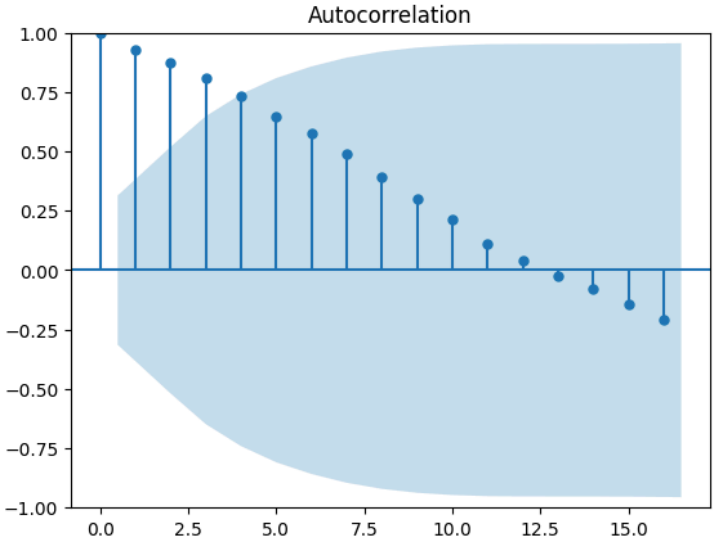
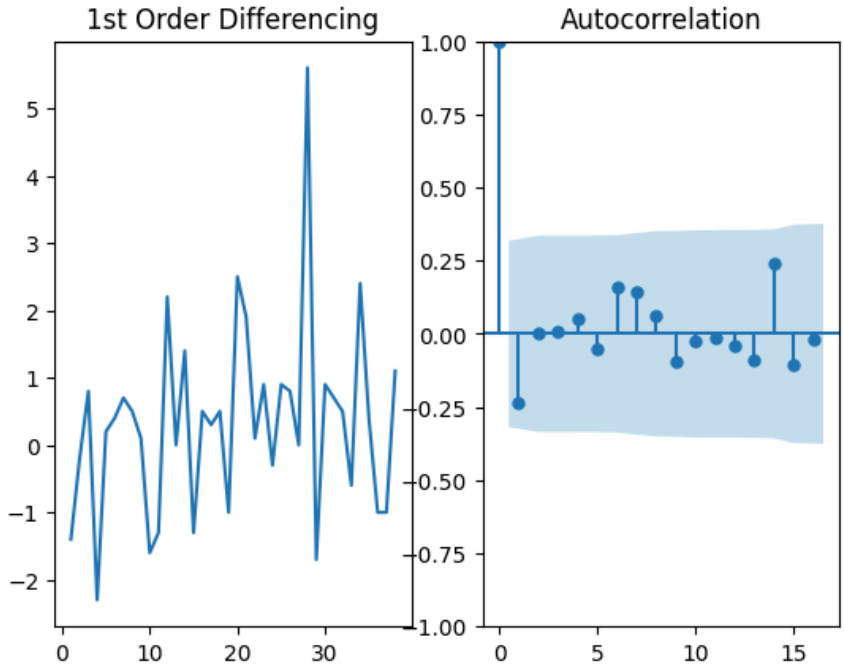
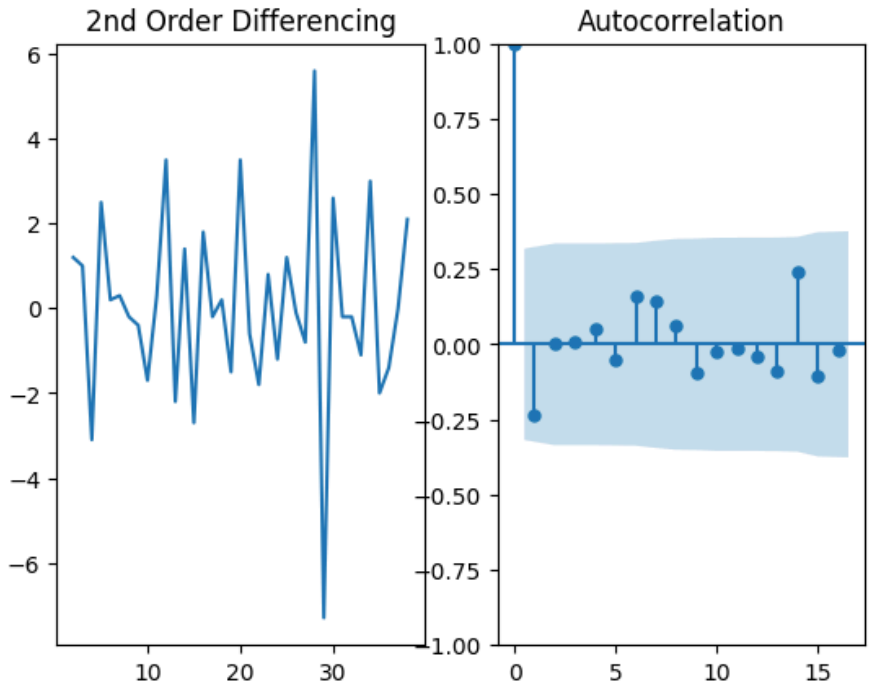
Choosing best ARIMA parameters







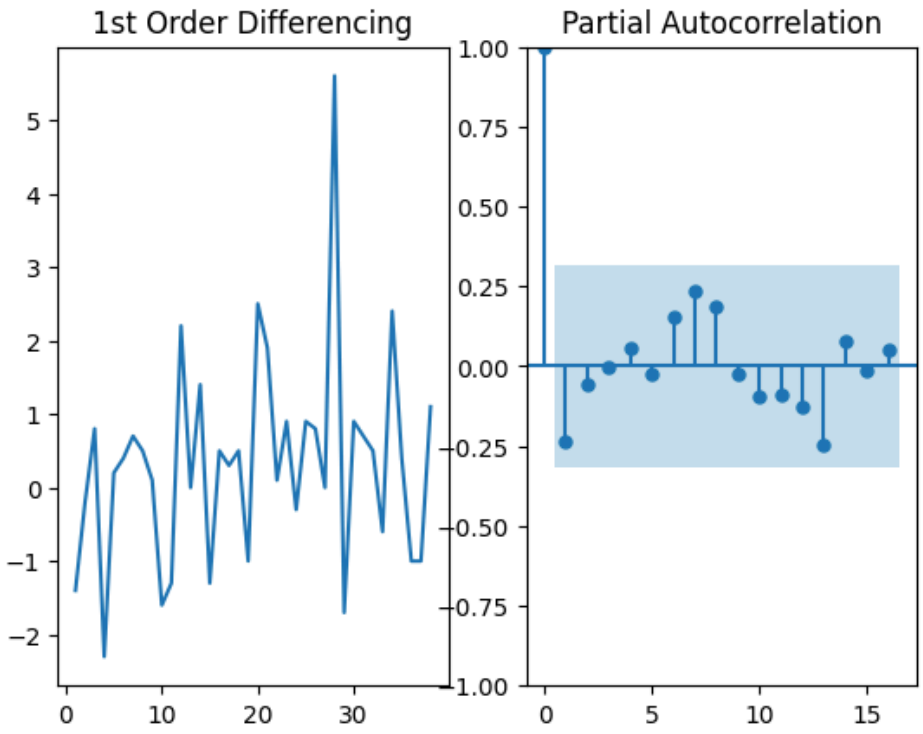
Testing if our data is stationary or not stationary

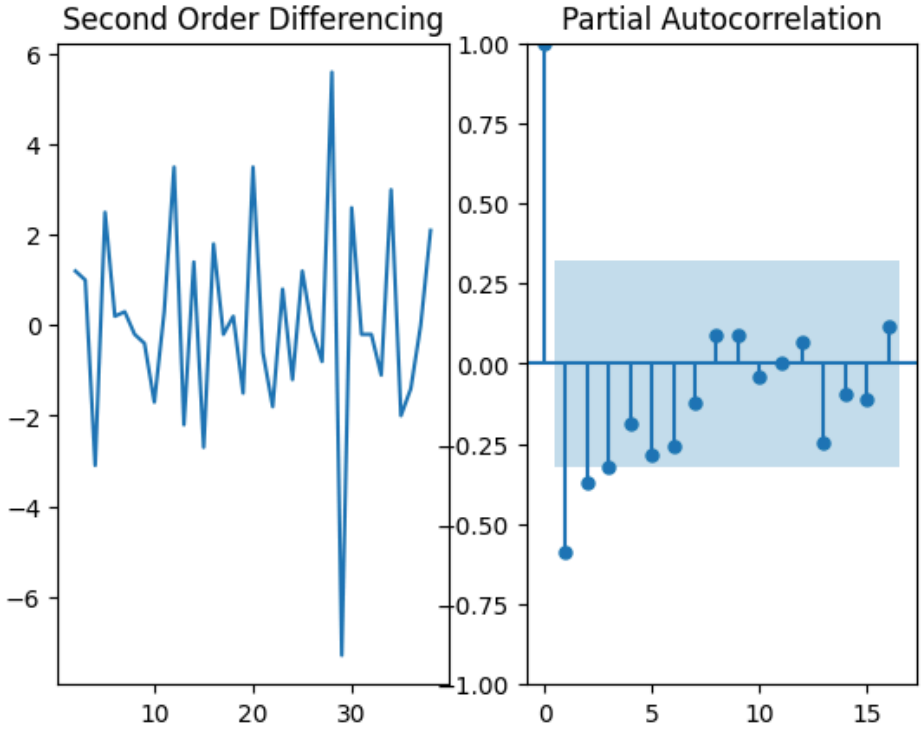
Augmented Dickey-Fuller Test, with first and second differencing included

```
p value:  0.029983770167539794
p value:  1.6134859992644947e-11
p value:  0.00010345091848076797
```

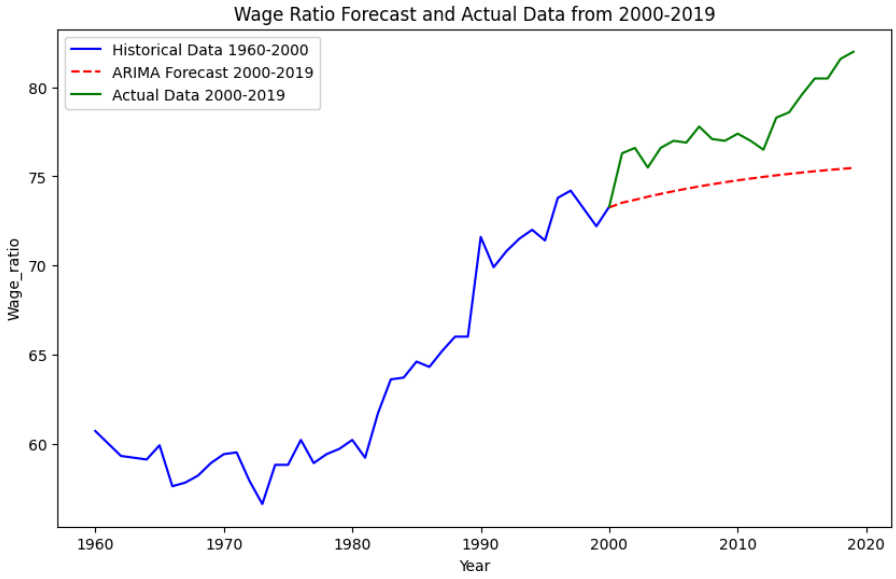
KPSS Test

```
(np.float64(0.207634429618148),
 np.float64(0.013137088893194504),
 4,
 {'10%': 0.119, '5%': 0.146, '2.5%': 0.176, '1%': 0.216})
```


1st Order Differencing
Partial Autocorrelation


Second Order Differencing
Partial Autocorrelation

Now actually using the ARIMA model



Summary of model fit

SARIMAX Results

Dep. Variable:	Wage_ratio	No. Observations:	39
Model:	ARIMA(2, 1, 1)	Log Likelihood	-66.589
Date:	Tue, 22 Oct 2024	AIC	141.179
Time:	22:08:22	BIC	147.729
Sample:	0	HQIC	143.509
	- 39		
Covariance Type:	opg		

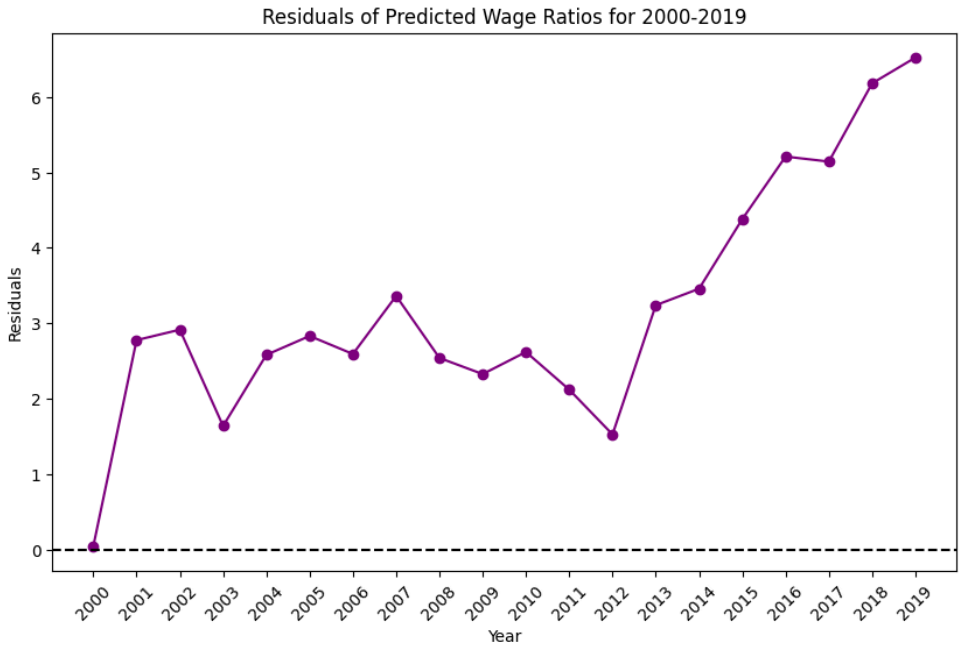
	coef	std err	z	P>|z|	[0.025	0.975]
ar.L1	0.6482	0.587	1.103	0.270	-0.503	1.800
ar.L2	0.2686	0.233	1.155	0.248	-0.187	0.725
ma.L1	-0.8464	0.591	-1.433	0.152	-2.004	0.312
sigma2	1.9354	0.411	4.709	0.000	1.130	2.741

Ljung-Box (L1) (Q):	0.18	Jarque-Bera (JB):	19.30
Prob(Q):	0.67	Prob(JB):	0.00
Heteroskedasticity (H):	2.04	Skew:	1.11
Prob(H) (two-sided):	0.21	Kurtosis:	5.70

Calculating MSE, RMSE, and create new dataframe with predicted and actual wage ratios, as well as the corresponding residuals

```
MSE = 12.6607
RMSE = 3.5582
Predicted, Actual Wage Ratio, and Residuals for 2000-2019:
    Year  Predicted_Wage_Ratio  Actual_Wage_Ratio  Residuals
0   2000             73.256089               73.3   0.043911
1   2001             73.523076               76.3   2.776924
2   2002             73.684339               76.6   2.915661
3   2003             73.860579               75.5   1.639421
4   2004             74.018129               76.6   2.581871
5   2005             74.167588               77.0   2.832412
6   2006             74.306782               76.9   2.593218
7   2007             74.437149               77.8   3.362851
8   2008             74.559038               77.1   2.540962
9   2009             74.673060               77.0   2.326940
10  2010             74.779707               77.4   2.620293
11  2011             74.879459               77.0   2.120541
12  2012             74.972761               76.5   1.527239
13  2013             75.060031               78.3   3.239969
14  2014             75.141659               78.6   3.458341
15  2015             75.218009               79.6   4.381991
16  2016             75.289422               80.5   5.210578
17  2017             75.356219               80.5   5.143781
18  2018             75.418696               81.6   6.181304
19  2019             75.477135               82.0   6.522865
```

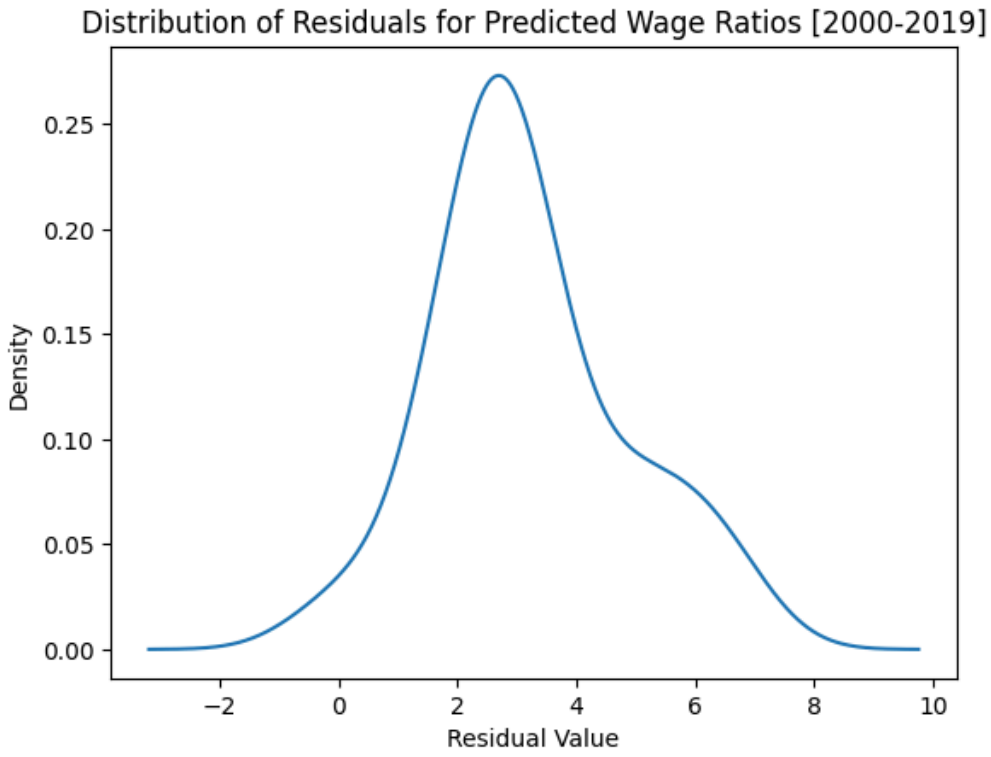
Line plot of the residuals of the predicted wage rations from the ARIMA model for 2001-2019



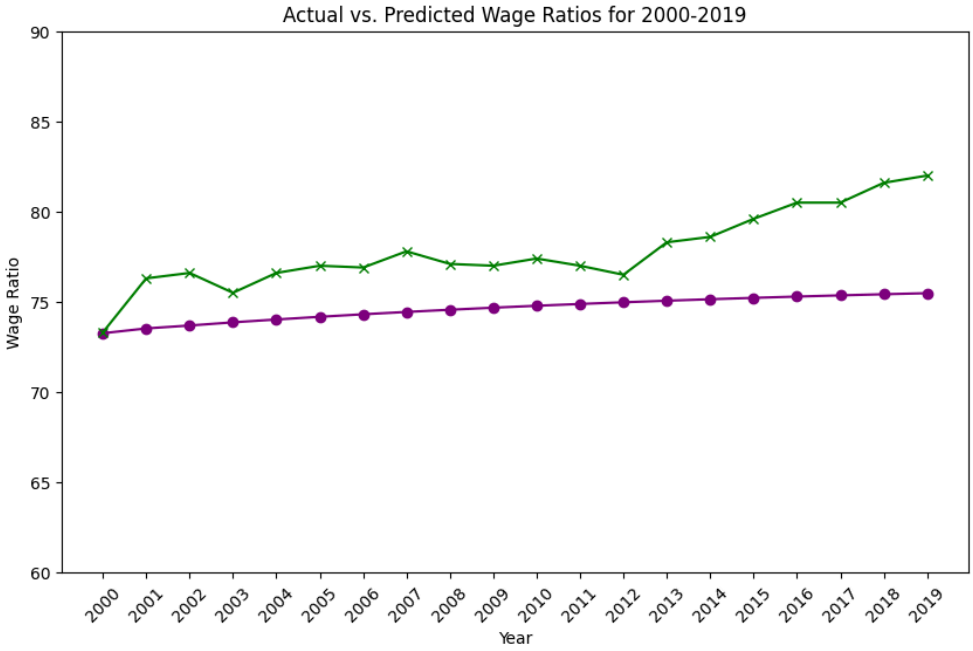
Summary statistics of the residuals

```
count    20.000000
mean      3.201054
std       1.594064
min       0.043911
25%       2.487456
50%       2.804668
75%       3.689254
max       6.522865
Name: Residuals, dtype: float64
```

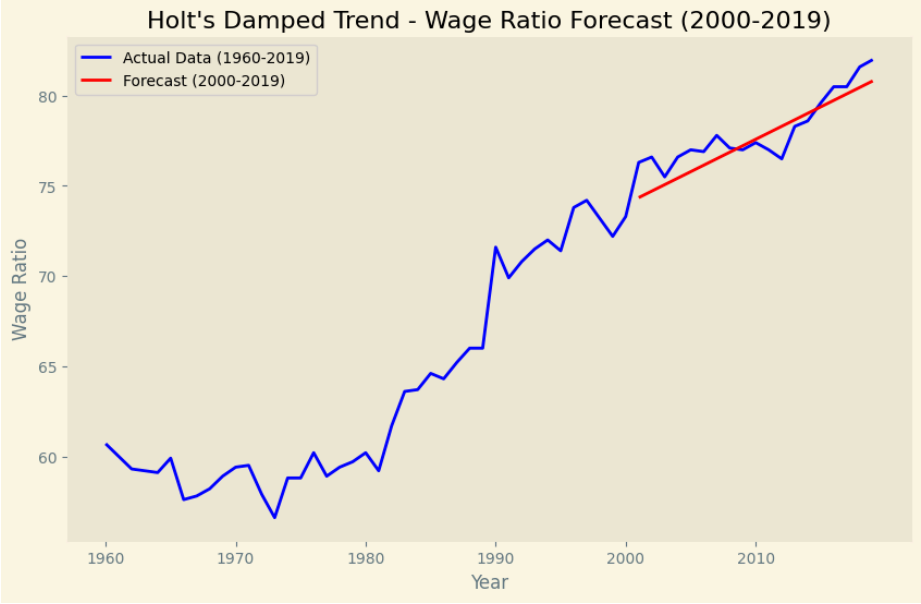
Kernel density plot for residuals



Plotting the actual and predicted wage ratios for 2001-2019

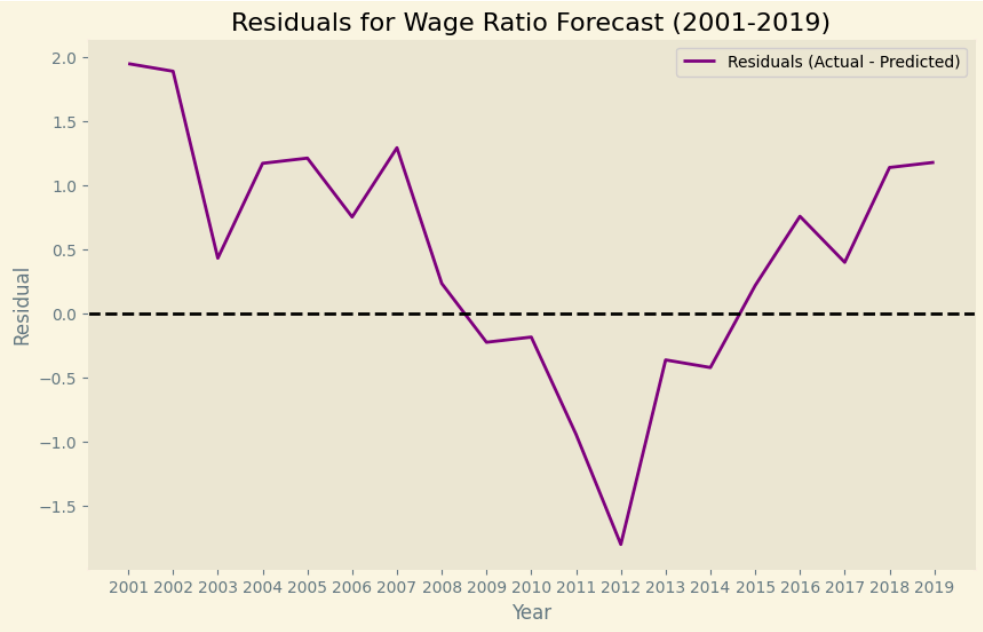


Attempting To Model Using Holt's Dampened Trend



Residuals from Holt model

	Year	Actual	Predicted	Residual
0	2001	76.3	74.349485	1.950515
1	2002	76.6	74.708958	1.891042
2	2003	75.5	75.068430	0.431570
3	2004	76.6	75.427902	1.172098
4	2005	77.0	75.787374	1.212626
5	2006	76.9	76.146846	0.753154
6	2007	77.8	76.506318	1.293682
7	2008	77.1	76.865790	0.234210
8	2009	77.0	77.225262	-0.225262
9	2010	77.4	77.584734	-0.184734
10	2011	77.0	77.944206	-0.944206
11	2012	76.5	78.303678	-1.803678
12	2013	78.3	78.663150	-0.363150
13	2014	78.6	79.022622	-0.422622
14	2015	79.6	79.382095	0.217905
15	2016	80.5	79.741567	0.758433
16	2017	80.5	80.101039	0.398961
17	2018	81.6	80.460511	1.139489
18	2019	82.0	80.819983	1.180017



Average Residual: 0.4574
RMSE: 1.0443