Constraints

Some loans are categorized as high balance (indicated in the dataset with the **HighBalFlag** variable). Similarly, pools are classified as either Standard Balance or High Balance (see **Pool Balance Type** variable). Standard Balance pools typically pay better prices, but have additional constraints, such as: a Standard Balance pool may contain no more than 10% high-balance loans. Instead of 10%, we will use a configurable parameter, c_1. Thus,

1) For each pool j, $\frac{\sum_i HighBalFlag_i * L_i}{\sum_i L_i} \leq \begin{cases} c_1, & j \text{ is Standard Balance Pool} \\ 1, & j \text{ is High Balance Pool} \end{cases}$

Pools are also categorized as either Single-Issuer or Multi-Issuer (see **Pool Type** variable). Single-Issuer pools have additional constraints, such as: a Single-Issuer pool must have a total unpaid principal balance of at least $1,000,000. Instead of $1,000,000, we will use a configurable parameter, c_2. Thus,

2) For each pool j, $\sum_i L_i \geq \begin{cases} c_2, & j \text{ is Single Issuer Pool} \\ 0, & j \text{ is Multi Issuer Pool} \end{cases}$

As mentioned above, each pool option also has a servicing option out of the following three: Retained, Pingora, or Two Harbors (see variable **Servicer**). The combination of pool option and servicing option is what drives the price difference for a given loan. Each servicing category may have many constraints:

Across all pools with servicing option *Retained*, no additional constraints.

Across all pools with servicing option, *Pingora*:

3) $\sum_i L_i \leq c_3$
4) $\frac{\sum_i HighBalFlag_i * L_i}{\sum_i L_i} \leq c_4$
5) $\frac{\sum_i FICO_i * L_i}{\sum_i L_i} \geq c_5$
6) $\frac{\sum_i DTI_i * L_i}{\sum_i L_i} \leq c_6$
7) $p_{CA,Pingora} \leq c_7 \text{ where } p_{CA} = \text{proportion of loans from California}$

Across all pools with servicing option, *Two Harbors*:

8) $\sum_i L_i \geq c_8$ (note: Two Harbors has a minimum here whereas Pingora had a maximum)

9) $\frac{\sum_i FICO_i * L_i}{\sum_i L_i} \geq c_9$

10) $\frac{\sum_i DTI_i * L_i}{\sum_i L_i} \leq c_{10}$

11) $p_{R,Two\ Harbors} \leq c_{11}\ where\ p_R = proportion\ of\ loans\ with\ purpose\ type\ of\ cash\ out$

12) $p_{PR,Two\ Harbors} \geq c_{12}\ where\ p_{PR} = proportion\ of\ loans\ of\ Property\ Occupancy\ type\ primary\ residence$

Comparability Constraints:

Each pool has an Agency type, Fannie Mae and Freddie Mac (see variable **Agency**). They expect some degree of fairness and comparability in what they receive, i.e. Fannie should not receive all the high FICO score loans while Freddie receives all the low ones. We will handle this constraint by comparing the difference in weighted average of FICO scores between all loans assigned to pools that are Fannie Mae type vs all loans assigned to pools that are Freddie Mac type (variable **FICO**).

13) $\left|\frac{\sum_{i,Fannie\ Mae} L_i * FICO_i}{\sum_{i,Fannie\ Mae} L_i} - \frac{\sum_{i,Freddie\ Mac} L_i * FICO_i}{\sum_{i,Freddie\ Mac} L_i}\right| \leq c_{13}$

Similar requirements for DTI, Property State, Property Type, Property Occupancy Type, Loan Purpose:

14) $\left|\frac{\sum_{i,Fannie\ Mae} L_i * DTI_i}{\sum_{i,Fannie\ Mae} L_i} - \frac{\sum_{i,Freddie\ Mac} L_i * DTI_i}{\sum_{i,Freddie\ Mac} L_i}\right| \leq c_{14}$

15) $|p_{s,Fannie} - p_{s,Freddie}| \leq c_{15}\ for\ each\ s\ in\ Property\ State, where\ p_s = proportion\ of\ loans\ from\ that\ Property\ State$

16) $|p_{o,Fannie} - p_{o,Freddie}| \leq c_{16}\ for\ each\ o\ in\ Property\ Occupancy, where\ p_o = proportion\ of\ loans\ of\ occupancy\ type\ o$

17) $|p_{R,Fannie} - p_{R,Freddie}| \leq c_{17}\ for\ each\ R\ in\ Purpose, where\ p_R = proportion\ of\ loans\ of\ purpose\ R$

18) $|p_{T,Fannie} - p_{T,Freddie}| \leq c_{18}\ for\ each\ T\ in\ Property\ Type, where\ p_R = proportion\ of\ loans\ with\ property\ type\ T$