consumption_eda

May 6, 2021

[1]:
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##########################
# Math380 Final Project
# Model Exploration
##########################

#%% import pyplot
from matplotlib import pyplot as plt
import numpy as np
import pandas as pd
```

[2]:
```
#%% CONSUMPTION

# using 2020's data for this!!!
start_OC = 5805959.921
start_RC = 3573412.701
```

[3]:
```
#%%
# case 1: OC growth > RC growth & OC's i-factor < RC's i-factor
OC = [start_OC]
RC = [start_RC]
n = np.arange(41) #until 2060!!!

# growth factor of oil consumption
a = 0.020

# growth factoer of renewable energy consumption
b = -0.006

# interaction factor of OC and RC for OC
c = -0.000000044

# interaction factor of OC and RC for RC
d = -0.000000014

for i in range(40):
    OC.append(((1+a)*OC[i]) + (c*OC[i]*RC[i]))
    RC.append(((1+b)*RC[i]) + (d*OC[i]*RC[i]))
```

```
data = {'years': n, 'Oil': OC, 'Renewable Energy': RC}
df = pd.DataFrame(data=data)
print(df)
df.to_csv(r'/Users/tiffwong/Desktop/math380/final project/consumption_case1.
 ↪csv', index = False)

#plot actual data and modeled data on the same graph to compare
ax = plt.gca()

ax.scatter(n, OC, color="b", label="Oil Consumption Amount")
ax.scatter(n, RC, color="r", label="Renewable Energy Consumption Amount")
plt.title("Consumption (Case 1)")
plt.xlabel("Year n since 2020")
plt.ylabel("Thousand Barrels/day")
plt.legend(loc="upper left")
ax.set_ylim([0, max(max(OC),max(RC))])
plt.show()
```

	years	Oil	Renewable Energy
0	0	5.805960e+06	3.573413e+06
1	1	5.009207e+06	3.261513e+06
2	2	4.390537e+06	3.013218e+06
3	3	3.896244e+06	2.809923e+06
4	4	3.492450e+06	2.639790e+06
5	5	3.156648e+06	2.494880e+06
6	6	2.873261e+06	2.369655e+06
7	7	2.631146e+06	2.260116e+06
8	8	2.422115e+06	2.163301e+06
9	9	2.240007e+06	2.076965e+06
10	10	2.080101e+06	1.999369e+06
11	11	1.938712e+06	1.929148e+06
12	12	1.812923e+06	1.865213e+06
13	13	1.700396e+06	1.806681e+06
14	14	1.599233e+06	1.752831e+06
15	15	1.507878e+06	1.703070e+06
16	16	1.425042e+06	1.656899e+06
17	17	1.349652e+06	1.613902e+06
18	18	1.280804e+06	1.573723e+06
19	19	1.217733e+06	1.536062e+06
20	20	1.159785e+06	1.500659e+06
21	21	1.106401e+06	1.467288e+06
22	22	1.057099e+06	1.435757e+06
23	23	1.011461e+06	1.405894e+06
24	24	9.691215e+05	1.377551e+06
25	25	9.297634e+05	1.350595e+06
26	26	8.931063e+05	1.324911e+06

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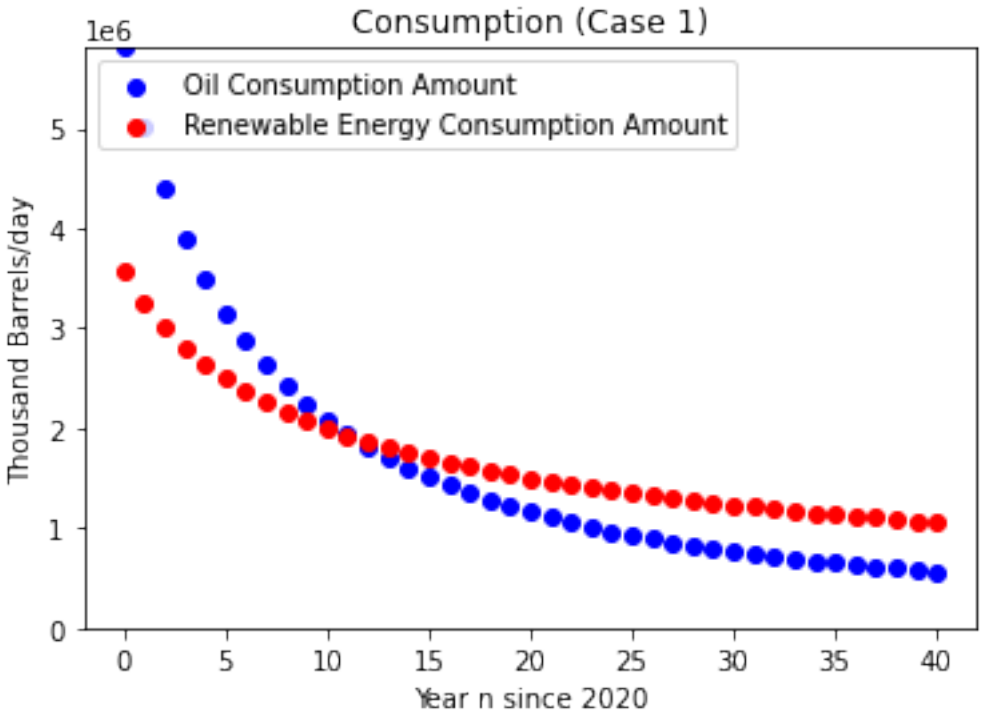
27      27  8.589038e+05       1.300396e+06
28      28  8.269377e+05       1.276957e+06
29      29  7.970140e+05       1.254511e+06
30      30  7.689603e+05       1.232986e+06
31      31  7.426223e+05       1.212315e+06
32      32  7.178619e+05       1.192437e+06
33      33  6.945550e+05       1.173298e+06
34      34  6.725896e+05       1.154849e+06
35      35  6.518648e+05       1.137046e+06
36      36  6.322893e+05       1.119847e+06
37      37  6.137801e+05       1.103215e+06
38      38  5.962620e+05       1.087116e+06
39      39  5.796662e+05       1.071518e+06
40      40  5.639301e+05       1.056393e+06
```



[4]:
```
#%%
# case 2: OC growth > RC growth & OC's i-factor > RC's i-factor
OC = [start_OC]
RC = [start_RC]
n = np.arange(41) #until 2060!!!

# growth factor of oil consumption
a = 0.020
```

```
# growth factoer of renewable energy consumption
b = -0.006

# interaction factor of OC and RC for OC
c = -0.000000014

# interaction factor of OC and RC for RC
d = -0.000000044

for i in range(40):
    OC.append(((1+a)*OC[i]) + (c*OC[i]*RC[i]))
    RC.append(((1+b)*RC[i]) + (d*OC[i]*RC[i]))

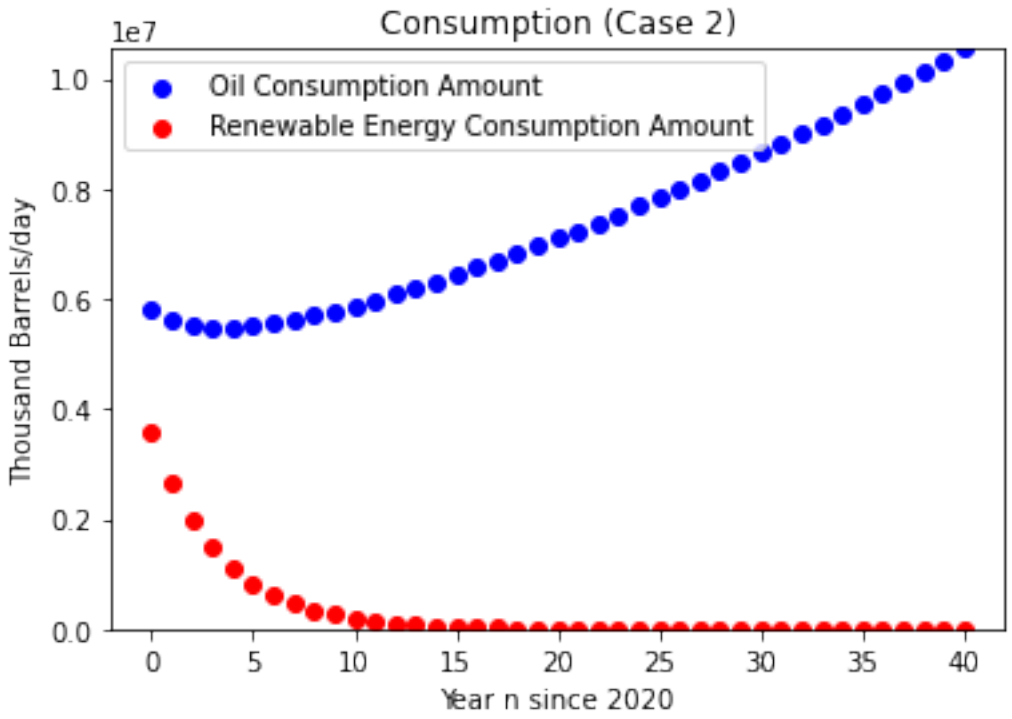
data = {'years': n, 'Oil': OC, 'Renewable Energy': RC}
df = pd.DataFrame(data=data)
print(df)
df.to_csv(r'/Users/tiffwong/Desktop/math380/final project/consumption_case2.
 ↪csv', index = False)

#plot actual data and modeled data on the same graph to compare
ax = plt.gca()

ax.scatter(n, OC, color="b", label="Oil Consumption Amount")
ax.scatter(n, RC, color="r", label="Renewable Energy Consumption Amount")
plt.title("Consumption (Case 2)")
plt.xlabel("Year n since 2020")
plt.ylabel("Thousand Barrels/day")
plt.legend(loc="upper left")
ax.set_ylim([0, max(max(OC),max(RC))])
plt.show()
```

	years	Oil	Renewable Energy
0	0	5.805960e+06	3.573413e+06
1	1	5.631620e+06	2.639100e+06
2	2	5.536179e+06	1.969320e+06
3	3	5.494267e+06	1.477793e+06
4	4	5.490481e+06	1.111673e+06
5	5	5.514840e+06	8.364441e+05
6	6	5.560557e+06	6.284598e+05
7	7	5.622844e+06	4.709272e+05
8	8	5.698229e+06	3.515919e+05
9	9	5.784145e+06	2.613305e+05
10	10	5.878666e+06	1.932533e+05
11	11	5.980335e+06	1.421066e+05
12	12	6.088043e+06	1.038608e+05
13	13	6.200952e+06	7.541602e+04
14	14	6.318424e+06	5.438687e+04

15	15	6.439981e+06	3.894042e+04
16	16	6.565270e+06	2.767265e+04
17	17	6.694032e+06	1.951277e+04
18	18	6.826084e+06	1.364845e+04
19	19	6.961301e+06	9.467279e+03
20	20	7.099605e+06	6.510673e+03
21	21	7.240950e+06	4.437788e+03
22	22	7.385319e+06	2.997274e+03
23	23	7.532715e+06	2.005314e+03
24	24	7.683158e+06	1.328642e+03
25	25	7.836678e+06	8.715108e+02
26	26	7.993316e+06	5.657728e+02
27	27	8.153119e+06	3.633925e+02
28	28	8.316140e+06	2.308497e+02
29	29	8.482436e+06	1.449944e+02
30	30	8.652068e+06	9.000855e+01
31	31	8.825098e+06	5.520306e+01
32	32	9.001593e+06	3.343625e+01
33	33	9.181621e+06	1.999254e+01
34	34	9.365251e+06	1.179577e+01
35	35	9.552554e+06	6.864300e+00
36	36	9.743605e+06	3.937964e+00
37	37	9.938476e+06	2.226058e+00
38	38	1.013725e+07	1.239262e+00
39	39	1.033999e+07	6.790675e-01
40	40	1.054679e+07	3.660448e-01



[5]:
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#%%
# actual (case 3): OC growth < RC growth & OC's i-factor < RC's i-factor
OC = [start_OC]
RC = [start_RC]
n = np.arange(41)
# growth factor of oil consumption
a = -0.006012076354

# growth factoer of renewable energy consumption
b = 0.020247218

# interaction factor of OC and RC for OC
c = -0.00000004382777105

# interaction factor of OC and RC for RC
d = -0.00000001382597676

for i in range(40):
    OC.append(((1+a)*OC[i]) + (c*OC[i]*RC[i]))
    RC.append(((1+b)*RC[i]) + (d*OC[i]*RC[i]))

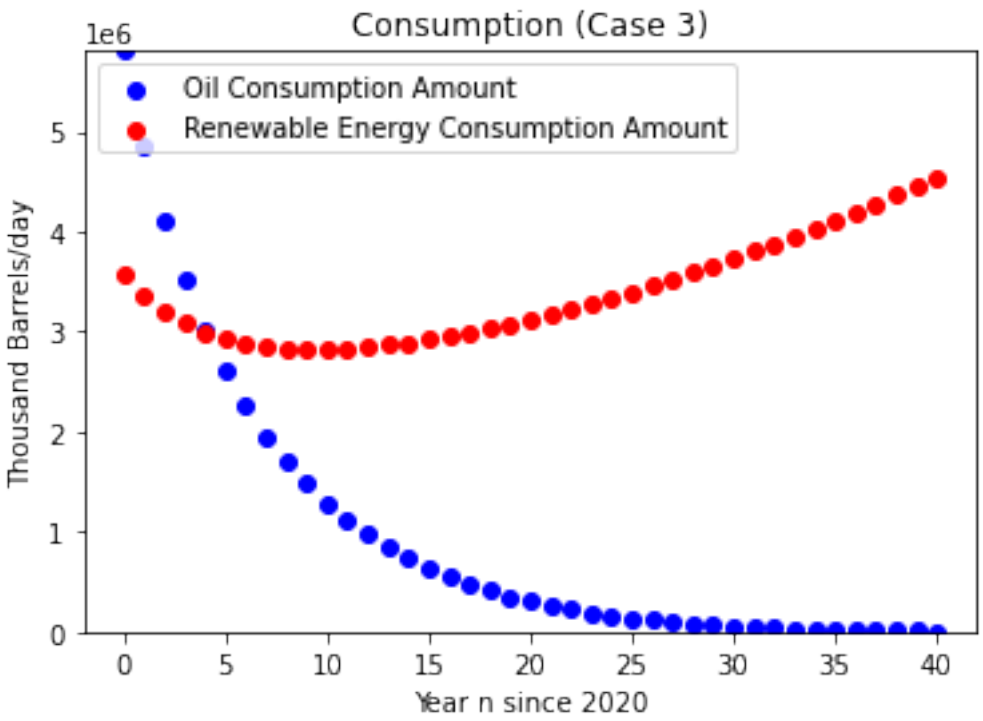
data = {'years': n, 'Oil': OC, 'Renewable Energy': RC}
df = pd.DataFrame(data=data)
print(df)
df.to_csv(r'/Users/tiffwong/Desktop/math380/final project/consumption_case3.
 ↪csv', index = False)

#plot actual data and modeled data on the same graph to compare
ax = plt.gca()

ax.scatter(n, OC, color="b", label="Oil Consumption Amount")
ax.scatter(n, RC, color="r", label="Renewable Energy Consumption Amount")
plt.title("Consumption (Case 3)")
plt.xlabel("Year n since 2020")
plt.ylabel("Thousand Barrels/day")
plt.legend(loc="upper left")
ax.set_ylim([0, max(max(OC),max(RC))])
plt.show()
```

```
    years           Oil  Renewable Energy
0       0  5.805960e+06      3.573413e+06
1       1  4.861755e+06      3.358916e+06
2       2  4.116809e+06      3.201143e+06
3       3  3.514474e+06      3.083752e+06
4       4  3.018350e+06      2.996346e+06
```

5	5	2.603824e+06	2.931972e+06
6	6	2.253574e+06	2.885784e+06
7	7	1.954999e+06	2.854298e+06
8	8	1.698680e+06	2.834939e+06
9	9	1.477408e+06	2.825757e+06
10	10	1.285553e+06	2.825250e+06
11	11	1.118642e+06	2.832238e+06
12	12	9.730586e+05	2.845778e+06
13	13	8.458446e+05	2.865112e+06
14	14	7.345454e+05	2.889616e+06
15	15	6.371024e+05	2.918776e+06
16	16	5.517718e+05	2.952163e+06
17	17	4.770625e+05	2.989415e+06
18	18	4.116900e+05	3.030224e+06
19	19	3.545391e+05	3.074330e+06
20	20	3.046367e+05	3.121506e+06
21	21	2.611282e+05	3.171561e+06
22	22	2.232608e+05	3.224326e+06
23	23	1.903685e+05	3.279656e+06
24	24	1.618604e+05	3.337428e+06
25	25	1.372116e+05	3.397533e+06
26	26	1.159550e+05	3.459878e+06
27	27	9.767462e+04	3.524384e+06
28	28	8.199999e+04	3.590984e+06
29	29	6.860145e+04	3.659620e+06
30	30	5.718582e+04	3.730246e+06
31	31	4.749280e+04	3.802824e+06
32	32	3.929168e+04	3.877323e+06
33	33	3.237844e+04	3.953722e+06
34	34	2.657315e+04	4.032004e+06
35	35	2.171755e+04	4.112159e+06
36	36	1.767290e+04	4.194185e+06
37	37	1.431799e+04	4.278080e+06
38	38	1.154730e+04	4.363853e+06
39	39	9.269364e+03	4.451512e+06
40	40	7.405185e+03	4.541072e+06



[6]:
```
#%%
# case 4: OC growth < RC growth & OC's i-factor > RC's i-factor
OC = [start_OC]
RC = [start_RC]
n = np.arange(41)
# growth factor of oil consumption
a = -0.006012076354

# growth factoer of renewable energy consumption
b = 0.020247218

# interaction factor of OC and RC for OC
c = -0.000000014

# interaction factor of OC and RC for RC
d = -0.000000044



for i in range(40):
    OC.append(((1+a)*OC[i]) + (c*OC[i]*RC[i]))
    RC.append(((1+b)*RC[i]) + (d*OC[i]*RC[i]))
```

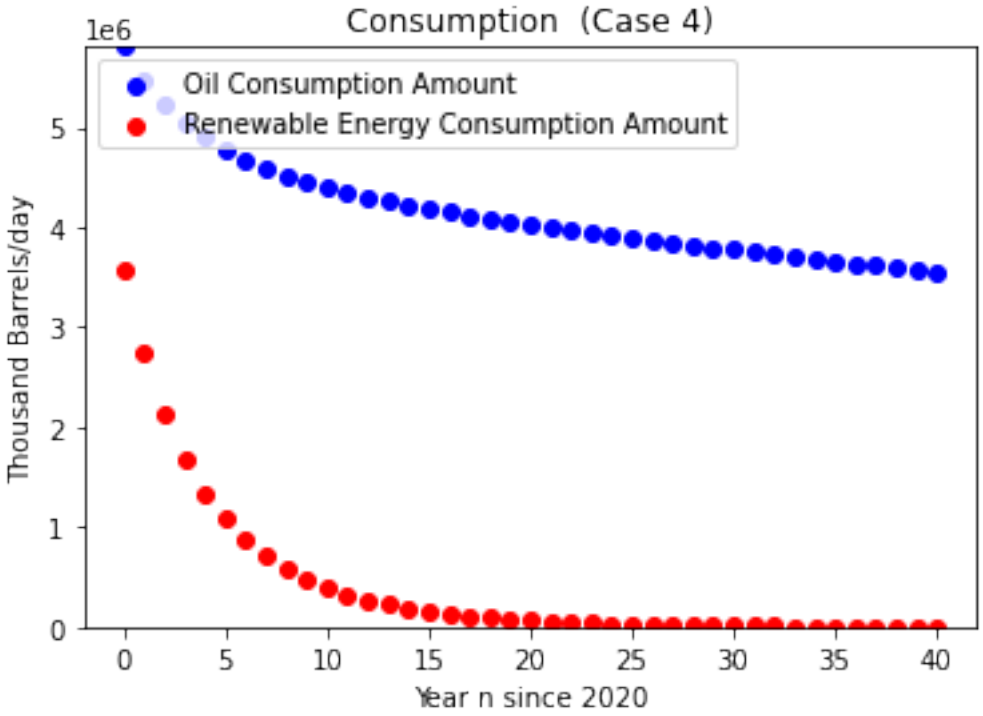
```
data = {'years': n, 'Oil': OC, 'Renewable Energy': RC}
df = pd.DataFrame(data=data)
print(df)
df.to_csv(r'/Users/tiffwong/Desktop/math380/final project/consumption_case4.
 ↪csv', index = False)

#plot actual data and modeled data on the same graph to compare
ax = plt.gca()

ax.scatter(n, OC, color="b", label="Oil Consumption Amount")
ax.scatter(n, RC, color="r", label="Renewable Energy Consumption Amount")
plt.title("Consumption  (Case 4)")
plt.xlabel("Year n since 2020")
plt.ylabel("Thousand Barrels/day")
plt.legend(loc="upper left")
ax.set_ylim([0, max(max(OC),max(RC))])
plt.show()
```

	years	Oil	Renewable Energy
0	0	5.805960e+06	3.573413e+06
1	1	5.480595e+06	2.732892e+06
2	2	5.237955e+06	2.129199e+06
3	3	5.050327e+06	1.681593e+06
4	4	4.901067e+06	1.341967e+06
5	5	4.779523e+06	1.079747e+06
6	6	4.678539e+06	8.745388e+05
7	7	4.593129e+06	7.122170e+05
8	8	4.519716e+06	5.827000e+05
9	9	4.455673e+06	4.786180e+05
10	10	4.399029e+06	3.944758e+05
11	11	4.348287e+06	3.261092e+05
12	12	4.302293e+06	2.703193e+05
13	13	4.260145e+06	2.246208e+05
14	14	4.221136e+06	1.870644e+05
15	15	4.184703e+06	1.561085e+05
16	16	4.150399e+06	1.305254e+05
17	17	4.117862e+06	1.093320e+05
18	18	4.086802e+06	9.173623e+04
19	19	4.056983e+06	7.709769e+04
20	20	4.028214e+06	6.489621e+04
21	21	4.000336e+06	5.470788e+04
22	22	3.973222e+06	4.618617e+04
23	23	3.946765e+06	3.904696e+04
24	24	3.920879e+06	3.305675e+04
25	25	3.895492e+06	2.802315e+04
26	26	3.870544e+06	2.378733e+04
27	27	3.845985e+06	2.021788e+04

```
28      28  3.821774e+06      1.720590e+04
29      29  3.797877e+06      1.466096e+04
30      30  3.774264e+06      1.250786e+04
31      31  3.750912e+06      1.068396e+04
32      32  3.727800e+06      9.136997e+03
33      33  3.704911e+06      7.823316e+03
34      34  3.682231e+06      6.706390e+03
35      35  3.659748e+06      5.755619e+03
36      36  3.637450e+06      4.945333e+03
37      37  3.615330e+06      4.253973e+03
38      38  3.593379e+06      3.663405e+03
39      39  3.571591e+06      3.158363e+03
40      40  3.549960e+06      2.725974e+03
```



[7]:
```
#%%
# case 5: OC growth = RC growth & OC's i-factor > RC's i-factor
OC = [start_OC]
RC = [start_RC]
n = np.arange(41) #until 2060!!!

# growth factor of oil consumption
a = 0.020

# growth factoer of renewable energy consumption
```

```
b = 0.020

# interaction factor of OC and RC for OC
c = -0.000000014

# interaction factor of OC and RC for RC
d = -0.000000044

for i in range(40):
    OC.append(((1+a)*OC[i]) + (c*OC[i]*RC[i]))
    RC.append(((1+b)*RC[i]) + (d*OC[i]*RC[i]))

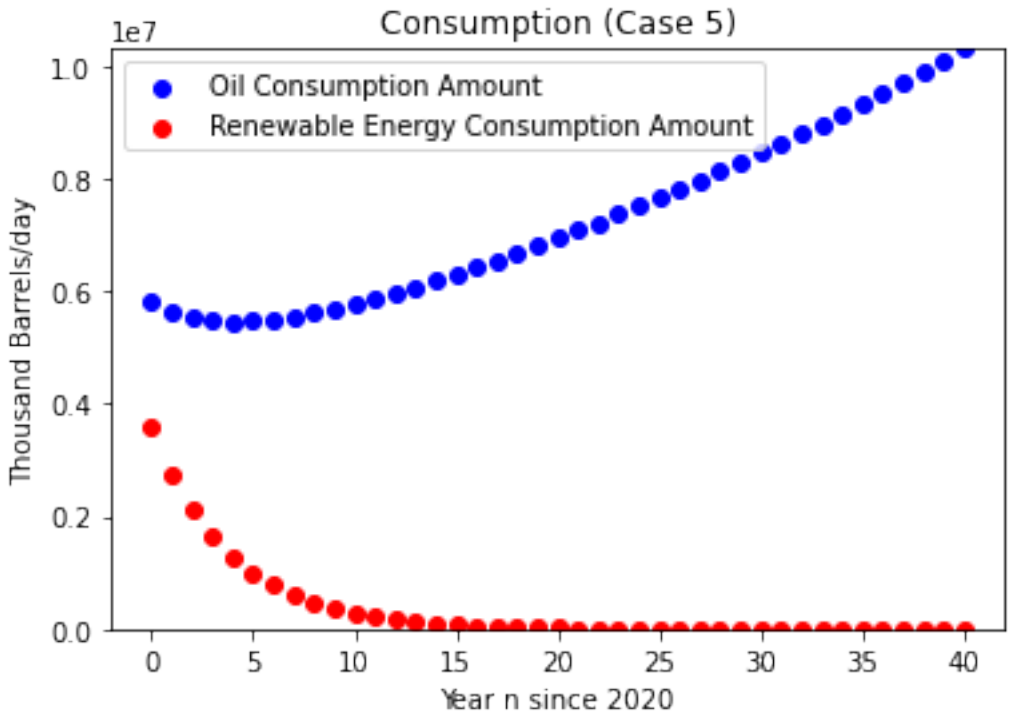
data = {'years': n, 'Oil': OC, 'Renewable Energy': RC}
df = pd.DataFrame(data=data)
print(df)
df.to_csv(r'/Users/tiffwong/Desktop/math380/final project/consumption_case5.
 ↪csv', index = False)


#plot actual data and modeled data on the same graph to compare
ax = plt.gca()

ax.scatter(n, OC, color="b", label="Oil Consumption Amount")
ax.scatter(n, RC, color="r", label="Renewable Energy Consumption Amount")
plt.title("Consumption (Case 5)")
plt.xlabel("Year n since 2020")
plt.ylabel("Thousand Barrels/day")
plt.legend(loc="upper left")
ax.set_ylim([0, max(max(OC),max(RC))])
plt.show()
```

	years	Oil	Renewable Energy
0	0	5.805960e+06	3.573413e+06
1	1	5.631620e+06	2.732009e+06
2	2	5.528853e+06	2.109681e+06
3	3	5.476133e+06	1.638654e+06
4	4	5.460027e+06	1.276593e+06
5	5	5.471644e+06	9.954349e+05
6	6	5.504823e+06	7.756904e+05
7	7	5.555139e+06	6.033225e+05
8	8	5.619321e+06	4.679211e+05
9	9	5.694895e+06	3.615860e+05
10	10	5.779965e+06	2.782132e+05
11	11	5.873051e+06	2.130227e+05
12	12	5.972997e+06	1.622350e+05
13	13	6.078890e+06	1.228425e+05
14	14	6.190014e+06	9.244249e+04

15	15	6.305803e+06	6.911365e+04
16	16	6.425817e+06	5.131997e+04
17	17	6.549717e+06	3.783637e+04
18	18	6.677242e+06	2.768913e+04
19	19	6.808198e+06	2.010788e+04
20	20	6.942446e+06	1.448651e+04
21	21	7.079887e+06	1.035108e+04
22	22	7.220458e+06	7.333584e+03
23	23	7.364126e+06	5.150375e+03
24	24	7.510878e+06	3.584550e+03
25	25	7.660718e+06	2.471624e+03
26	26	7.813668e+06	1.687942e+03
27	27	7.969756e+06	1.141384e+03
28	28	8.129024e+06	7.639634e+02
29	29	8.291518e+06	5.059905e+02
30	30	8.457289e+06	3.315114e+02
31	31	8.626396e+06	2.147794e+02
32	32	8.798898e+06	1.375530e+02
33	33	8.974859e+06	8.705021e+01
34	34	9.154345e+06	5.441563e+01
35	35	9.337425e+06	3.358580e+01
36	36	9.524169e+06	2.045890e+01
37	37	9.714650e+06	1.229450e+01
38	38	9.908941e+06	7.285175e+00
39	39	1.010712e+07	4.254590e+00
40	40	1.030926e+07	2.447609e+00



[ ]: