

High-Level Targets to Improve Two and Four-Year Graduation Rates for Pell-Receiving & URM Transfer Students: Iterative Modeling Results

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Executive Summary

Institutional Research staff performed quantitative modeling using two decision tree algorithms to identify academic and demographic characteristics that influence two and four-year graduation outcomes for Pell-receiving and Underrepresented Minority (URM) Transfer students in the Fall 2012 – Fall 2018 cohorts. Two and four-year graduation outcomes for individual students were modeled using two “decision tree” model types, with the same combinations of inputs used across model sets.

Results indicate that making good academic progress toward degree completion was most influential on increasing two-year graduation rates for both Pell-receiving and URM Transfer students: roughly 12 or more units passed in the first term brings two-year rates to parity with historical mean rates, while roughly 15 or more units passed raises two-year rates well above the historical mean rates. In slight contrast, staying in good academic standing (receiving a > 2.0 GPA in the first term) was more influential for increasing four-year graduation rates (from roughly 31% below 2.0 to roughly 80% above 2.0), as long as at least 12 units were also passed in the first term. Supporting models further indicate that Pell-receiving and URM Transfer students with Entry GPAs below roughly 2.6 (for URM) to 2.8 (for Pell), and who had declared majors in specific groups of colleges or had declared majors in STEM, had lower rates of graduation within both two and four years. While these college groups vary by model (i.e., two- vs. four-year graduation outcomes and Pell-receiving vs. URM subgroups), the colleges of Behavioral and Social Sciences and Business were consistently identified as graduating Transfer students at higher two- and four-year rates, while the college of Natural Sciences was consistently identified as graduating Transfer students at lower two- and four-year rates. Regardless of their college of major, Transfer students with STEM majors had lower two- and four-year graduation rates than peers with non-STEM majors. However, the gap in Transfer graduation outcomes is not reducible to having a STEM vs. non-STEM major alone, as colleges without a core STEM focus (such as Humanities and Fine Arts) were also identified fairly consistently as having lower graduation rates.

Modeling is ongoing and iterative, with all results subject to future revision by IR staff. All model-based threshold and group values were identified using probabilistic, not deterministic, criteria and are therefore subject to variability. As models are further refined and as campus makes changes to underlying social and academic conditions, further variability in rankings of indicator importance will inevitably occur. **Due to limited data availability, model inputs largely represent the academic, and not behavioral or social, characteristics of students and results are therefore likely to be affected by the omission of confounding factors that influence both model inputs (E.G., First-term GPA) and outcomes (E.G., four-year graduation).** It is critically important for the Chico State community to consider means by which to collect these types of data more thoroughly at a systematic level, both through existing

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instruments as well as by creating new, empirically-supported means for their collection at the college and departmental levels. IR staff will continue to work with campus partners to update model inputs and results as systematic social and behavioral data become more fully available.

Data and Methodology

The principal analysis of two- and four-year graduation outcomes utilized institutional enrollment data from the CSU, Chico Enrollment Reporting System (ERS) for Transfer students in the Fall 2012 – Fall 2018 cohorts. The sample includes all Spring term Transfer cohorts during this period. Table 1 shows counts and proportions for students in these cohorts by gender, first-generation status, underrepresented minority (URM) status, and whether or not students received Pell Grant support. As can be seen, female students make up a larger proportion of the sample than males. We can also note that a high proportion of URM students and Pell-receiving students in the sample were also the first in their family to attend a four-year postsecondary institution.

Table 1: Selected Demographic Characteristics of Transfer Student Cohorts, Fall 2012 – Fall 2018

Gender	First-Generation Status	Headcount	URM Headcount	% URM	Pell Headcount	% Pell
Female	First-Generation	1,858	814	43.8%	1,386	74.6%
	Not First-Generation	4,714	912	19.3%	2,178	46.2%
	Subtotal	7,399	1,945	26.3%	3,960	53.5%
Male	First-Generation	1,599	766	47.9%	1,131	70.7%
	Not First-Generation	5,005	935	18.7%	1,980	39.6%
	Subtotal	7,491	1,896	25.3%	3,455	46.1%
Total		14,890	3,841	25.8%	7,415	49.8%

Besides baseline demographic characteristics, the input variables used to model two and four-year graduation outcomes focused on student academic characteristics during the first year of study, and in particular the first term. The inputs currently used in each model are as follows:

- Hispanic / Latino status
- Concentration / Major
- College of Major
- Department of Major
- Enrollment County
- Residence Area
- Entry Grade Group
- Entry GPA
- One-Term Continuation
- First-term GPA
- First-term Units Attempted
- First-term Units Passed
- IPEDS Race / Ethnicity
- Gender
- URM Status
- Pell Status

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- Age Group at Census
- Age at Census
- Parent’s Education
- STEM / non-STEM Major
- Summer Orientation Attendance

Modeling using decision trees was performed using the same techniques as those outlined in the previous IR report, *High-Level Targets to Improve Six-Year Graduation Rates for Pell & URM First-Time Freshmen*, pp. 3 – 5. Readers should refer to that report for further exposition and details on the use of decision trees to model graduation outcomes.

It should be noted that each model was limited by the types of institutional data that are currently available on a systematic and historical basis to Institutional Research. For example, the models largely use academic inputs to predict academic outcomes: First-term GPA is used as a predictor of graduation / non-graduation, but First-term GPA itself is *also an academic outcome* that is influenced by other, prior factors. Furthermore, the lack of systematic institutional data on key social and behavioral topics such as socioeconomic status, engagement with student services, organizational affiliations, or student social experiences, means that the models cannot account for the effects of these likely-influential, but unfortunately omitted, factors. Institutional Research will continue to work with its campus partners to update and refine these and other models as new data on such important topics becomes available.

Results – 2-Year Graduation Rates, Fall 2012 – Fall 2018 Cohorts

For historical context, the two-year graduation rates for Transfer students by URM and Pell-receiving status are shown in Figure 1. These rates should be considered when interpreting the figures that follow, as factors shown to have increased graduation rates above the historical mean rates can be considered to be beneficial for student success, while factors that produced rates lower than the historical mean rates can be considered to need improvement to better support student success.

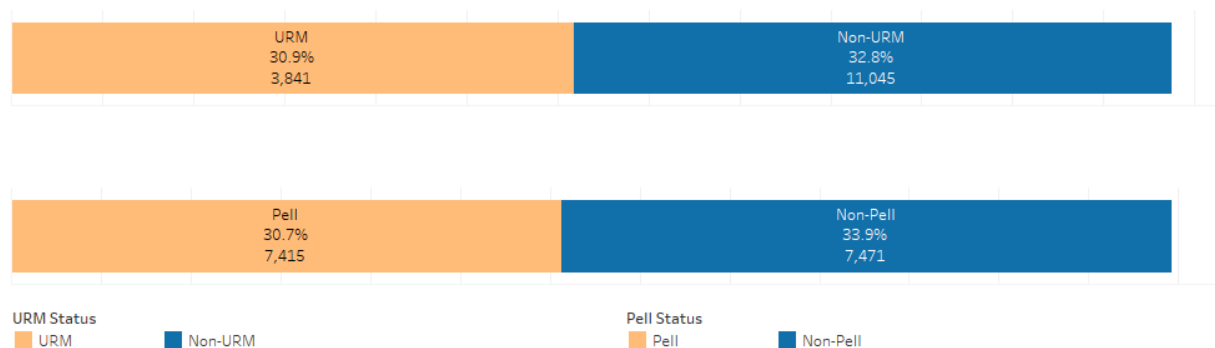


Figure 1. Historical Two-Year Graduation Rates for Transfer Students by Pell-Receiving and URM Status, Fall 2012-Fall 2018 Cohorts

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First-term Units Passed

Separate decision tree models for Pell-receiving and URM Transfer students both identified the same threshold for baccalaureate units passed in the first term – above or below 11.5 units – as being the most predictive factor for two-year graduation outcomes. While this initial threshold accounts for a significant improvement in the likelihood of graduation in two years, it merely raises graduation rates to near-equivalence with historical group averages; further decision tree results identified 14 units passed as a unit threshold that raises graduation rates well above the historical average. When these two thresholds are applied to historical graduation rate data, as shown in Figure 2, we can see that URM Transfer students who passed equal to or less than 11.5 units in their first term had a two-year graduation rate of 9.8%, while those who passed between 11.5 and 14 units in their first term had a two-year rate of 29.7%, a significant increase that is nevertheless slightly below the historical average. Those who passed more than 14 units in their first term had a two-year rate of 52.4%, now well above

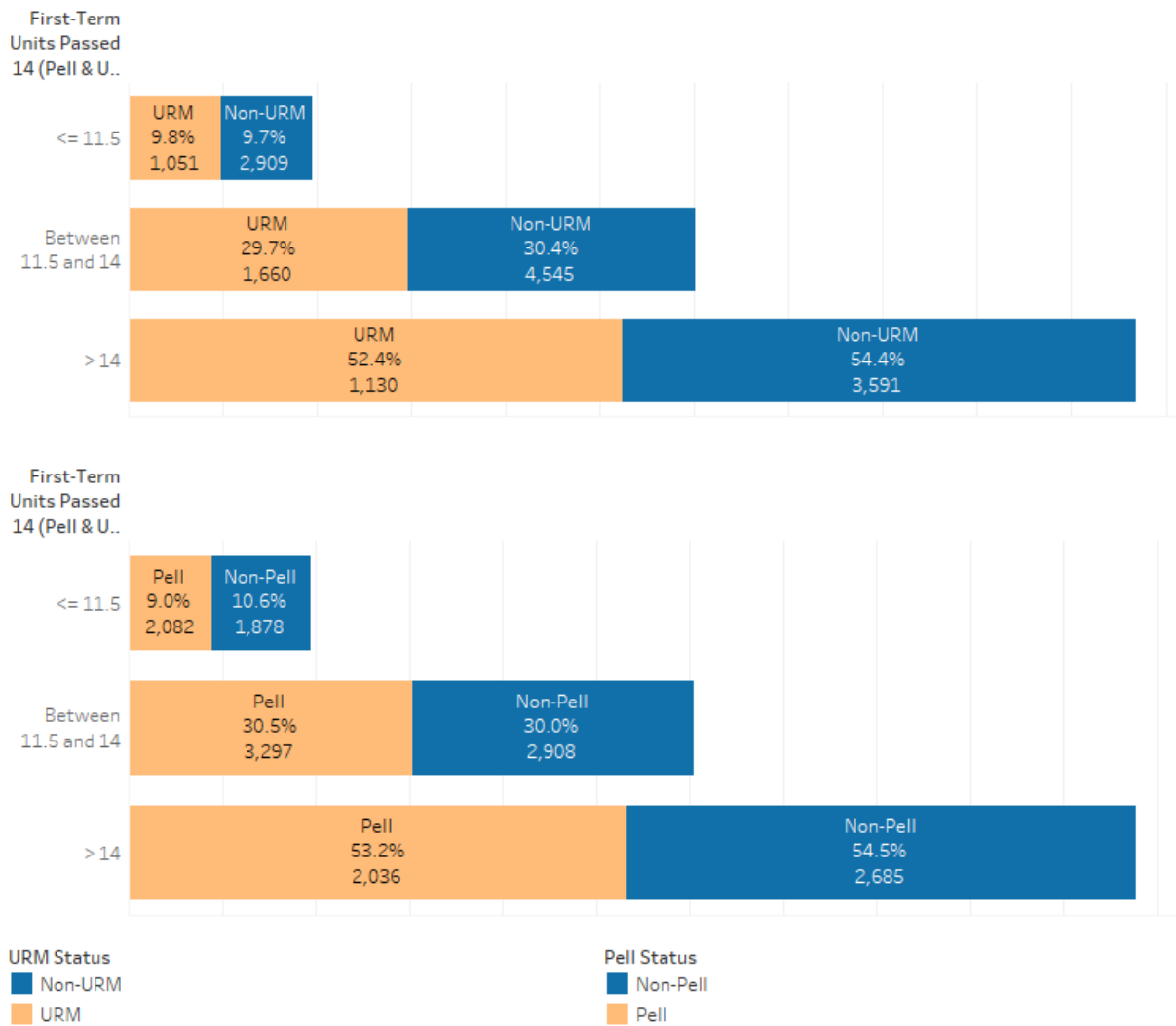


Figure 2. Historical Two-Year Graduation Rates for Transfer Students by Pell-Receiving and URM Status and First-term Units Passed, Fall 2012-Fall 2018 Cohorts

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the historical average. For Pell-receiving Transfer students, we can observe a similar contrast: those who passed equal to or less than 11.5 units in their first term had a two-year graduation rate of 9%, while those who passed between 11.5 and 14 units had a two-year graduation rate of 30.5%, and those passing greater than 14 units had a two-year rate of 53.2%.

College of Major

After the threshold for units passed in the first term, the models next sorted Pell and URM students who passed more than 11.5 units into two respective groups based on their College of Major. The models did not identify further predictive criteria for those who passed equal to or less than 11.5 units in their first term, indicating that graduation was already highly unlikely for this group. However, for purposes of comparison, historical graduation rates are shown in the figures below for those who passed equal to or less than 11.5 units.

For URM Transfer students, one group represented those with declared majors in Behavioral and Social Sciences or Business, while the other represented those with declared majors in the colleges of Agriculture, Engineering, Computer Science, and Construction Management, Communication and Education, Humanities and Fine Arts, or Natural Sciences. For Pell-receiving students, one group represented those with declared majors in the colleges of Agriculture, Behavioral and Social Sciences, Business, or Communication and Education, while the other represented students with declared majors in the colleges of Engineering, Computer Science, and Construction Management, Humanities and Fine Arts, or Natural Sciences.

When we apply these College groups to historical graduation rate data, as shown in Figure 3, we can see that URM Transfer students who earned more than 11.5 units in their first term, and with declared majors in Behavioral and Social Sciences or Business, had a historical two-year graduation rate of 53.3%, while those with declared majors in Agriculture, Engineering, Computer Science, and Construction Management, Communication and Education, Humanities and Fine Arts, or Natural Sciences had a historical two-year rate of 25.5%. For Pell-receiving Transfer students, we can see that those who earned more than 11.5 units in their first term, and with declared majors in the colleges of Agriculture, Behavioral and Social Sciences, Business, or Communication and Education, had a historical two-year graduation rate of 48.4%, while those with declared majors in the colleges of Engineering, Computer Science, and Construction Management, Humanities and Fine Arts, or Natural Sciences had a historical two-year rate of 17.5%.

For Pell-receiving and URM students who earned equal to or less than 11.5 units in their first term, we can observe differences in two-year graduation rates across the college groups, varying between about 5% and 15% for URM Transfers and about 4% to 12% for Pell-receiving Transfers, but these differences are less pronounced than for those in the higher units-passed subgroup, and in general two-year rates for those in this lower unit-earning bracket are quite low, further indicating the importance of making good progress towards degree completion in graduating within two years of transfer.

It should be noted that many STEM majors and programs require a slightly longer time to degree than other STEM and non-STEM disciplines, and the colleges that contain these programs (such as Natural Sciences or Engineering, Computer Science, and Construction Management) may therefore

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underperform other colleges in their two-year Transfer graduation rates. It is therefore worth comparing the results for both two- *and* four-year Transfer graduation rates within colleges to see if certain colleges are also grouped together by having lower or higher four-year graduation rates, as shall be done in the next results section.

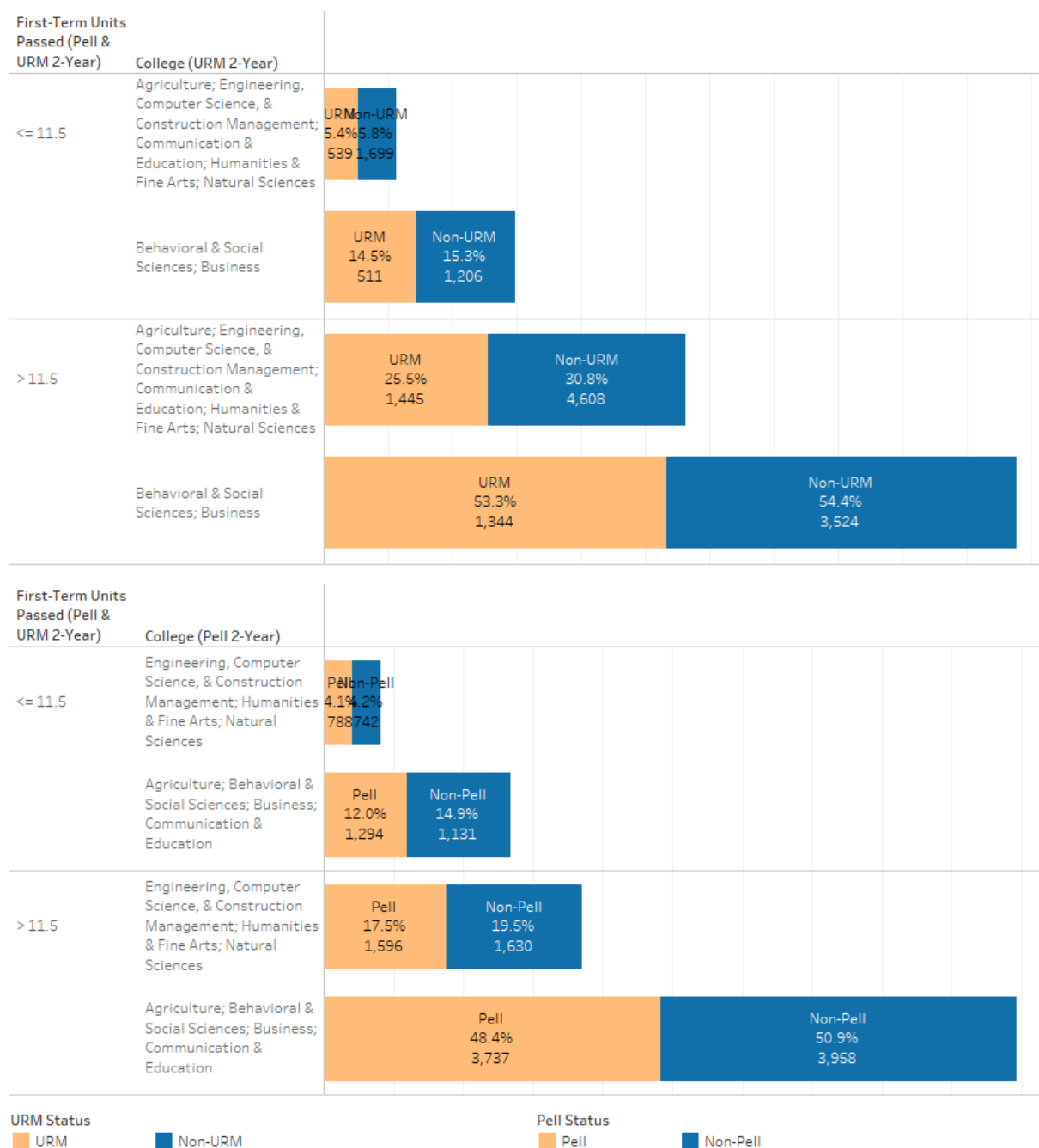


Figure 3. Historical Two-Year Graduation Rates for Transfer Students by Pell-Receiving and URM Status, First-term Units Passed, and College of Major, Fall 2012-Fall 2018 Cohorts

Note: In each of the two college groups at the top of each section, the URM and non-URM rates are 5.4% and 5.8% respectively, while the Pell and non-Pell rates are 4.1% and 4.2% respectively.

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STEM Major Status

Because the college groups noted above were identified on the basis of students' declared majors, and because several of the colleges identified as having lower two-year graduation rates also have a higher concentration of STEM (Science, Technology, Engineering, and Mathematics) disciplines, IR staff also explored whether or not having a STEM-based major declared upon matriculation was also a predictive factor. To do so, College and Department of Major were removed as inputs from the models, while leaving STEM / non-STEM Major status as an input. Results showed that STEM / non-STEM Major status was identified as a predictive factor at exactly the same point that College of Major had previously occupied: for Pell-receiving and URM Transfer students who passed > 11.5 units in their first term. The effect of STEM / non-STEM major status on historical two-year graduation rates is shown in Figure 4.

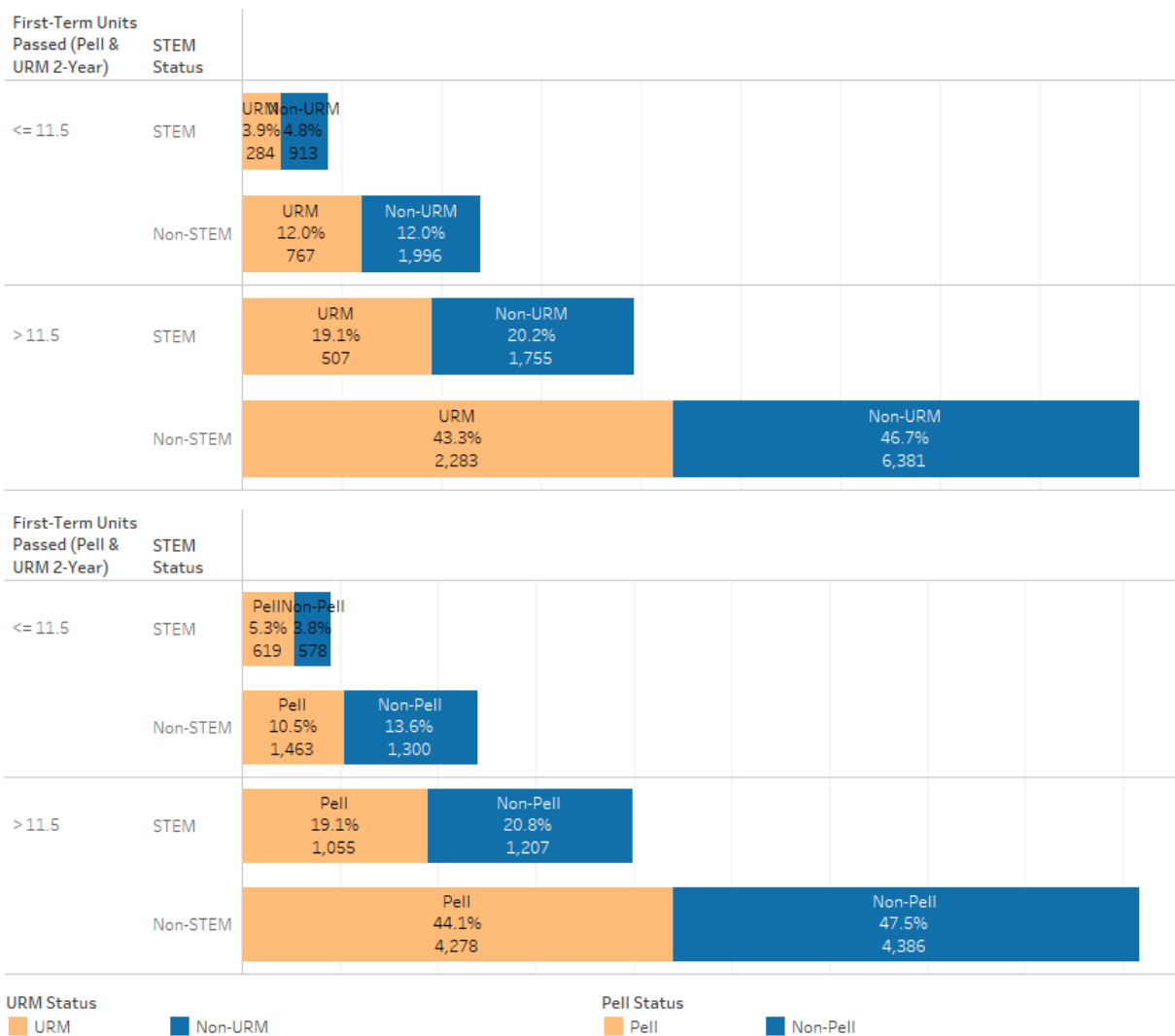


Figure 4. Historical Two-Year Graduation Rates for Transfer Students by Pell-Receiving and URM Status, First-term Units Passed, and STEM Major Status, Fall 2012-Fall 2018 Cohorts

Note: In each of the two STEM groups at the top of each section, the URM and non-URM rates are 3.9% and 4.8% respectively, while the Pell and non-Pell rates are 5.3% and 3.8% respectively.

Once more, historical data for those who passed less than or equal to 11.5 units are also shown for comparison purposes.

As can be seen, the contrasts between STEM / non-STEM major graduation rates shown in Figure 4 and the previous contrasts between the college group-based graduation rates in Figure 3 are quite comparable, and once again exhibit the largest differences within the group of students who earned more than 11.5 units in their first term. For both URM and Pell-receiving Transfer students in this group, non-STEM majors had a 24-25% higher two-year graduation rate than their peers with STEM majors. Once again, it should be noted that these effects may be due in part to the longer time to degree that is required for some STEM majors, and these results should therefore be interpreted alongside STEM Major-based results for four-year graduation outcomes, which are presented in the next section.

Results – 4-Year Graduation Rates, Fall 2012 - Fall 2016 Cohorts

For historical context, the two-year graduation rates for Transfer students by URM and Pell-receiving status are shown in Figure 5. These rates should be considered when interpreting the figures that follow, since factors that increase graduation rates above the historical mean rates below can be considered to be beneficial for student success, while factors that produce rates lower than the historical mean can be considered to be in need of improvement to better support student success.

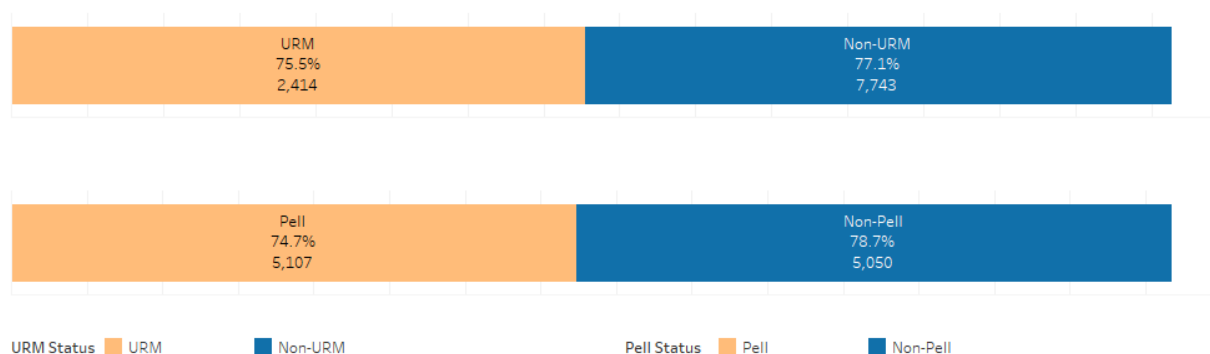


Figure 5. Historical Four-Year Graduation Rates for Transfer Students by Pell-Receiving and URM Status, Fall 2012-Fall 2016 Cohorts

First-term GPA and Units Passed

Decision tree models for Pell-receiving and URM Transfer students both identified First-term GPA as the most predictive factor for four-year graduation outcomes. Each model set identified similar GPA thresholds for Pell-receiving and URM students – 1.99 and 1.95, respectively – which are both essentially the same as the threshold for being placed on academic probation in the first term (2.0). This is not coincidental, and provides strong indication that avoiding probation in the first term is highly consequential for graduation within four years. While the number of units passed in the first term was found to be most influential for two-year graduation, indicating that making steady progress towards degree completion matters most for graduation within two years of transferring to Chico State, staying

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in good academic standing was more predictive for the longer-term outcome of graduation within four years of transfer.

However, for both Pell-receiving and URM Transfer students who received a First-term GPA greater than the respective group threshold (> 1.99 or > 1.95), graduation outcomes were further sorted by the number of units passed in the first term at the same threshold as identified for two-year graduation outcomes: above or below 11.5 units passed; earning 14 units was once again identified as a secondary threshold that further increased chances of graduation. However, in this case, earning roughly 12 or more units and receiving a GPA greater than roughly 2.0 in the first term was sufficient to bring rates slightly above the historical mean. Remaining in good academic standing *and* making *relatively* steady progress towards degree completion were therefore both influential for Transfer graduation within four years, with academic standing (i.e., staying above a 2.0 GPA in the first term) making the most significant difference.

The application of these threshold values to historical four-year graduation data are shown in Figure 6. As can be seen, four-year graduation rates for URM Transfer students increased from 31.3% for those with a First-term GPA equal to or lower than 1.95, to 82.6% for those with a First-term GPA greater than 1.95. As noted earlier, this aggregate effect was further sorted by First-term units passed: students with a GPA greater than 1.95, but who passed equal to or less than 11.5 units in their first term, had a graduation rate of 67.5%, while those who passed between 11.5 and 14 units had an 83.2% graduation rate, and those who passed more than 14 units had a 91.6% rate. A similar dynamic can be seen for Pell-receiving Transfer students, whose historical four-year rate increased from 31.5% to 80.3% for students who received a First-term GPA greater than 1.99. Pell-receiving students with a First-term GPA greater than 1.99, who also earned equal to or less than 11.5 units in their first term, had a 62.7% four-year graduation rate, while those who earned between 11.5 and 14 units in their first term had an 82.4% four-year graduation rate, and those earning more than 14 units had an 89.7% rate.

Entry GPA and College of Major

IR staff next removed First-term GPA, Units Passed, and Units Attempted from the decision tree models to identify other significant predictors of four-year graduation outcomes. Entry GPA emerged as the next most important predictor of graduation, with slightly different thresholds identified for Pell-receiving (2.77) and URM (2.59) students. After Entry GPA, College of Major was found to be the next-most important predictor for both Pell-receiving and URM students, with slightly different subgroups of colleges identified for the two student groups. While some groups of college did either consistently well or consistently poorly when compared to others, some groups fell within a middle range group whose influence on four-year graduation outcomes fluctuated in relation to the other comparison groups and in relation to the respective student Entry GPA threshold.

The application of these criteria to historical graduation rate data for the two groups are shown in Figures 7 and 8. As can be seen, having entered Chico State with a Transfer GPA greater than 2.59 or 2.77, respectively, increased the rate of graduation within four years, on average, from 62.6% to 78.9% for URM students, and from 66.7% to 78.3% for Pell-receiving students. Within this higher GPA band, URM Transfer students with declared majors in the Colleges of Agriculture, Behavioral and Social Sciences, or Business had an even higher rate of graduation within four years – 82.6% – while Pell-

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receiving Transfer students with declared majors in the Colleges of Agriculture, Behavioral & Social Sciences, Business, or Communication & Education had an 82% four-year graduation rate. In contrast, URM Transfer students who entered Chico State with a GPA less than 2.59, and with declared majors in

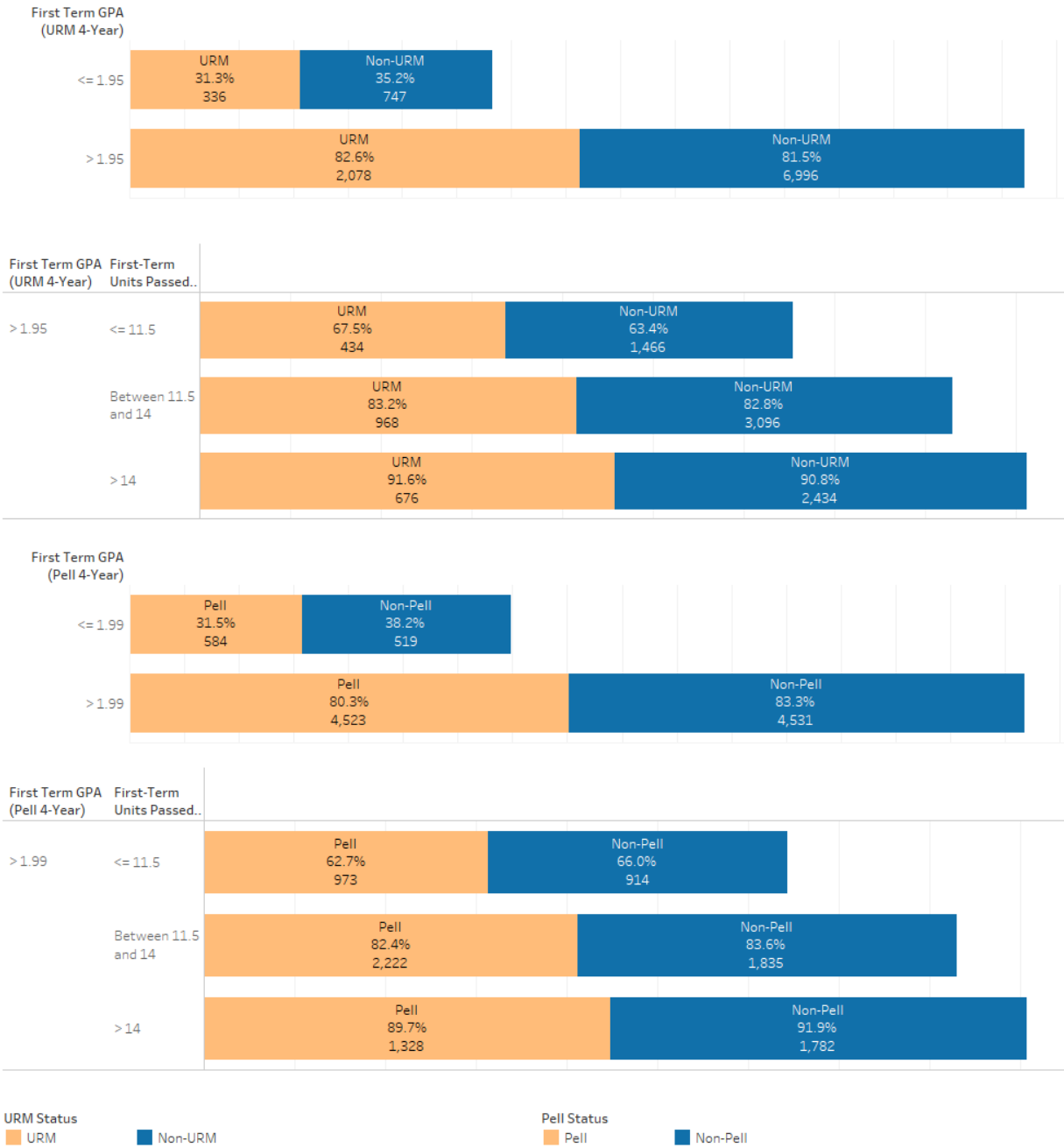


Figure 6. Historical Four-Year Graduation Rates for Transfer Students by Pell-Receiving and URM Status, First-term GPA, and First-term Units Passed, Fall 2012-Fall 2016 Cohorts

either Natural Sciences or Engineering, Computer Science, and Construction Management, had a 43.7% four-year graduation rate, while Pell-receiving Transfer students who entered Chico State with a GPA

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less than 2.77, and with declared majors in Engineering, Computer Science, and Construction Management or Humanities and Fine Arts, had a 55.1% four-year graduation rate.

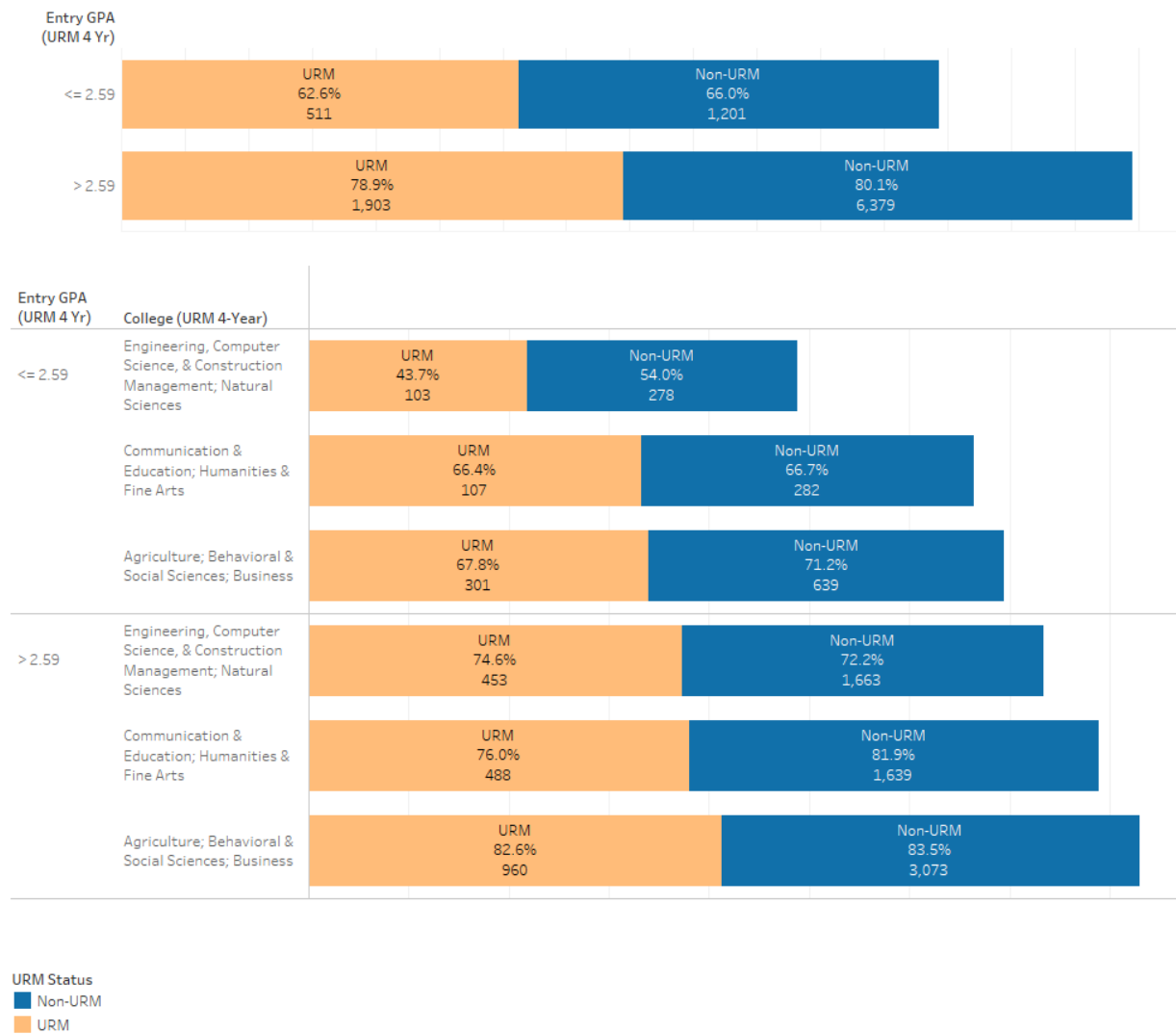


Figure 7. Historical Four-Year Graduation Rates for Transfer Students by URM Status, Entry GPA, and College of Major, Fall 2012-Fall 2016 Cohorts

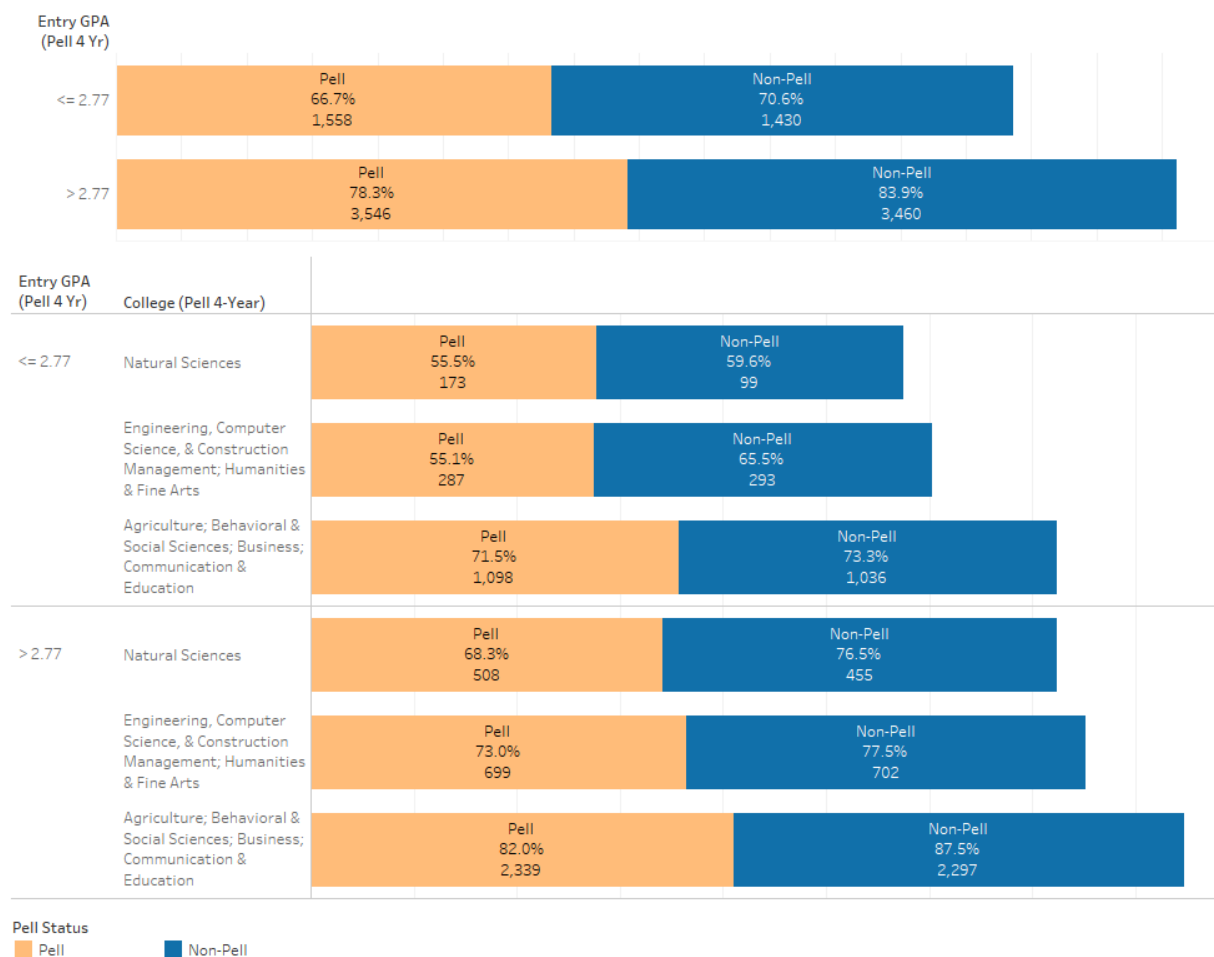


Figure 8. Historical Four-Year Graduation Rates for Transfer Students by Pell-Receiving Status, Entry GPA, and College of Major, Fall 2012-Fall 2016 Cohorts

STEM Major Status

Similar to the previous analysis of two-year graduation rates, IR staff once again removed College of Major from the four-year graduation models for Pell-receiving and URM Transfer students in order to identify whether or not potential STEM Major effects might be omitted due to the importance of College of Major as a predictor. Results once again indicate that STEM Major status was an influential predictor of graduation within four years, particularly for both Pell-receiving and URM students whose entry GPAs were equal to or below the respective group threshold (≤ 2.77 or ≤ 2.59). The application of these criteria to historical four-year graduation rate data are shown in Figure 9. As can be seen, URM students who entered Chico State with a GPA equal to or lower than 2.59 with a declared STEM major had a 49.5% four-year graduation rate, while Pell-receiving students who entered Chico State with a GPA equal to or lower than 2.77 with a declared STEM major had a 57.4% four-year graduation rate.

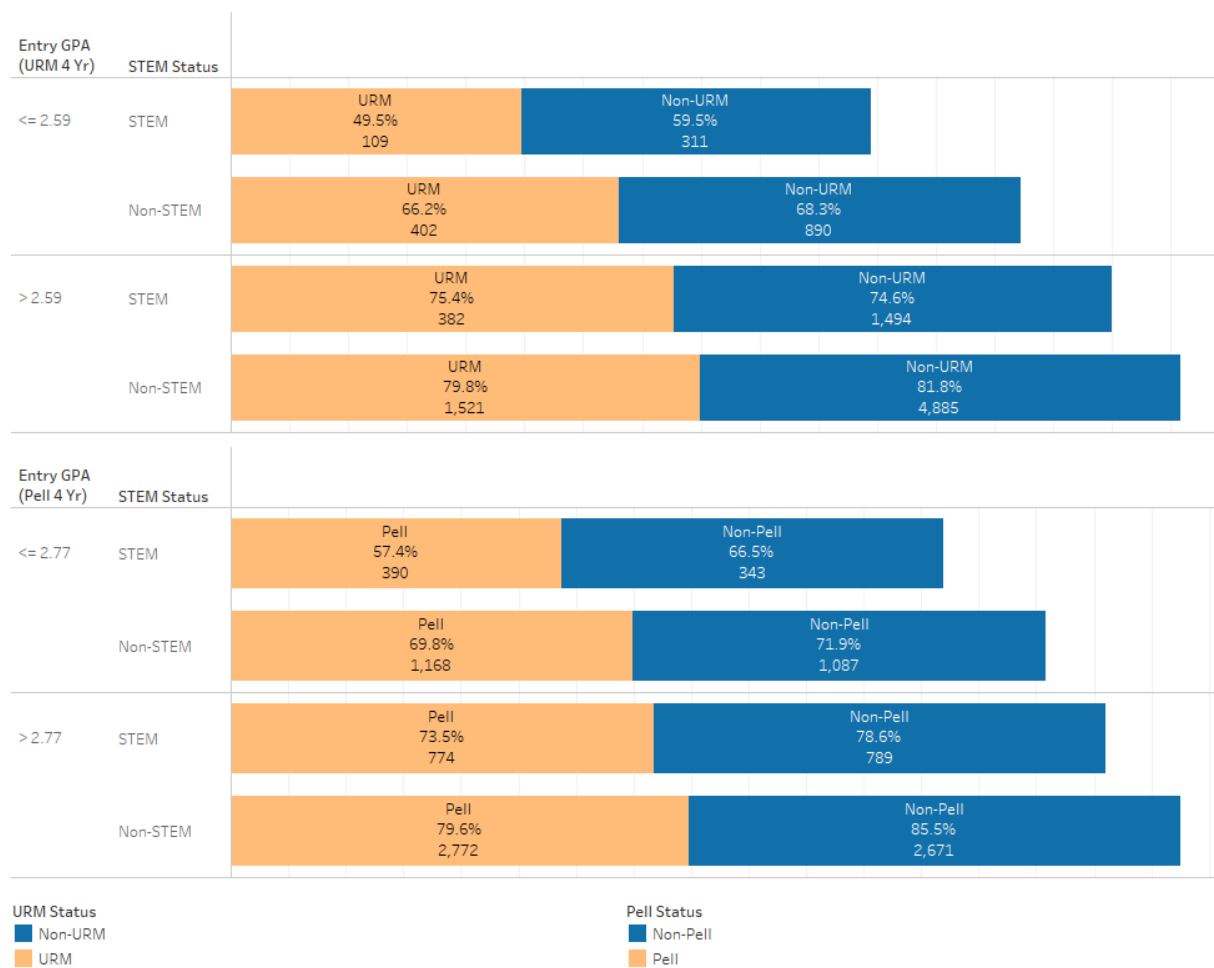


Figure 9. Historical Four-Year Graduation Rates for Transfer Students by Pell-Receiving and URM Status, Entry GPA, and STEM Major Status, Fall 2012-Fall 2016 Cohorts

In combination with the earlier discussion of results for two-year graduation outcomes as shown in Figures 3 and 4, the results in Figures 7 through 9 further demonstrate that both Pell-receiving and URM Transfer students have had historically lower two- and four-year graduation rates when they have declared majors within colleges that have a large number of STEM-based disciplines, and for those with declared majors in STEM fields. These results indicate a relatively consistent, negative association between STEM and graduation rates. However, it should be noted that the presence the college of Humanities and Fine Arts, which does not have a STEM focus, in the middle-to-lower tier colleges groups in these figures suggests that the disparity in graduation rates is not reducible to a STEM / non-STEM major alone, although this is certainly a central factor. Further modeling at the level of specific colleges, departments, and majors / concentrations may be needed to parse these distinctions.

Note on Equity Gaps in Graduation Rates in Results Figures

In many of the preceding figures, readers should note that the effect of being above or below a particular GPA or units-passed threshold often has a similar magnitude of effect for URM / non-URM

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and Pell / non-Pell Transfer students – all become more likely to graduate with a higher First-term GPA or number of units passed, and their respective groups' graduation rates often increase by similar amounts once above the respective GPA or units-based threshold.

However, readers can also readily note that equity gaps in historical graduation rates *between* these student groups are frequently quite consistent, *both above and below* GPA- and units-based thresholds and *within* the various college groups. In other words, **while increasing First-term units passed and GPAs will undoubtedly benefit all students, and are of particular value to URM and Pell-receiving students in making graduation within two- and four- years more likely, they do not necessarily make academic outcomes more equitable *between* groups in these same ranges.** This further underscores the importance of collecting systematic behavioral, social, and affiliation- / engagement-based data on students at the institutional level, as such data will likely aid Institutional Research and its partners in identifying factors that explain these inequitable outcomes between social groups. These results also suggest that the unit of analysis for further research will need to extend beyond individual students and into the various colleges, departments, and classroom environments that they navigate on our campus.

Furthermore, while the discussion of results above focuses on differences in rates as we move between ranges in one or two relatively basic factors, which necessarily affect the largest volumes of students, in reality the movement of any *individual* student from a lower to a higher GPA, for example, will have complicated interactions with the multitude of characteristics that they embody and the social, behavioral, and institutional contexts that they navigate in their daily lives. In other words, each individual student exists at the intersection of a network of complex factors that are not reducible to simple GPA ranges or STEM / non-STEM majors. This is why decision tree results become increasingly complex as we move from the base, or “trunk,” of the tree out to its “branches” and “leaves”; individual students – even those earning a lower number of units or a lower GPA in the first term – may ultimately be sorted into a very specific, small group with a likelihood of graduation that is higher than where they started at the base. As IR staff continues to refine these analyses, we will focus on the increasing specificity of these subgroups and their relations to graduation and retention outcomes.

Further Discovery

Institutional Research staff will continue to refine and update these models and results as improved institutional data become available. Factors of interest include segmenting Pell-receiving students by relative level of financial needs, further disaggregating first-generation students by level of parental education, introducing data on DFW rates as an input, and exploring results within specific colleges, departments, and majors. IR staff are also working to segment models by the recency of cohort terms and by different academic outcomes. E.G., to see if different sets of input factors are found to be useful predictors of one- and two-year retention outcomes, versus those identified as predictors of two- and four-year graduation for earlier cohorts. As models are further refined and as campus makes changes to underlying social and academic conditions, some variability in rankings of input importance will become likely. For example, First-term GPA and Entry GPA may not persist as the most significant predictors of two and four-year graduation, and other factors may rise to the top.

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Once more, the importance of behavioral, social, organizational affiliation, and engagement-based data on students cannot be emphasized enough for successfully modeling academic outcomes such as retention and graduation, as the omission of these factors due to data availability is perhaps the single-greatest limitation of the models presented in this report. For instance, one could make a strong hypothesis that major influencers of First-term GPA and Units Passed (and by extension, two and four-year graduation rates) might include the average number of hours per week that a student works at an off-campus job, the quality of their experiences with advising or tutoring services, their organizational affiliations, or their relative level of engagement with support services. It is critically important for the Chico State community to consider means by which to collect these types of data more thoroughly at a systematic level, both through existing instruments such as the National Survey of Student Engagement (NSSE) and Student Evaluation of Teaching (SET) forms, as well as by creating new, empirically-supported means for their collection at the college and departmental levels.