In [21]:
```
import numpy as np
import csv
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sb
import statsmodels.api as sm
from numpy.linalg import inv
from sklearn.metrics import explained_variance_score, mean_absolute_error, mean_s
```

Basic Exploration

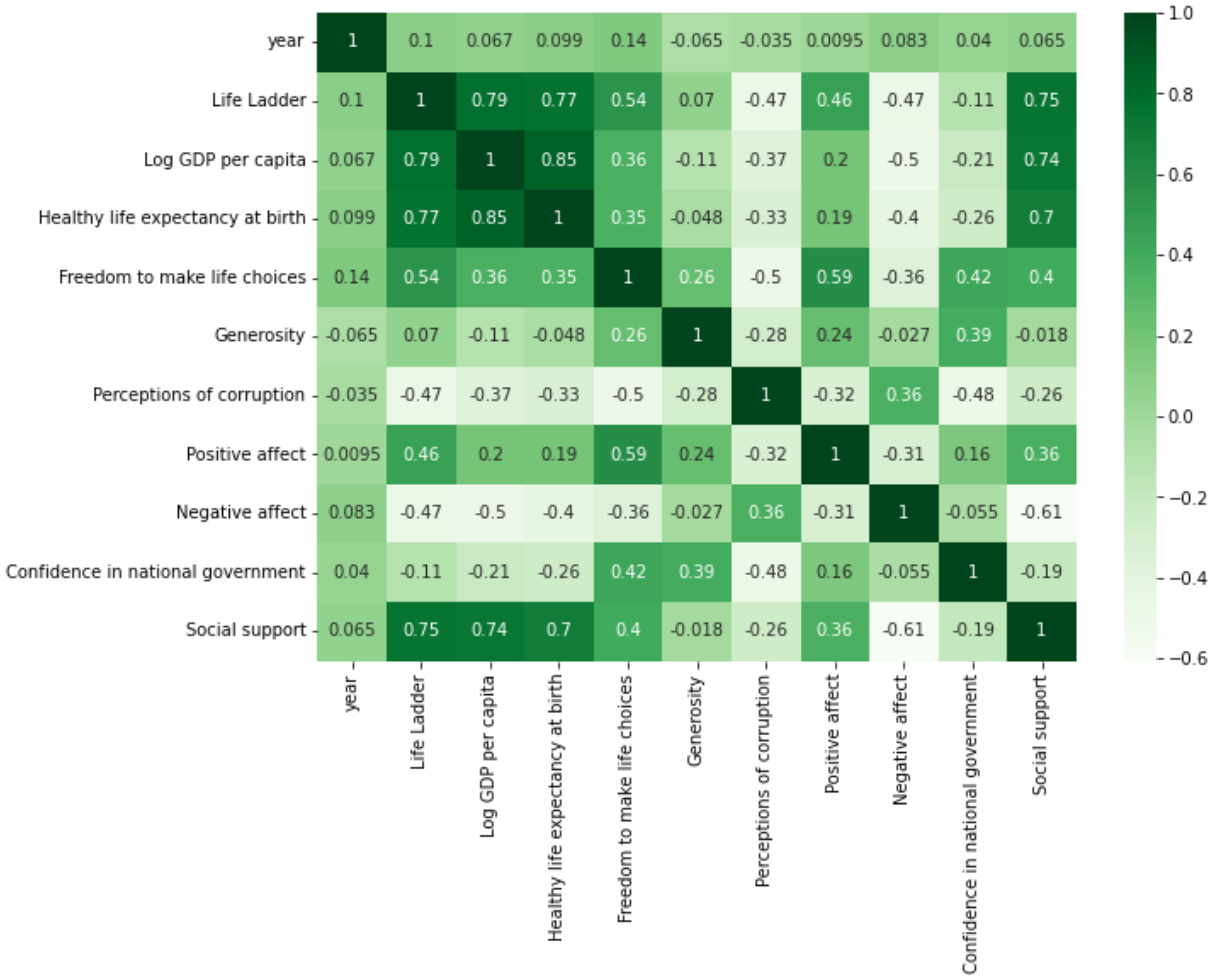
In [116]:
```
df_nas = pd.read_excel('Training Data.xlsx')
```

In [11]:
```
df = df_nas.dropna() ### Hopefully won't be needed if Matthew's idea works but we

plt.figure(figsize=(10, 7))

dataplot = sb.heatmap(df.corr(), cmap="Greens", annot=True)

plt.show()
```



Convert data into right shape

In [126]:
```
# Take out the columns we need

X_train_pre = df[['Log GDP per capita','Healthy life expectancy at birth', 'Freed
                  'Generosity', 'Perceptions of corruption', 'Life Ladder', 'Positive
                 'Confidence in national government']]

y_train_pre = df[['Social support']]
```

In [127]:
```
X_train= X_train_pre.to_numpy()
X_train.shape
```

Out[127]:
```
(720, 9)
```

In [128]:
```
y_train= y_train_pre.to_numpy()
y_train.shape
```

Out[128]:
```
(720, 1)
```

Find the best coefficients and predict

In [129]:
```
def find_optz_w(A,y):

    '''
    A: Takes a matrix with our predictors
    y: Takes in a vector with our traning target variables
    '''

    (n, predictors) = A.shape
    p = predictors + 1

    new_A = np.ones(shape=(n,p)) # Will leave our first column with 1s for when w
    new_A[:,1:]=A

    w = np.linalg.inv(new_A.T @ new_A) @ new_A.T @ y #minimizes_mean_squared_erro
    return w
```

In [130]:
```
optz_w = find_optz_w(X_train,y_train)
optz_w
```

Out[130]:
```
array([[ 0.18521929],
       [ 0.02353781],
       [ 0.00256426],
       [-0.00395562],
       [ 0.0122431 ],
       [ 0.1144781 ],
       [ 0.0403437 ],
       [ 0.1018497 ],
       [-0.42893811],
       [-0.00947399]])
```

In [19]:
```
def get_targets(optz_w, A):

    '''
    optz_w: Takes in our array of optz_w (our coefficients)
    A: Takes a matrix with our predictors
    '''

    (n, predictors) = A.shape # P is the number of predictors we have
    p = predictors + 1

    new_A = np.ones(shape=(n,p)) # Will leave our first column with 1s for when w
    new_A[:,1:]=A

    targets = np.dot(new_A, optz_w)

    return targets
```

In [137]:
```
# We convert our optimized w's into a numpy array. This is our model
model = np.array(optz_w)
```

In [138]:
```
# Run the model on our training data
predicted_target = get_targets(model, X_train)

# Output  mse:
mse = mean_squared_error(y_train,predicted_target)
print("mse:", mse)
```

```
mse: 0.004247051562830176
```

IMPORTANT NOTE: I just used a function to calculate mse here so that you can make a function for it

Find optz_w using a function

In [50]:
```
from sklearn import datasets, linear_model, metrics
from sklearn.linear_model import LinearRegression
from sklearn.metrics import explained_variance_score, mean_absolute_error, mean_s


regr = linear_model.LinearRegression()
regr.fit(X_train, y_train)

X_train = sm.add_constant(X_train)

print('Intercept:', regr.intercept_)
print('Coefficients:', regr.coef_)

model = sm.OLS(y_train, X_train).fit()
predictions = model.predict(X_train)

mse = mean_squared_error(y_train,predictions)
print(" ")
print("mse:", mse)
```

```
Intercept: [0.18521929]
Coefficients: [[ 0.          0.02353781  0.00256426 -0.00395562  0.0122431   0.
1144781
   0.0403437   0.1018497  -0.42893811 -0.00947399]]

mse: 0.004247051562830176
```

```
<div class="alert alert-block alert-success">

### Compare "scratch" function vs the official function on the training data
set
```

In [94]:
```
# First convert to the right data type and shape

scratch_coeff = optz_w.reshape(10,)
print(scratch_coeff.shape)

func_coeff = (regr.coef_.T).reshape(10,)
print(func_coeff.shape)
```

```
(10,)
(10,)
```

In [91]:
```
optz_w.shape
```

Out[91]:
```
(10, 1)
```

In [106]:
```
arr_coeff = np.array([scratch_coeff,func_coeff])

names_coeff = ["Scratch coefficients", "Function coefficients"]

compare_coef = pd.DataFrame(arr_coeff, names_coeff)
compare_coef
```

Out[106]:

	0	1	2	3	4	5	6	7	
Scratch coefficients	0.185219	0.023538	0.002564	-0.003956	0.012243	0.114478	0.040344	0.10185	-0.428
Function coefficients	0.000000	0.023538	0.002564	-0.003956	0.012243	0.114478	0.040344	0.10185	-0.428

In [109]:
```
arr_mse = np.array([0.004247051562830176,0.004247051562830176])
names_mse = ["Scratch", "Function"]

compare_mse = pd.DataFrame(arr_mse, names_mse, columns=["mse"])
compare_mse
```

Out[109]:

	mse
Scratch	0.004247
Function	0.004247

Use our "scratch" function on the testing data set

In [118]:
```
df_test_nas = pd.read_excel('Testing Data 2021.xlsx')

df_test = df_test_nas.dropna()

len(df_test)
```

Out[118]: 100

In [120]:
```
X_test_pre = df_test[['Log GDP per capita','Healthy life expectancy at birth', 'F
              'Generosity', 'Perceptions of corruption', 'Life Ladder', 'Positive
             'Confidence in national government']]

y_test_pre = df_test[['Social support']]
```

In [132]:
```
X_test= X_test_pre.to_numpy()
X_test.shape
```

Out[132]: (100, 9)

In [133]:
```
y_test= y_test_pre.to_numpy()
y_test.shape
```

Out[133]:
```
(100, 1)
```

Note to self: Don't send to find_opz_w, use the optimized model we previously found

In [140]:
```
# Run the model on our testing data
predicted_target_test = get_targets(model, X_test)
```

In [141]:
```
mse_test = mean_squared_error(y_test,predicted_target_test)
print("mse:", mse_test)
```

```
mse: 0.0029650796848547235
```

Very close to our training data set!