

Planning Ahead:
Forecasting US Airways'
international passenger traffic in
PHOENIX

*How does historical information and other hubs'
performance influence prediction?*

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Agenda

- * Our Research Goals
- * Stakeholder Analysis
- * Our Data Analysis
- * Visualizing the Concepts
- * Benchmarking: Naïve Forecast
- * Methods Considered and Chosen
- * The Chosen Model's Performance
- * Forecasts and Useful Prediction Intervals

Research Goals

- * **CONTEXT:** Limited historic data on international traffic in Phoenix
- * **GOALS:**
 - * Understand the trends that describe international passenger traffic Phoenix
 - * Determine whether Phoenix is similar to other hubs
 - * Determine whether traffic at other hubs can be used to better predict Phoenix traffic

Stakeholder Analysis

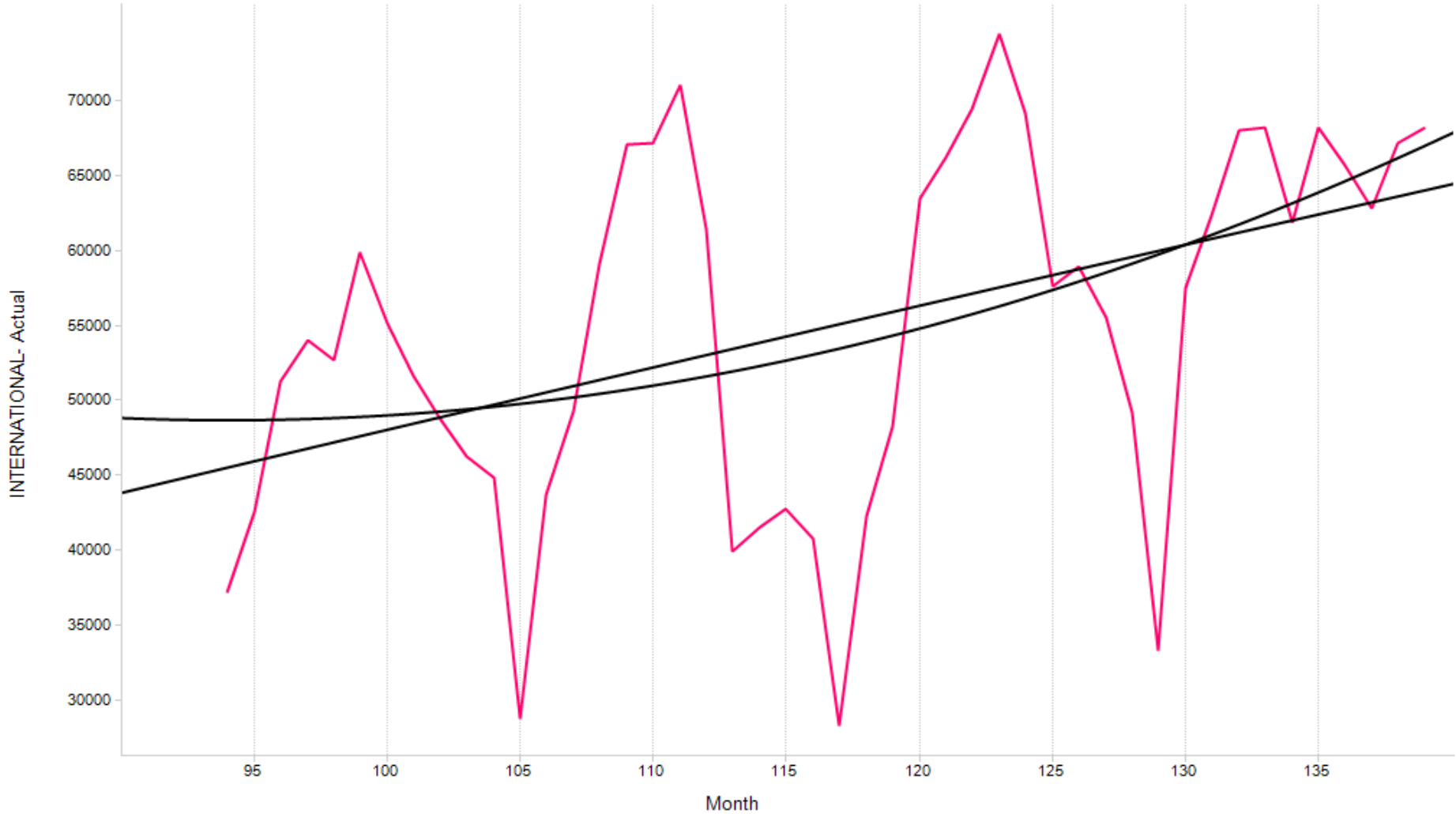
- * Key Stakeholder: U.S. Airways
 - * Optimal resource utilization for ground crews and other airport staff
- * Other stakeholders: Secondary service providers and airport facility advisors

Data Analysis

- * Forecasted international passenger traffic in Phoenix, Philadelphia, Charlotte
- * Tested MLR, Polynomial, Holt-Winter's Smoothing and Ensemble methods
- * Benchmarked all models against the Naïve forecast

Visualizing the Data

US Airways International Passengers - Phoenix



Breaking Headlines Spring 2011:

U.S. - US

Texas Officials Warn Students Not to Travel to Mexico for Spring Break

Published March 02, 2011 | FoxNews.com



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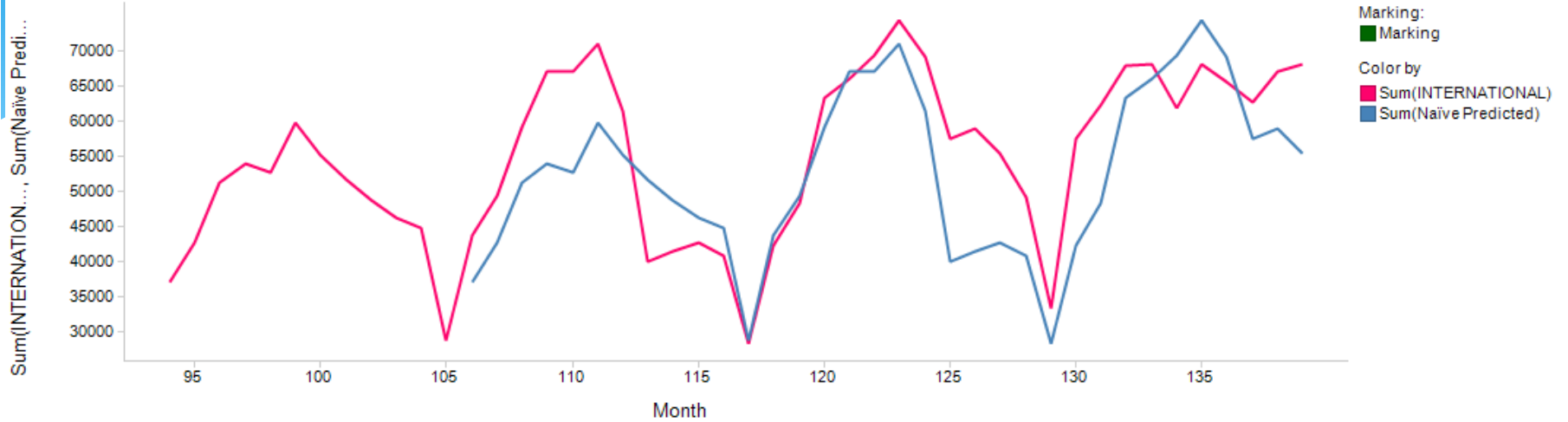
The Texas Department of Public Safety has issued a travel warning to college students on spring break, urging them not to travel to Mexico, MyFoxAustin.com reports.

Authorities are pointing to several recent incidents of drug-related violence in the country, including the murders of a U.S. Immigration and Customs Enforcement agent and two El Paso boys last month.

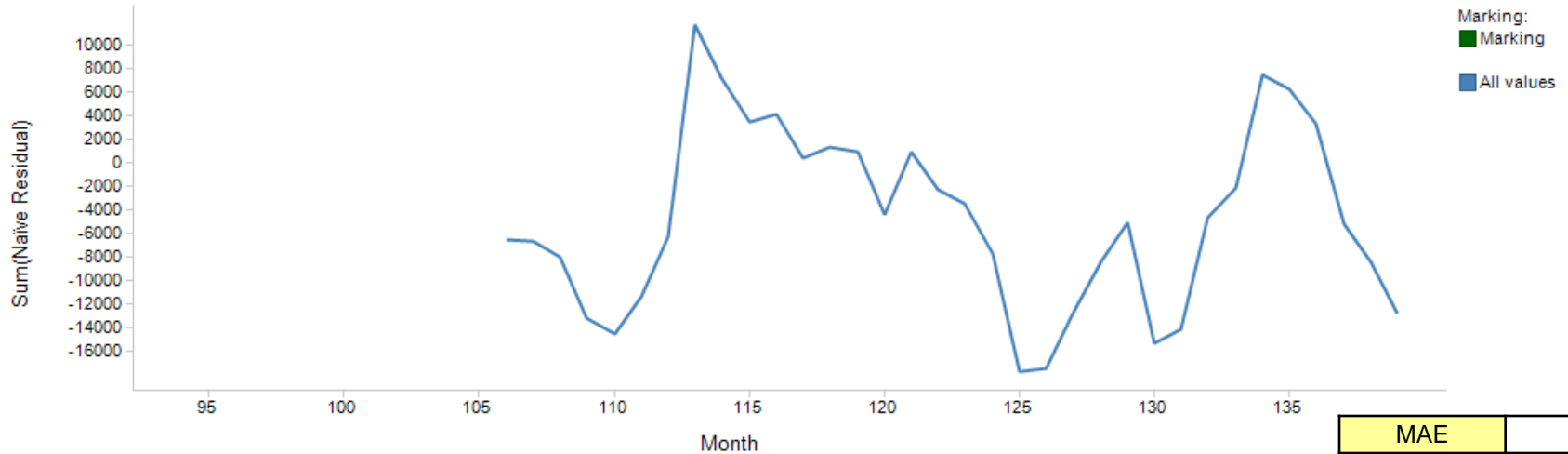
DPS Assistant Chief Tom Vinger said many American students feel invincible while vacationing in popular spring break destinations, like Cancun or Acapulco.

Benchmarking: Naïve Forecast

Naive vs. Actual



Residuals



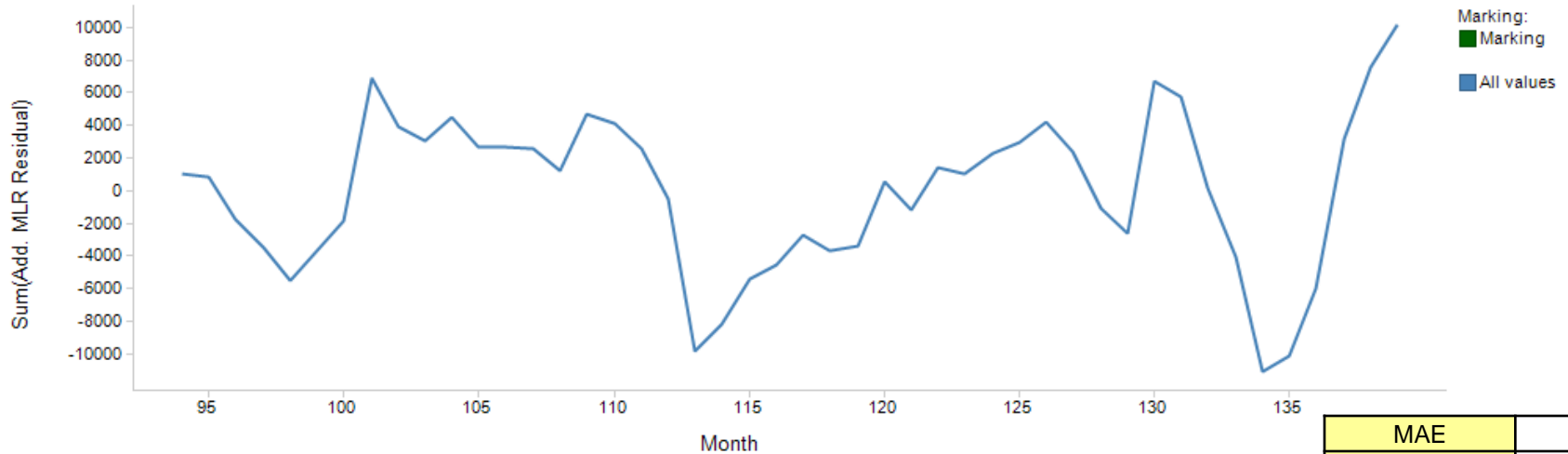
MAE	7,732.50
Avg. Error	(4,870.33)
MAPE	13.07%
RMSE	8,744.07

Considered Method (1/4) - Additive MLR

Additive MLR vs. Actual



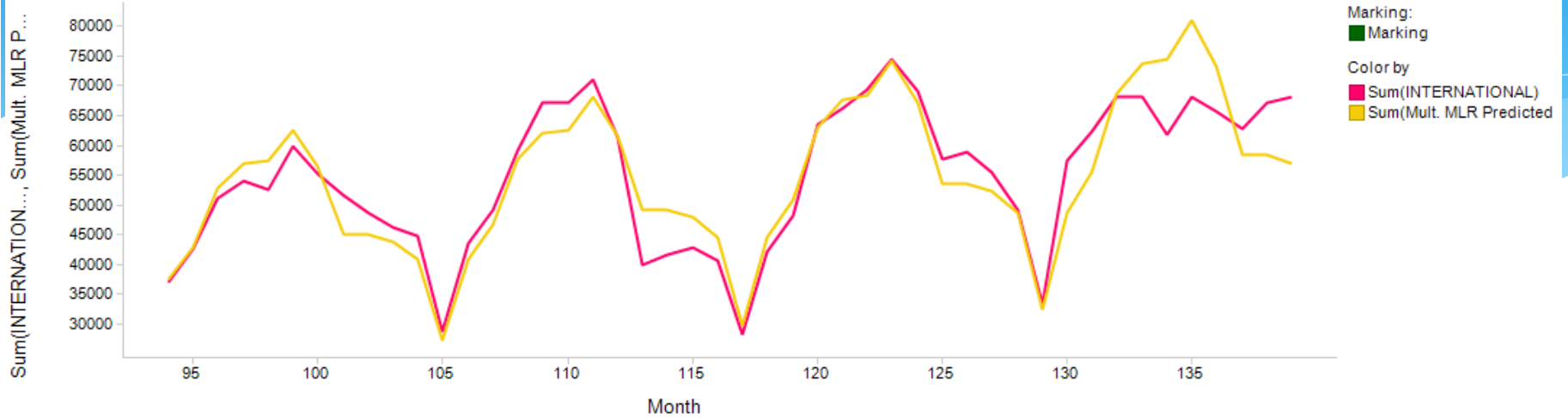
Residuals



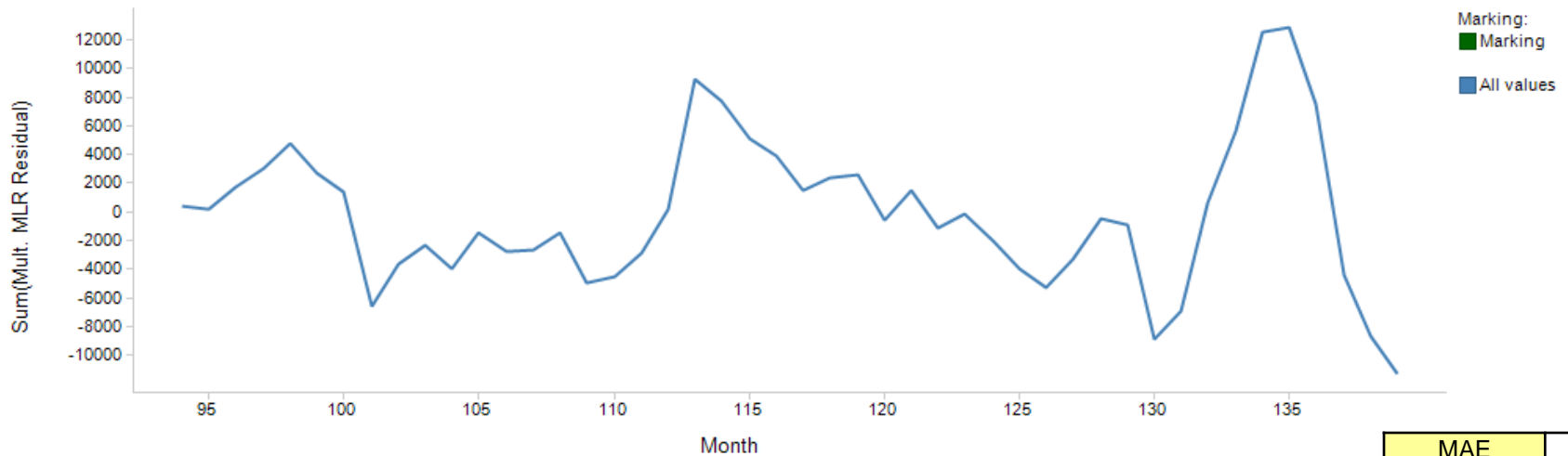
MAE	5,711.19
Avg. Error	(113.12)
MAPE	9.19%
RMSE	6,674.69

Considered Method (2/4) - Multiplicative MLR

Multiplicative MLR vs. Actual



Residuals



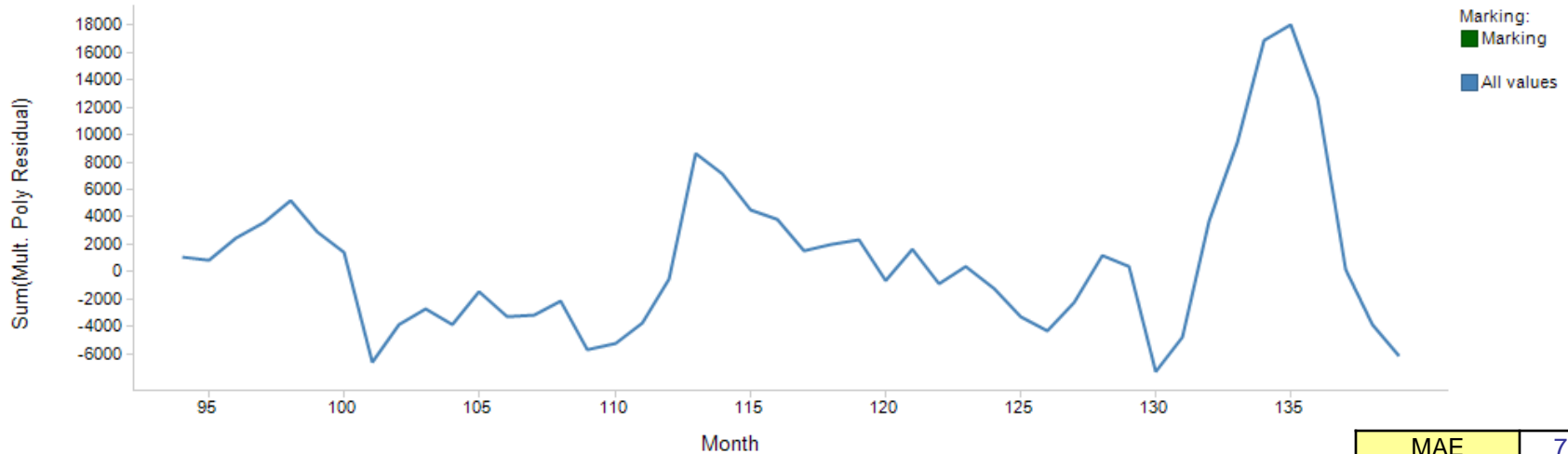
MAE	6,718.70
Avg. Error	187.99
MAPE	10.51%
RMSE	7,966.12

Methods Considered (3/4) - 2nd Degree Polynomial

2nd Degree Polynomial vs. Actual



Residuals



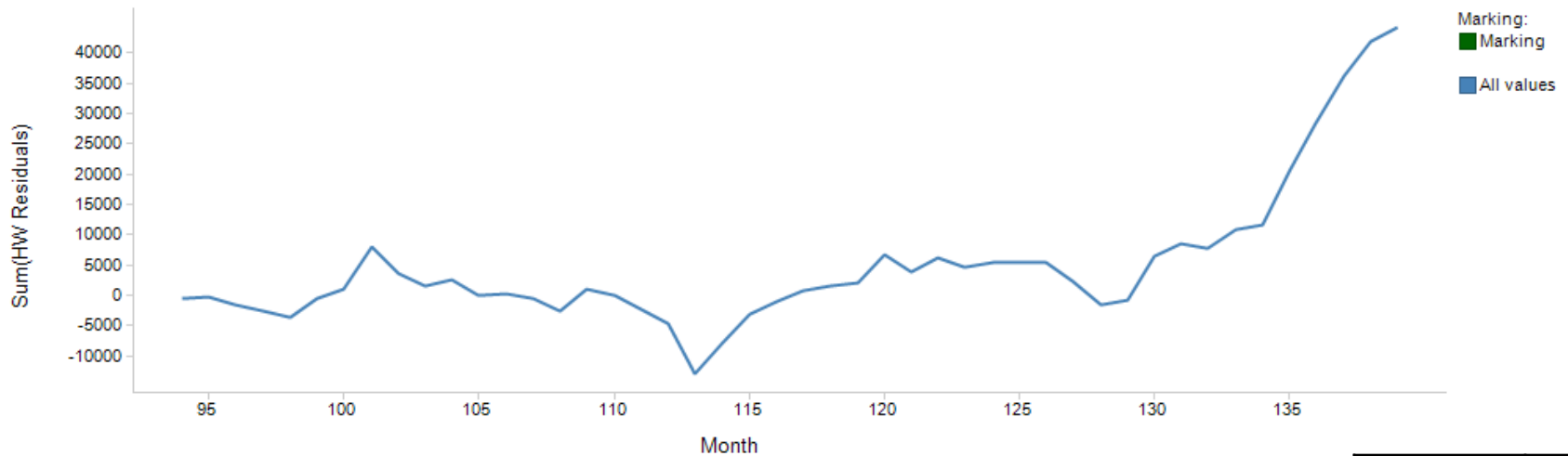
MAE	7,036.27
Avg. Error	-3,363.21
MAPE	10.92%
RMSE	9,145.30

Method's Considered (4/4) - Holt-winter's Smoothing

Holt-Winter's Smoothing vs. Actual



Residuals



MAE	18,229.08
Avg. Error	17,836.09
MAPE	27.87%
RMSE	23,591.47

Comparing Methods

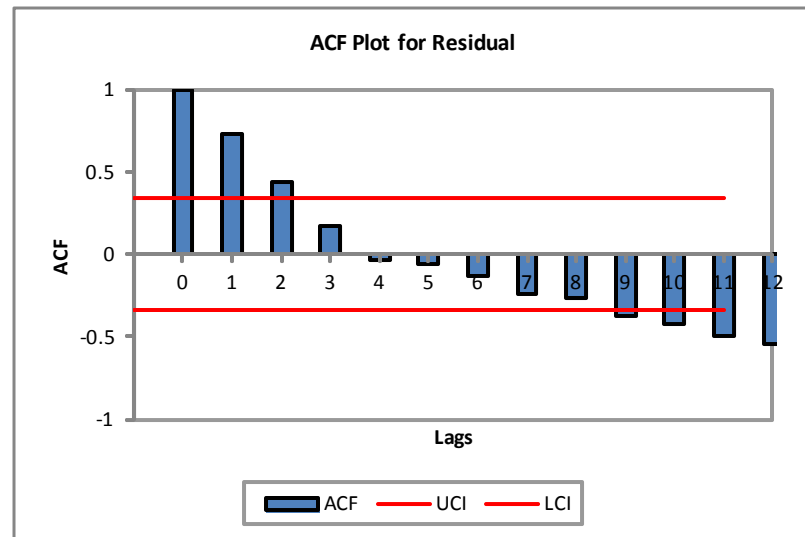
	Naive	MLR – Additive Seasonality	MLR – Multiplicative Seasonality	2 nd Degree Polynomial	Holt-Winter's
MAE	7,732.50	5,711.19	6,718.70	7,036.27	18,229.08
Avg. Error	(4,870.33)	(113.12)	187.99	-3,363.21	17,836.09
MAPE	13.07%	9.19%	10.51%	10.92%	27.87%
RMSE	8,744.07	6,674.69	7,966.12	9,145.30	23,591.47

Chosen Model Limitations

- * Model did not adequately account for seasonality
 - * Solution – Adjusted for error using AR methods

ACF Values

Lags	ACF
0	1
1	0.72789294
2	0.43858048
3	0.1726654
4	-0.03343721
5	-0.06151973
6	-0.13661568
7	-0.23889127
8	-0.26340884
9	-0.37127
10	-0.41827866
11	-0.49331972
12	-0.54856366

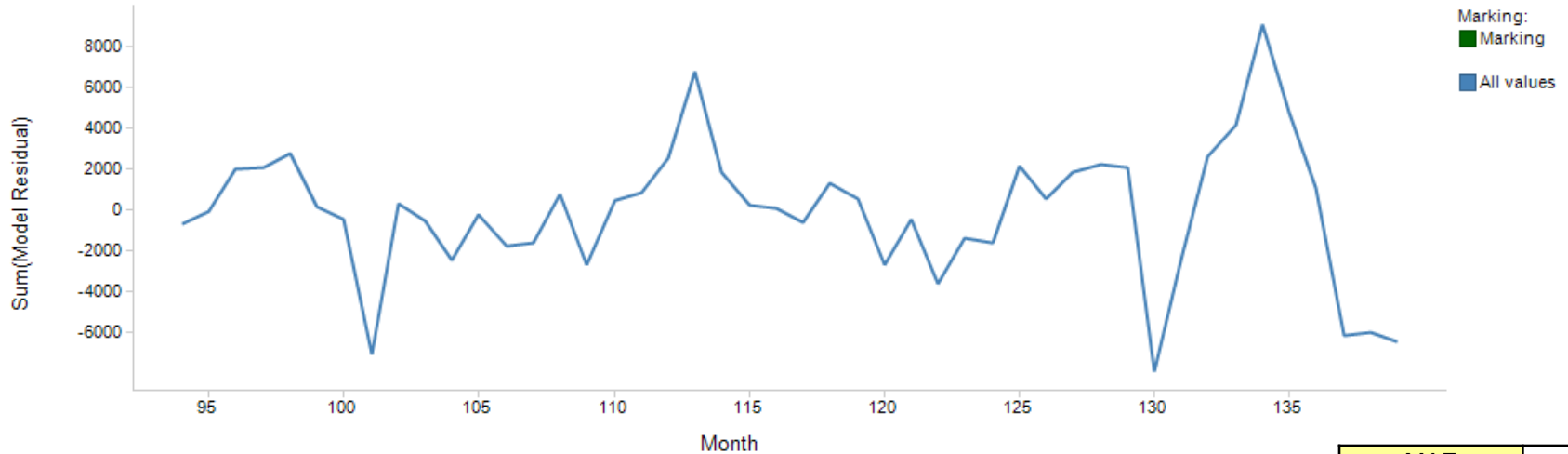


AR adjusted additive MLR

Final Model vs. Actual



Residuals

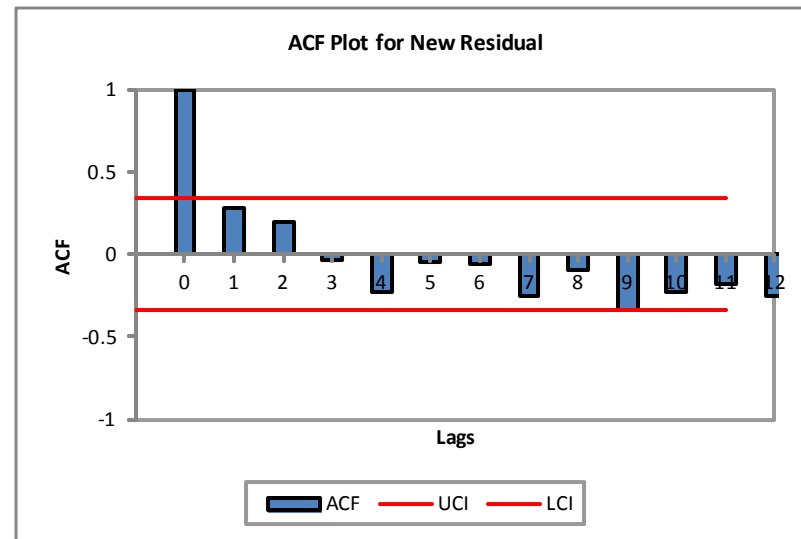


MAE	4,581.70
Avg. Error	(258.59)
MAPE	7.65%
RMSE	5,197.81

Adjusted Model Residual Analysis

ACF Values

Lags	ACF
0	1
1	0.28593364
2	0.19717161
3	-0.02901737
4	-0.22454795
5	-0.04297523
6	-0.05233738
7	-0.24819994
8	-0.09859764
9	-0.33851564
10	-0.223617
11	-0.18280546
12	-0.2484265



Impact of Other Hubs

- * There is no visible relationship between Phoenix traffic and traffic at other major hubs

The Regression Model

Input variables	Coefficient	Std. Error	p-value	SS
Constant term	34059.65625	36204.42969	0.36000499	94254340000
Month	418.0504456	122.8245697	0.003381	518875100
Season_1	9855.724609	6510.30127	0.14842966	354820000
Season_2	9713.866211	6724.275879	0.16675071	451665000
Season_3	8229.101563	7449.505371	0.28470105	1071529000
Season_4	9889.301758	11357.90625	0.39604846	580195800
Season_5	-8905.42676	13937.03418	0.53135455	17472270
Season_6	-9111.32129	23054.61719	0.69760585	18091630
Season_7	-4168.74414	24546.38086	0.86714745	2297245
Season_8	-10351.6738	26320.81055	0.69899482	14793040
Season_9	-24691.2012	32295.86523	0.45503291	769933900
Season_10	-10468.335	23223.64648	0.65785742	228943200
Season_11	-7385.17529	8559.124023	0.40023336	175488500
Philly Int L1	-0.31917939	0.26289284	0.24130528	43256210
Char Int L1	-0.06092461	0.27132195	0.82500821	326264.3438
Philly Int NF	0.31263313	0.41695362	0.46362436	14620290
Char Int NF	-0.2271006	0.55385715	0.68690151	4448868

Residual df	17
Multiple R-squared	0.904626274
Std. Dev. estimate	5144.038574
Residual SS	449839300

Model Forecast and Useful Prediction Intervals

The Regression Model

Input variables	Coefficient
Constant term	13487.73828
Month	411.6845398
Season_1	4065.648682
Season_2	4324.297363
Season_3	9277.946289
Season_4	2314.594971
Season_5	-10301.75586
Season_6	-10692.10742
Season_7	-12645.79199
Season_8	-15961.03613
Season_9	-30702.2207
Season_10	-16124.63086
Season_11	-10818.98242

ARIMA Model

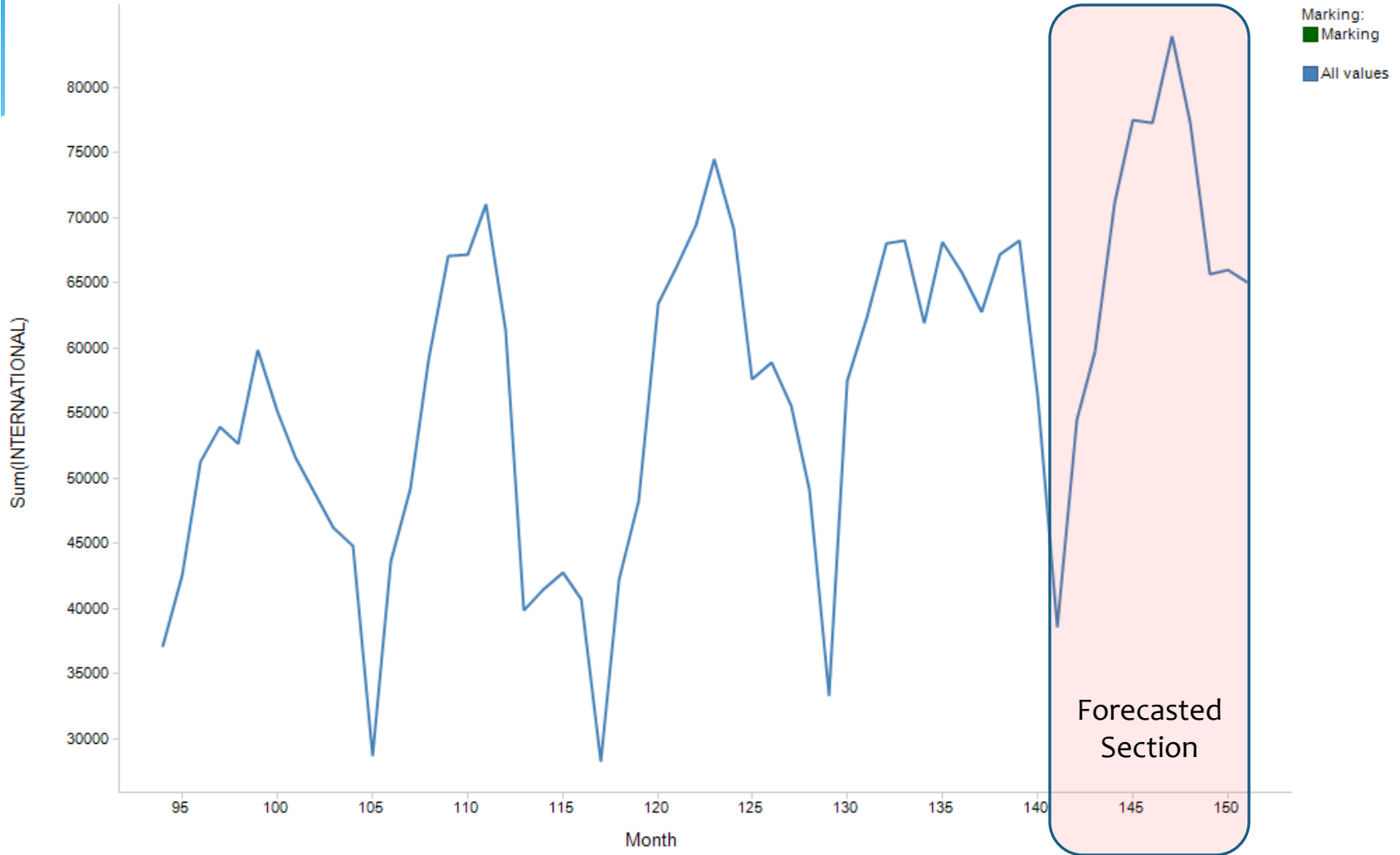
ARIMA	Coefficient
Const. term	-0.00159042
AR1	0.48902389
SAR1	-0.40426528

Prediction

Month	MLR Prediction	Previous Mo. Error	Naïve Prev. Mo. Error	Predicted Error	Model prediction
140	55,163	2,410		1,178	56,341
141	40,833		(4,522)	(2,212)	38,621
142	55,822		(2,686)	(1,314)	54,509
143	61,540		(3,710)	(1,815)	59,725
144	72,770		(3,373)	(1,650)	71,120
145	77,248		589	288	77,535
146	77,918		(1,169)	(572)	77,346
147	83,283		1,396	682	83,966
148	76,732		1,061	519	77,250
149	64,527		2,315	1,132	65,659
150	64,548		2,928	1,432	65,980
151	63,006		4,241	2,074	65,080

International Passenger Traffic Including Modeled Forecast

International Passenger Traffic Including 12-Month Forecast



Questions?

