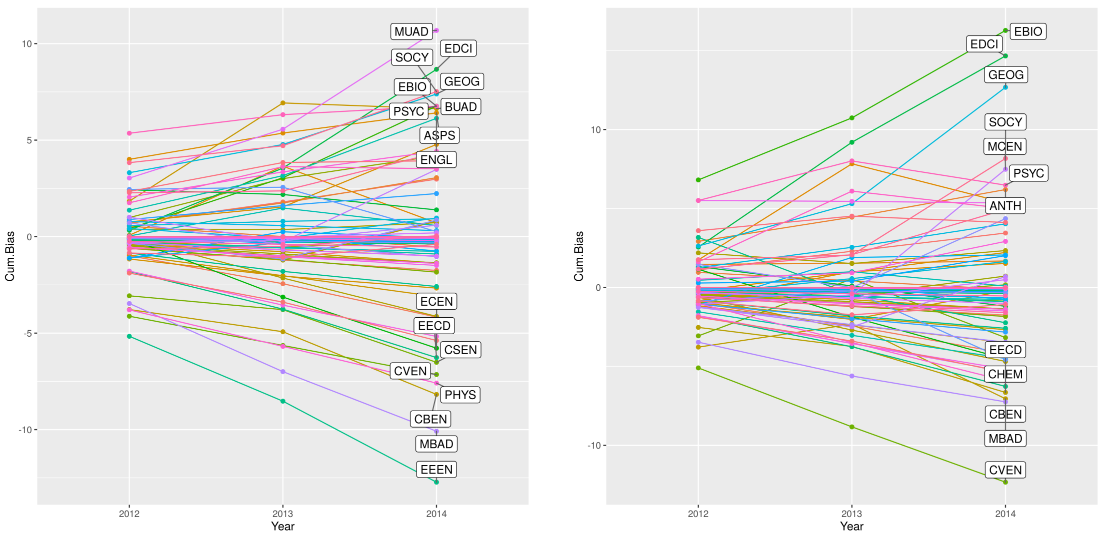
For this analysis we will define department bias as over or under representation of a department in the applicant/awardee pool, relative to the departments proportional size. We define ‘applicants’ as individuals applying for a travel grant and ‘awardees’ as individuals selected to receive a travel grant. We denote the bias towards department i as B_i and calculate it as follows:

$$B_i = \frac{A_i}{P} - \frac{M_i}{T} \tag{1}$$

Here A_i is the number of applicants/awardees from department i in an applicant/award pool of size P, while in the case of applicant bis M_i is the total number of graduate students in department i and T is the total number of graduate students enrolled at CU.

Hence when $B_i < 0$ then the percentage of applications/awards from/to department i is smaller than the percentage of students in department i (ie. department i is being under represented), and when $B_i > 0$ then the percentage of applications/awards from/to department i is greater than the percentage of students in department i (ie. department i is being over represented). When $B_i > 0$ we say there is bias *towards* department i and when $B_i < 0$ there is bias *against* department i.

While the ideal situation is $B_i = 0$ for all departments, in any single year one expects *some* bias towards or against a considerable subset of departments. This may be due to any number of innocuous factors; a department may have suddenly gained or lost a substantial amount of funding causing fluctuations in its applicants, an unusually motivated department staffer may have pressed some students to apply, etc. Because of this we would like to ignore one-time biases towards or against a department, and instead look for departments which receive *sustained bias* (towards or against). To do this we look at the cumulative bias which is defined as follows. Extending our notation for the bias of department i, we use $B_{i,t}$ to denote the bias towards department i in year t. Cumulative



(a) (b)

Figure 1: Time series of cumulative bias for (a) applicants and (b) awardees. Only departments with a notable biases (either sloping upwards or downwards substantially) are labelled.

bias up to a time T is then defined as $\beta_i(T) = \sum_{t=0}^{T} B_{i,t}$, ie. the sum of the yearly biases from the start of the time series up until the current time T. If we plot this over time then we can visually distinguish departments which are consistently being biased towards by their increasing cumulative bias, and departments being biased against by their decreasing cumulative bias. In the ideal situation $\beta_i(T) = 0$ for large values of T and for all i, however for short time scales it is likely that some department recieves a one-time bias towards or against them, and then no further significant biases. These cases will appear as flat lines. Hence we look for 'notable bias', ie. cumulative bias lines which are sloped upwards or downwards (indicating sustained bias towards or against this department, respectively) and ignore lines which are relatively flat. See Fig. 1 for the resulting plots of cumulative bias.

A few notes on the departments which have both notable applicant and award bias (these are department labels that appear on both plots). Under-application by a de-

	Over-Applying	Under-Applying
Over-Recieving	Not Okay	Not Okay
Under-Recieving	Not Okay	Probably Okay

Table 1: A table summary of the four possible cases of a department with 'notable' bias for both applicants and awardees.

partment may cause under-representation in awards given to that department. This is because a smaller number of applications caps the maximum possible awards that can be given to that department, and hence caps the maximum proportional representation in the awards pool of that department. To see concretely consider the hypothetical example where 100 awards are given out. If in a pool of 200 candidates, only 10 are from department D which happens to account for 20% of the graduate student population then there is no way to give appropriate representation to department D in this application cycle. The maximum percentage of awards that can be given to D is only 10%. Therefore if any departments which appear to be biased against are also in the departments which are under-applying then it is possible (and, given how grants are awarded, I would hazard that it is likely) that there is not 'true' bias against those departments. The converse is not true however: departments which over-apply should not necessarily also over-recieve grants. Furthermore departments which over apply should not be under-recieving and vice versa. In an earlier draft of these plots it was true that over-appliers should be under-recieving as awardee bias was measured relative to the proportion of applicants, instead of proportion of enrolled students in that department. Ultiamtely, however, it made more sense to have both biases relative to enrollment. Therefore this is no longer the case. For a simple summary of these points see Table 1.