hw3-question2

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1 Assignment 3

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1.0.3 Oct. 18

```
In [4]: # Import initial packages
        import numpy as np
        import matplotlib.pyplot as plt
        from matplotlib.ticker import MultipleLocator
```

1.0.4 2. Simulating your income

(a) Simulate 10,000 different realizations of lifetime income

```
In [8]: def income_sim(p):
            """
            Requires a simulation profile, p, structured as a dictionary

            p = {
                'inc0'          : 80000,        #starting income
                'g'             : 0.025,        #growth rate
                'st_year'       : int(2020),    #start year
                'wk_years'      : 40,           #years to work
                'sigma'         : 0.13,         #standard deviation of income process
                'rho'           : 0.4,          #income persistence
                'num_draws'     : 10000         #simulations
            }
            """

            #set random seed
            np.random.seed(524)

            normal_errors = np.random.normal(0,p['sigma'], (p['wk_years'], p['num_draws']))

            #create a matrix of dim (wk_years, num_draws)
```

```
    ln_inc_mat = np.zeros((p['wk_years'], p['num_draws']))

    #fill the matrix
    ln_inc_mat[0, :] = np.log(p['inc0']) + normal_errors[0, :]

    #loop and apply model
    for yr in range(1, p['wk_years']):
        ln_inc_mat[yr, :] = (1-p['rho'])* ((np.log(p['inc0'])) +
                                p['g']*yr) + p['rho'] * ln_inc_mat[yr - 1, :] + normal_erro

    inc_mat = np.exp(ln_inc_mat) #dealing with large numbers so put in terms of 10k's
    return inc_mat
```

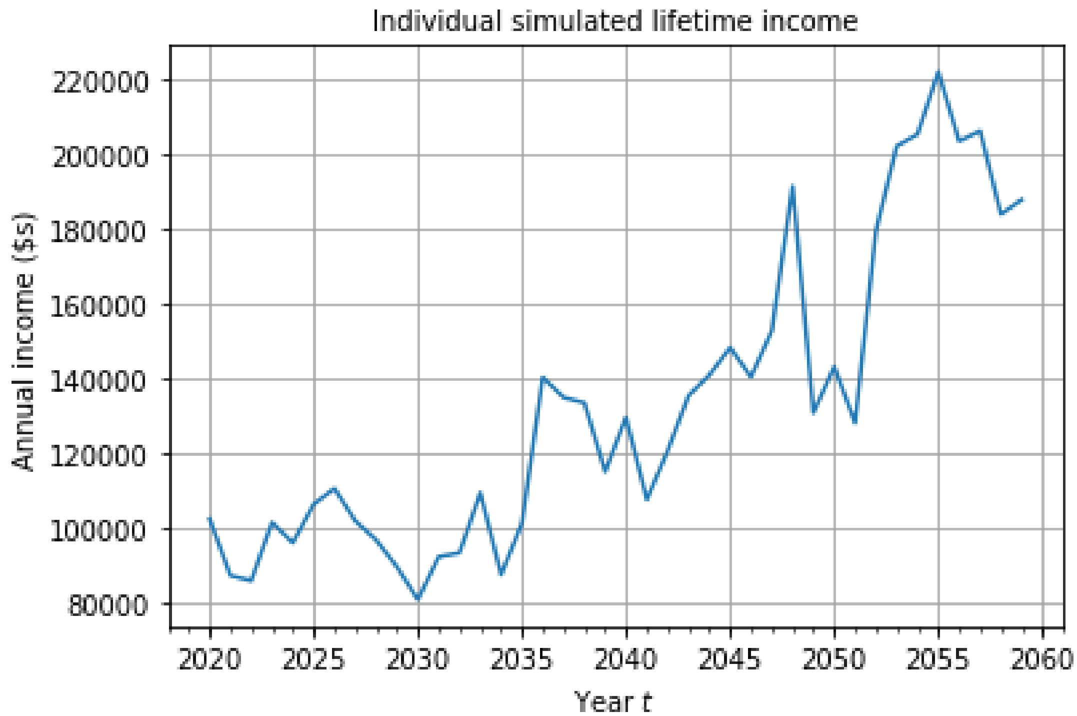
```
In [9]: simulation_profile = {
            'inc0'        : 80000,      #starting income
            'g'           : 0.025,      #growth rate
            'st_year'     : int(2020),  #start year
            'wk_years'    : 40,         #years to work
            'sigma'       : 0.13,       #standard deviation of income process
            'rho'         : 0.4,        #income persistence
            'num_draws'   : 10000       #simulations
        }

        inc_mat = income_sim(simulation_profile)
        print(inc_mat)
```

```
[[ 66409.15585396  98274.13534194 101939.81109509 ...  98720.39690442
   72404.51636886  68710.32820307]
 [ 80020.53020329  67383.19350738  84557.85626308 ...  68247.7770509
   74518.33613244  80555.96068584]
 [ 75805.26636606  66134.42494243  91458.20304692 ...  67268.53350159
   90012.42673528  80645.62355527]
 ...
 [272690.56519108 217821.73027242 184724.24512469 ... 159922.45424852
  253961.68337673 209741.55004062]
 [231539.17420799 202509.15149494 197955.96626493 ... 199502.43481758
  210951.71828579 205420.27946389]
 [197895.95201384 165115.10025278 172644.86927513 ... 248654.44847819
  234237.14656466 221566.29879732]]
```

```
In [10]: %matplotlib inline
         p = simulation_profile
         year_vec = np.arange(p['st_year'], p['st_year'] + p['wk_years'])
         fig, ax = plt.subplots()
         plt.plot(year_vec, inc_mat[:, 3])
         minorLocator = MultipleLocator(1)
```

```
        ax.xaxis.set_minor_locator(minorLocator)
        plt.grid(b=True, which='major', color='0.65', linestyle='-')
        plt.title('Individual simulated lifetime income', fontsize=10)
        plt.xlabel(r'Year $t$')
        plt.ylabel(r'Annual income (\$s)')
```

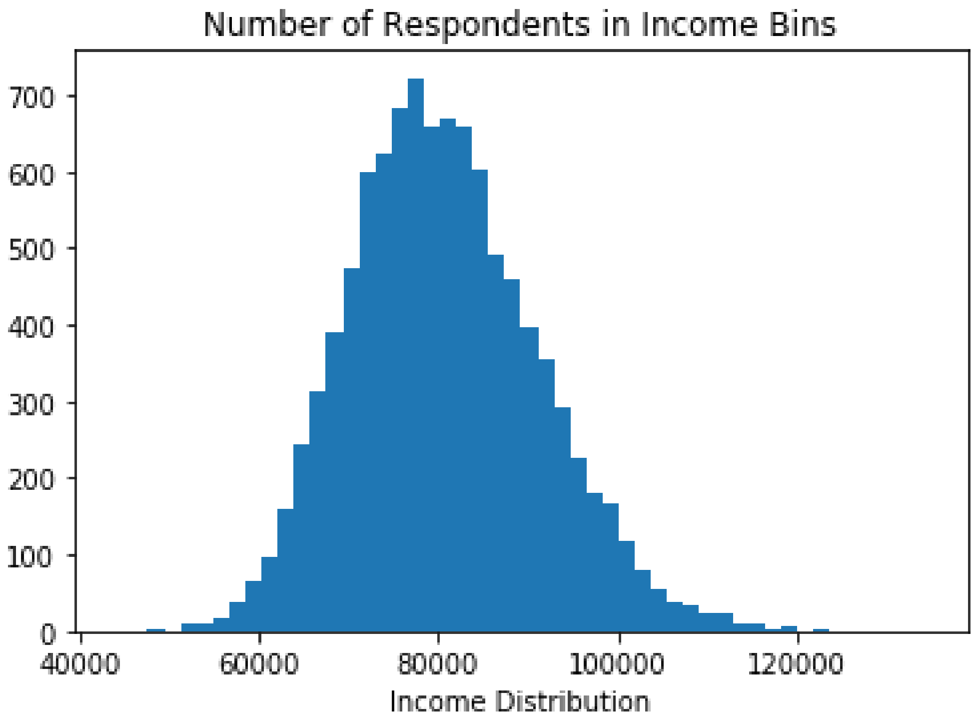
```
Out[10]: Text(0,0.5,'Annual income (\\$s)')
```



(b) Histogram with 50 bins of year t = 2020 initial income for each of the 10,000 simulations

```
In [11]: plt.hist(inc_mat[0,:], bins=50)
         plt.xlabel("Income Distribution")
         plt.title("Number of Respondents in Income Bins")
         large = 0
         small = 0
         for i in inc_mat[0,:]:
             if i>100000:
                 large+=1
             elif i<70000:
                 small+=1
         print("percent of the class earn more than $100,000 in the first year out of the progr
         print("percent of the class earn less than $70,000 in the first year out of the progra
```

```
percent of the class earn more than $100,000 in the first year out of the program:  0.0417
percent of the class earn less than $70,000 in the first year out of the program:  0.1512
```



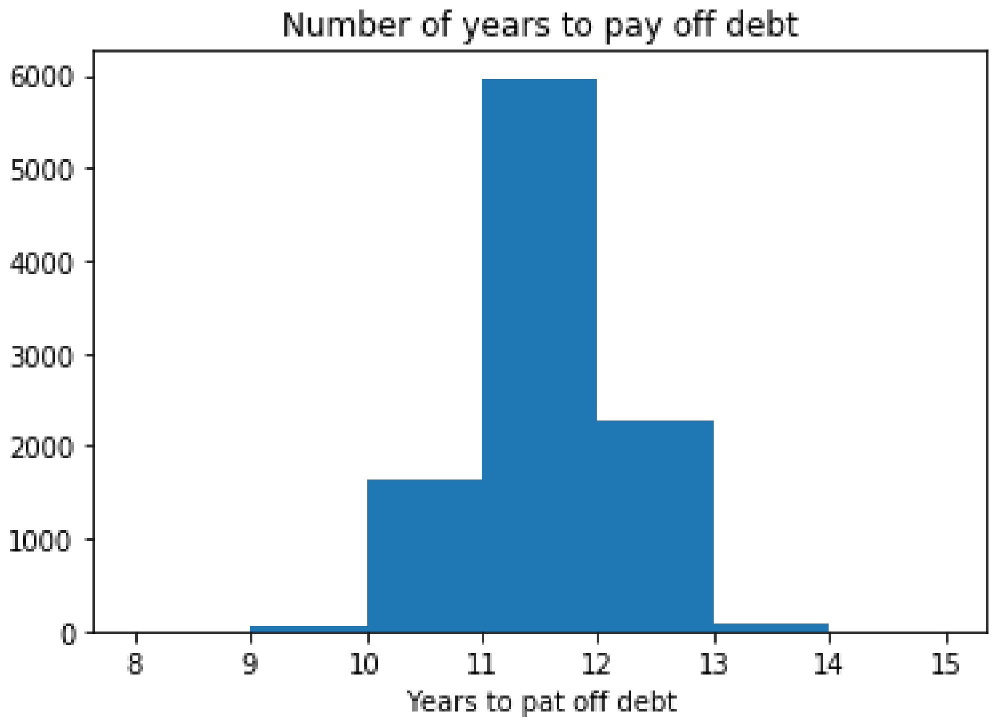
The plot above shows that the distribution is nearly normal.

(c) Years to pay off debt

```
In [12]: def year_to_pay_debt(inc_mat):
             year = []
             pay = 0
             y=0
             for i in range(p['num_draws']):
                 for j in inc_mat[:,i]:
                     pay+=j/10
                     y+=1
                     if pay>=95000:
                         year.append(y)
                         pay=0
                         y=0
                         break
             return year
         yearlist = year_to_pay_debt(inc_mat)

         plt.hist(yearlist, np.arange(min(yearlist)-1,max(yearlist)+3))
         plt.xlabel("Years to pat off debt")
         plt.title("Number of years to pay off debt")
```

```
year_less_than_ten = [i for i in yearlist if i<=10]
print("percent of the simulations able to pay off the loan in 10 years: ",len(year_les
```

```
percent of the simulations able to pay off the loan in 10 years:  0.1678
```



(d) After MACSS becomes well known

```
In [13]: simulation_profile2 = {
             'inc0'          : 90000,       #starting income
             'g'             : 0.025,       #growth rate
             'st_year'       : int(2020),   #start year
             'wk_years'      : 40,          #years to work
             'sigma'         : 0.17,        #standard deviation of income process
             'rho'           : 0.4,         #income persistence
             'num_draws'     : 10000        #simulations
         }

         inc_mat2 = income_sim(simulation_profile2)

         yearlist2 = year_to_pay_debt(inc_mat2)

         plt.hist(yearlist2, np.arange(min(yearlist2),max(yearlist2)+1))
         plt.xlabel("Years to pat off debt")
```

```
plt.title("Number of years to pay off debt")

year_less_than_ten2 = [i for i in yearlist2 if i<=10]
print("percent of the simulations able to pay off the loan in 10 years: ",len(year_les
```

```
percent of the simulations able to pay off the loan in 10 years:  0.7602
```