Nova School of Business and Economics

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Recovery rate

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Ex. 1 — Corporation XYZ issued bond A sometime ago. It is now issuing a second bond B. The issuance prospect says that bond B is subordinated to bond A.

1. What does it mean to be *subordinated*?
   Subordinated debt refers to loans or bonds that have second claim, behind more "Senior" securities, in the repayment process in the event of default. This means that, priority wise, creditors that hold bond A are entitled to be repaid in full, before holders of bond B start being repaid. Henceforth, the recovery rate is higher for "Senior" than for subordinated debt.

2. Which bond do you expect to trade at a higher yield in the market? Why?
   Bond A should trade at a relative premium compared to bond B, meaning it should trade at a higher price, given the higher seniority ranking. Thus, given the inverse relationship between bond prices and yields, one would expect bond B to trade at a higher yield than bond A, to compensate investors for the lower priority ranking in the event of default.

Ex. 2 — Plot the beta density for the recovery rate of *Junior subordinated* bonds in table 1.1 of the handouts.

The Beta distribution, as shown in Eq. 1, is a continuous probability distribution representing probabilities of the random variable which can have only finite set of values. This is unlike other probability distributions where the random variable's value can take infinity as values, at least in one direction [1].

$$f(x, a, b) = \frac{\Gamma(a+b)}{\Gamma(a)\Gamma(b)} x^{a-1}(1-x)^{b-1} \tag{1}$$

Note that $f(x, a, b)$ is defined for a > 0, b > 0 and 0 <= x <= 1.

As noticeable from the equation above, the beta distribution has two shape parameters namely a and b. The main advantage of the beta distribution is that for random variables having values between 0 and 1, it can be used to model probabilities whose values lie between 0 and 1 since by nature, its domain is bounded between those two values.

For this exercise, the group was asked to model the beta density for the recovery rate of the *Junior subordinated bonds*, whose μ and σ are defined in Table 1.

Senority	Mean	Standard Deviation
Junior Subordinated	35.00%	22.00%

TABLE 1: Parameters from the handout

The group followed the following modelling approach:

1. All calculations were done in Python and additionally in Excel (with except of Ex. 3)
2. In order to compute the beta density for the Junior subordinated bonds, the parameters a and b were first calculated by using the following formulas:
   - a = $\left(\frac{1-\mu}{\sigma^2} - \frac{1}{\mu}\right)\mu^2$
   - b = $\left(\frac{1-\mu}{\sigma^2} - \frac{1}{\mu}\right)\mu(1-\mu)$
3. Finally, the scipy library in Python was used to compute the respective probabilities

In Figure 1, the computed beta density plot for the junior subordinated bonds, with $a = 1.30$ and $b = 2.41$ is depicted.

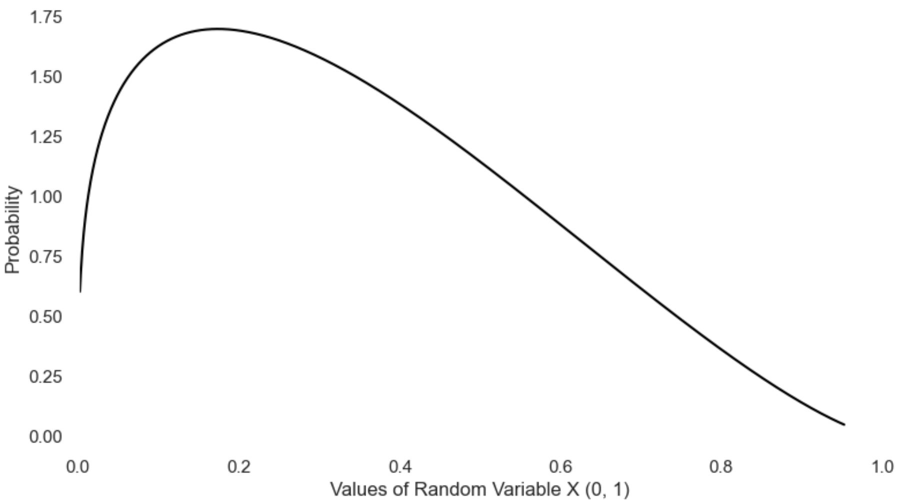

FIGURE 1: Beta density for recovery rate

Ex. 3 — Draw 10,000 numbers from this distribution and plot the histogram.

From the computed distribution of Ex. 2, the group draw 10,000 random numbers and plotted the results in a so called *distplot*, which combines a histogram and a kernel density estimate (KDE) plot [2]. The distplot represents the univariate distribution of data, i.e. data distribution of a variable against the density distribution.

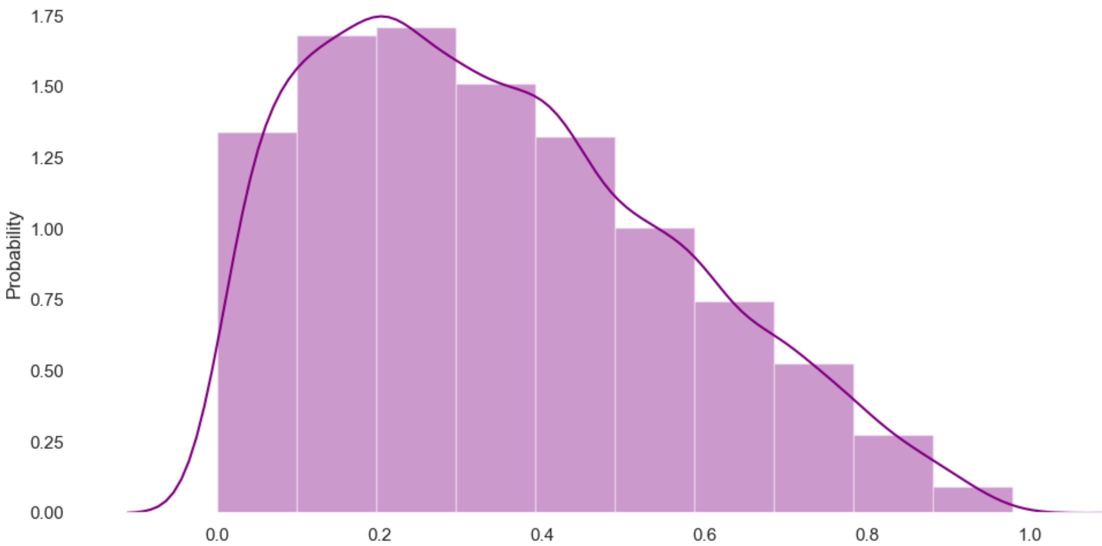

FIGURE 2: Random draws from beta distribution

Auxiliary

All materials (Python code and pdf) for this assignment are visible on the author's Github account.

References

[1] Ajitesh Kumar. *Beta Distribution Explained with Python Examples*. https://vitalflux.com/beta-distribution-explained-with-python-examples/. Accessed on 2021-04-06. Sept. 2020.

[2] seaborn. *seaborn.distplot*. https://seaborn.pydata.org/generated/seaborn.distplot.html. Accessed on 2021-04-06.