Week 10 - Assignment 12.1

In [43]:
```
#Exercise 12-1.
#The linear model I used in this chapter has the obvious drawback that it is linear
#there is no reason to expect prices to change linearly over time. We can add flexi
#to the model by adding a quadratic term, as we did in “Nonlinear Relationships” on
#page 133.
#Use a quadratic model to fit the time series of daily prices, and use the model to
#predictions. You will have to write a version of RunLinearModel that runs that qua
#model, but after that you should be able to reuse code in timeseries.py to generat
#predictions.
```

In [44]:
```
import thinkstats2
import thinkplot
import numpy as np
import pandas as pd
import random
import timeseries
import statsmodels.formula.api as smf
```

In [45]:
```
from os.path import basename, exists

def download(url):
    filename = basename(url)
    if not exists(filename):
        from urllib.request import urlretrieve

        local, _ = urlretrieve(url, filename)
        print("Downloaded " + local)
```

In [46]:
```
download("https://github.com/AllenDowney/ThinkStats2/raw/master/code/mj-clean.csv")
```

In [47]:
```
transactions = pd.read_csv("mj-clean.csv", parse_dates=[5])
transactions
```

Out[47]:

	city	state	price	amount	quality	date	ppg	state.name	lat	
0	Annandale	VA	100	7.075	high	2010-09-02	14.13	Virginia	38.830345	-77.213
1	Auburn	AL	60	28.300	high	2010-09-02	2.12	Alabama	32.578185	-85.472
2	Austin	TX	60	28.300	medium	2010-09-02	2.12	Texas	30.326374	-97.771
3	Belleville	IL	400	28.300	high	2010-09-02	14.13	Illinois	38.532311	-89.983
4	Boone	NC	55	3.540	high	2010-09-02	15.54	North Carolina	36.217052	-81.687
...	...	...	...	...	...	...	...	...	...	
147065	West Palm Beach	FL	140	28.300	high	2014-05-13	4.95	Florida	26.669744	-80.127
147066	Wilmington	OH	30	3.540	medium	2014-05-13	8.47	Ohio	39.463476	-83.844
147067	Youngstown	OH	100	10.000	medium	2014-05-13	10.00	Ohio	41.086279	-80.664
147068	Ypsilanti	MI	35	3.540	medium	2014-05-13	9.89	Michigan	42.235261	-83.607
147069	Yuma	AZ	20	3.540	medium	2014-05-13	5.65	Arizona	32.700018	-114.526

147070 rows × 10 columns

In [48]:
```
data = timeseries.GroupByQualityAndDay(transactions)
```

In [49]:
```
def RunQuadraticModel(daily):
    daily["years2"] = daily.years**2
    model = smf.ols("ppg ~ years + years2", data=daily)
    results = model.fit()
    return model, results
```

In [50]:
```
# Solution

name = "high"
daily = data[name]

model, results = RunQuadraticModel(daily) #quadratic model to fit the time series o
results.summary()
```

Out[50]:

OLS Regression Results

Dep. Variable:	ppg	**R-squared:**	0.455
Model:	OLS	**Adj. R-squared:**	0.454
Method:	Least Squares	**F-statistic:**	517.5
Date:	Sun, 19 Feb 2023	**Prob (F-statistic):**	4.57e-164
Time:	01:29:33	**Log-Likelihood:**	-1497.4
No. Observations:	1241	**AIC:**	3001.
Df Residuals:	1238	**BIC:**	3016.
Df Model:	2		
Covariance Type:	nonrobust		

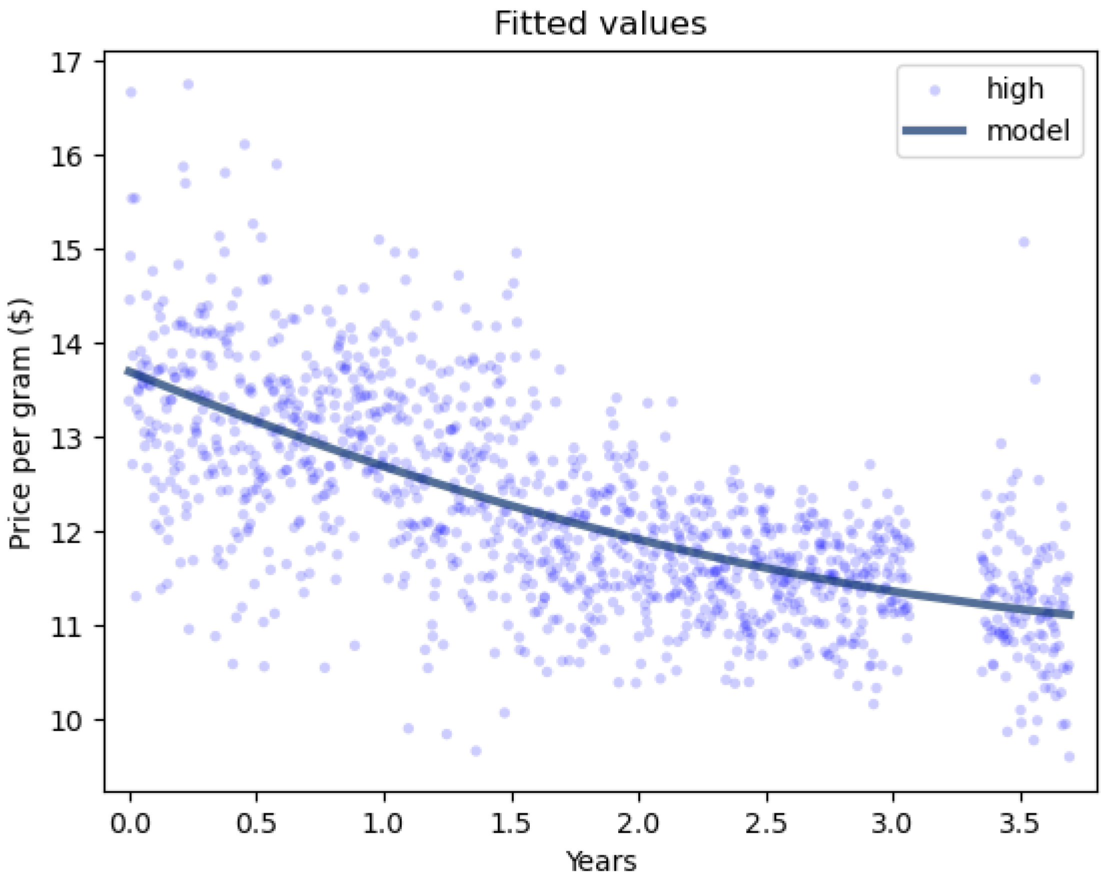
	coef	**std err**	**t**	**P>|t|**	**[0.025**	**0.975]**
Intercept	13.6980	0.067	205.757	0.000	13.567	13.829
years	-1.1171	0.084	-13.326	0.000	-1.282	-0.953
years2	0.1132	0.022	5.060	0.000	0.069	0.157

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.

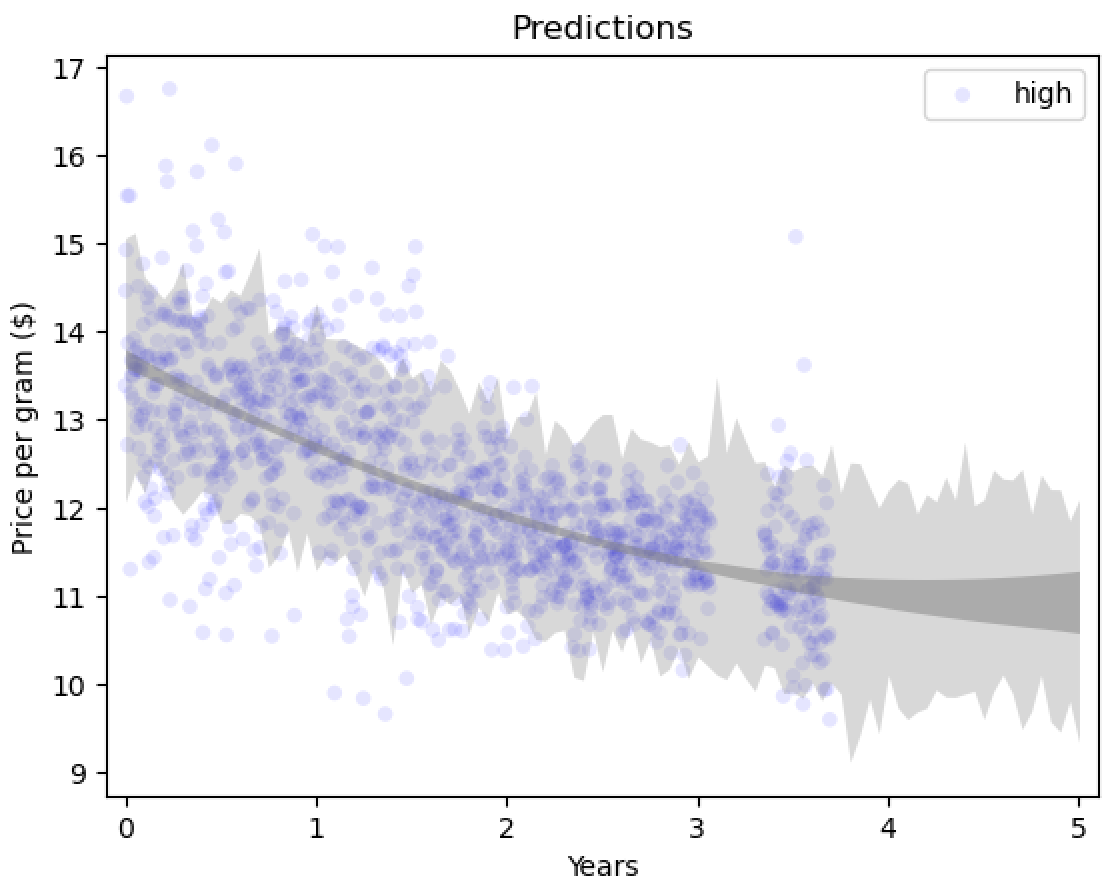
In [51]:

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



In [52]:

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



Week 10 - Assignment 12.2

In [53]:
```
#Exercise 12-2.
#Write a definition for a class named SerialCorrelationTest that extends
#HypothesisTest from “HypothesisTest” on page 102. It should take a series and a la
#as data, compute the serial correlation of the series with the given lag, and then
#the p-value of the observed correlation.
#Use this class to test whether the serial correlation in raw price data is statist
#nificant. Also test the residuals of the linear model and (if you did the previous
#the quadratic model.
```

In [54]:
```
def SerialCorr(series, lag=1):
    xs = series[lag:]
    ys = series.shift(lag)[lag:]
    corr = thinkstats2.Corr(xs, ys)
    return corr
```

In [55]:
```
class SerialCorrelationTest(thinkstats2.HypothesisTest):

    def TestStatistic(self, data):
        series, lag = data
        test_stat = abs(SerialCorr(series, lag))
        return test_stat

    def RunModel(self):
        series, lag = self.data
```

```python
        permutation = series.reindex(np.random.permutation(series.index))
        return permutation, lag
```

In [56]:
```python
name = "high"
daily = data[name]

series = daily.ppg
test = SerialCorrelationTest((series, 1)) # serial correlation of the series with t
pvalue = test.PValue() #p-value of the observed correlation
test.actual, pvalue
```

Out[56]: (0.4852293761947381, 0.0)

In [57]:
```python
#Residuals of the Linear Model
_, results = timeseries.RunLinearModel(daily)
series = results.resid
test = SerialCorrelationTest((series, 1))
pvalue = test.PValue()
test.actual, pvalue
```

Out[57]: (0.07570473767506262, 0.008)

In [58]:
```python
#Residuals of the quadratic model
_, results = RunQuadraticModel(daily)
series = results.resid
test = SerialCorrelationTest((series, 1))
pvalue = test.PValue()
test.actual, pvalue
```

Out[58]: (0.056073081612899166, 0.048)