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In[1]:= (* Solving for the duration weights Assignment #3-24-3
        Macaulay duration of the par bonds *)
        (1.0452 / (.0452)) * (1 - (1 / ((1.0452)^30))) // N
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Out[1]= 16.9851581
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In[2]:= (1.0405 / .0405) * (1 - (1 / ((1.0405)^5))) // N
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Out[2]= 4.62562196
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In[3]:= ((1.0408) / (.0408)) * (1 - (1 / ((1.0408)^2))) // N
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Out[3]= 1.96079939
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In[4]:= Solve[(x * 1.9608) + ((1 - x) * 16.985) == 4.6256, x, Reals]
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Out[4]= {{x -> 0.822632819}}
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In[5]:= (* Verify *)
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4.6256 - ((.8226 * 1.961) + ((1 - .8226) * 16.985))
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Out[5]= -0.0006576
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In[6]:= (* Calculating the convexities for the par bonds in the asset
        portfolios and the par bond liability *)
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y = .0408
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((2 / y) * ((1 / y) - (1 / (y ((1 + y)^2)))) - ((2 * 2) / (y ((1 + y)^3))))
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Out[6]= 0.0408
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Out[7]= 5.39406284
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In[8]:= y = .0405
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Out[8]= 0.0405
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((2 / y) * ((1 / y) - (1 / (y ((1 + y)^5)))) - ((2 * 5) / (y ((1 + y)^6))))
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Out[9]= 24.9571905
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In[10]:= y = .0452
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Out[10]= 0.0452
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((2 / y) * ((1 / y) - (1 / (y ((1 + y)^30)))) - ((2 * 30) / (y ((1 + y)^31))))
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Out[11]= 381.898029
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In[12]:= (* Calculating the barbell asset convexity using the duration weights *)
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(.8226 * 5.3941) + ((1 - .8226) * 381.898)
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Out[12]= 72.1858919
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In[13]:= (* Calculating the theta, i.e., time value *)
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(.8226 * .0408) + ((1 - .8226) * .0452)
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Out[13]= 0.04158056
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(* This indicates the cost of convexity is NEGATIVE -->
paying 11 bp to take convexity *)
(.0405 - .04158)

Out[14]= -0.00108

(*This result is inconsistent with a positive standard
deviation of the interest rate in a dy model, i.e.,
solving for variance of y divided by 2 in one factor model *)
(.0405 - .04158) / (71.186 - 24.957)

Out[16]= -0.0000233619589