A3_junhoc

October 21, 2018

0.1 Assignment 3, MACS30000 (Dr. Evans)

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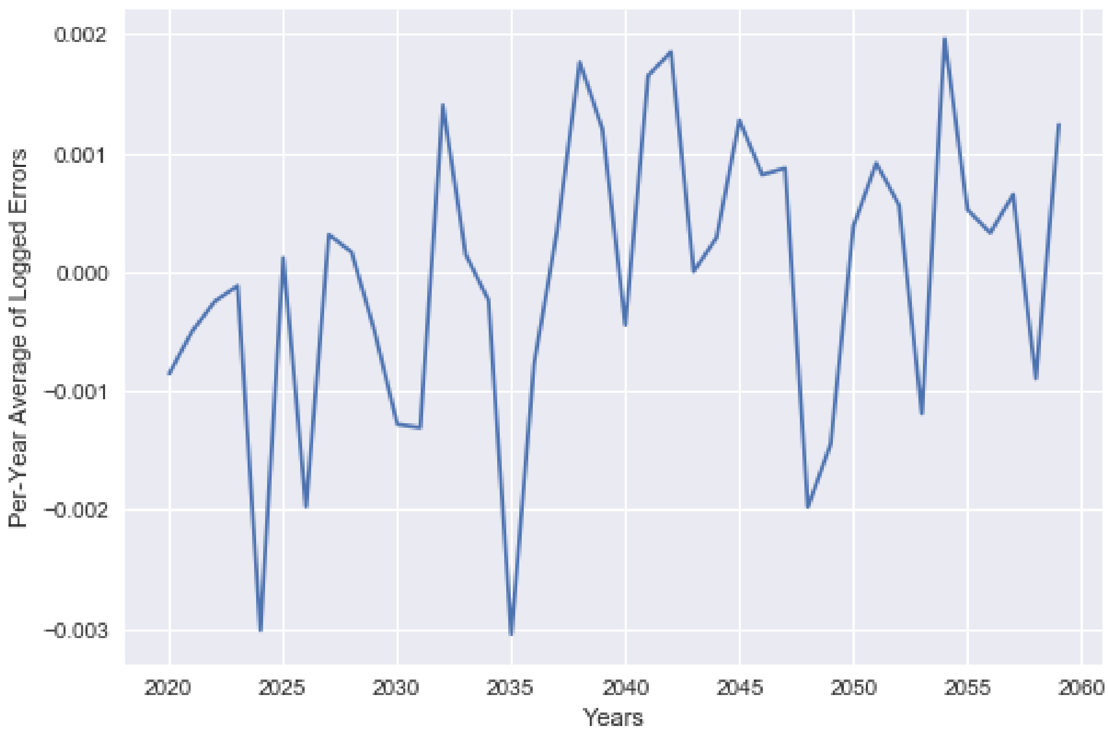
October 21, 2018

0.1.1 Problem 2-(a)

```
In [46]: # Import initial packages
         import numpy as np
         import matplotlib.pyplot as plt
         from matplotlib.ticker import MultipleLocator
         import math
         plt.style.use('seaborn')
```

```
In [152]: # For the sake of consistent results, I set a random seed
          # 20181020: the day I started this problem set!
          np.random.seed(20181020)

          # Generating the log-normal errors; for convenience's sake,
          # I will refer to the logged version of errors as "shocks"

          # I draw a list of 40 random shocks (one for each year)
          # which is done for 10,000 times.
          def shock_generator(sim_times, years, SIGMA):

              list_shocks_40 = []
              for i in range(0, sim_times):
                  shocks_40 = []
                  for j in range(0, years):
                      shock = np.random.normal(loc=0.0, scale=SIGMA)
                      shocks_40.append(shock)
                  mean_40.append(sum(shocks_40)/len(shocks_40))
                  list_shocks_40.append(shocks_40)

              return list_shocks_40

          list_shocks_40 = shock_generator(10000, 40, 0.13)
```

In [153]:
```
# To ensure that that the errors are not "abnormal,"
# I produce a graph showing trend (for each year)
# of the averages of 10,000 shocks
mean_shock_yearly = []
years = []
initial_year = 2019

for j in range(0, 40):
    sum_shock_single = 0
    initial_year += 1
    for i in range(0, 10000):
        sum_shock_single += list_shocks_40[i][j]
    mean_shock_single = sum_shock_single / 10000
    mean_shock_yearly.append(mean_shock_single)
    years.append(initial_year)

plt.plot(years, mean_shock_yearly)
plt.xlabel("Years")
plt.ylabel("Per-Year Average of Logged Errors")
plt.show()
```



In [128]:
```
# Making a function for the one-to-next year simulation
def one_year_sim(prev_lny, year, RHO, G, Y_0, shock_list):
```

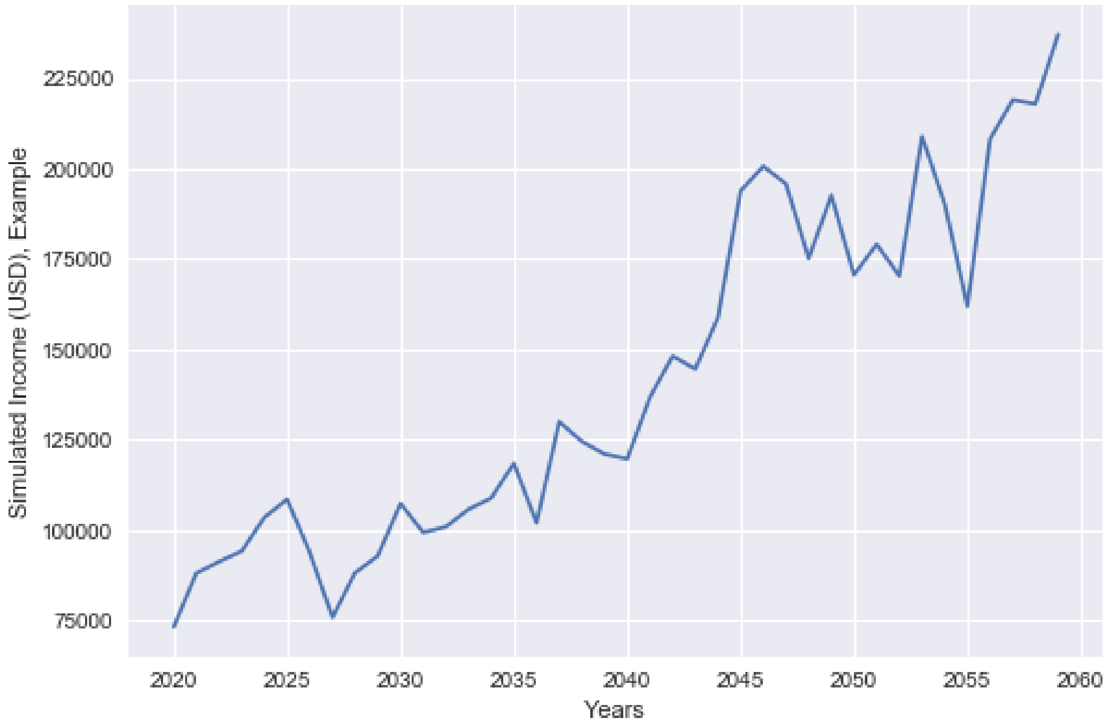
```
    assert year >= 2021 and year <= 2059
    first_term = (1 - RHO) * (math.log(Y_0) + G * (year - 2020))
    second_term = RHO * prev_lny
    shock = shock_list[(year - 2020)]
    next_lny = first_term + second_term + shock
    return next_lny
```

```
In [131]: # Making a function for the entire simulation
          def entire_sim(RHO, G, Y_0, list_shocks_40):
              simulations_10000 = []

              for i, shock_list in enumerate(list_shocks_40):
                  list_40_yrs_y = []

                  lny_2020 = math.log(Y_0) + shock_list[0]
                  list_40_yrs_y.append(math.exp(lny_2020))

                  prev_lny = lny_2020
                  year = 2021

                  for j in range(1, 40):
                      next_lny = one_year_sim(
                                   prev_lny, year, RHO, G, Y_0, shock_list)
                      next_y = math.exp(next_lny)
                      list_40_yrs_y.append(next_y)

                      prev_lny = next_lny
                      year += 1

                  simulations_10000.append(list_40_yrs_y)

              return simulations_10000
```

```
In [132]: # Simulating the entire 40 years, Y_0 = 80000; RHO = 0.4; G = 0.025
          Y_0 = 80000
          RHO = 0.4
          G = 0.025

          simulations_10000 = entire_sim(0.4, 0.025, 80000, list_shocks_40)
```

```
In [133]: # Randomly pick one of the 10,000 sets of 40 shocks
          # Random seed: 30000
          np.random.seed(30000)
          index = round(np.random.random()*10000)
```

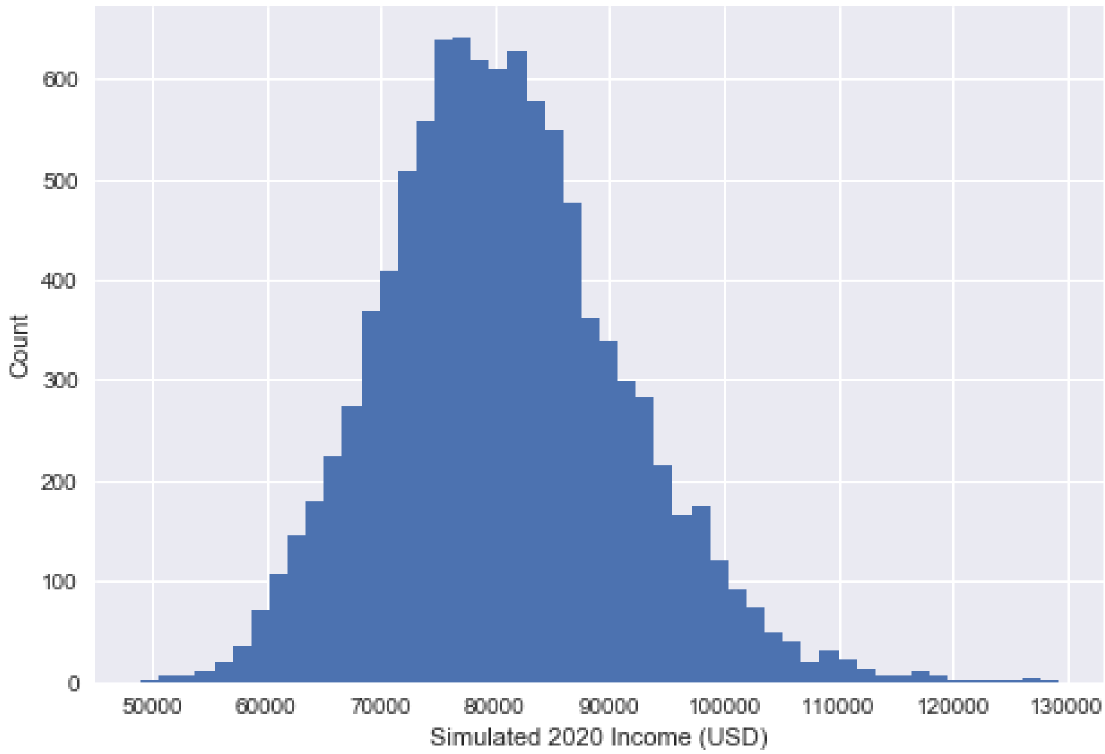
```
In [134]: plt.plot(years, simulations_10000[index])
          plt.xlabel("Years")
          plt.ylabel("Simulated Income (USD), Example")
          plt.show()
```



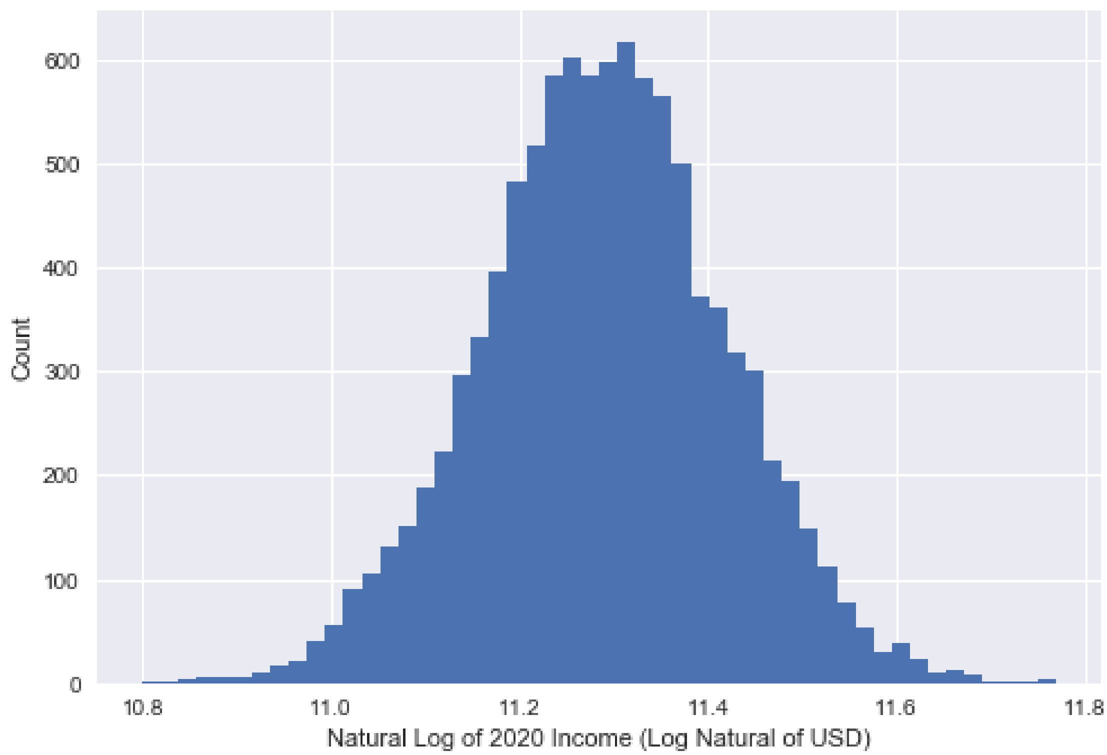
0.1.2 Problem 2-(b)

```
In [89]: initial_incomes = []
         log_initial_incomes = []
         more_100k = 0
         less_70k = 0
         for i in simulations_10000:
             if i[0] > 100000:
                 more_100k += 1
             elif i[0] < 70000:
                 less_70k += 1
             initial_incomes.append(i[0])
             log_initial_incomes.append(math.log(i[0]))
```

```
In [116]: plt.hist(initial_incomes, bins = 50)
          plt.ylabel("Count")
          plt.xlabel("Simulated 2020 Income (USD)")
          plt.show()
```




```
In [117]: plt.hist(log_initial_incomes, bins = 50)
          plt.ylabel("Count")
          plt.xlabel("Natural Log of 2020 Income (Log Natural of USD)")
          plt.show()
```

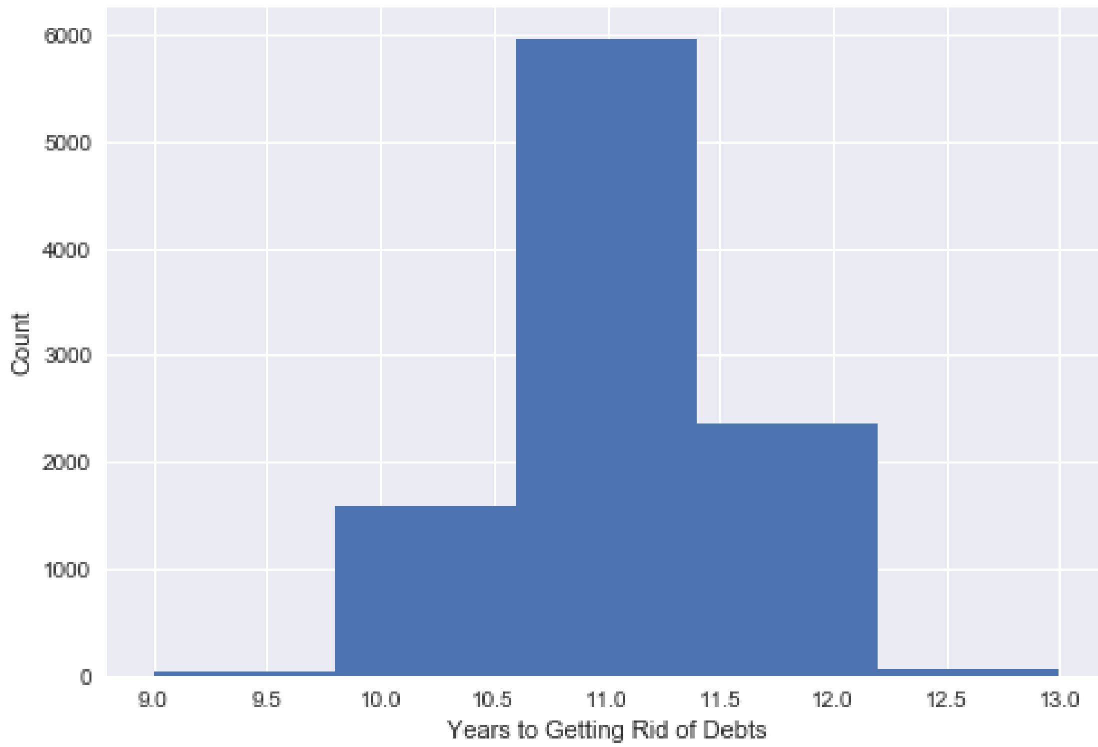



```
In [93]: percent_more_100k = 100 * (more_100k / 10000)
         percent_less_70k = 100 * (less_70k / 10000)

         print(percent_more_100k,"% ", percent_less_70k, "%")

4.0 %  14.82 %
```

0.1.3 Problem 2-(c)

```
In [141]: def years_till_debt_free(simulations, DEBT):
              when_debt_free = []
              for i, income in enumerate(simulations):
                  DEBT = 95000
                  for j in range(len(income)):
                      DEBT += (-1) * ((income[j]) / 10)
                      if DEBT <= 0:
                          when_debt_free.append(j + 1)
                          break
              return when_debt_free

In [148]: when_debt_free = years_till_debt_free(simulations_10000, 95000)
          debt_free_array = np.array(when_debt_free)
```

```
unique_debt_free = np.unique(debt_free_array)
unique_numbers = len(unique_debt_free)

plt.hist(when_debt_free, bins = unique_numbers)
plt.ylabel("Count")
plt.xlabel("Years to Getting Rid of Debts")
plt.show()
print(unique_debt_free)
```




```
[ 9 10 11 12 13]
```

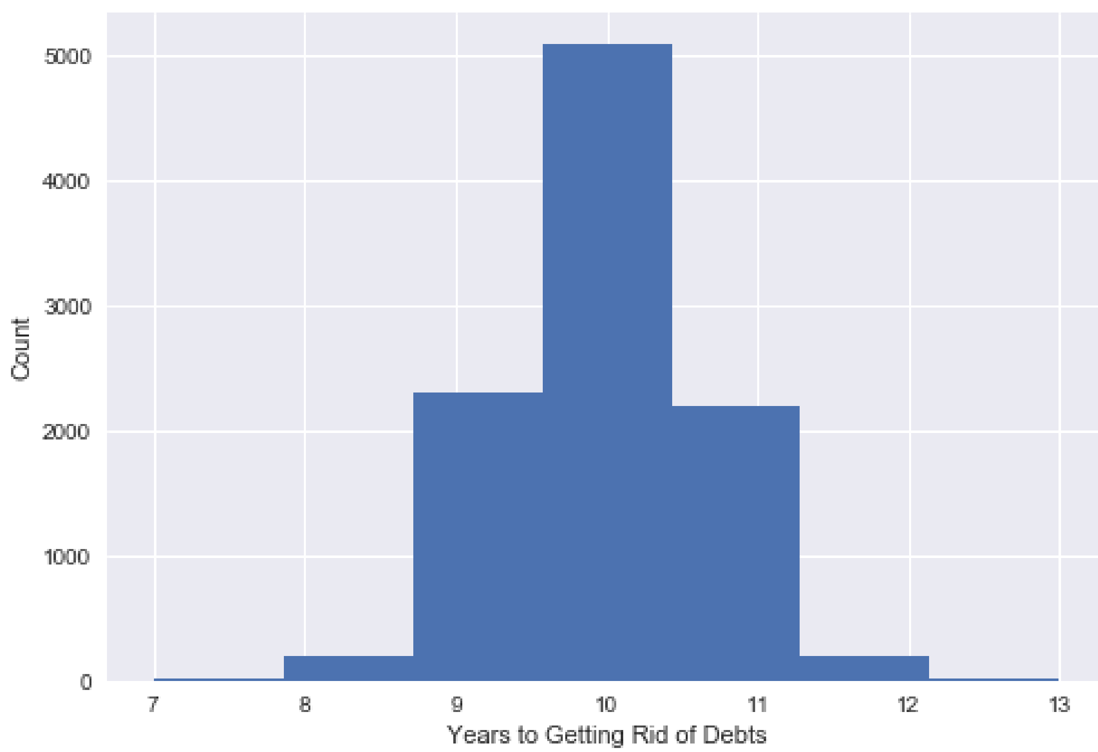
```
In [124]: count_less_10 = 0
          for i in when_debt_free:
              if i <= 10:
                  count_less_10 += 1

          what_percent = 100 * (count_less_10 / len(when_debt_free))
          print(what_percent)
```

```
16.08
```

0.1.4 Problem 2-(d)

```
In [137]: np.random.seed(20181021)
          list_shocks_40_2 = shock_generator(10000, 40, 0.17)

          simulations_10000_2 = entire_sim(0.4, 0.025, 90000, list_shocks_40_2)
```

```
In [150]: when_debt_free_2 = years_till_debt_free(
                                          simulations_10000_2, 95000)
          debt_free_array_2 = np.array(when_debt_free_2)
          unique_debt_free_2 = np.unique(debt_free_array)
          unique_numbers_2 = len(unique_debt_free)

          plt.hist(when_debt_free_2, bins = unique_numbers_2)
          plt.ylabel("Count")
          plt.xlabel("Years to Getting Rid of Debts")
          plt.show()
          print(unique_debt_free)
```




```
[ 7  8  9 10 11 12 13]
```

```
In [151]: count_less_10 = 0
          for i in when_debt_free_2:
```

```
        if i <= 10:
            count_less_10 += 1

    what_percent = 100 * (count_less_10 / len(when_debt_free_2))
    print(what_percent)
```

```
76.08
```