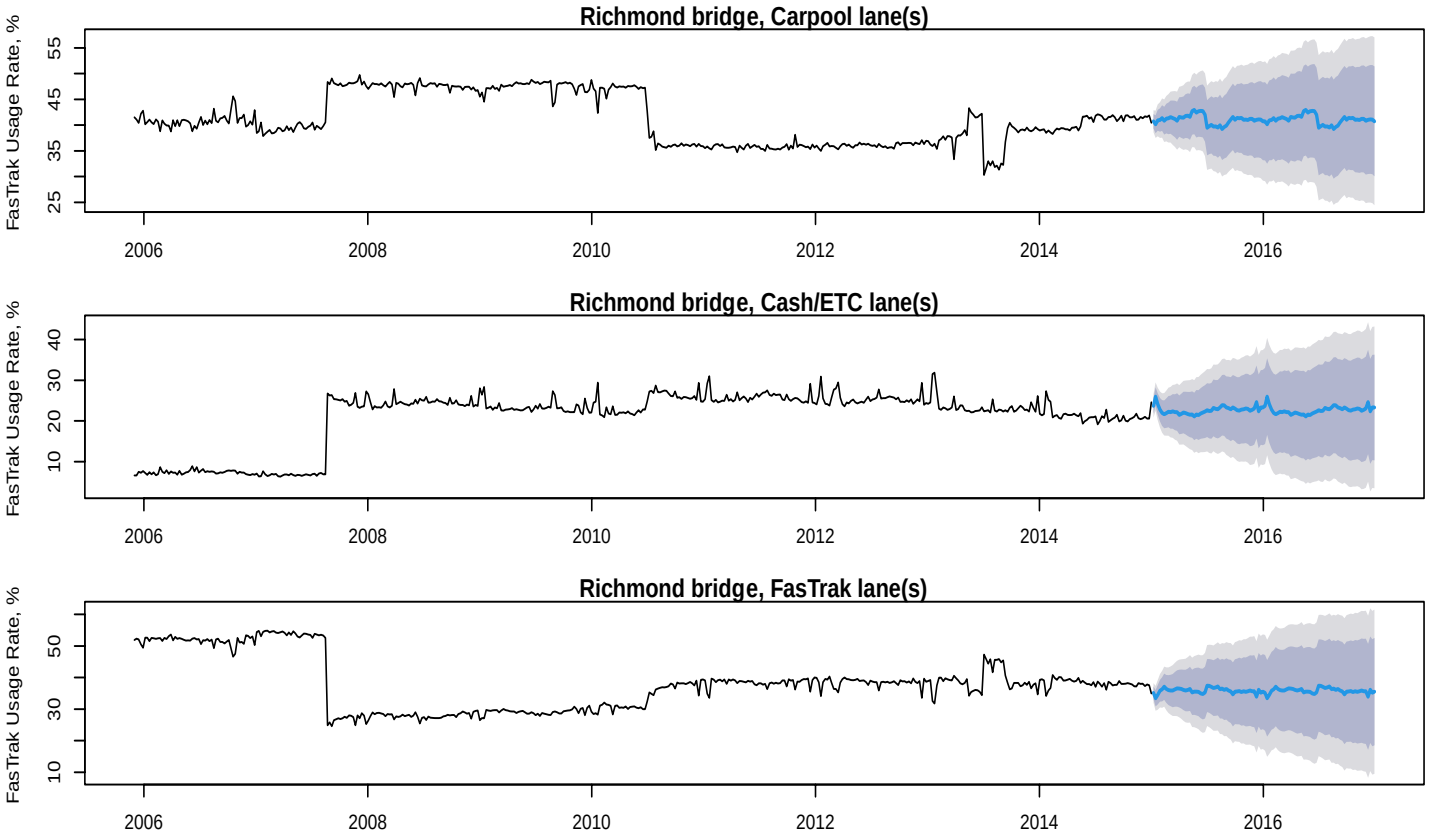


**Figure 5.6**: Corresponds to the San Mateo Bridge. The mean of forecasts for the carpool lane is around 17%, whereas the means of the forecasts for the Cash/ETC and FasTrak lanes are around 29% and 54%, respectively.

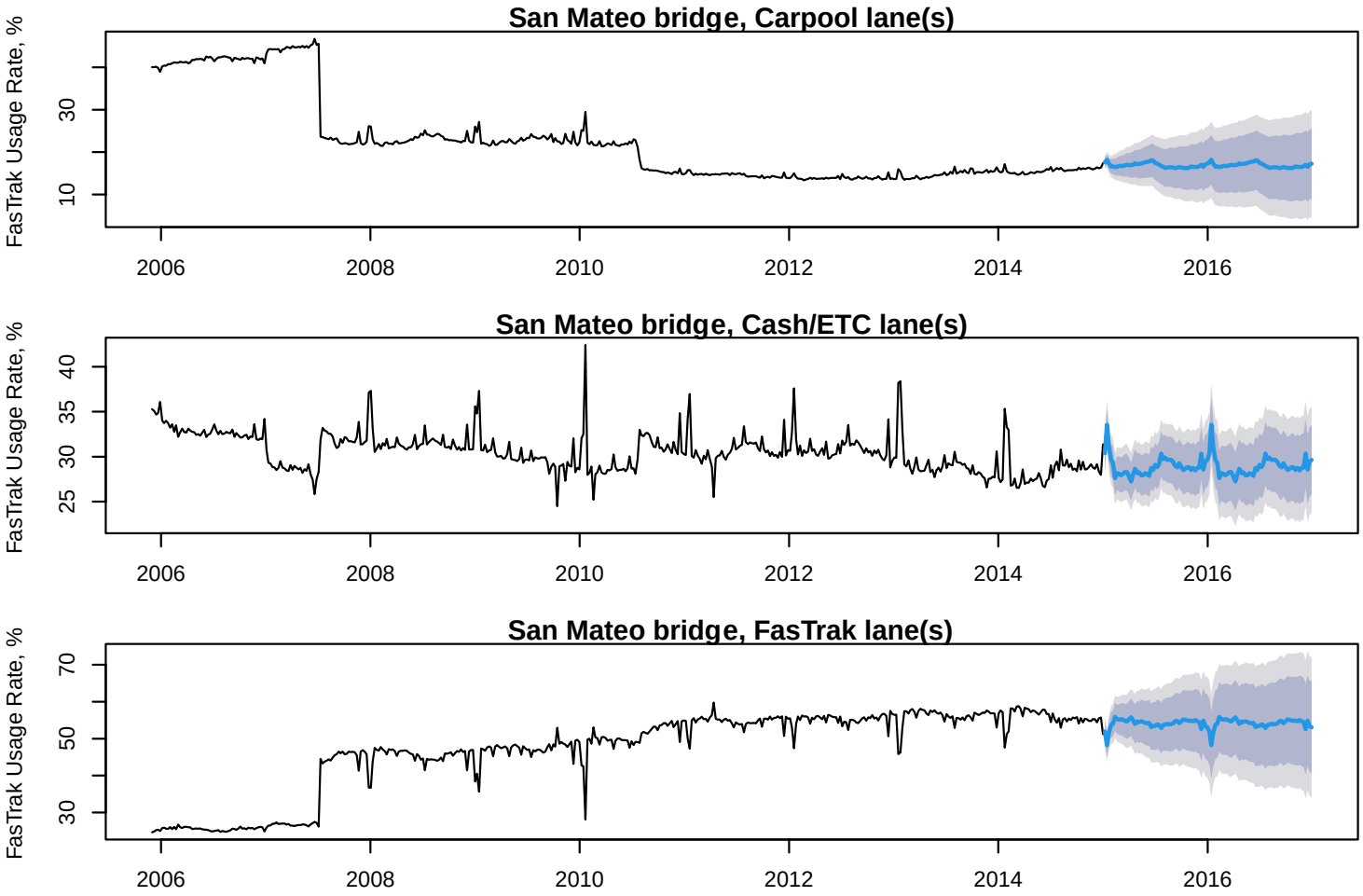
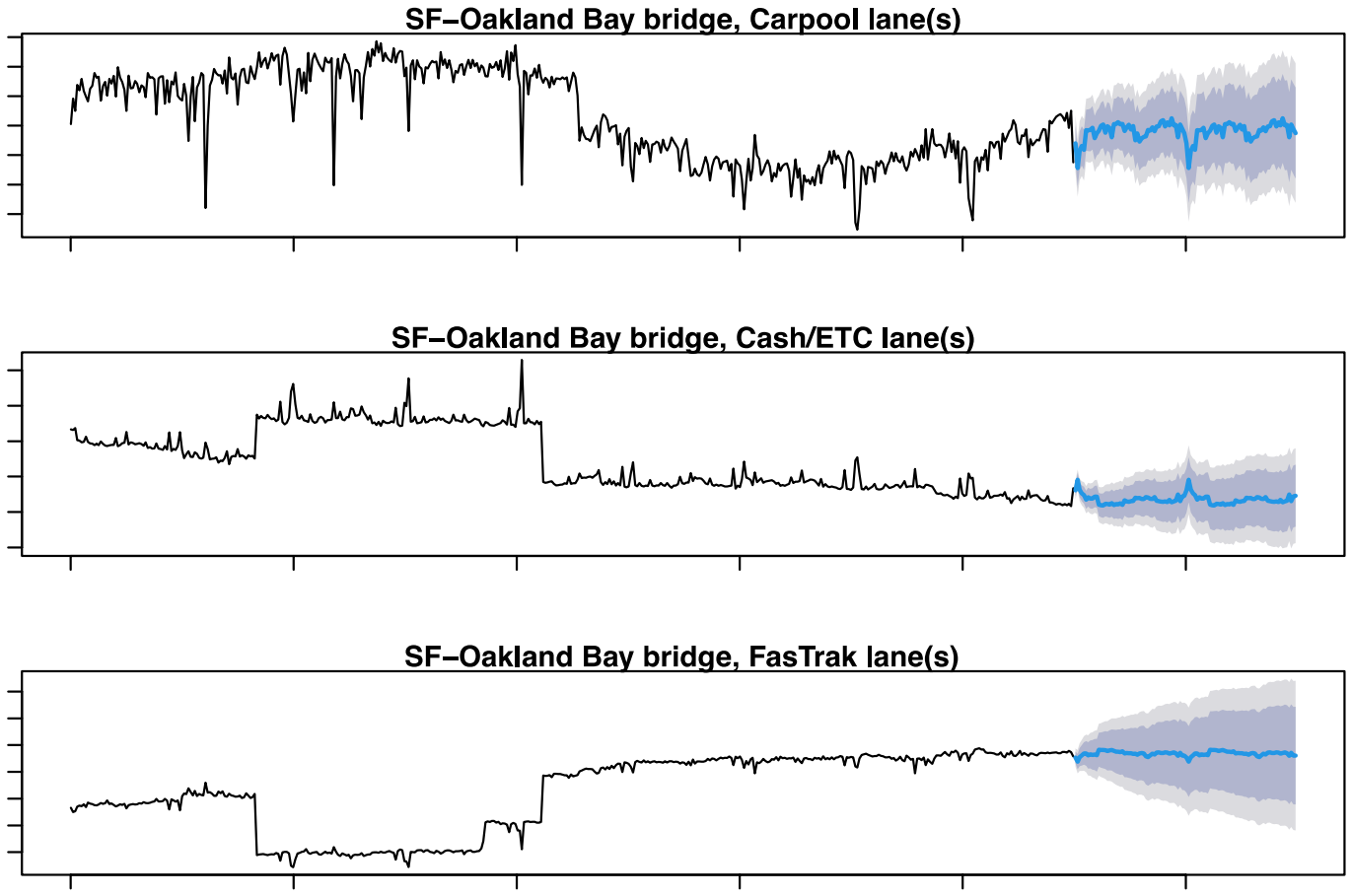


**Figure 5.7**: Corresponds to the SF-Oakland Bay Bridge. The mean of forecasts for the carpool lane is around 20%, whereas the means of the forecasts for the Cash/ETC and FasTrak lanes are around 24% and 57%, respectively.



## Section 6: Detailed Implementation of Recommendations

### Implementation of Recommendations in Year 2007

MTC began trying to implement the recommendations in the FasTrak Strategic plan starting in January 2007. The process of lengthening of FasTrak lanes occurred over the summer of 2007. Even though this was a simple and not a time-consuming process, the return was extremely beneficial. The first two bridges to accommodate these updates were the Antioch and San Mateo-Hayward Bridges. Antioch Bridge, the least traveled among all the bridges, did not get a new FasTrak lane. However, the already existing lane was extended from a mere 300 feet to 2000 feet. The San Mateo-Hayward Bridge got a new FasTrak lane, and all of its FasTrak lanes were extended to 4000 feet. During late summer 2007, similar changes were made to the Benicia-Martinez, Dumbarton, Carquinez, and Richmond-San Rafael Bridges. The biggest transformation was at the Benicia-Martinez crossing, which operated the first state-of-the-art toll plaza employing open-road tolling technology in Northern California. FasTrak Express, the twin open-road tolling lanes, allowed drivers to pass through the toll area at normal highway speeds without slowing down. The last to be converted was the San Francisco-Oakland Bay Bridge, the busiest of them all. A FasTrak-only lane was added, and all FasTrak lanes were extended to about 2700 feet. The FasTrak-only lanes were strategically clustered in the center to accommodate commuters from both Interstates 80 and 580.

New signage on the approaches to the state-owned bridges to separate cash payers and FasTrak customers farther in advance of the toll plazas helped organize the traffic ahead of time, thereby reducing bottlenecks at the toll plazas. Despite measures taken to incentivize commuters about FasTrak, weekend traffic required special consideration. With cash lanes increasingly converted to FasTrak lanes, weekend traffic with many travelers not carrying FasTrak started to experience longer delays. Most bridges had a few FasTrak-only lanes converted to Cash/FasTrak lanes during the weekend and non-peak hours for greater utilization.

### Actual FasTrak Usage (2007-2008) after implementation of the Recommendations in Year 2007

The impact of these recommendations on specific bridges shows in the FasTrak Strategic Plan. A discussion on four bridges that account for 75% of the total traffic across all the seven Bay bridges is presented. These include the Benicia-Martinez Bridge (15% of the traffic), Richmond-San Rafael Bridge (10% of the traffic), San Mateo-Hayward Bridge (13% of the traffic), and the San Francisco-Oakland Bay Bridge (35% of the traffic). The increases in usage rates of the Benicia-Martinez Bridge for 2005, 2006, 2007, and the first two quarters

of 2008 were -0.7%, 3.23%, 9.29%, and 4.51%, respectively. The increase in usage rates for 2005, 2006, 2007, and the first two quarters of 2008 for the Richmond-San Rafael Bridge were 0.3%, 4.39%, 7.98%, and 0.85%. Similarly, the increase in usage rates for the San Mateo-Hayward Bridge for 2005, 2006, 2007, and first two quarters of 2008 were 0.17%, 4.22%, 4.59%, and 2.35%. The increase in usage rate for the San Bay Bridge for 2005, 2006, 2007, and the first two quarters of 2008 were 4.54%, 6.09%, 4.46% and 1.18%.

The below tables present the analysis of the actual usage rates achieved at important time snapshots, specifically Quarter 1 of 2002 and Quarter 4 of 2006, as these two points guide the average increase in usage rates/year before the recommendations. To show the impact of this implementation, data on FasTrak usage rates for Quarter 4 of 2007 and the increase in usage rate/year (Quarter 4 of 2006 through Quarter 4 of 2007) are presented. Data for Quarter 2 of 2008 show continued growth beyond Quarter 4 of 2007.

**Analysis of an "Increase in Usage Rates/year" before and after this study,**

**pp = percentage points**

| Quarter | All State-Owned Bridges | Antioch peak) | Benicia-Martinez (peak) | Carquinez (peak) | Dumbarton (peak) | Richmond - San Rafael (peak) | SF-Oakland Bay (peak) | San Mateo-Hayward peak) |
|---|---|---|---|---|---|---|---|---|
| Qtr. 1 2002 | 27.40% | 18.62% | 29.65% | 28.07% | 36.92% | 30.18% | 21.76% | 26.62% |
| Qtr. 4 2006 | 42.70% | 35.68% | 44.97% | 38.54% | 44.55% | 45.13% | 47.29% | 42.75% |
| ↑ in Usage (5 Yrs., pp) | 15.30 | 17.06 | 15.32 | 10.47 | 7.63 | 14.95 | 25.53 | 16.13 |
| Avg. ↑ in Usage / Year (pp) | 3.06 | 3.41 | 3.06 | 2.09 | 1.53 | 2.99 | 5.11 | 3.23 |

| Quarter | All State-Owned Bridges | Antioch (peak) | Benicia-Martinez (peak) | Carquinez (peak) | Dumbarton (peak) | Richmond-San Rafael (peak) | SF-Oakland Bay (peak) | San Mateo-Hayward (peak) |
|---|---|---|---|---|---|---|---|---|
| Qtr. 4 2006 | 42.70% | 35.68% | 44.97% | 38.54% | 44.55% | 45.13% | 47.29% | 42.75% |
| Qtr. 4 2007 | 45.75% | 38.90% | 54.26% | 41.21% | 47.70% | 53.11% | 51.76% | 47.34% |
| ↑ in Usage in 1 yr. (pp/year) | 5.05 | 3.22 | 9.29 | 2.67 | 3.15 | 7.98 | 4.47 | 4.59 |

| Quarter | All State - Owned Bridges | Antioch (peak) | Benicia-Martinez (peak) | Carquinez (peak) | Dumbarton (peak) | Richmond-San Rafael (peak) | SF-Oakland Bay (peak) | San Mateo - Hayward (peak) |
|---|---|---|---|---|---|---|---|---|
| Qtr. 2 2008 | 49.35% | 40.87% | 56.98% | 41.83% | 49.20% | 53.96% | 52.93% | 49.69% |

**Implementation of Recommendations in Year 2011-2012**

Based on the implementation of the recommendations from 2007, the usage rates of FasTrak improved. It was further recommended in 2010 that MTC should offer permanent discounts of $1 for FasTrak commuters (i.e.

25% discount), like the ETC systems in other parts of the United States. In the year 2010, when the bridge tolls in the Bay Area went up from $4 to $5 on all bridges, congestion pricing was introduced on the San Francisco-Oakland Bay Bridge ($4 to $6; the toll was $4 during weekday non-peak hours, $6 during weekday peak periods, and $5 all day on weekends). In addition, a 60% discount during peak hours was provided for carpool commuters on all bridges using FasTrak. It had been free for a commuter to use a carpool lane before 2010, but starting in 2010, commuters had to pay $2.50 (Bay Bridge) or $2 (all other bridges) to use a carpool lane after discounts for carpoolers. In comparison, a commuter using regular FasTrak lane paid $6 on the Bay Bridge and $5 on all other bridges in the peak hours on weekdays. This encouraged users to switch to carpool lanes from 2010. The reconfiguration of carpool lanes into FasTrak lanes took place on many of the bridges, and the number of carpool lanes increased on some bridges. This significantly improved the FasTrak usage rates on the Bay Bridge, from 52.83% in 2008-2009 to 63.47% in 2011-2012. The Bay Bridge achieved 70% FasTrak usage in 2014-2015 and stood at 73% usage in 2016-2017. For toll traffic across all bridges combined, the FasTrak usage rates improved from 50.21% in 2008-2009 to 59.46% in 2011-2012, standing at almost 70% (68.61%) for all bridges combined in 2016-2017.

| Fiscal Year | San Francisco Oakland Bay | San Mateo Hayward | Dumbarton | Carquinez | Benicia Martinez | Antioch | Richmond San Rafael | All Bridges Totals |
|---|---|---|---|---|---|---|---|---|
| **08 - 09** | 52.83% | 51.18% | 49.74% | 44.04% | 49.33% | 38.07% | 54.35% | 50.21% |
| **09 - 10** | 55.13% | 53.95% | 52.18% | 45.61% | 51.46% | 39.81% | 56.79% | 52.44% |
| **10 - 11** | 62.28% | 60.75% | 59.69% | 50.63% | 55.05% | 44.00% | 59.83% | 58.32% |
| **11 - 12** | 63.47% | 61.65% | 60.67% | 51.76% | 56.29% | 44.72% | 60.97% | 59.46% |
| **12 - 13** | 64.36% | 62.71% | 61.35% | 52.70% | 56.99% | 45.60% | 62.53% | 60.43% |
| **13 - 14** | 67.69% | 65.01% | 62.97% | 55.23% | 59.06% | 47.60% | 66.35% | 63.20% |
| **14 - 15** | 69.78% | 66.64% | 64.98% | 57.35% | 60.99% | 48.77% | 68.08% | 65.13% |
| **15 - 16** | 71.45% | 68.61% | 66.91% | 59.14% | 62.75% | 50.94% | 69.57% | 66.84% |
| **16 - 17** | 73.03% | 70.90% | 68.69% | 61.15% | 64.63% | 53.98% | 70.96% | 68.61% |