

## Predictors of Four-Year Graduation Rate, 2005-2016 Cohorts

Bill Altermatt, Institutional Research & Assessment

April 14, 2021

### Executive Summary

This report examines factors that predict whether a student will graduate from Carleton within four calendar years of matriculation. Graduating within four years is important not only for fulfilling students' and parents' expectations for the duration of a college career but also because of the added debt and opportunity costs of lost income that are incurred if education is extended beyond four years. Analysis of 12 cohorts of Carleton students (2005 to 2016) reveals several factors, both alone and in combination, that predict a graduation rate lower than the average of 89.2%. Alone, first-generation status accounts for the largest reduction, of 5.8%. This is larger than the unique effects of ethnicity (e.g., Black: 3.9%, Hispanic: 4.3%, Asian: 2.1%), gender (3.8%), and financial need (the largest gap, of 3.6%, occurred between students with 100% need and those with 29% need). Larger gaps were found at the intersections of two factors. The gender gap was considerably larger at a mean SAT score of 600 (14.3%) than 700 (2.4%). Full-pay international students had a four-year graduation rate that was 11.1% lower than full-pay US students, while showing little difference from US students at higher levels of financial need. The gap between first-generation and non-first-generation students was wider (averaging 13.1%) at intermediate levels of financial need (between 2% and 82%) than it was at very low and very high levels of financial need (averaging 1%). Among first-generation students, those who were Asian had a slightly above-average graduation rate, while non-Asian first-generation students showed a gap of 7.0%.

### Data and Analysis

The data for this analysis includes all students who matriculated to Carleton as first-time, degree-seeking students in fall terms between 2005 and 2016 (12 years): 6,181 students. The outcome of interest was graduation by August 31 in the fourth year after matriculation (i.e., if a student matriculated in fall 2016, did they graduate by August 31, 2020?). The analysis involved modeling graduation within four years from a combination of the following predictor variables<sup>1</sup>:

---

<sup>1</sup> The modeling involved logistic regression of graduation within four years from the variables listed, including two-way interactions between all variables except combinations of ethnicities (excluded because of low cell sizes) and three-way interactions between first-generation, gender, and each ethnicity (as well as International). Continuous variables (percent need, test scores, and cohort year) were centered and modeled using 3rd-order orthogonal polynomial contrasts to detect possible quadratic and cubic trends. After the

1. First Generation
2. Asian
3. Black
4. Hispanic
5. International (International students are not recorded as having a separate ethnicity)
6. Gender (recorded only as the two levels male and female)
7. Cohort year
8. Percent need (the percent of the cost of attendance not covered by expected family contribution, a proxy for student financial resources), and
9. Mean SAT (the mean of math and verbal portions of the SAT, resulting in a number on a 400-800 point scale<sup>2</sup>)

The goal of this analysis is to understand the role of the above 9 variables in four-year graduation. One variable, cohort year, was unrelated to graduation rate and none of the other effects changed systematically by cohort year. This indicates that the other effects reported here are neither getting worse nor better over the past 12 years. All of the other variables were significantly related to graduation rate. Each effect is expressed as a gap between a particular group (e.g., first generation students) and a control group that is identical to that group in every way except the characteristic in question (e.g., non-first-generation students). In cases where an effect changes systematically depending on another variable (i.e., a “statistical interaction”), the effect is expressed by showing several gaps at different points on the other variable that highlight those changes.

### Summary of Significant Effects

Figure 1 reports a summary of the gaps in graduation rates between the groups described. Each gap is the difference in the predicted graduation rate for the groups listed, holding all other predictors constant.<sup>3</sup> Thus, the gap represented by the “Hispanic” group is the gap between the predicted graduation rate of Hispanic students and the predicted graduation rate of non-Hispanic students, holding all other variables (SAT, financial need, first-generation, etc.) constant.

---

initial fitting, the model was optimized using forward and backward stepwise selection to maximize the Akaike Information Criterion (AIC). This procedure retains variables and interactions that contribute to increased predictive power and discards variables that do not.

<sup>2</sup> When SAT scores were unavailable, concordance-table-converted ACT scores were used.

<sup>3</sup> Each effect is the difference between the groups listed, setting the values of all unspecified predictors at the average. This average is the mean for binary predictors and the mean weighted by the proportion of students at every level of the joint distribution of mean SAT and financial need for continuous predictors.

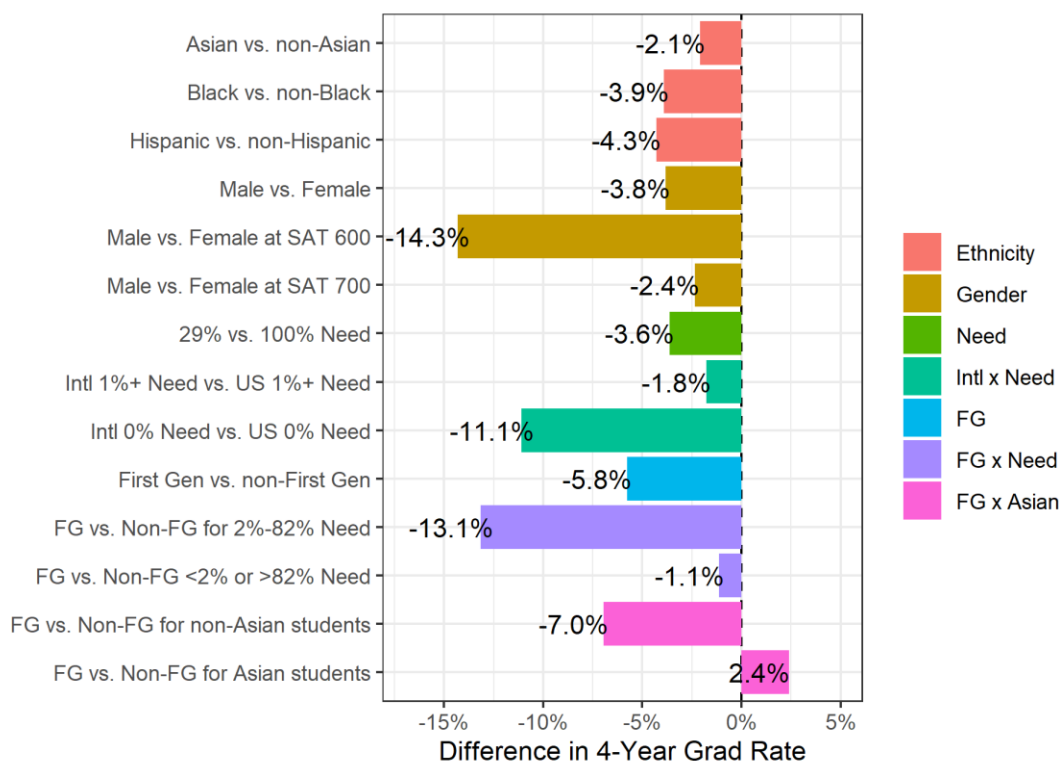


Figure 1: Summary of Estimated Effects

Observations:

1. Graduation rate gaps for Hispanic, Black, and Asian students were in the range of 2-4%. These gaps were statistically significant, indicating that even after controlling for financial need, first-generation status, and SAT scores, there are still gaps in graduation rate by ethnicity. The gaps could be the result of racial discrimination faced by these students, by other risk factors associated with their ethnicity that were not captured by the predictors in this study, or both (e.g., feelings of belonging). The relatively small size of the gaps is surprising given that Black and Hispanic students have an average four-year graduation rate that is 9% and 7%, respectively, below the population graduation rate of 89%. The discrepancy between those differences and the effects reported in Figure 1 is due to the statistical model separating the effects of ethnicity from the effects of other factors that tend to be correlated with ethnicity, such as financial need and first-generation status. This is important because it suggests that the graduation rate gaps for Black and Hispanic students might be ameliorated through interventions that mitigate the effects of other predictors that are correlated with ethnicity.
2. Male students with a mean SAT score of 600 had a predicted four-year graduation rate that was 14.3% lower than female students with the same SAT score, holding all other variables constant. The gender gap shrinks to only 2.4% at mean SAT scores of 700 and, averaging across SAT, is 3.8% (see Figure 2 below). This suggests a vulnerability at the intersection of low-SAT and male.

3. Financial need alone explains only a small amount of variation in graduation rates and is not linear. The largest gap is between students with 29% need and those with 100% need, but that gap is only 3.6%. Figure 3 shows the relatively small variability in predicted graduation rate, holding other variables constant, at different levels of financial need. The small independent effect of financial need is surprising given all the hazards to four-year graduation rate that might accompany financial need: unemployment, health complications, housing insecurity, etc. Each of these events could precipitate a family financial crisis requiring the student to withdraw from college to work full-time. Although financial need by itself does not explain a large amount of the variance in graduation rate, it explains more when considered in the context of international students and first-generation students. These combinations are considered below.
4. Averaging across financial need levels from 1% to 100%, international students are very similar to US students in their four-year graduation rate, averaging only 1.8% lower. However, at 0% need, which indicates that a student is “full-pay”, the gap grows to 11.1%. This is not a small group, as 51% of International students have 0% need, compared to 40% of US students. Figure 4 illustrates this pattern and shows some additional gaps at higher levels of need.
5. First-generation students had a graduation rate gap of 5.8%, which is the largest gap observed that was not at a specific level of another variable (such as the gender gap at an SAT of 600). However, this overall effect of first-generation status varied significantly across financial need and was attenuated for Asian students. These two interactions are considered below.
6. First-generation students with financial need between 2% and 82%<sup>4</sup> had an average graduation rate deficit of 13.1%, while first-generation students with financial need either below 2% or above 82% had a gap of only 1.1%. 39% of students had financial need in the range of 2% and 82%. First-generation students with either very low or very high financial need showed little difference in four-year graduation rate from non-first-generation students. Gaps by first-generation status are restricted to students with intermediate levels of financial need.
7. The graduation rate deficit of first-generation students is significantly attenuated among Asian first-generation students. Whereas non-Asian first-generation students had a graduation rate that was 7.0% below the rate for non-first-generation, non-Asian students, Asian first-generation students had a graduation rate that was actually 2.4% *above* the graduation rate for Asian non-first-generation students.

---

<sup>4</sup> These cutoffs for financial need were selected because they were the points between which the model predicted a gap between First-Generation and non-First-Generation students in excess of 3%.

## Interactions

The sections below go into more detail on effects that involve more than one predictor at a time (i.e., “statistical interactions”).

### 1. Gender Gap at Lower SAT Scores

Figure 2 below shows the relationship between SAT (the average of math and verbal, so on a 400-800 scale), on the horizontal axis, and four-year graduation rate on the y-axis, separately for male (blue line) and female (red line) students. The students in the sample were partitioned into 12 approximately equally-sized groups based on SAT score, and the size of each group is displayed by the colored numbers above or below each point. The points are predicted graduation rates for male and female students at a particular SAT level. They are created using the logistic regression model by setting the values of gender to either Male or Female and the values of the other predictors (e.g., Asian, Black, etc.) to the mean for the students in each of the 12 groups. This creates a gender comparison that holds all other variables in the model constant (permitting an apples-to-apples comparison between male and female students) and is also sensitive to the context of demographics that correspond to a given level of SAT. SAT scores in Figure 2 are restricted to those between 600 and 800 because only 3% of students had scores below that level and estimates for their graduation rate are less reliable. Points that differ between male and female students by more than 3% are highlighted with dashed vertical black lines and labels showing the magnitude of the gender gap.

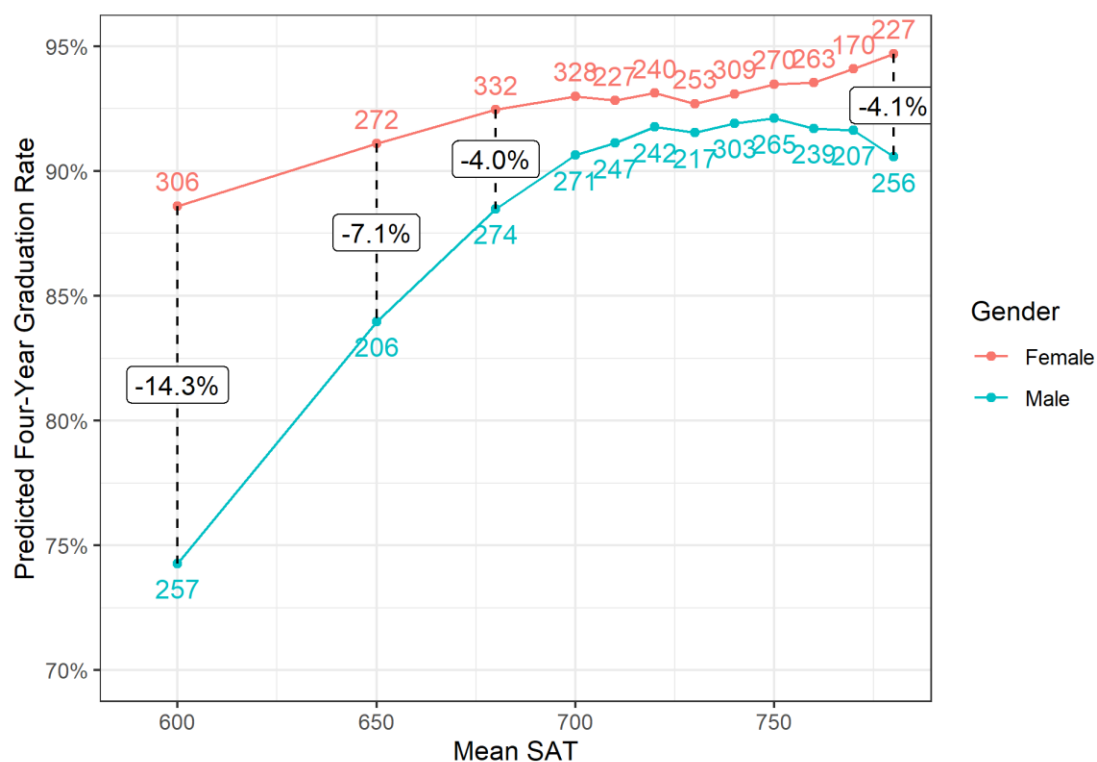


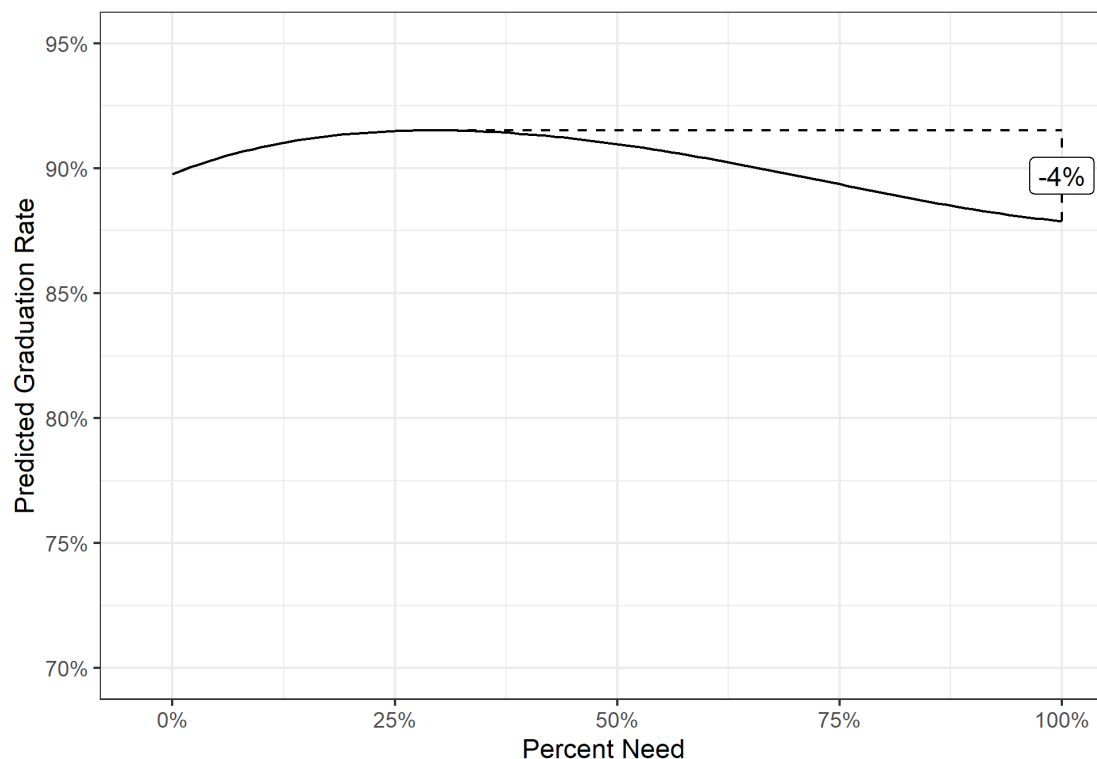
Figure 2: Gender Differences Depend on Mean SAT

Observations from Figure 2:

1. The gap is uneven across SAT scores and is largest at low SAT scores, where the gap is 14.3%. The gap shrinks as SAT scores increase, becoming less than 3% by 700. Why would low-SAT male students have more problems graduating within four years than low-SAT female students? Some insight into this question might come from examining the reasons for the failure of these low-SAT male students to graduate in four years. Are they being dismissed from the College for low grades, or are their problems more related to fulfilling degree requirements?
2. Averaging across all students, there is a significant graduation rate gap that can be attributed to gender. Weighting the average by the number of students at each level of SAT, the overall gap is 3.8%.
3. Although there is a gender gap at the highest SAT scores (the group with an average of 780 in Figure 2), the magnitude of the gap is only 4.1% and is driven both by increases among female students and decreases among male students. Although this is a curious gender gap, it is important to keep in mind that the predicted graduation rate for males in this group is still above 90%, suggesting that the priority for investigation should be aimed at low-SAT male students.

## 2. The Surprisingly Weak Effect of Financial Need Alone

Figure 3 below shows the predicted four-year graduation rate across levels of financial need, which is measured as the percent of the total cost of attendance that is not met by a student's Expected Family Contribution. The dashed lines and statistic of "-4%" highlight the largest gap across levels of financial need.



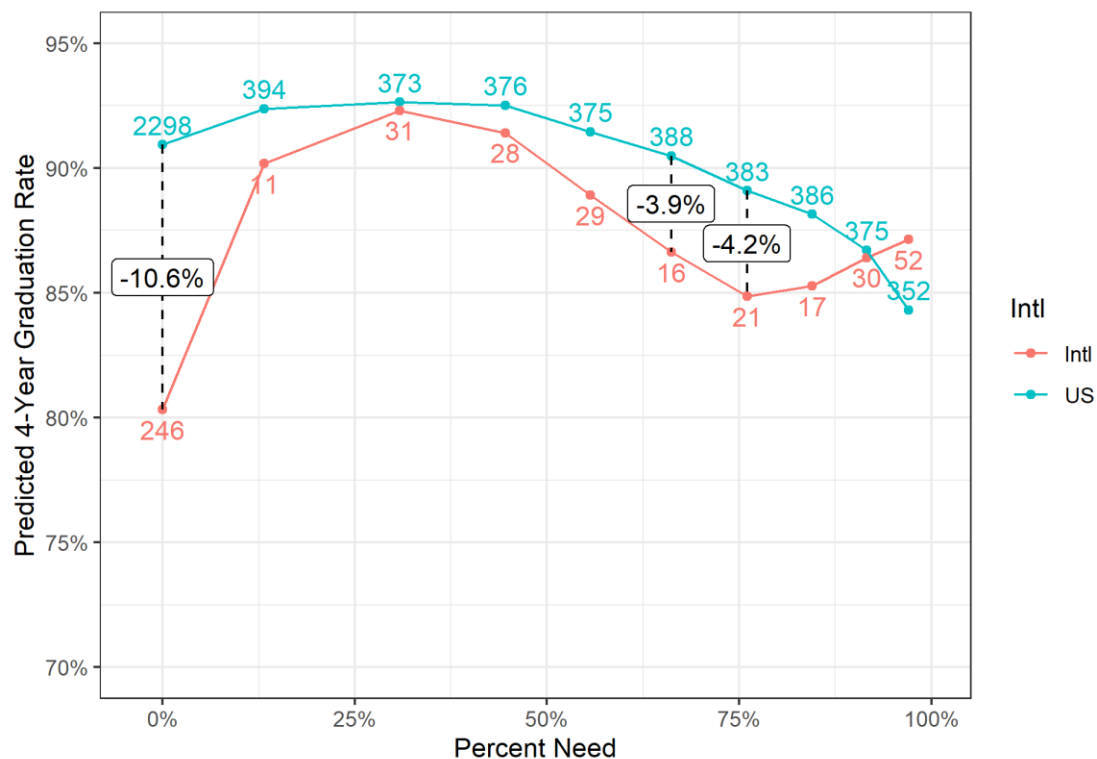
*Figure 3: Relation between Financial Need and Graduation Rate*

Figure 3 is plotted on the same vertical axis range as the other figures in this report so that the magnitude of the effect of financial need alone can be considered in their context. Although 4% is a significant gap in graduation rate, that is the largest gap across all values of financial need and most students are not at the maximum or minimum in the plot above. Approximately 40% of students have 0% need, and it is noteworthy that their graduation rate is slightly lower than the graduation rate of students with 29% need. Although financial need does not explain a great deal of variation in graduation rate by itself, it is predictive of much larger gaps when considered in combination with other predictors such as international students and first-generation students. These combinations are considered below.

### 3. Lower Graduation Rate for Full-Pay International Students

Figure 4 shows the predicted graduation rate for students split into 10 groups based on financial need. One group is the 0%-need group and is much larger than the others, but the other nine are approximately equally sized. Those groups are then split into separate colored lines by whether students are international or domestic. The number of students in each group is printed as colored text above and below the lines. The predicted graduation rate at each point is calculated using the logistic regression model with International status set to either International or US, and all other predictors set to the average level for the students in a given financial need group. As a result, the predicted graduation rates at each level of financial need reflect a comparison in which the only difference is international student status; all other variables are held constant. At the same time, the magnitude of

that difference reflects the possible effects of other variables that may be distinctive to that level of financial need. Gaps between international and domestic students that are greater than 3% are indicated with dashed black vertical lines and labels showing the gap in graduation rates.



*Figure 4: Full-Pay International Students Show Lower Graduation Rates*

Figure 4 shows a large gap between international and US students at 0% need. These students are from affluent families whose expected family contribution meets or exceeds the expected costs of attending Carleton. Furthermore, this gap does not affect only a few students. As the red text in Figure 4 indicates, there were 246 full-pay international students in the data set. Why would this group have such a large gap in graduation rate? It is not because they had lower SAT scores; the effect in Figure 4 controls for SAT score. Further research could examine the causes of this group's failure to graduate within four years. Was it due to dismissal for low grades? Voluntary withdrawal? Failure to complete particular graduation requirements? More evidence could be obtained through survey data, especially items on the Senior Survey and Enrolled Student Survey examining well-being: feelings of belonging, stress, community, and friends.

#### 4. First-Generation Gap Restricted to Students with Intermediate Financial Need

Figure 5 below shows the predicted graduation rate across levels of financial need (the horizontal axis) separately for first-generation (red) and non-first-generation (blue) students. As in Figure 4 above, financial need was split into 10 groups: a 0%-need group and nine others of approximately equal size. At each level of need, the predicted graduation rate was computed using either First Generation or Non-First-Generation status and other



predictors set to the average levels for that level of financial need. This produces estimates for First-Generation and non-First-Generation students in which the only difference is First-Generation status; all other variables are controlled. At the same time, the estimated graduation rate at each level of financial need reflects the context of other demographic variables that are distinctive to different levels of financial need. The colored integers indicate the number of first-generation or non-first-generation students at each level of need. The black vertical dashed lines and labels mark graduation rate gaps greater than 3% across first-generation status.

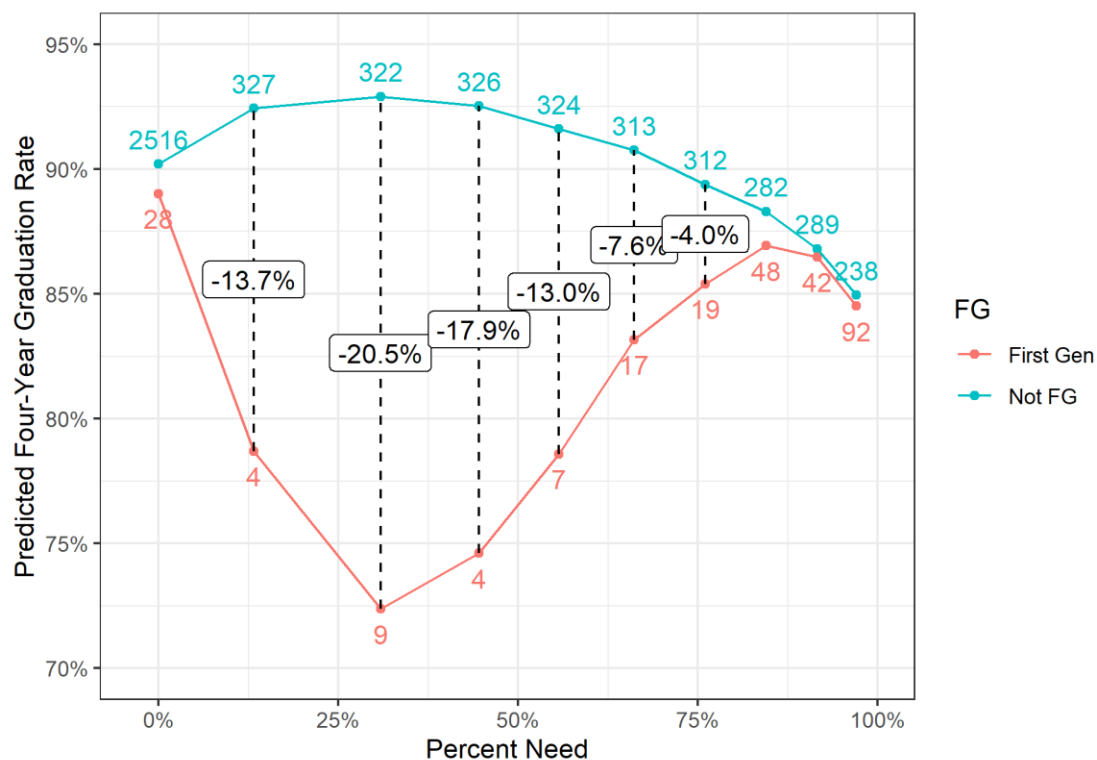


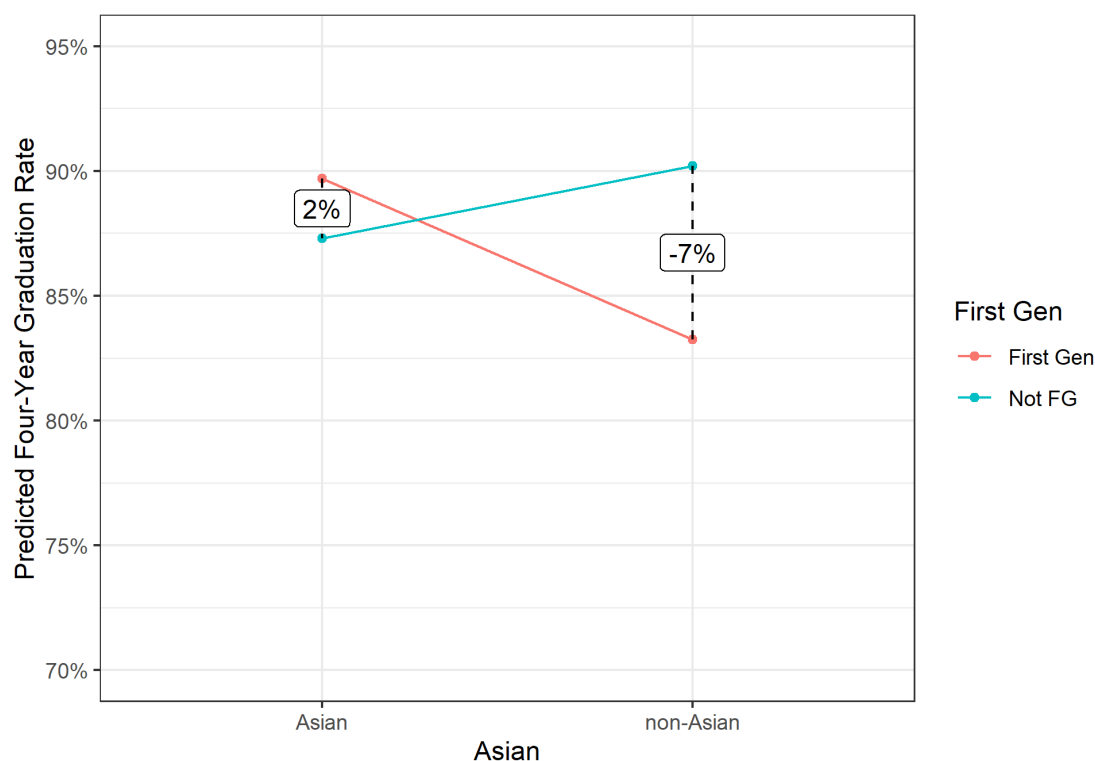
Figure 5: Effects of Financial Need Differ by First Generation Status

Figure 5 indicates that the relation between first generation, financial need, and graduation rate is complex. It would be safe to say that first-generation students graduated at a lower rate than non-first-generation students because the red line is below the blue line at every level of need. However, the magnitude of that gap varies widely across levels of need. Among full-pay (zero need) students, first-generation students graduate at a rate only 1% lower than non-first-generation students, and at very high need (above 88%), the difference is even smaller. Between those two points, however, the graduation rate gap between first-generation and non-first-generation students is wide, especially around 25% need. However, the colored numbers in Figure 5 put the largest gap in context by showing that very few first-generation students have need at this level. Although they are somewhat rare, first-generation students with need between 10% and 80% appear to face greater challenges to graduating within four years than their non-first-generation peers with the same level of need.

More research is needed to investigate why first-generation students with intermediate financial need are at greater risk than first-generation students with very high need. One possibility is that a small number of high-need first-generation students receive generous scholarships that could offset the effects of family financial need.

### 5. Narrower Gap for First-Generation Students Who are Asian

Figure 6 below shows the predicted graduation rate for students who are Asian and not Asian, and students who are First Generation and not First Generation. The levels of other binary predictor variables (e.g., International) are set to the average for the student population, and the effects of continuous predictors (mean SAT and financial need) are controlled by making predictions at each level of the joint distribution of those two variables and computing an average weighted by the number of students at each point of intersection between mean SAT and financial need. Thus, the predicted values in Figure 6 represent cases where all variables except first-generation and Asian status are held constant at levels that are representative of the student body.



*Figure 6: First-Generation Gap Attenuated for Asian Students*

Figure 6 shows that for Asian students (left side), there is little difference in graduation rate between first-generation and non-first generation students – only 2.4% – and the predicted graduation rate for first-generation Asian students was actually above that for non-first-generation Asian students. In contrast, among non-Asian students, first-generation students had a graduation rate that was 7.0% below the graduation rate of non-first-generation students. This pattern suggests that there is something distinctive about Asian students that buffers them against the effects of first-generation status. One

possibility for this buffering effect is that Asian immigrant communities often place especially high priority on children's academic outcomes, leading to more support or pressure from parents to graduate within four years. A second possibility is that the stereotype of high academic motivation and ability for Asian students may create a self-fulfilling prophecy that leads to graduation within four years. These and other possibilities could be examined through interviews or focus groups as well as survey items that examine parent expectations.

## Conclusions

Analysis of the role of first generation, gender, ethnicity, international student status, test scores, and financial need in graduating within four years indicates that there are significant relationships between each of these factors and four-year graduation. The single variable that explained the greatest amount of variation in four-year graduation rates was first-generation status, but this effect was not found for students with zero need, students with need above 82%, or Asian students. There was a small gender gap favoring female students that widened as SAT scores fell below 700. Financial need alone explained only a small amount of differences in four-year graduation rate, but the intersection of need and international student status revealed a group with unusually low graduation rates: zero-need (full-pay) international students. There were significant unique effects predicting lower graduation rates for Black and Hispanic students, and these effects were similar in magnitude to the overall effect of gender and the largest gap observed across levels of financial need.

Given these findings, it is important to gather information that might shed light on why these gaps occur. In particular, it would be valuable to know the proximal causes for failure to graduate within four years: dismissal for low academic performance? A voluntary leave of absence that postpones graduation? Failure to complete a particular graduation requirement such as comps? These different proximal causes are likely to have different distal causes and require different interventions. Persistent academic struggle, for example, will require different support than feelings of discrimination and alienation.