Reppeto530Week10

February 18, 2024

0.1 Chapter 12

Brian Reppeto 530 Prof. Jim Week 10 HW 12-1

[19]:
```
# import libraries

import numpy as np
import pandas as pd
import statsmodels.formula.api as smf
import random
import thinkstats2
import thinkplot
```

[20]:
```
# read the mj-clean file

transactions = pd.read_csv("mj-clean.csv", parse_dates=[5])
```

[21]:
```
# head the new df

transactions.head()
```

[21]:
```
          city state  price  amount quality       date    ppg      state.name  \
0   Annandale    VA    100   7.075    high 2010-09-02  14.13        Virginia
1      Auburn    AL     60  28.300    high 2010-09-02   2.12         Alabama
2      Austin    TX     60  28.300  medium 2010-09-02   2.12           Texas
3  Belleville    IL    400  28.300    high 2010-09-02  14.13        Illinois
4       Boone    NC     55   3.540    high 2010-09-02  15.54  North Carolina

         lat        lon
0  38.830345 -77.213870
1  32.578185 -85.472820
2  30.326374 -97.771258
3  38.532311 -89.983521
4  36.217052 -81.687983
```

[24]:
```
# create a function to process transactions aggregated by date and summarize␣
 ↪the data for each day

def GroupByDay(transactions, func=np.mean):
```

```
    grouped = transactions[["date", "ppg"]].groupby("date")
    daily = grouped.aggregate(func)
    daily["date"] = daily.index
    start = daily.date[0]
    one_year = np.timedelta64(1, "Y")
    daily["years"] = (daily.date - start) / one_year

    return daily
```

[25]:
```
# create a function to group transaction data by both quality and date

def GroupByQualityAndDay(transactions):
    groups = transactions.groupby("quality")
    dailies = {}
    for name, group in groups:
        dailies[name] = GroupByDay(group)

    return dailies
```

[26]:
```
# call the groupbyquality function with transactions as the argument to process␣
 ↪transactions

dailies = GroupByQualityAndDay(transactions)
```

[27]:
```
# create a function to fit a quadratic regression model to a dataset

def RunQuadraticModel(daily):
    daily["years2"] = daily.years**2
    model = smf.ols("ppg ~ years + years2", data=daily)
    results = model.fit()
    return model, results
```

[28]:
```
# apply the runquadraticmodel function to a subset of daily data filtered to␣
 ↪high

name = "high"
daily = dailies[name]

model, results = RunQuadraticModel(daily)
results.summary()
```

[28]:

Dep. Variable:	ppg	**R-squared:**	0.455
Model:	OLS	**Adj. R-squared:**	0.454
Method:	Least Squares	**F-statistic:**	517.5
Date:	Wed, 14 Feb 2024	**Prob (F-statistic):**	4.57e-164
Time:	16:08:22	**Log-Likelihood:**	-1497.4
No. Observations:	1241	**AIC:**	3001.
Df Residuals:	1238	**BIC:**	3016.
Df Model:	2		
Covariance Type:	nonrobust		

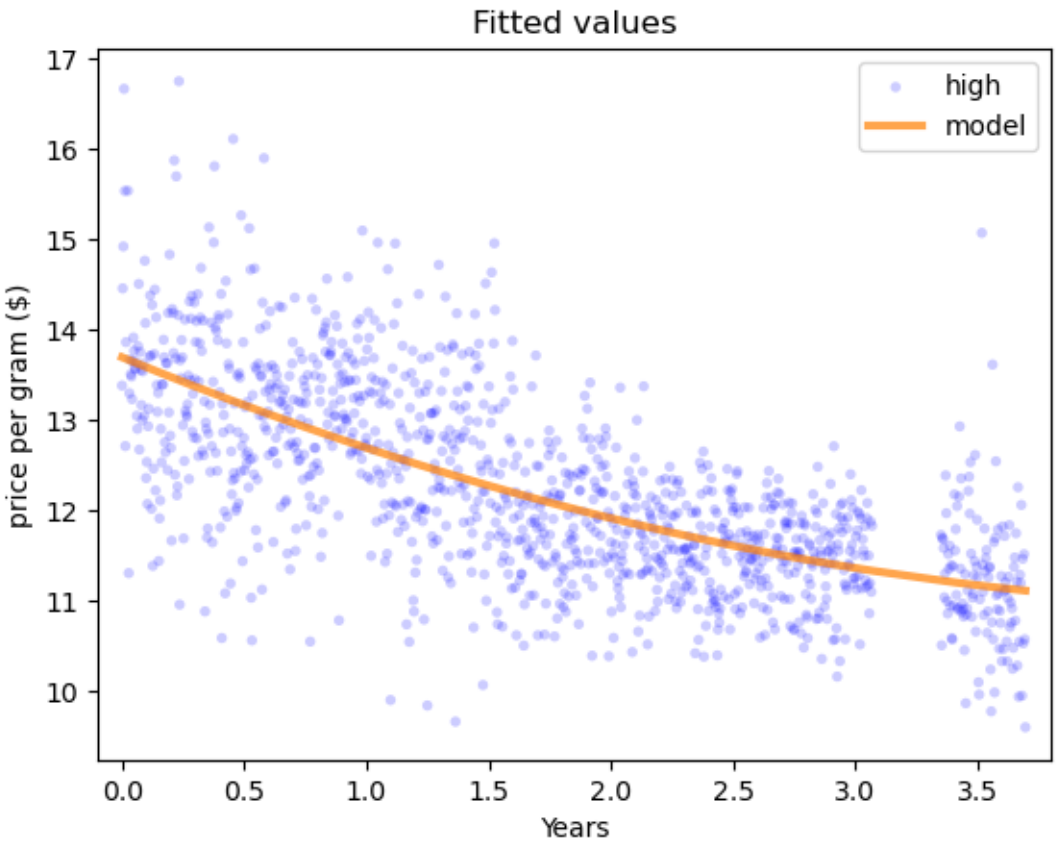
	coef	**std err**	**t**	**P> |t|**	**[0.025**	**0.975]**
Intercept	13.6980	0.067	205.757	0.000	13.567	13.829
years	-1.1164	0.084	-13.326	0.000	-1.281	-0.952
years2	0.1131	0.022	5.060	0.000	0.069	0.157

Omnibus:	49.112	**Durbin-Watson:**	1.885
Prob(Omnibus):	0.000	**Jarque-Bera (JB):**	113.885
Skew:	0.199	**Prob(JB):**	1.86e-25
Kurtosis:	4.430	**Cond. No.**	27.5

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.

[29]:
```
# create a function to plot the original data points and the fitted values from␣
 ↪a regression model

def PlotFittedValues(model, results, label=""):
    years = model.exog[:, 1]
    values = model.endog
    thinkplot.Scatter(years, values, s=15, label=label)
    thinkplot.Plot(years, results.fittedvalues, label="model", color="#ff7f00")
```

[30]:
```
# plot the fitted values from a regression model against the actual data points

PlotFittedValues(model, results, label=name)
thinkplot.Config(title="Fitted values",
                 xlabel="Years", xlim=[-0.1, 3.8],
                 ylabel="price per gram ($)")
```



[34]:
```
# create a function to fit a linear regression model to predict a dependent␣
↪variable

def RunLinearModel(daily):
    model = smf.ols("ppg ~ years", data=daily)
    results = model.fit()
    return model, results
```

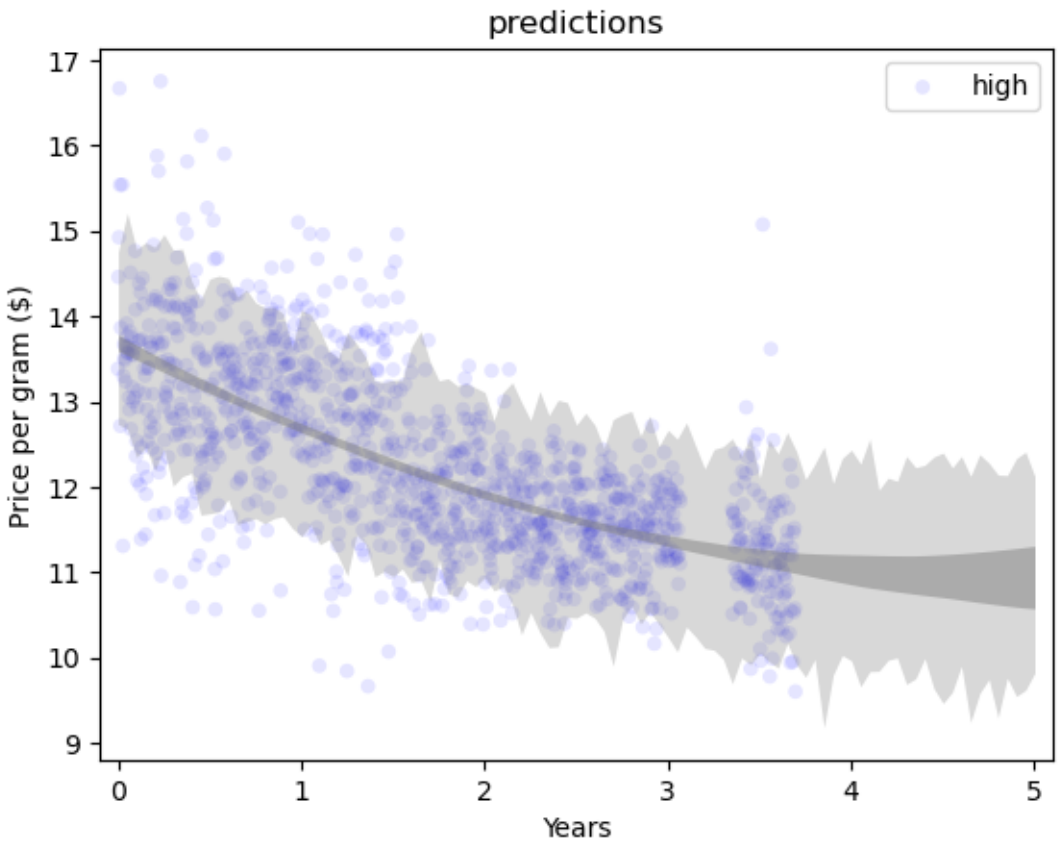
[35]:
```
# create a function to visualize the predictions of a statistical model
# with confidence intervals, for a given dataset over a specified range of years

def PlotPredictions(daily, years, iters=101, percent=90, func=RunLinearModel):
    result_seq = SimulateResults(daily, iters=iters, func=func)
    p = (100 - percent) / 2
    percents = p, 100 - p

    predict_seq = GeneratePredictions(result_seq, years, add_resid=True)
    low, high = thinkstats2.PercentileRows(predict_seq, percents)
    thinkplot.FillBetween(years, low, high, alpha=0.3, color="gray")
```

```
    predict_seq = GeneratePredictions(result_seq, years, add_resid=False)
    low, high = thinkstats2.PercentileRows(predict_seq, percents)
    thinkplot.FillBetween(years, low, high, alpha=0.5, color="gray")
```

[37]:
```
# create a function to perform simulations on a dataset to assess the␣
 ↪variability of model predictions
# using a specified model function linear regression

def SimulateResults(daily, iters=101, func=RunLinearModel):
    _, results = func(daily)
    fake = daily.copy()

    result_seq = []
    for _ in range(iters):
        fake.ppg = results.fittedvalues + thinkstats2.Resample(results.resid)
        _, fake_results = func(fake)
        result_seq.append(fake_results)

    return result_seq
```

[39]:
```
# create a function to generate predictions from a sequence of model results␣
 ↪for specified years

def GeneratePredictions(result_seq, years, add_resid=False):
    n = len(years)
    d = dict(Intercept=np.ones(n), years=years, years2=years**2)
    predict_df = pd.DataFrame(d)

    predict_seq = []
    for fake_results in result_seq:
        predict = fake_results.predict(predict_df)
        if add_resid:
            predict += thinkstats2.Resample(fake_results.resid, n)
        predict_seq.append(predict)

    return predict_seq
```

[40]:
```
# plot observed data points and predict future values based on a quadratic model

years = np.linspace(0, 5, 101)
thinkplot.Scatter(daily.years, daily.ppg, alpha=0.1, label=name)
PlotPredictions(daily, years, func=RunQuadraticModel)
thinkplot.Config(
    title="predictions",
    xlabel="Years",
    xlim=[years[0] - 0.1, years[-1] + 0.1],
    ylabel="Price per gram ($)",)
```



12-2

[41]:
```
# create a class designed to test for serial correlation in a dataset


class SerialCorrelationTest(thinkstats2.HypothesisTest):

    def TestStatistic(self, data):  # this method calculates the test statistic␣
 ↪for the absolute value of the serial correlation
        series, lag = data          # for a given series of data and a␣
 ↪specified lag
        test_stat = abs(SerialCorr(series, lag))
        return test_stat

    def RunModel(self):           # this method simulates the null hypothesis␣
 ↪which involves randomly shuffling the
        series, lag = self.data  # series' values while keeping the lag constant
        permutation = series.reindex(np.random.permutation(series.index))
        return permutation, lag
```

[43]:
```
# create a function to calculate the autocorrelation of a given series with a␣
 ↪specified lag

def SerialCorr(series, lag=1):
    xs = series[lag:]
    ys = series.shift(lag)[lag:]
    corr = thinkstats2.Corr(xs, ys)
    return corr
```

[44]:
```
# test for serial correlation in a daily time series data set looking for␣
 ↪correlation of data points

name = "high"
daily = dailies[name]

series = daily.ppg
test = SerialCorrelationTest((series, 1))
pvalue = test.PValue()
print(test.actual, pvalue)
```

```
0.48522937619473755 0.0
```

[45]:
```
# chech the presence of serial correlation in the residuals of a linear␣
 ↪regression model

_, results = RunLinearModel(daily)
series = results.resid
test = SerialCorrelationTest((series, 1))
pvalue = test.PValue()
print(test.actual, pvalue)
```

```
0.07570473767506251 0.007
```

[46]:
```
# evaluate the presence of serial correlation in the residuals of a quadratic␣
 ↪model fitted to a dataset

_, results = RunQuadraticModel(daily)
series = results.resid
test = SerialCorrelationTest((series, 1))
pvalue = test.PValue()
print(test.actual, pvalue)
```

```
0.05607308161289923 0.05
```

[ ]:
```

```