K-Means Clustering of Higher Education Closures

Stat 479 Final Project by Kim Dancy

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"Happy [colleges] are all alike; every unhappy [college] is unhappy in its own way." -Tolstoy, Kind Of.

College closures, while relatively rare events, have dramatic consequences for their local communities, and are particularly devastating for current students who must scramble to make plans to transfer their credits to a different institution or decide to forgo further education.[1] In some cases, institutions are able to support their students through this transition by developing "teach-out" plans where a nearby institution agrees to accept transfer credits from all current students, or to stay in operation while current students finish their degrees. However, not all students make use of their options, and some institutions–most notably the high-profile closures of large for-profit chains such as Corinthian Colleges, ITT Technical Institute, and others–close suddenly and without adequate support in place for students to transfer credits. For students who have borrowed federal loans, those who do not finish their degree are eligible for a "closed-school discharge," which means any loans incurred for the degree-program in question are cancelled. Because of the high costs to taxpayers and difficulty for students in navigating their options, policy makers in recent years have begun to pay particular attention to the issue of sudden school closures. In light of the recent COVID-19 pandemic, several colleges (including Holy Family College in Manitowoc) have already announced that they will not be able to stay open this fall and it is likely that many more will follow.

Given the diversity of higher education institutions in the U.S., it is likely that there are different routes to closure based on the institutional characteristics and student demographics of a particular school. In addition, a better understanding of these pathways can help inform policy and practice to prevent closures in the first place. To shed light on the pathways to closure, this project uses data from the U.S. Department of Education's Federal Student Aid Data Center, which describes school-level information on the number of students who have received closed-school discharges and the total amount of loan debt forgiven for all schools where a loan has been discharged since 2013.[2] This data is merged with institutional records from the College Scorecard, the most comprehensive source of information on colleges in the United States, including details on the institutional characteristics, student enrollment and demographics, field of study and level of degree programs offered, tuition and financial aid available, loan borrowing and repayment metrics, degree completion rates, and average earnings of former students.[3] Because the year an institution closed is not readily available, this analysis uses the most recent year of data in which closed schools appear in the College Scorecard.

Figure 1. Student Borrowers Receiving Closed School Discharge

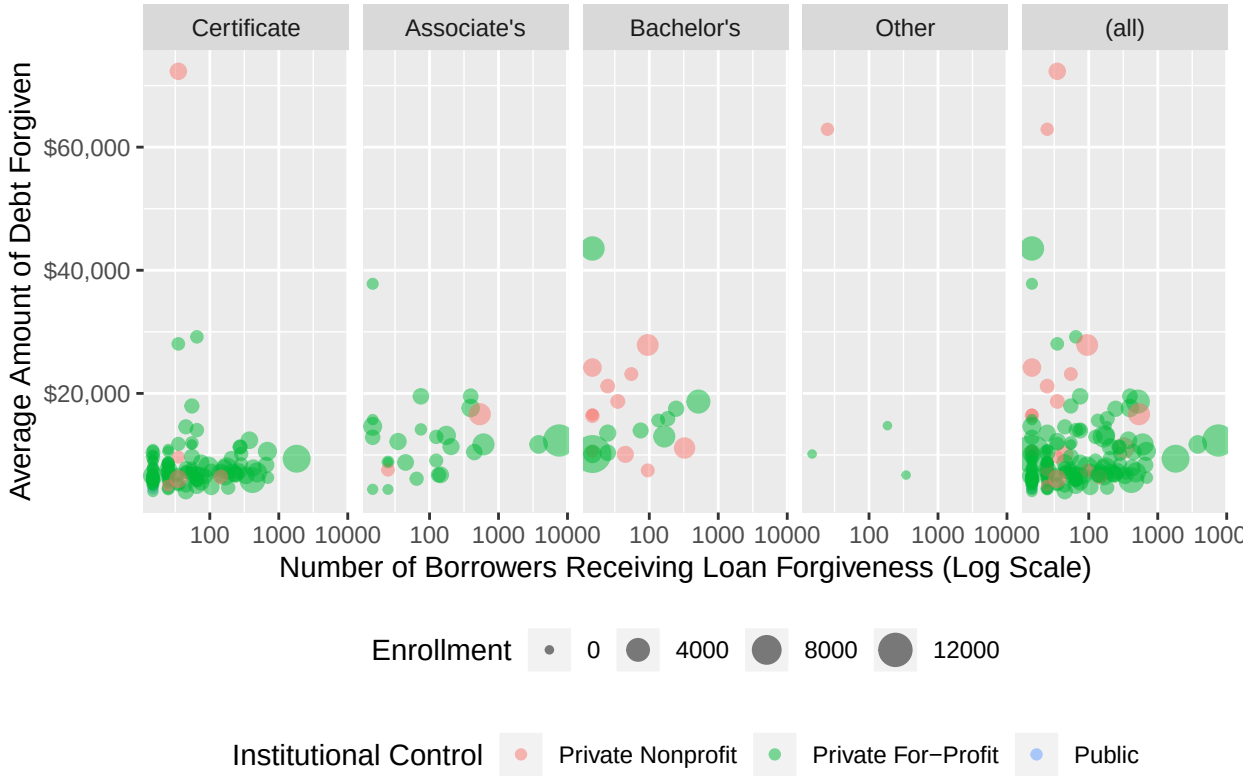


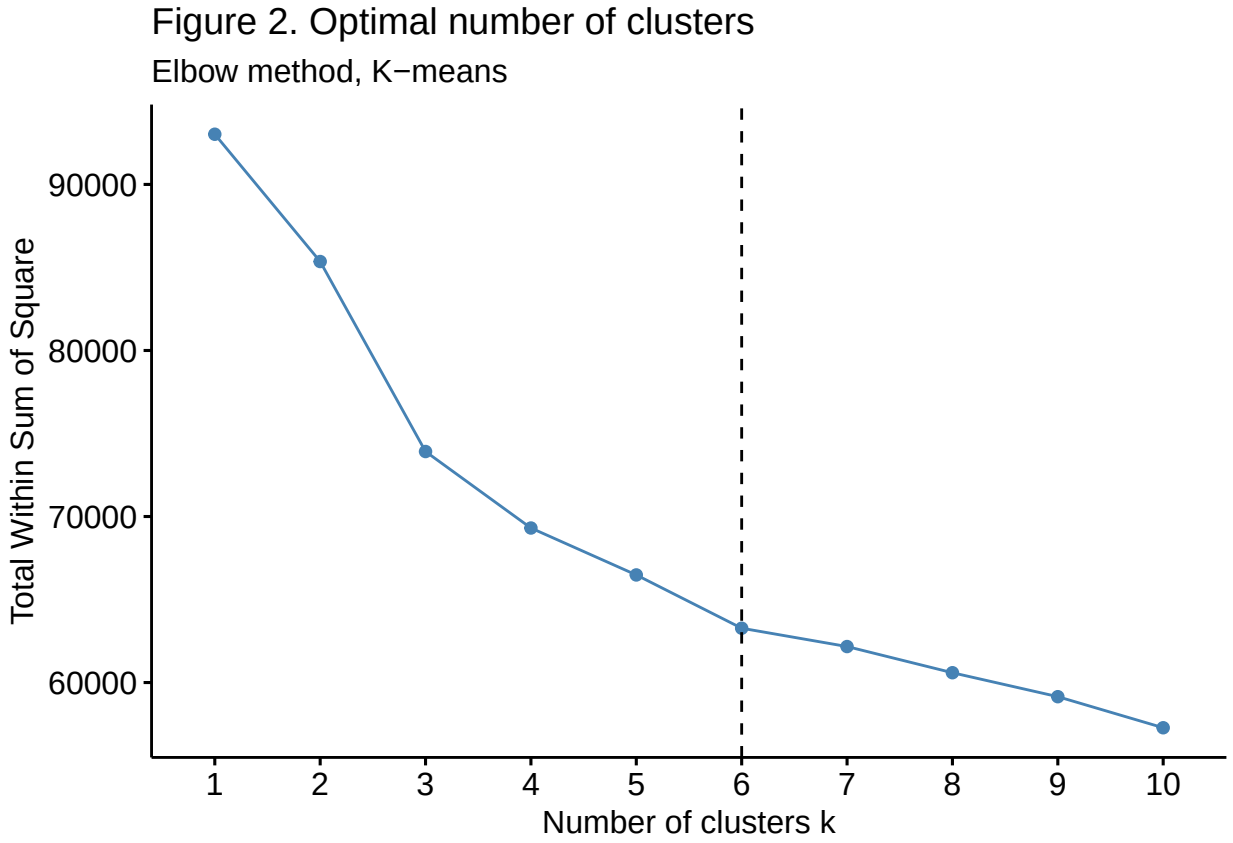
Figure 1 shows all 161 institutions where students have successful claimed a closed-school discharge since 2013. The x-axis shows the number of borrowers who received a student loan discharge at their higher education institution, while the y-axis shows the average amount of debt forgiveness received for each borrower. The school closure data is merged with infromation from the College Scorecard from the last year in which a school was operating, which enables a comparison of these outcomes across institution types. From this merged data, *Figure 1* also displays selected characteristics about the institutions where those borrowers were enrolled.

The figure shows that borrowers who received forgiveness were overwhelmingly enrolled in for-profit institutions, while a number of private non-profit institutions at the four-year level have also closed. Borrowers are also concentrated at institutions who primarily award Certificates, and these students typically receive smaller amounts of forigveness compared to those at institutions who primarily award Associate's or Bachelor's degrees.

In order to identify more distinct patterns among institutions where students have received closed school discharges, this analysis employs K-means clustering. The Scorecard data requires some preparation before a K-means clustering model can be run. The data are first standardized to have a mean of zero and a standard deviation of one, and missing data are set to the mean value of that variable. Scorecard data are reported annually, however because not all data elements are collected every year, the files contain missing values for all schools for some variables. Variables for which all observations are missing are dropped. In addition, some schools do not have valid values for all variables because a particular data element is inapplicable, such as variables that apply only to four-year institutions or public schools. In other cases, data is not reported for schools or groups of students within schools if small sample sizes are determined to threaten student privacy. In addition, some variables that serve to identify institutions such as the school name, website information, and other duplicative identifiers are dropped, resulting in a data frame of 1479 variables across 161 schools.

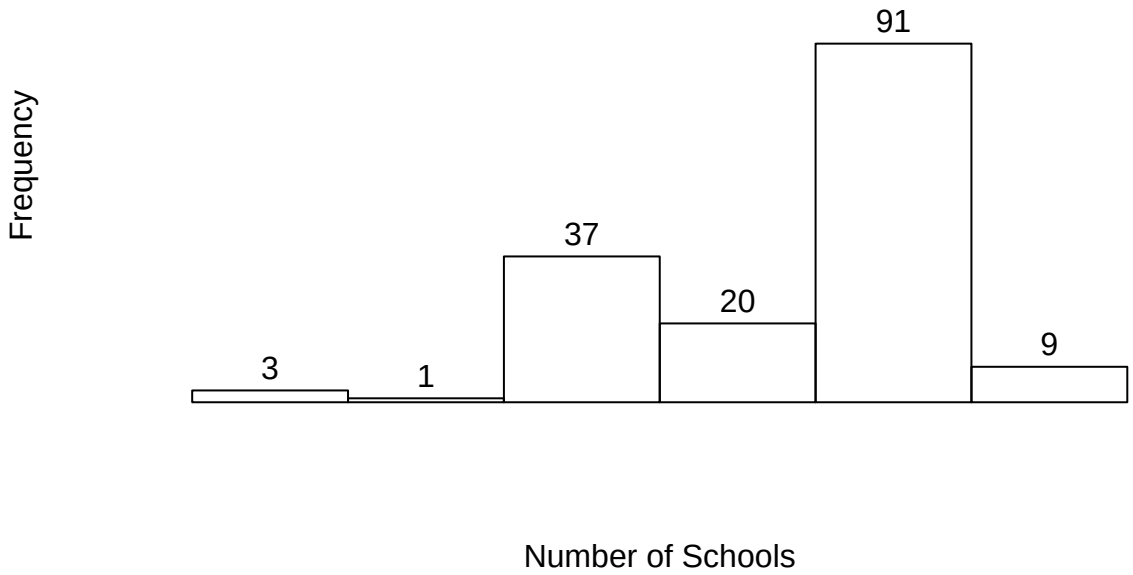
To determine the optimal number of clusters for this data, comparing the within-sum of squares is a useful method. As seen in *Figure 2* the WSS drops with the addition of each new cluster. There is not a unambiguously clear "elbow" in the below curve, which means that the optimal number of clusters is

somewhat subjective. However, the change in WSS between models with 6 or 7 clusters is relatively small, so 6 clusters is a reasonable choice for this model.



The clustering algorithm results in six clusters of institutions, with a minimum of one and as many as 91 institutions in a particular cluster, as shown in *Figure 3*.

Figure 3. Institutions in Each Cluster



In addition, *Table 1* shows the mean values for institutions according to their assigned cluster. (Because of the large number of variables in the Scorecard data, it is not advisable to compare means on all values simultaneously.) *Table 1* shows that cluster two consists of a single school with 135 branch campuses. Further exploration of the data output show that this cluster corresponds to ITT Technical Institute, a massive for-profit chain that closed in a high-profile and unexpected closure in the fall of 2016. Clusters 3 and 5 consist of fewer schools and certificate programs are the most commonly awarded degrees at the typical school in each of these groups. Cluster 5 is overwhelmingly made up of school that focus on personal and culinary services programs, which includes cosmetology and culinary programs, while schools in Cluster 3 tends to emphasis health services programs. Clusters 1, 4, and 6 all have at least some schools that offer a Bachelor's degree or higher, but these schools also have emphasis different degree programs (not all fields of study are shown in *Table 1*). Clusters also differ in the number of undergraduate students they enroll, the share of students who borrow federal loans, receive federal Pell grants awarded to low-income students, or who are women. Ultimately, the clusters also vary by the average number of borrowers whose debts have been forgiven, the total amount of debt forgiven and the per borrower discharge.

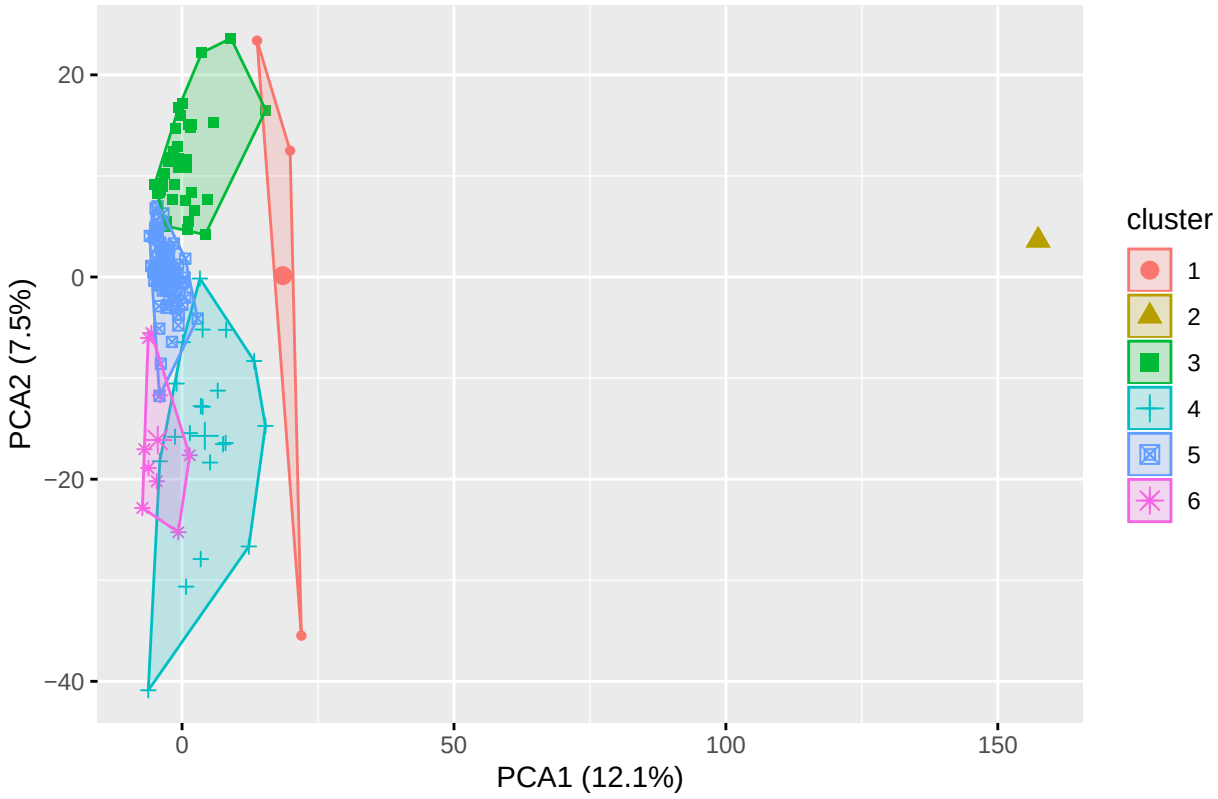
Table 1: Table 1. Selected Mean Values of Scorecard Variables by Cluster

	1	2	3	4	5	6
Number of Schools	3.0	1.0	37.0	20.0	91.0	9.0
Averge Number of Campuses	5.3	135.0	4.5	7.0	3.4	1.0
Highest Degree Offered	2.7	4.0	1.6	3.0	1.4	3.8
Share of Students in Computer Related Fields	5.1	35.5	1.1	9.8	2.9	1.6
Share of Students in Personal Culinary Services	0.0	0.0	10.1	0.0	48.2	0.0
Share of Students in Security and Protective Services	8.8	21.6	1.6	9.8	0.3	1.8
Share of Students in Health Professions	58.9	4.8	71.2	28.8	31.0	0.9
Share of Students in Business Management	16.1	23.4	3.1	29.6	7.0	20.8
Degree-Seeking Undergraduates	1058.0	2395.0	541.7	1025.2	222.5	858.0
Share Women	65.2	38.5	71.5	64.3	78.0	51.4

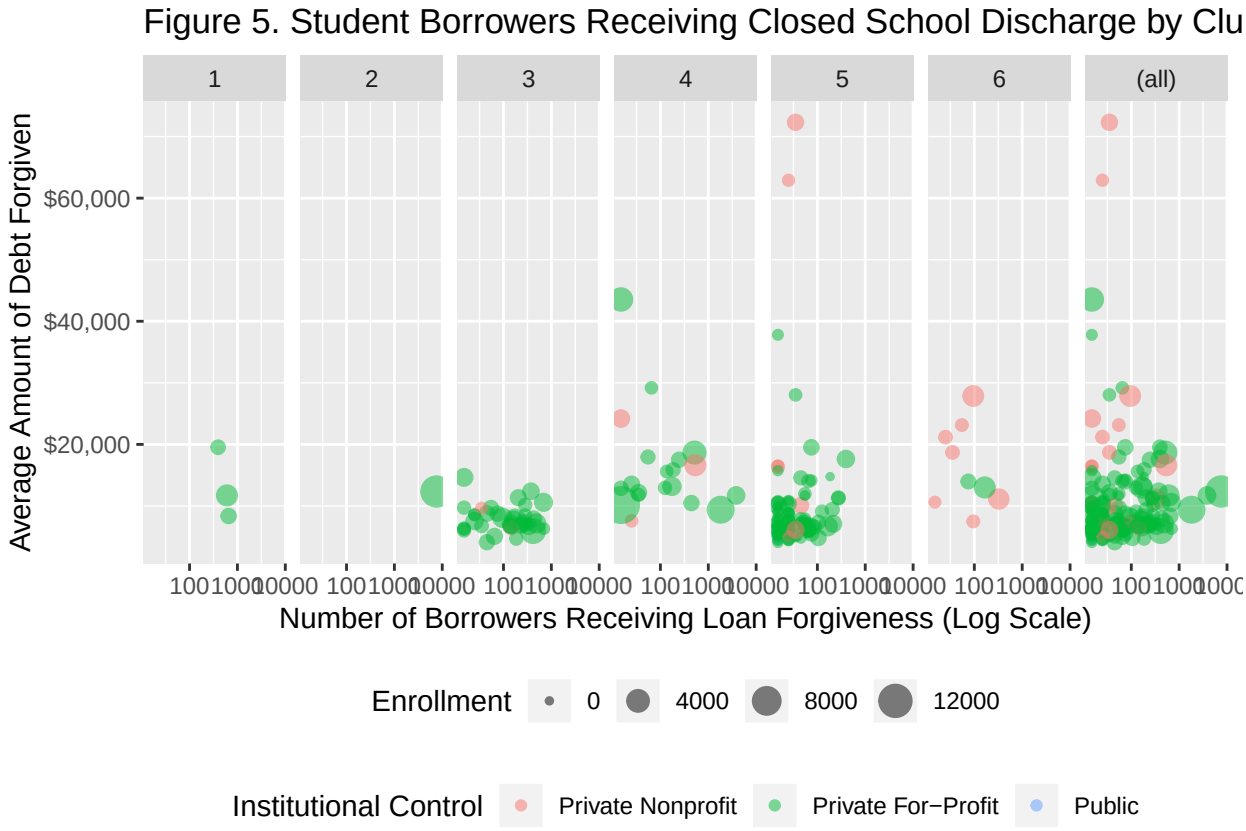
Share Borrowing Federal Loans	81.9	73.7	65.4	72.3	65.6	61.7
Share Pell Eligible	75.1	67.0	71.4	72.1	66.0	48.5
Number of Discharged Borrowers	551.7	7575.0	188.2	414.5	51.4	98.3
Total Debt Discharged (Thousands)	6762.6	93546.8	1489.0	5189.3	539.9	1420.9
Average Borrower Discharge	13207.5	12349.4	7865.1	16251.3	10034.9	16345.6

Figure 4 shows the graphical groupings of institutions within each cluster based on their first two principal components. Cluster 2–ITT Technical Institute–is extremely isolated from the other institutions, emphasizing the extreme nature of the collapse of the chain. The other five clusters are much more similar to one another, however distinct groupings emerge from the data.

Figure 4. Cluster Plots by First and Second Principal Components



Finally, *Figure 5* replicates the first graphic, this time sorting institutions according to cluster. There is significantly more similarity between institutions in some clusters, though a wide range of values is present in others, particularly cluster 3.



References:

1. Colston, et. al. *Anticipating and Managing Precipitous College Closures.* New America, Washington, D.C.: March, 2020.
2. Federal Student Aid Data Center. Closed School Discharge Data. U.S. Department of Education, Washington, D.C. Updated December, 2019.
3. U.S. Department of Education. College Scorecard Data Documentation. U.S. Department of Education, Washington, D.C. Updated March, 2020.