In [1]:

```
import pandas as pd
import numpy as np
```

In [3]:

```
df =
pd.read_csv(r'C:\Users\HS_MichalP\Documents\Mike_priv\ECG_estimation_repo\E
estimation\results\results_finished.txt', delimiter=';', header=None)
df.columns= ['year', 'illness_code', 'ilness_name', 'n_hospit', 'procedure'
, 'n_proc']
df.n_proc=df.n_proc.map(lambda x: str(x)[:-1])
df["n_proc"] = df["n_proc"].apply(pd.to_numeric)
```

In [4]:

```
df.head()
```

Out[4]:

	year	illness_code	ilness_name	n_hospit	procedure	n_proc
0	2009	A01	Zabiegi wewnAtrzczaszkowe z powodu powaLznego ...	5517	Elektrokardiogram z 12 lub wiAcej odprowadzeniami	313
1	2009	A01	Zabiegi wewnAtrzczaszkowe z powodu powaLznego ...	5517	Monitorowanie elektrokardiograficzne - inne	209
2	2009	A01	Zabiegi wewnAtrzczaszkowe z powodu powaLznego ...	5517	Elektrokardiogram	195
3	2009	A01	Zabiegi wewnAtrzczaszkowe z powodu powaLznego ...	5517	Elektrokardiogram nieokreLlony	173
4	2009	A01	Zabiegi wewnAtrzczaszkowe z powodu powaLznego ...	5517	Elektrokardiogram z 1-3 odprowadzeniami	148

In [5]:

```
# procedures by year
df_proc_by_year = df[["year", "n_proc"]]
df_year = df_proc_by_year.groupby(['year']).sum()
df_year.index
df_year = df_year.reset_index()

mean_proc_year = np.mean(df_year)
```

In [6]:

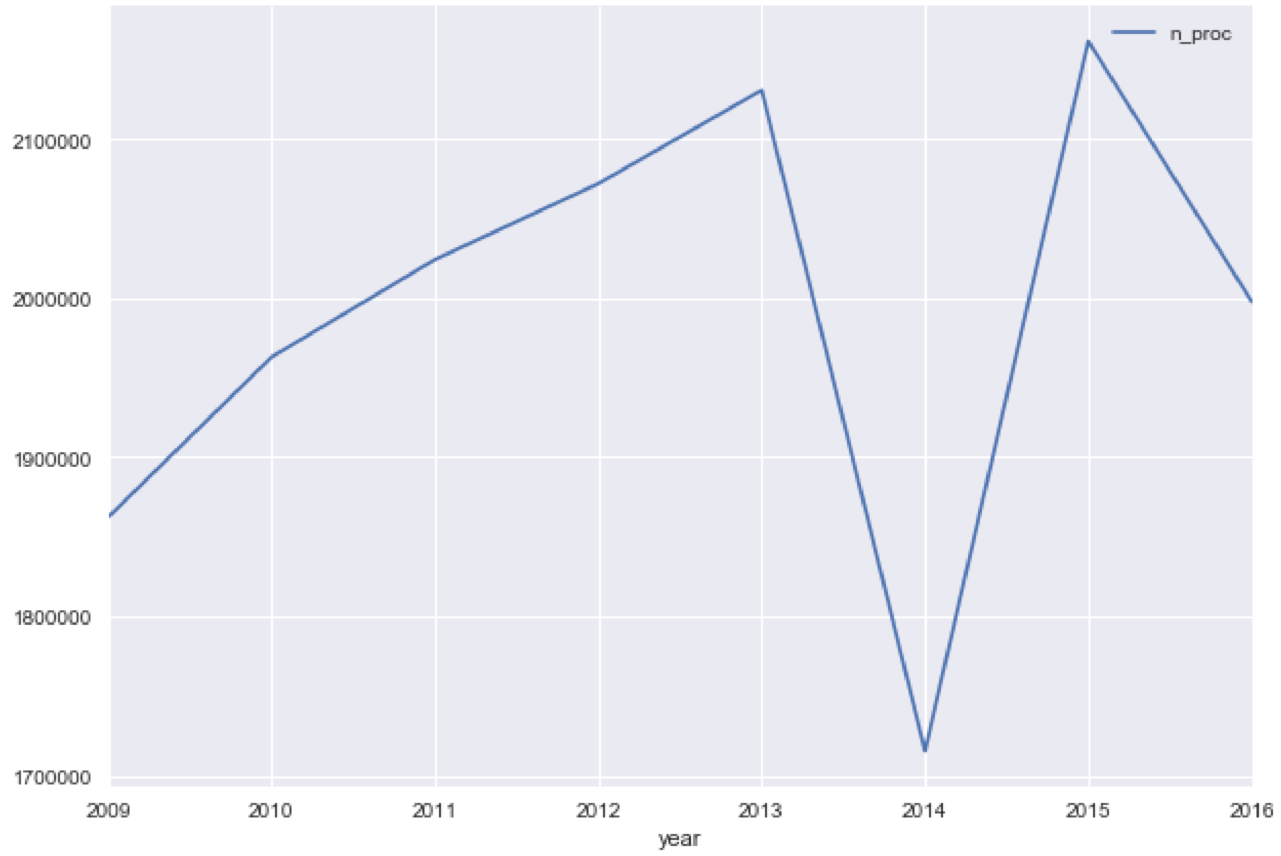
```
# mean annual EKG performed
mean_proc_year
```

Out[6]:

```
year          2012.500
n_proc     1990866.375
dtype: float64
```

In [7]:

```
import seaborn as sns
import matplotlib.pyplot as plt
%matplotlib inline
# plot number of EKG performed in a period 2009-2016
plot = df_year.plot(x ='year', y ='n_proc', figsize=(10, 7))
fig = plot.get_figure()
fig.savefig('data_2009_2016.png')
```



In [8]:

```
# prepare training variable
X = np.array(df_year["year"])
X = X.reshape(-1,1)
y = np.array(df_year["n_proc"])
```

In [9]:

```
#display training variable
X
```

Out[9]:

```
array([[2009],
       [2010],
       [2011],
       [2012],
       [2013],
       [2014],
       [2015]
       [2015]],
       [2016]], dtype=int64)
```

In [11]:

```
#display target variable
y
```

Out[11]:

```
array([1862393, 1962989, 2024214, 2071940, 2130648, 1715625, 2161318,
       1997804], dtype=int64)
```

In [12]:

```
#prepare prediciting variable
z = np.array([i+2016 for i in range (1,10)])
z = z.reshape(-1,1)
```

In [13]:

```
# prepare linear model
from sklearn import linear_model
lm = linear_model.LinearRegression()
model = lm.fit(X,y)

predictions = lm.predict(z)
# show predicitions
print(predictions)
```

```
[ 2048319.75         2061087.16666667  2073854.58333334  2086622.
  2099389.41666667  2112156.83333334  2124924.25         2137691.66666667
  2150459.08333334]
```

In [14]:

```
#print R^2
lm.score(X,y)
```

Out[14]:

```
0.045835623805929981
```

In [15]:

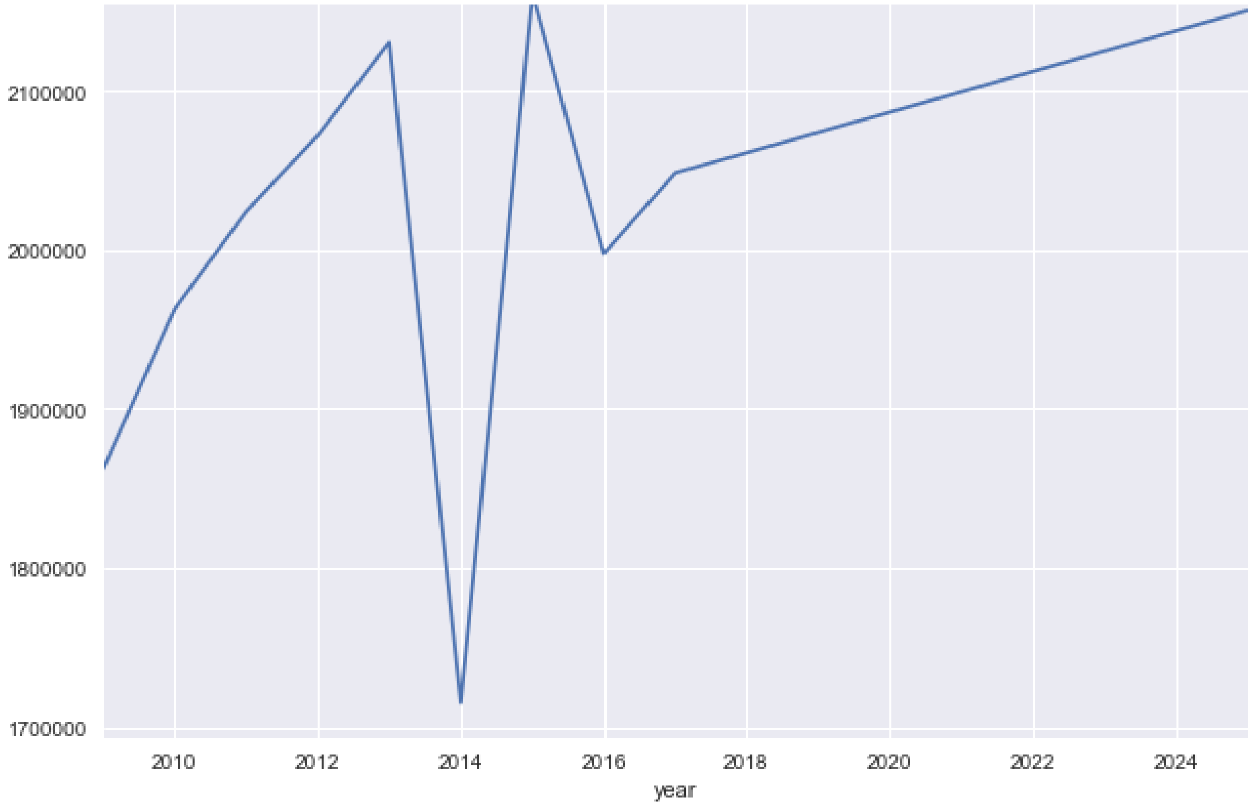
```
# create dataframes with all predicted and training data
all_X = pd.DataFrame(np.concatenate((X, z), axis=0), columns=['year'])
all_y = pd.DataFrame(np.concatenate((y, predictions)), columns=['n_proc'])
```

In [16]:

```
# Add target variable
all_X['n_proc'] = all_y
```

In [17]:

```
# Plot gathered data and linear predictions
plot = all_X.plot(x ='year', y ='n_proc', figsize=(10, 7))
fig = plot.get_figure()
fig.savefig('prediction_from_2017.png')
```



There are some strange results for 2014, that could be caused by exogenous factors. Below will be the model build on data from 2009-2013 period.

In [18]:

```
# prepare prediction variables
z = np.array([i + 2013 for i in range (1, 10)])
z = z.reshape(-1, 1)
```

In [19]:

```
# build model
lm = linear_model.LinearRegression()
model = lm.fit(X[:-3],y[:-3])
# display predictions
predictions = lm.predict(z)
print(predictions)
```

```
[ 2204075.09999999  2268621.2         2333167.3         2397713.40000001
  2462259.5         2526805.59999999  2591351.7         2655897.8
  2720443.90000001]
```

In [20]:

```
# check R^2 score
lm.score(X[:-3],y[:-3])
```

Out[20]:

```
0.9781773644110846
```

In [21]:

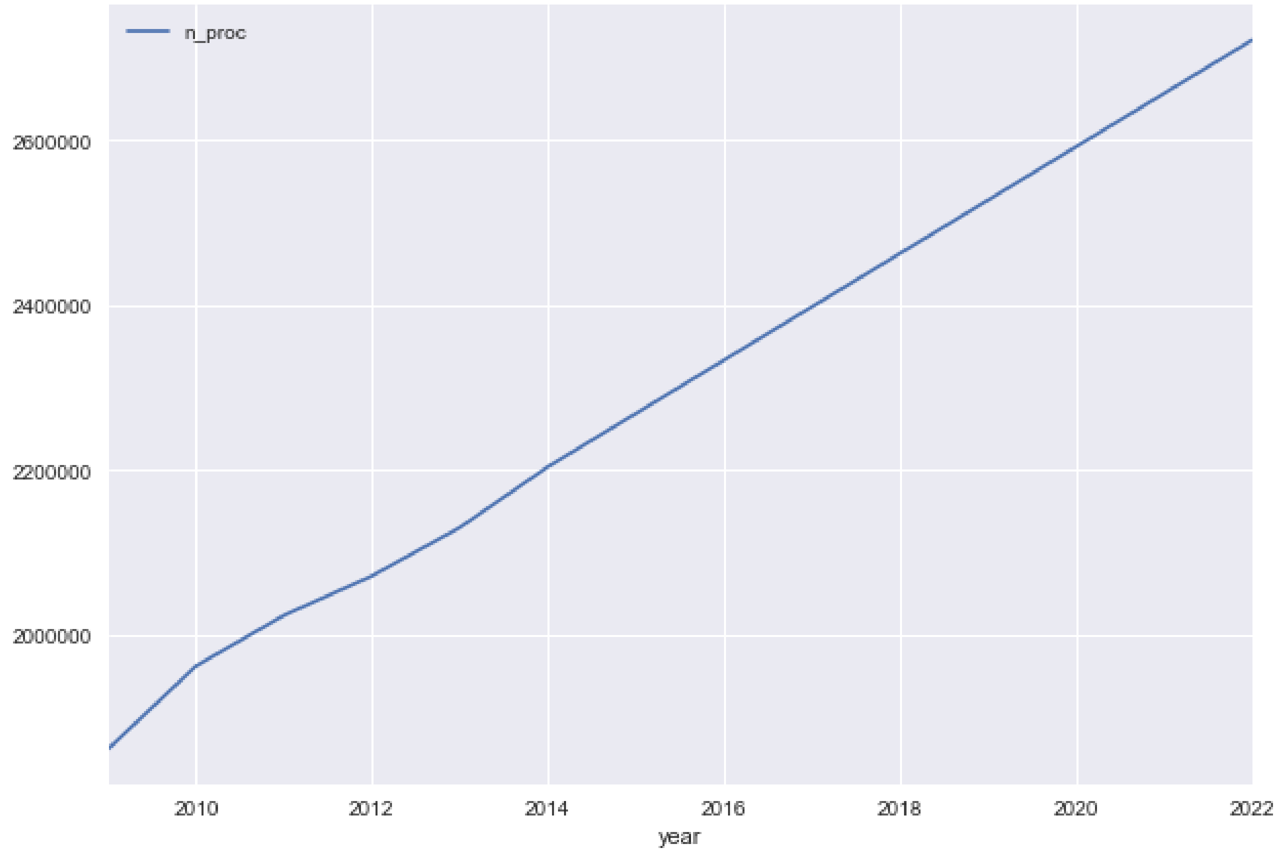
```
# create dataframes with all predicted and training data
all_X = pd.DataFrame(np.concatenate((X[:-3], z), axis=0), columns=['year'])
all_X = pd.DataFrame(np.concatenate((X[:-3], Z), axis=0), columns=['year'])
all_y = pd.DataFrame(np.concatenate((y[:-3], predictions)), columns=['n_pro
c'])
```

In [22]:

```
# Add target variable
all_X['n_proc'] = all_y
```

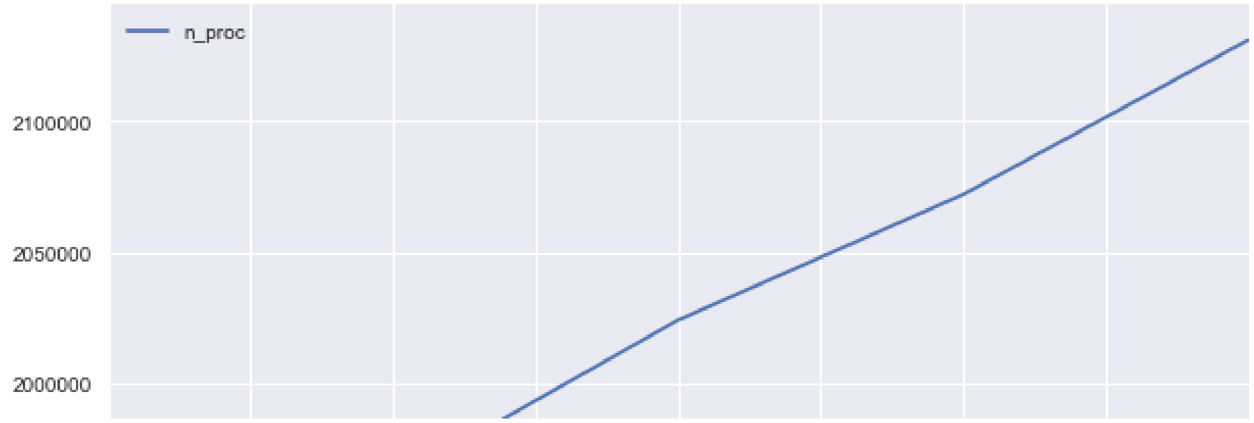
In [23]:

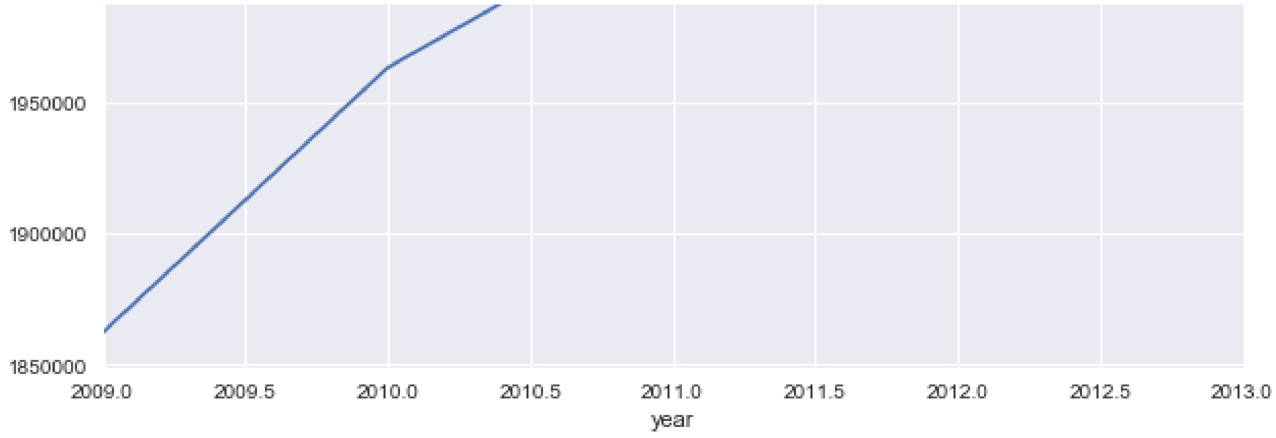
```
# Plot gathered data and linear predictions
plot = all_X.plot(x ='year', y ='n_proc', figsize=(10, 7))
fig = plot.get_figure()
fig.savefig('prediction_from_2014.png')
```



In [24]:

```
# plot only trainging data
plot = df_year[:-3].plot(x ='year', y ='n_proc', figsize=(10, 7))
fig = plot.get_figure()
fig.savefig('data_2009_2013.png')
```





Thank you for reading!