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Predicting College Enrollment During A Global Crisis

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Abstract

This paper looks at how the COVID-19 pandemic has affected college enrollment at colleges and universities within New England, how this effect compares to the Great Recession of 2008-2009, and then predict future trends in total enrollment by first identifying the major factors of change in college enrollment during the Great Recession and COVID-19 pandemic. These factors include the perceived value of getting a degree by traditional and nontraditional students, where colleges and universities generate their revenue, and where and how students are enrolling in higher education, and the cost and value of online learning. Based on these factors, questions about the effect of the current pandemic on total college enrollment in New England and how different colleges and universities will fare based off their classification as either a 4-year public university, 4-year private university, or community college are raised as well as a hypothesis that more students will attend community college while less students will attend traditional 4-year public and private universities, leading to a net zero effect on total enrollment is predicted. This hypothesis is tested using enrollment data from 73 colleges and universities in New England on 2 linear regression models and an Autoregressive Integrated Moving Average (ARIMA) model. From this analysis, the models find that college enrollment stays the same at 4-year public and private universities as well as community colleges, meaning the hypothesis is unsupported. It is determined that more models must be tested as well as student data must be collected to better predict total college enrollment.

Keywords: Universities and Colleges, College Enrollment, Prediction, New England, COVID-19, Great Recession, ARIMA

Predicting College Enrollment During A Global Crisis

COVID-19 is a novel virus that is constantly changing in understanding. Various industries have had to quickly adapt to ensure long-term profitability and sustainability while also promoting the health of their employees and customers. Among these industries, higher education has had to adapt its learning opportunities to support more online learners while also facing increased cleaning and technology costs and decreased revenue from lower enrollment. With many businesses uncertain of their future, colleges and universities need to think of not only how they will fare during the crisis, but also after it is over.

This paper is organized as follows: The first section reviews the literature, which discusses the major factors in the change in enrollment during the Great Recession and COVID-19 pandemic. The second section discusses research questions and a hypothesis created based upon the review of literature, which is the focus of the paper. The third section explains the data collection and methodologies used, looking at what college enrollment data was collected and where it came from, as well as the predictive models used to predict total college enrollment. The fourth section describes the models and evaluates their performance in terms of accuracy at predicting total college enrollment. The fifth section concludes the paper by comparing the results to the hypothesis and lists the future work of the paper. It is important to investigate total college enrollment because crises will continue to occur, but by understanding what factors affect college enrollment during a crisis, and using those factors to create predictive models, colleges and universities can better prepare for them.

Review of Literature

This section reviews the literature of how college enrollment has been affected with respect to contributions to value, university revenue, university & student classification, and online learning during the Great Recession of 2008-2009 and the COVID-19 pandemic. While both crises had major impacts on higher education, there were similarities and differences in how and who they impacted. These similarities and differences will be highlighted in the following subsections.

College Enrollment and the Great Recession

Value

Due to the housing market collapse during the Great Recession of 2008-2009, many were laid off. As noted by Barr & Turner (2015), these increased layoffs may have led to more nontraditional students (i.e. adult learners) to pursue higher education to get or to finish their degree. This is supported by Barr & Turner (2015), who also conclude that those who receive unemployment insurance are more likely to pursue higher education as a transitionary activity to improve their skills and be a more desirable job candidate when they return to the workforce. This is because those individuals are now eligible for unemployment insurance, which pays a percentage of the wages laid-off workers were earning while working. The more weeks an individual is on unemployment insurance, the more time they have, meaning they are more likely to enroll in college and use part of the insurance to pay tuition. This is supported by Barr & Turner (2013), who concluded that the demand for higher education tends to increase during a recession due to the opportunity cost of time being lower. As Barrow & Davis (2012) point out, this increase may not be as substantial as some believe because while displaced workers will see an increase in earnings post displacement, these returns may be lower during a recession due to

continued poor labor market outcomes upon graduation, which will deter some nontraditional students from pursuing a degree. This increase in nontraditional student enrollment led to an increase in total college enrollment. More specifically, Barr & Turner (2013) found that total college enrollment in the United states increased from 18.2 to 21 million from 2007 to 2010. Dunbar et al. (2011) found similar results, stating the total national college enrollment increased by 6.9% from 2006 to 2010. It is important to note that these increases were consistent from 2006-2010 but decreased in 2010. Dunbar et al. (2011) and Barrow & Davis (2012) believe this is due to high school graduates increasing from 2007-2008 but decreasing from 2008-2010. Between full-time and part-time students, Long (2014) found that while overall university and part-time enrollment increased, full-time enrollment decreased during the Great Recession. This is refuted by Dunbar et al. (2011), who concluded that outside of 2009, the share of part-time and full-time enrollment remained constant during the recession. They also found that the increase in enrollment was due to class capacity limits at more traditional 4-year residential universities, leading to a shift from private universities to public 2-year and 4-year universities.

The Great Recession of 2008-2009 not only saw an increase in non-traditional enrollment, but also historic highs in university cost of attendance and national student debt. Long (2014) found the causes of increased student debt was due to stagnant or decreased household income due to a higher unemployment rate and a change in the value of one's home. For the latter point, if there is a decrease in the value of one's home, the student may be less able to finance their education through private loans, leading them to be less likely of enrolling in a university. Long (2014) also found that private student lenders had to suspend or stop lending to students, which led to increased lending and Pell grants from the federal government and universities. This helped reduce the increase in net price to attend universities, but also increased

how many students are dependent of financial aid. This also deterred some students from enrolling because of how complicated the financial aid process is. To maintain enrollment, Dunbar et al. (2011) found that universities increased outreach, marketing efforts, and aid to those most likely to enroll. The increased need for financial aid, paired with a decrease in state appropriations due to lower state tax revenue, led to an inflation of tuition. Long (2014) found that families paid more for college after the Great Recession than before.

University Revenue

A major consequence of the Great Recession of 2008-2009 for universities was the change in where they generated their revenue. Prior to the Great Recession, universities would rely on a mix of different revenue sources, such as tuition & fees, endowments, and state appropriations (only for public universities). However, as Barr & Turner (2013) found, states generated less revenue from taxes due to a high reliance on income tax, changes on what was taxed and a reduction in diversity of the tax profile. This limited state tax revenue then had to be split between different areas. Due to an increase in demand on social services such as Medicaid, less funding was given to public universities. The researchers make note that this decrease in state appropriations to public universities was already in the works in many states since legislators saw it as less of a necessity than other social services. They also make note that states with natural resource reserves were less affected than others due to their reliance on severance taxes. All universities also saw a decrease in endowments due to less donations, but private universities tend to see a return in donors soon after a crisis. To help maintain revenue, the researchers recommend public universities focus on out-of-state enrollment because those students typically pay higher tuition & fees.

The decrease in state appropriations and endowments led universities to rely more on tuition & fees, leading to an increase in cost of attendance for students. As noted by Barr & Turner (2013), tuition & fees increased at a higher rate than inflation. This is supported by Long (2014), who concluded that a decrease in state appropriations may shift students to look at private universities instead of public universities due to a lower inflation rate in cost of attendance and 4-year universities rather than 2-year universities. They also found that the Great Recession also coincided with the largest class of graduating high school seniors, leading to an increase in those who were eligible for financial aid due to their personal or family situation caused by the recession or due to a change in university policy. This led to an increase in financial aid support, which included the issuance of Pell grants, tuition tax credits, student loans, and unemployment insurance. However, financial support per student decreased due to universities being strained on resources, leading to an overall marginal increase in net price (the price students pay on average to enroll at a university). They also found that universities were collecting more in tuition revenue per student and were offering less grants per person due to more students attending part-time, leading grants increasing student loans rather than decreasing the cost of attendance.

University & Student Classification

A unique factor that arises during a global crisis when it comes to college enrollment is where students choose to enroll. The Great Recession brought about an increase in total enrollment. However, this enrollment increase was felt differently depending on the type of university it was. As noted by Barrow & Davis (2012), there was a larger than expected increase in enrollment at two-year, four-year public, and four-year private universities as compared to the historical trend of unemployment and college enrollment. More specifically, enrollment at two-

year universities experienced the highest growth over the entire period (1965-2010), but growth in enrollment at four-year private universities grew sharply after 2000, driven by an increase in enrollment at for-profit four-year institutions. This is supported by Dunbar et al. (2011) and Barr & Turner (2013). For community colleges, Dunbar et al. (2011) found that there was an increase in first-year enrollment at community college because of the Great Recession, especially in the Northeast. More specifically, there was a slight increase in full-time enrollment and an even smaller decrease in part-time enrollment at community colleges, leading to an overall increase in total enrollment. The researchers believe this was because these students may have been looking for a less expensive alternative to four-year universities or may have opted to pursue a degree rather than enter the job market. Community colleges also benefitted from targeted marketing campaigns, increased federal investment in Pell grants, and increased capacity. To support this point, Barr & Turner (2013) found that community colleges can hire faculty more easily without worrying about residential infrastructure as well as offer short-term programs nontraditional students want as compared to 4-year universities when demand is higher. Barr & Turner (2015) also further this point by concluding that non-traditional students were more likely to enroll in community college than traditional students. This is beneficial to community colleges as nontraditional students made up much of the total enrollment increase. This increase lasted until 2010, where total enrollment at community colleges decreased due to a strain on capacity because of the 2009 enrollment increase, the beginning of economic recovery, and community colleges adapting to budget cuts when it comes to course scheduling, financial aid, recruitment, and admissions practices.

For 4-year universities, the change in enrollment was smaller but nonetheless present. Dunbar et al. (2011) found that 4-year universities saw a less drastic but constant increase in

enrollment as compared to community colleges from 2006-2010. The researchers also found that the enrollment share between public and private 4-year universities remained constant (20% private, 80% public). As Barr & Turner (2015) noted, this is because traditional and non-traditional students were equally likely to enroll in a 4-year university. However, as noted by Dunbar et al. (2011), research universities and liberal arts colleges are less likely to respond to changes in enrollment demand due to their residential nature and subsidy per student as compared to community colleges. With the decline in federal and state funding, a focus on out-of-state and community college graduate recruitment, and more selective admissions due to capacity limits at public universities, for-profit universities saw an increase in enrollment. As noted by Barr & Turner (2013), unlike non-profit or public universities, for-profit universities can rent additional facilities and hire temporary staff more easily since they focus on wealth generation for their shareholders. Since the recession led more nontraditional students to enroll in college, for-profits can also more easily change their course offerings, focusing on online, technical, and career programs in demand of nontraditional students. Even though enrollment increased over the Great Recession, universities were affected differently due to their classification.

College Enrollment and COVID-19

Online Learning

A major change brought about by the COVID-19 pandemic for universities is the need to offer more online learning opportunities. Dworak (2020) highlighted this point by concluding that institutions with established online programs that are cheaper than traditional universities may see an increase in student enrollment. This is supported by Rizun & Strzelecki (2020), who concluded that if universities offered online programs before the pandemic began, they had less

issues transitioning to online learning. Kuklenski (2020) also supports this point and concluded that higher quality online courses taught by higher quality professors have the potential to attract students across the United States and Internationally through the ease of access. An example of online program success comes from Mega-Universities, where most of the students enrolled take courses online asynchronously. These universities target adult learners that have some college background but did not complete a degree from around the world and offer programs that help them develop and apply their skills to get a better job at their current workplace or find a new job. For online courses to be successful, universities need to allocate appropriate training and resources to them, such an allowance for professors to buy a new computer to teach from and training on how to teach and engage students in online courses. Wotto (2020) and Dietrich et al. (2020) concluded that faculty also need proper training and guidance by the university. This is supported by Wolinsky (2020), who acknowledged that faculty will also need to rework their assignments and how they teach to accommodate for an online course. This is because online learning can vary from synchronous classes, where there is a set time to meet and learn, to asynchronous classes, where the student can take classes at their own pace, as well as what platform the university decides to use, such as Zoom or Microsoft Teams. Additionally, Genord (2020) found that online learning brings an increased Information Technology cost to the University due to the need for additional equipment and staff.

A major factor in determining the success of online learning is students' acceptance of online learning. Wotto (2020) found that since 2012, there has been an increase in demand for higher education and online learning. This general increase in demand does not affect all programs equally. In fact, some programs have seen a decrease in enrollment since 2012 due to decreased demand. Since many schools must currently offer either a hybrid or a completely

online learning experience due to the pandemic, it is important to figure out how to entice students to take online classes that may want to defer enrollment until an in-person learning experience is available. Rizun & Strzelecki (2020) concluded that the best predictors for students' acceptance of online learning is the enjoyment of online learning as well as self-efficacy. This is important because Genord (2020) found that due to the pandemic, students are more concerned with how the school is offering courses than the job placement rate upon graduation. This is because some students feel they are not getting the same learning experience online as in-person whereas others may not have devices or reliable internet to access online classes. They also found that students still prioritize the availability of financial aid, grants and work-study jobs because of tuition increases due to the increased IT cost faced by Universities. Additionally, Dietrich et al. (2020) found that students benefitted more from synchronous classes, where they could engage with the professor rather than asynchronous learning, where they could learn at their own pace. Students also appreciated online assessments because they were allowed more time to complete their work, but it also led to an increase in cheating. Furthermore, varying home situations (i.e., limited bandwidth, family obligations, and available workspaces) made it hard for both professors and students to attend and engage in class. They make a note that while students were satisfied with how professors adapted to online classes and the online tools; many were unsatisfied with their work. This is supported by Kim et al. (2020), who found that students do not feel confident in getting a quality education through remote classes or building relationships through a remote environment. Due to this, some of these students plan to look at different schools that offer better online capabilities at a lower cost of attendance, and with better job-placement resources. Dietrich et al. (2020) conclude that in addition to providing students and teachers the proper academic resources and equipment,

additional support must be given to the wellbeing of students, whose social life has been drastically changed due to the pandemic.

Safety and Value

The COVID-19 pandemic is changing in understanding every day. However, one thing remains constant; the danger it presents. Every day, thousands of U.S. citizens are testing positive for the virus. While many recover, there are still those who die because of it. With this danger, many colleges had to evaluate whether they could offer a hybrid model, where students would take some classes in person and others online or go fully online. With so much uncertainty, Genord (2020) found that there was decreased undergraduate enrollment nationwide for the 2020-2021 academic year compared to previous years due to students taking a gap-year or enrolling part-time. Dworak (2020) and Wolinsky (2020) believe this is because unlike an economic recession, the pandemic questions the safety of going back to college, and the value students will receive from online learning. Furthermore, since many family members were laid off due to the economic recession caused by the pandemic, some students cannot afford to go to college during the 2020-2021 academic year. In addition, with limited jobs available, students are questioning whether a degree will guarantee them a job upon graduation. Kim et al. (2020) found that some students are choosing not to enroll in full-time four-year degrees, instead opting for two-year degrees or gap years while others are considering going to full-time four-year degrees from two-year degrees. Further, some students changed where they would enroll, either because they wanted a lower cost of attendance, a desire to be closer to home, or because they wanted to avoid a COVID-19 outbreak at their first-choice school's location. Due to this, more students chose to attend in-state public universities. The researchers note that the size of the university, the urban or rural setting, or online capabilities of the schools did not change in preference.

While no university can guarantee the safety of all students from the pandemic, Dworak (2020) found that reassuring students about the value of a college degree and online courses, as well as establishing clear guidelines about how the university will operate during the pandemic may encourage students to continue to enroll. Rizun & Strzelecki (2020) and Kim et al. (2020) further this point by stating that if a university communicates with their students, faculty, and staff about the support offered and about staying safe during the pandemic, they create a greater feeling of belonging. To further encourage students to enroll and reduce dropout rates, Copley & Douthett (2020) recommend that universities emphasize frequent advisor meetings, tutoring, financial support, and student life programs, as well as look to new pools of applicants, such as working adults, first-generation students, and international students. Additionally, Kim et al. (2020) recommend universities emphasize mental and academic resources to help with student preparedness, emphasize financial aid and CARES act funding (an act passed by the federal government, giving over $14 billion dollars to aid universities in covering refunds and financial aid), develop online portals for FAQs and to apply, offer stipends for internet or equipment for remote learning or rent out equipment, and provide info on and advocate for students in need to providers and agencies that can help.

University Revenue

With universities facing increased costs from supplies to make their campuses safer from COVID-19 and Information Technology to allow for online learning, and decreased revenue due to decreased undergraduate enrollment, universities must figure out how to properly allocate their resources to promote the longevity of the university and maximize their revenue. This is important because Kuklenski (2020) and Sullivan (2020) found that the financial losses due to COVID-19 will close some universities sooner than expected. Within New England alone, 25 are

now predicted to close as compared to 13 in the next 6 years. A major reason for this is a decreased donor pool, meaning smaller endowments to pay for scholarships and fees. This means that the cost to enroll at universities will be higher, which will deter more students from enrolling. This also means that universities will become more dependent on tuition and fees, which Kim et al. (2020) noted already makes up 26% of public four-year university revenue and 35% of private nonprofit four-year university revenue. With the addition of less in-person activities, revenue will continue to decrease whereas expenses will increase due to the need to refund or offer reduced rates to students for not being able to offer the same college experience as previous academic years. This is supported by Wolinsky (2020), who concluded that due to decreased tax revenue for states, public institutions will also receive less in state appropriations. Kim et al. (2020) noted that with a 15% decrease in domestic first-year student enrollment and 5% decrease in upperclassmen enrollment for the 2020-2021 academic year, universities could face a $7 billion loss in tuition and fees. They also make a note that universities will fare differently depending on their graduate and international student population, reliance on out-of-state students, cost of attendance, and online capabilities. On top of the pandemic, Kuklenski (2020) and Copley & Douthett (2020) also found that due to a lower national fertility rate coinciding with the Great Recession of 2008 as well as a decreased immigration rate, there is also less students applying and enrolling in universities. More specifically, the authors state that there will be a 15% decrease in college-age population between 2025 and 2029. Due to their prestige and endowments, top-ranked universities will not be affected as much as regional public and private institutions since they can offer larger financial aid packages. They also note that during a crisis, while some universities will close, others will merge and even more will see an

increase in alumni donations. However, depending on the length of the pandemic and if there is a continued economic recession, may negatively change the outcome for universities.

Looking at New England universities, Sullivan (2020) found that declining enrollment at 71 universities (18 private and 53 public) at 57 cities and towns (19 of which are home to universities (10 private and 9 public)), and 25 campus closures would lead to layoffs. This would hurt the local economy, especially in small towns where some universities are located because New England universities account for 3.4% of total employment in New England, as compared to 2.5% nationwide. More specifically, "In the municipalities that are most dependent on higher education (the top 20 percent), the local college or university provides nearly 38% of total employment, on average" (Sullivan, 2020, p. 3). It is important to note that these communities tend to have smaller resident populations. In addition, decreased enrollment and campus closures will lead to fewer student consumers, further hurting the local economy.

To try and figure out what universities should do, Thatcher et al. (2020) looked at how Australian university revenue has been affected by COVID-19. They found that most of their revenue comes from international enrollment. This is bad because with travel restrictions in place, many cannot return to their home institutions. Due to many living in different time zones, online learning may not be a feasible option, leading to decreased enrollment and revenue. To reduce this risk, they recommend Australian universities diversify their revenue pool, including a focus on domestic enrollment, so that they reduce financial risk. While this solution may need to be adapted for American universities, diversifying their revenue pool, and focusing on in-state enrollment may sustain these universities for years to come. To lower long-term expenses, Robinson & Maitra (2020) concluded that universities should implement an immediate hiring freeze of all staff and faculty, mandate faculty who teach a few courses and do little research to

teach more courses, eliminate or merge departments with low student return on investment, research contribution, and degree productivity, freeze capital projects and plan future projects around efficiency rather than luxury, lay off non-essential workers, and enact salary cuts for those with large salaries. This is supported by Copley & Douthett (2020), who further suggested pausing the introduction of new programs. The researchers also note that when eliminating or consolidating programs, universities must still allow currently enrolled students to finish the program, which can take several years.

To expand more on international enrollment, Wolinsky (2020) found that while most current international students will continue taking classes virtually due to the value of a U.S. degree in their home country, prospective students may be less attracted to American universities due to the handling of the pandemic and the rise of China as an educational superpower. Copley & Douthett (2020) furthered this point by discussing how the U.S. travel restrictions, focused primarily on China at first due to the pandemic originating there, have also led to a rise in hate speech and violence against Asian travelers and citizens. This will further push international students away from attending American universities, hurting both enrollment and institutional revenue. International students are also less likely to enroll in American universities due to a decreased household income from a global economic downturn. Wolinsky (2020) does make a point that even though international enrollment could decrease, domestic enrollment could increase due a worse job market within the U.S., leading more high school graduates and laid off workers to consider attaining a degree.

Research Questions and Hypothesis

Based on the review of literature, it is clear what has been investigated as well as what still needs to be investigated when it comes to COVID-19's impact on higher education. Currently, there is a clear understanding that COVID-19 does affect colleges and universities across the nation. Due to the nature of the virus, colleges and universities have either offered a hybrid or 100% online learning model to ensure students can continue to learn through the pandemic. However, due to their preference of in-person learning or loss of revenue to be able to afford college, some students are taking a gap year or going to college part-time to also work. From this, colleges and universities are seeing decreased revenue from lower enrollment as well as increased costs from information technology and COVID-19 protection. However, this may only be the surface, so this paper further investigates how a global crisis affects college enrollment, by comparing the current pandemic with that of the Great Recession of 2008-2009. More specifically, this paper looks at how different university classifications (i.e., community colleges, 4-year public universities, and 4-year private universities) fare in terms of total enrollment during both crises. This paper focuses on one hypothesis; that more students will attend community college while less students will attend traditional 4-year public and private universities, leading to a net zero effect on total enrollment.

Data and Methodology

Based on the research questions and predictions, it is clear what data needs to be analyzed to answer these questions. Since this data needs to start before the Great Recession of 2008-2009, secondary data that is publicly available is used. Colleges and universities are always collecting enrollment data to get a better sense of who the students are, where they are coming

from, and their educational background. For this paper, college enrollment data is used to identify what factors affect college enrollment in the past and present to predict future enrollment trends. Since there are thousands of universities across the United States of America, it is important to identify the scope of the data. It is also important to attain this data from reputable sources. Therefore, this paper focuses on college enrollment from 73 different colleges and universities in New England (Connecticut, Rhode Island, Massachusetts, New Hampshire, Vermont, and Maine). The colleges and universities used are shown in Table 1. It is also important to acquire this data from reputable sources. Therefore, college enrollment data from the fall of 2006-2019 was collected from the National Center for Education Statistics. It is important to note three things about this data: one, the National Center for Educational Statistics is a part of the U.S. Department of Education Institute of Education Sciences. This entity collects higher education data annually and colleges and universities are required to submit their data if they participate in or are an applicant for participation in any federal financial assistance program authorized by Title IV of the Higher Education Act (U.S. Department of Education); two, the tuition & fees data for public schools is based on out-of-state numbers; three, graduate and professional students have been combined for consistency amongst all the colleges and universities. Since the National Center for Educational Statistics did not have the fall of 2020 college enrollment data available on their website at the time of writing this paper, it was instead collected from the individual college and university's research centers where available (more specifically, 41 of the 73 universities identified).

Using both past and present data, two different predictive models were created and analyzed as to how accurately they predict total college enrollment. The first model tested was a multiple linear regression model. A multiple linear regression model analyzes the relationship

between a variable of interest and two or more variables to see how significant they are when predicting future values. Once analyzed, a model is created using the estimates of the significant variables and predicts future values. The error is assumed to be white noise (i.e., randomness). The second model tested was an Autoregressive Integrated Moving Average (ARIMA) model. An ARIMA model analyzes the variable of interest using autoregression, differencing, and moving average values. Autoregression is a regression testing the variable of interest against itself. Moving average is a regression testing the error of the variable of interest against its past error. However, these values can only be determined if the data is stationary, meaning the mean and variance are constant over time. If they are not, differencing is needed to transform the nonstationary data into stationary data. Once these values have been determined, a model is created to predict future values of the variable of interest. By comparing the accuracy of these models, a determination can be made as to which model is the best to predict college enrollment of New England colleges and universities.

Data Analysis

Before the analysis began, the variable of interest and additional variables were identified for collection. Beyond collecting total enrollment from the 73 colleges and universities, 24 other variables were collected to break down enrollment into different categories such as part-time enrollment, full-time enrollment, transfer undergraduates (undergraduates who started at a different college or university but moved to a different college or university), first-time first-year undergraduates (undergraduates who have not previously enrolled in a college or university), continuing undergraduates (undergraduates who have already been at the college or university for at least one semester), and graduates. The college enrollment variables collected are shown in

Table 2. Once the variables were identified, the data was then collected and centralized into one location for analysis since it came from multiple different sources. This was done via manual input on Microsoft Excel. To uniquely identify each row of data, identification columns were created to uniquely identify each row of data, which included the name of the university, the state in which it was located, its classification, and the year. Part of the final data set is displayed in Table 3 for reference. Once the data was collected and cleaned on Excel, it was then analyzed using R Studio. R Studio is an open-source integrated development environment (IDE) for R that allows data analysts to analyze their data using different models through code and visualizations. Before analyzing the data set, it first had to be read into R Studio. Once it was read in, the data set was further cleaned by omitting null values and then plotted by university classification to see if there were any obvious trends. The plot can be found in Figure 1 below. After that, the data was then split into training and testing data sets. The training set looks at all the data from all colleges and universities from the fall of 2006 to 2017 when creating the model. The testing set tests whether the model does a good job of forecasting future values by using data from all colleges and universities from the fall of 2018-2020.

Having prepared the data, it was then analyzed using a linear regression model. As stated previously, the benefit of using a linear regression model is that it allows the analyst to look at multiple different variables in a dataset to see how they relate to one another. With 25 variables, this model appears to be the perfect way to tell how different enrollment variables, such as full-time first-time undergraduates and part-time graduates, affect total enrollment. However, due to the nature of the data set, many of the enrollment variables are closely related, creating singularities. Due to this issue, many of the variables had to be cut from the final linear regression model, leaving only the university, university classification, total full-time, first-time-

full-time undergraduates, transfer-in full-time undergraduates, continuing full-time undergraduates, non-degree/non-certificate-seeking undergraduates, and undergraduate tuition & fees variables in the model. Once the variables were selected, they were inserted into the mlr function in R using the training data to find the values of each variable and their significance. The associated output is given in Figure 2. The top 2 significant variables outside of the colleges and universities themselves are Transfer-In Full-Time Undergraduates with a value of 3.574 and Non-Degree/Non-Certificate-Seeking Full-Time Undergraduates with a value of 3.786. Both variables are significant any level. This means that whenever there is a 1 student increase in either Transfer-In or Non-Degree/Non-Certificate-Seeking Full-Time Undergraduate population, total enrollment will increase by 3.574 or 3.786, respectively. With this knowledge, the best way to increase enrollment at universities and colleges is by increasing the number of transfer-in and non-degree/non-certificate-seeking full-time undergraduate students. Once the linear regression model was calculated, it was then used to predict total college enrollment and compare the results to the actual total enrollment in the testing data set. Since this model predicts the total enrollment for all 73 colleges and universities, Figure 3 displays a scatter plot of the predicted (fitted) total enrollment numbers vs. the actual total enrollment numbers for the fall of 2018, 2019, and 2020 when available. Looking at the plot, many of the points on the plot are close to or on the line, meaning that the model does a good job of predicting total enrollment as compared to actual total enrollment. However, there are other points that are further away from the line, meaning that the predicted values do not match the actual values. This is supported by the Mean Absolute Percentage Error (MAPE) using the accuracy function in R, which was 21.0779% for the entire model. This means that there is 21.0779% error when predicting total enrollment as compared to the actual total enrollment. To better understand how the model predicts total

college enrollment at different university classifications, 2 colleges or universities of each classification were selected and analyzed. Starting with public 4-year institutions, the University of New Hampshire at Durham has a predicted total enrollment of 15,603, whereas the actual total enrollment was 15,298 for the fall of 2018. Likewise, the University of New Hampshire at Manchester has a predicted total enrollment of 515 and an actual total enrollment being 750 for the fall of 2018. Looking at private 4-year institutions, Bentley University has a predicted total enrollment of 5,062 and 4,994 and an actual total enrollment of 5,460 and 5,314 for the fall of 2018 and 2019, respectively. Likewise, Harvard university has a predicted total enrollment of 20,841 and an actual total enrollment of 20,739 for the fall of 2018. Looking at community colleges, Northwestern Connecticut Community College has a predicted total enrollment of 1,051 and an actual total enrollment of 1,299 for the fall of 2018. Likewise, York Community College has a predicted total enrollment of 1,208 and an actual total enrollment of 1,632 for the fall of 2018. It is important to note that the predicted total enrollment for the fall of 2019 and 2020 could not be predicted for most universities and colleges using this model as many of the variables had null values due to the universities not having the data available for public use at the time of collection.

To improve the accuracy of the linear regression model, Southern New Hampshire University was removed from the data set. Unlike most of the colleges and universities collected, Southern New Hampshire University had an exponentially increasing enrollment trend, as seen in Figure 1. This is explained by SNHU's expansion of their online programs and marketing campaigns to nontraditional and international students. By removing this university from the data set, a major outlier is removed. Figure 4 shows the new line plot of the total enrollment for the fall of 2006 – 2020. The new plot more clearly shows the trends in total enrollment at the

remaining 72 New England colleges and universities. The new data set was then used to create a new model using the same function and variables as the previous model, and the associated output can be found in Figure 5. The top 2 significant variables outside of the colleges and universities themselves are again Transfer-In Full-Time Undergraduates with a value of 1.621 and Non-Degree/Non-Certificate-Seeking Full-Time Undergraduates with a value of 4.555. Both variables are significant any level. Figure 6 displays a scatter plot of the predicted (fitted) total enrollment numbers vs. the actual total enrollment numbers for the fall of 2018, 2019, and 2020 when available. As compared to the previous model, it appears more points are close to if not on the line, meaning that the model does a better job of predicting total enrollment as compared to actual total enrollment. This is supported by the Mean Absolute Percentage Error (MAPE), which is 8.0494% for the entire model, and the predicted vs actual total enrollment numbers found for the selected colleges and universities used in the previous model. Starting with public 4-year institutions, the University of New Hampshire at Durham has a predicted total enrollment of 15,380, whereas the actual total enrollment was 15,298 for the fall of 2018. Likewise, the University of New Hampshire at Manchester has a predicted total enrollment of 798 and an actual total enrollment being 750 for the fall of 2018. Looking at private 4-year institutions, Bentley University has a predicted total enrollment of 5,607 and 5,503 and an actual total enrollment of 5,460 and 5,314 for the fall of 2018 and 2019, respectively. Likewise, Harvard university has a predicted total enrollment of 20,891 and an actual total enrollment of 20,739 for the fall of 2018. Looking at community colleges, Northwestern Connecticut Community College has a predicted total enrollment of 1,337 and an actual total enrollment of 1,299 for the fall of 2018. Likewise, York Community College has a predicted total enrollment of 1,379 and an actual total enrollment of 1,632 for the fall of 2018. While Harvard University's predicted total

enrollment become became less accurate due to the new model, all the other universities predicted total enrollment have improved, meaning that this model is better at predicting total college enrollment.

Since the linear regression model could further be improved upon when predicting total college enrollment, the data set was then analyzed using the ARIMA model. Unlike the linear regression model, this model only looks at the total enrollment variable and compares it to its previous years and error to predict future values. To create the ARIMA function, the AR, I, and MA processes were determined using an autocorrelation function (ACF) plot and partial autocorrelation function (PACF) plot. These plots look at the correlations of the lagged variable of interest and the lagged residuals of the variable of interest against the variable of interest. The ACF and PACF plots of the total enrollment variable in the training set were created using the acf2 function in R, which can be seen in Figure 7. Since the data is stationary (i.e., the lagged values drop off quickly), differencing is not needed, leading the I or d value to be 0. Since there are more significant lines in the ACF plot than the PACF plot (i.e., lines that are outside of the blue dashed lines), the MA process or q value is 0. With only one significant line in the PACF plot, the AR process or p value is 1, making it an ARIMA (1,0,0) model. With the ARIMA process having been determined, the model was then created using the auto arima function in R. It is important to note that due to the nature of the data (it being longitudinal data, where the same data was collected from different universities during the same period), this data had to be separated through the group by function in R to predict each university's total enrollment. To generate the output, the subset function was then used on the auto arima function. Unlike the linear regression models, this output only generates one university's predictions, so this paper again focuses on the output for the University of New Hampshire at Durham and Manchester,

Bentley University, Harvard University, Northwestern Connecticut Community College, and York Community College, which is shown in Table 4 – 6, to capture the differences in university classification. For 4-year public universities, 4-year private universities, and community colleges, the predicted total enrollment was at most off by a little over a thousand as compared to the actual total enrollment for the fall of 2018, 2019, and 2020. For accuracy, the University of New Hampshire at Durham had a MAPE of 3.9550%, the University of New Hampshire at Manchester had a MAPE of 14.2392%, Bentley University had a MAPE of 4.3066%, Harvard University had a MAPE of 2.9960%, Northwestern Connecticut Community College had a MAPE of 0.6509%, and York Community College had a MAPE of 4.7211%. All these MAPEs are an improvement in terms of accuracy as compared to the MAPE of the linear regression models except for the University of New Hampshire at Manchester, meaning the ARIMA model does a better job of predicting total college enrollment as compared to the linear regression models.

Conclusion

After the linear regression and Autoregressive Integrated Moving Average (ARIMA) models were analyzed, it was determined that the ARIMA model does a better job of predicting total enrollment at colleges and universities in New England based upon the Mean Absolute Percentage Error (MAPE). While the University of New Hampshire at Manchester predicts a decreasing trend in total enrollment, all the other colleges and universities have the same predicted value for the fall of 2018, 2019, and 2020, meaning that overall, the ARIMA model does not support the hypothesis that more students will attend community college while less students will attend traditional 4-year public and private universities, leading to a net zero effect

on total enrollment. Since the linear regression models were only able to predict total college enrollment for the fall of 2018 for most colleges and universities, these models are unable to support the thesis as well. The accuracy of these predictions could be further improved upon and, in turn, may support this hypothesis by testing and comparing additional models. One such example is a dynamic regression model, which combines the ARIMA process for the variable of interest with the relationship of independent variables from a linear regression model to create a combined model to predict values of the variable of interest. This is done by assuming the error is an ARIMA process rather than white noise. It is important to note that while some additional models may improve the accuracy, there will be other models that will worsen the accuracy of the model. It is also important to note that some models will not be relevant when predicting total college enrollment due to the data set. Therefore, going forward, it will be important to test different models to find which models and which variables are best when predicting total college enrollment. In addition to improving the accuracy, testing additional models will help identify which models are best for which colleges and universities depending on what variables are significant to them. Therefore, in addition to testing additional models, more data must also be collected to better predict total college enrollment. One such area could be student data that looks at what factors were more important to students when deciding to enroll and where to enroll for college outside of and during a crisis, such as net price, modes of learning offered, and the state and operating status of on-campus facilities. By testing more models and collecting more data, more accurate predictions about college enrollment can be made to help college and university administrators make more educated decisions to ensure the longevity of their college or university during and after a global crisis.

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Tables

Table 1

Colleges & Universities

University	State	Classification
Amherst College	MA	Private
Bentley University	MA	Private
Berklee College of Music	MA	Private
Boston College	MA	Private
Boston University	MA	Private
Brandeis University	MA	Private
Bridgewater State University	MA	Public
Bryant University	RI	Private
Bunker Hill Community College	MA	Community College
Cape Cod Community College	MA	Community College
Champlain College	VT	Private
Connecticut College	CT	Private
Dartmouth College	NH	Private
Eastern Connecticut State University	CT	Public
Emerson College	MA	Private
Endicott College	MA	Private
Fairfield University	CT	Private
Fitchburg State University	MA	Public
Granite State College	NH	Public
Great Bay Community College	NH	Community College
Harvard University	MA	Private
Keene State College	NH	Public
Manchester Community College	CT	Community College
Manchester Community College	NH	Community College
Massachusetts Bay Community College	MA	Community College
Massachusetts College of Art and Design	MA	Public

University	State	Classification
Massachusetts College of Liberal Arts	MA	Public
Massachusetts Institute of Technology	MA	Private
Massachusetts Maritime Academy	MA	Public
Merrimack College	MA	Private
New Hampshire Technical Institute	NH	Community College
North Shore Community College	MA	Community College
Northeastern University	MA	Private
Northern Essex Community College	MA	Community College
Northwestern Connecticut Community College	CT	Community College
Norwich University	VT	Private
Plymouth State University	NH	Public
Providence College	RI	Private
Quincy College	MA	Community College
Quinnipiac University	CT	Private
Salem State University	MA	Public
Simmons University	MA	Private
Southern Connecticut State University	CT	Public
Southern New Hampshire University	NH	Private
Suffolk University	MA	Private
University of Connecticut at Avery Point	CT	Public
University of Connecticut at Stamford	CT	Public
University of Connecticut at Storrs	CT	Public
University of Connecticut at Waterbury	CT	Public
University of Maine at Augusta	ME	Public
University of Maine at Farmington	ME	Public
University of Maine at Fort Kent	ME	Public
University of Maine at Machias	ME	Public
University of Maine at Orono	ME	Public
University of Maine at Presque Isle	ME	Public
University of Massachusetts at Amherst	MA	Public
University of Massachusetts at Boston	MA	Public
University of Massachusetts at Dartmouth	MA	Public

University	State	Classification
University of Massachusetts at Lowell	MA	Public
University of New England	ME	Private
University of New Hampshire at Durham	NH	Public
University of New Hampshire at Manchester	NH	Public
University of New Haven	CT	Private
University of Rhode Island	RI	Public
University of Southern Maine	ME	Public
University of Vermont	VT	Public
Wellesley College	MA	Private
Western Connecticut State University	CT	Public
Western New England University	MA	Private
Westfield State University	MA	Public
Worcester State University	MA	Public
Yale University	CT	Private
York Community College	ME	Community College

Note: The table above shows the colleges and universities collected for the data set as well as their location in New England and classification

Table 2

College Enrollment Variables

College Enrollment Variable
Total Enrollment
Total Full-Time
First-Time Full-Time Undergraduates
Transfer-In Full-Time Undergraduates
Continuing Full-Time Undergraduates
Total Full-Time Degree/Certificate-Seeking Undergraduates
Non-Degree/Non-Certificate-Seeking Full-Time Undergraduates
Total Full-Time Undergraduates
Undergraduate Tuition & Fees
Total Full-Time Graduates
Total Part-Time
First-Time Part-Time Undergraduates
Transfer-In Part-Time Undergraduates
Continuing Part-Time Undergraduates
Total Part-Time Degree/Certificate-Seeking Undergraduates
Non-Degree/Non-Certificate Seeking Part-Time Undergraduates
Total Part-Time Undergraduates
Total Part-Time Graduates
Total Undergraduates
Total First-Time Undergraduates
Total Transfer-In Undergraduates
Total Continuing Undergraduates
Total Degree/Certificate-Seeking Undergraduates
Total Non-Degree/Non-Certificate-Seeking Undergraduates
Total Graduates

Note: The table above shows all the college enrollment variables collected in the data set.

Table 3

College Enrollment Data

ID	University	State	Classification	Year	Total Enrollment	Total Full-Time	First-Time Full-Time Undergraduates	Transfer-In Full-Time Undergraduates	Continuing Full-Time Undergraduates
891	University of New Hampshire at Durham	NH	Public	2006	14811	12667	3078	NA	8221
892	University of New Hampshire at Durham	NH	Public	2007	15005	12798	2646	496	8226
893	University of New Hampshire at Durham	NH	Public	2008	14898	12934	2711	513	8375
894	University of New Hampshire at Durham	NH	Public	2009	15253	13290	3006	551	8327
895	University of New Hampshire at Durham	NH	Public	2010	15095	13263	2850	592	8453
896	University of New Hampshire at Durham	NH	Public	2011	15128	13399	2949	503	8617
897	University of New Hampshire at Durham	NH	Public	2012	15267	13614	2999	505	8784
898	University of New Hampshire at Durham	NH	Public	2013	14913	13336	2869	517	8610
899	University of New Hampshire at Durham	NH	Public	2014	15117	13593	3227	487	8592

ID	University	State	Classification	Year	Total Enrollment	Total Full-Time	First-Time Full-Time Undergraduates	Transfer-In Full-Time Undergraduates	Continuing Full-Time Undergraduates
900	University of New Hampshire at Durham	NH	Public	2015	15351	13929	3221	515	8853
901	University of New Hampshire at Durham	NH	Public	2016	15188	13680	2881	571	8963
902	University of New Hampshire at Durham	NH	Public	2017	15363	13984	3019	533	9078
903	University of New Hampshire at Durham	NH	Public	2018	15298	13896	3031	449	8982
904	University of New Hampshire at Durham	NH	Public	2019	14784	13385	2730	NA	9169
905	University of New Hampshire at Durham	NH	Public	2020	14288	NA	NA	NA	NA

Note: The table above is a partial of the full data set created for this research. It shows the ID columns as well as a few of the variables captured.

Table 4

University of New Hampshire ARIMA output

	University of New Hampshire at Durham		University of New Hampshire at Manchester	
Year	Predicted Enrollment	Actual Enrollment	Predicted Enrollment	Actual Enrollment
2018	15363	15298	726	750
2019	15363	14784	695	866
2020	15363	14288	663	826

Note: The table above is the output generated for the University of New Hampshire at Durham and Manchester using the ARIMA model for the fall of 2018 – 2020.

Table 5

Private 4-year University ARIMA output

	Bentley University		Harvard University	
Year	Predicted Enrollment	Actual Enrollment	Predicted Enrollment	Actual Enrollment
2018	5543	5460	20768	20739
2019	5543	5314	20768	20970
2020	5543	5176	20768	22546

Note: The table above is the output generated for Bentley and Harvard University using the ARIMA model for the fall of 2018 – 2020.

Table 6

Community College ARIMA output

	Northwestern Connecticut Community College		York Community College	
Year	Predicted Enrollment	Actual Enrollment	Predicted Enrollment	Actual Enrollment
2018	1295	1299	1708	1632
2019	1295	1308	1708	1630

Note: The table above is the output generated for Northwestern Connecticut Community College and York Community College using the ARIMA model for the fall of 2018 and 2019.

Figures

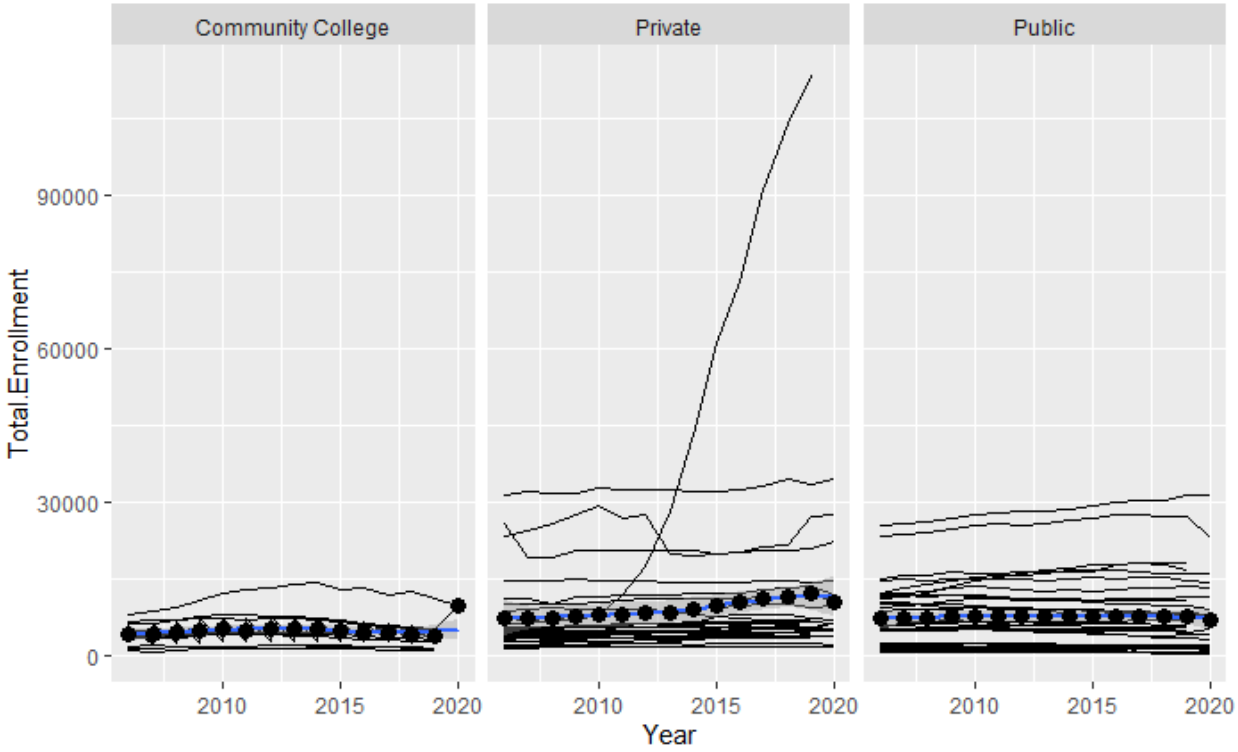

Figure 1. A line plot of the total enrollment at all 73 colleges and universities from the fall of 2006 - 2020, sorted by university classification.

```
Call:
lm(formula = Total.Enrollment ~ . - ID - State - Year - Total.Full.Time.Degree.Certificate.Seeking.Undergraduates -
    Total.Full.Time.Undergraduates - Total.Full.Time.Graduates -
    Total.Part.Time - First.Time.Part.Time.Undergraduates - Transfer.In.Part.Time.Undergraduates -
    Continuing.Part.Time.Undergraduates - Non.Degree.Non.Certificate.Seeking.Part.Time.Undergraduates -
    Total.Part.Time.Degree.Certificate.Seeking.Undergraduates -
    Total.Part.Time.Undergraduates - Total.Part.Time.Graduates -
    Total.Undergraduates - Total.First.Time.Undergraduates -
    Total.Transfer.In.Undergraduates - Total.Continuing.Undergraduates -
    Total.Degree.Certificate.Seeking.Undergraduates - Total.Non.Degree.Non.Certificate.Seeking.Undergraduates -
    Total.Graduates, data = train)

Residuals:
    Min      1Q  Median      3Q     Max
-5468.6  -369.7   -27.4   325.7 22153.3

Coefficients: (2 not defined because of singularities)
                                                      Estimate Std. Error t value Pr(>|t|)
(Intercept)                                          4.201e+02  6.392e+02   0.657 0.511223
UniversityBentley University                        -4.097e+03  5.236e+02  -7.824 1.73e-14 ***
UniversityBerklee College of Music                  -4.962e+03  5.101e+02  -9.728  < 2e-16 ***
UniversityBoston College                            -1.319e+04  9.273e+02 -14.227  < 2e-16 ***
UniversityBoston University                         -2.468e+04  2.041e+03 -12.092  < 2e-16 ***
UniversityBrandeis University                       -3.261e+03  5.915e+02  -5.513 4.84e-08 ***
UniversityBridgewater State University              -1.263e+04  6.959e+02 -18.146  < 2e-16 ***
UniversityBryant University                         -3.026e+03  5.061e+02  -5.980 3.43e-09 ***
UniversityBunker Hill Community College              1.383e+03  6.729e+02   2.056 0.040147 *
UniversityCape Cod Community College                 8.755e+02  6.586e+02   1.329 0.184142
UniversityChamplain College                         -1.083e+03  5.146e+02  -2.104 0.035710 *
UniversityConnecticut College                        8.641e+02  5.149e+02   1.678 0.093713 .
UniversityDartmouth College                         -4.373e+03  6.322e+02  -6.917 9.86e-12 ***
UniversityEastern Connecticut State University      -6.200e+03  5.935e+02 -10.447  < 2e-16 ***
UniversityEmerson College                           -4.058e+03  5.245e+02  -7.735 3.30e-14 ***
UniversityEndicott College                          -5.773e+02  5.431e+02  -1.063 0.288103
UniversityFairfield University                      -2.143e+03  5.181e+02  -4.136 3.94e-05 ***
UniversityFitchburg State University                -2.900e+03  6.157e+02  -4.711 2.94e-06 ***
UniversityGranite State College                     -1.027e+03  6.730e+02  -1.526 0.127384
UniversityGreat Bay Community College                1.127e+03  6.061e+02   1.859 0.063438 .
UniversityHarvard University                        -1.127e+04  2.598e+03  -4.337 1.64e-05 ***
UniversityKeene State College                       -6.232e+03  6.085e+02 -10.242  < 2e-16 ***
UniversityManchester Community College               9.063e+02  5.764e+02   1.572 0.116286
UniversityMassachusetts Bay Community College        6.389e+02  6.483e+02   0.985 0.324718
UniversityMassachusetts College of Art and Design   -9.593e+02  5.253e+02  -1.826 0.068203 .
UniversityMassachusetts College of Liberal Arts     -1.278e+03  5.818e+02  -2.197 0.028346 *
UniversityMassachusetts Institute of Technology     -6.345e+03  1.376e+03  -4.611 4.71e-06 ***
UniversityMassachusetts Maritime Academy            -9.061e+02  5.574e+02  -1.626 0.104431
UniversityMerrimack College                         -1.554e+03  5.127e+02  -3.030 0.002526 **
UniversityNew Hampshire Technical Institute          5.939e+02  6.329e+02   0.938 0.348322
UniversityNorth Shore Community College              4.565e+01  6.600e+02   0.069 0.944873
UniversityNortheastern University                   -2.310e+04  1.190e+03 -19.422  < 2e-16 ***
UniversityNorthern Essex Community College           9.944e+02  6.513e+02   1.527 0.127224
UniversityNorthwestern Connecticut Community College 8.199e+02  6.382e+02   1.285 0.199297
UniversityNorwich University                        -1.599e+03  5.697e+02  -2.806 0.005142 **
UniversityPlymouth State University                 -4.582e+03  6.058e+02  -7.564 1.14e-13 ***
UniversityProvidence College                        -3.010e+03  5.140e+02  -5.855 7.10e-09 ***
UniversityQuincy College                            -7.300e+02  6.868e+02  -1.063 0.288206
UniversityQuinnipiac University                     -6.796e+03  6.454e+02 -10.530  < 2e-16 ***
```

```
UniversitySalem State University                          -8.370e+03  6.422e+02 -13.034  < 2e-16 ***
UniversitySimmons University                               1.438e+03  5.543e+02   2.594 0.009668 **
UniversitySouthern Connecticut State University           -1.088e+04  6.610e+02 -16.454  < 2e-16 ***
UniversitySouthern New Hampshire University               -1.579e+03  7.178e+02  -2.200 0.028113 *
UniversitySuffolk University                              -5.629e+03  6.324e+02  -8.900  < 2e-16 ***
UniversityUniversity of Connecticut at Avery Point         1.185e+03  5.339e+02   2.219 0.026764 *
UniversityUniversity of Connecticut at Stamford            4.807e+02  5.323e+02   0.903 0.366773
UniversityUniversity of Connecticut at Storrs             -2.949e+04  1.319e+03 -22.353  < 2e-16 ***
UniversityUniversity of Connecticut at Waterbury          -1.313e+02  5.398e+02  -0.243 0.807905
UniversityUniversity of Maine at Augusta                   4.538e+02  5.972e+02   0.760 0.447521
UniversityUniversity of Maine at Farmington               -2.132e+03  5.833e+02  -3.656 0.000274 ***
UniversityUniversity of Maine at Fort Kent                 8.421e+01  6.230e+02   0.135 0.892522
UniversityUniversity of Maine at Machias                   6.411e+02  5.803e+02   1.105 0.269644
UniversityUniversity of Maine at Orono                    -1.034e+04  7.015e+02 -14.736  < 2e-16 ***
UniversityUniversity of Maine at Presque Isle             -3.555e+02  6.086e+02  -0.584 0.559256
UniversityUniversity of Massachusetts at Amherst          -3.103e+04  1.284e+03 -24.159  < 2e-16 ***
UniversityUniversity of Massachusetts at Boston           -1.188e+04  6.808e+02 -17.447  < 2e-16 ***
UniversityUniversity of Massachusetts at Dartmouth        -8.756e+03  6.461e+02 -13.552  < 2e-16 ***
UniversityUniversity of Massachusetts at Lowell           -1.049e+04  6.459e+02 -16.243  < 2e-16 ***
UniversityUniversity of New England                       -9.015e+02  7.585e+02  -1.188 0.235033
UniversityUniversity of New Hampshire at Durham           -1.872e+04  9.060e+02 -20.665  < 2e-16 ***
UniversityUniversity of New Hampshire at Manchester        4.767e+02  5.507e+02   0.866 0.386976
UniversityUniversity of New Haven                         -3.568e+03  5.845e+02  -6.105 1.64e-09 ***
UniversityUniversity of Rhode Island                      -1.624e+04  9.386e+02 -17.307  < 2e-16 ***
UniversityUniversity of Southern Maine                    -4.665e+03  6.234e+02  -7.483 2.02e-13 ***
UniversityUniversity of Vermont                           -1.417e+04  7.592e+02 -18.661  < 2e-16 ***
UniversityWellesley College                               -9.986e+02  4.915e+02  -2.032 0.042538 *
UniversityWestern Connecticut State University            -6.513e+03  5.919e+02 -11.003  < 2e-16 ***
UniversityWestern New England University                  -1.352e+03  5.343e+02  -2.530 0.011605 *
UniversityWestfield State University                      -6.792e+03  6.374e+02 -10.656  < 2e-16 ***
UniversityWorcester State University                      -5.110e+03  6.192e+02  -8.253 6.86e-16 ***
UniversityYale University                                 -8.065e+03  1.377e+03  -5.858 7.01e-09 ***
UniversityYork Community College                           2.776e+02  6.767e+02   0.410 0.681761
ClassificationPrivate                                             NA         NA      NA       NA
ClassificationPublic                                              NA         NA      NA       NA
Total.Full.Time                                            1.292e+00  2.055e-01   6.288 5.42e-10 ***
First.Time.Full.Time.Undergraduates                       -1.503e+00  4.284e-01  -3.508 0.000478 ***
Transfer.In.Full.Time.Undergraduates                       3.574e+00  6.101e-01   5.857 7.04e-09 ***
Continuing.Full.Time.Undergraduates                        2.378e+00  2.440e-01   9.745  < 2e-16 ***
Non.Degree.Non.Certificate.Seeking.Full.Time.Undergraduates 3.786e+00 7.213e-01   5.249 1.99e-07 ***
Undergraduate.Tuition...Fees                              -7.617e-02  1.213e-02  -6.280 5.71e-10 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1172 on 756 degrees of freedom
Multiple R-squared:  0.9801,    Adjusted R-squared:  0.9781
F-statistic: 483.1 on 77 and 756 DF,  p-value: < 2.2e-16
```

Figure 2. The output from the mlr function in R Studio.

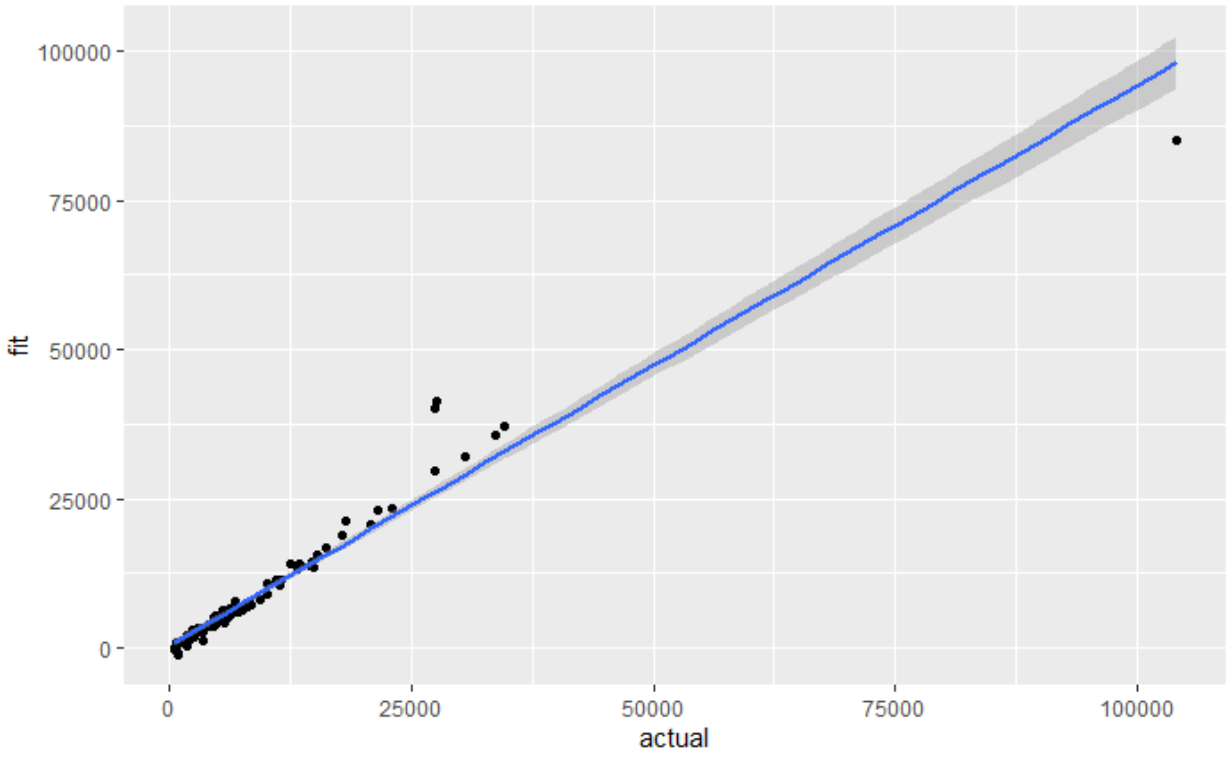

Figure 3. A scatterplot comparing the actual total enrollment vs. the predicted total enrollment using the linear regression model.

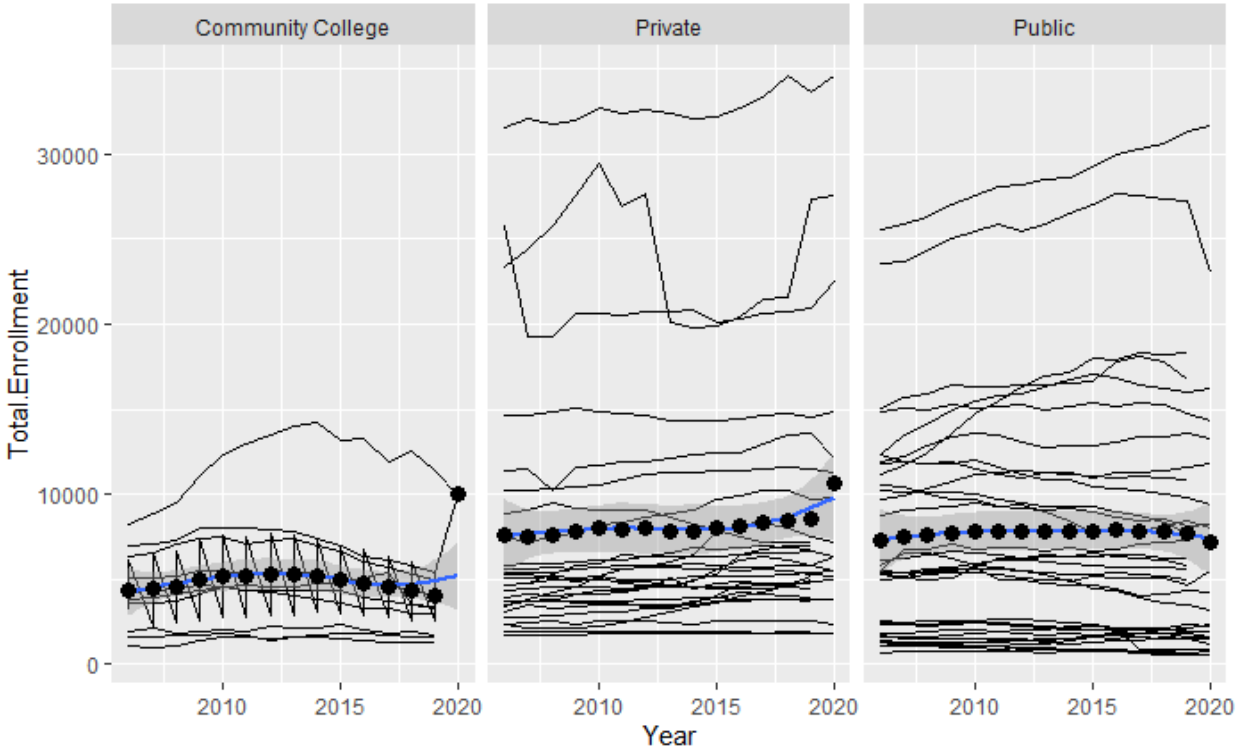

Figure 4. A line plot of the total enrollment for the fall of 2006 – 2020 without Southern New Hampshire University, sorted by university classification.

```
Call:
lm(formula = Total.Enrollment ~ . - ID - State - Year - Total.Full.Time.Degree.Certificate.Seeking.Undergraduates -
    Total.Full.Time.Undergraduates - Total.Full.Time.Graduates -
    Total.Part.Time - First.Time.Part.Time.Undergraduates - Transfer.In.Part.Time.Undergraduates -
    Continuing.Part.Time.Undergraduates - Non.Degree.Non.Certificate.Seeking.Part.Time.Undergraduates -
    Total.Part.Time.Degree.Certificate.Seeking.Undergraduates -
    Total.Part.Time.Undergraduates - Total.Part.Time.Graduates -
    Total.Undergraduates - Total.First.Time.Undergraduates -
    Total.Transfer.In.Undergraduates - Total.Continuing.Undergraduates -
    Total.Degree.Certificate.Seeking.Undergraduates - Total.Non.Degree.Non.Certificate.Seeking.Undergraduates -
    Total.Graduates, data = train)

Residuals:
     Min       1Q   Median       3Q      Max
-1874.99  -161.68   -17.49   137.95  2050.58

Coefficients: (2 not defined because of singularities)
                                                    Estimate Std. Error t value Pr(>|t|)
(Intercept)                                        1.558e+02  2.205e+02   0.706 0.480113
UniversityBentley University                      -4.586e+02  1.945e+02  -2.358 0.018624 *
UniversityBerklee College of Music                -9.578e+02  1.920e+02  -4.990 7.54e-07 ***
UniversityBoston College                          -1.711e+03  3.991e+02  -4.286 2.06e-05 ***
UniversityBoston University                       -1.505e+03  8.847e+02  -1.701 0.089435 .
UniversityBrandeis University                      2.738e+01  2.171e+02   0.126 0.899698
UniversityBridgewater State University            -1.626e+03  3.299e+02  -4.929 1.02e-06 ***
UniversityBryant University                       -6.280e+02  1.797e+02  -3.495 0.000502 ***
UniversityBunker Hill Community College            5.608e+03  2.518e+02  22.273  < 2e-16 ***
UniversityCape Cod Community College               1.911e+03  2.289e+02   8.348 3.36e-16 ***
UniversityChamplain College                        4.466e+02  1.799e+02   2.483 0.013252 *
UniversityConnecticut College                      1.535e+02  1.768e+02   0.869 0.385367
UniversityDartmouth College                       -6.253e+02  2.342e+02  -2.670 0.007744 **
UniversityEastern Connecticut State University    -1.054e+03  2.308e+02  -4.565 5.84e-06 ***
UniversityEmerson College                         -7.416e+02  1.941e+02  -3.820 0.000145 ***
UniversityEndicott College                         1.104e+03  1.902e+02   5.805 9.54e-09 ***
UniversityFairfield University                     3.178e+02  1.841e+02   1.726 0.084711 .
UniversityFitchburg State University               1.335e+03  2.310e+02   5.779 1.11e-08 ***
UniversityGranite State College                    3.846e+02  2.351e+02   1.636 0.102324
UniversityGreat Bay Community College              1.190e+03  2.100e+02   5.668 2.07e-08 ***
UniversityHarvard University                       1.793e+03  9.830e+02   1.824 0.068626 .
UniversityKeene State College                     -1.576e+03  2.286e+02  -6.895 1.15e-11 ***
UniversityManchester Community College             2.148e+03  2.040e+02  10.527  < 2e-16 ***
UniversityMassachusetts Bay Community College      2.172e+03  2.282e+02   9.518  < 2e-16 ***
UniversityMassachusetts College of Art and Design  1.127e+02  1.823e+02   0.618 0.536556
UniversityMassachusetts College of Liberal Arts   -1.249e+02  2.023e+02  -0.618 0.537084
UniversityMassachusetts Institute of Technology    4.329e+02  5.177e+02   0.836 0.403314
UniversityMassachusetts Maritime Academy          -1.991e+02  1.920e+02  -1.037 0.299957
UniversityMerrimack College                       -2.214e+02  1.783e+02  -1.242 0.214562
UniversityNew Hampshire Technical Institute        1.496e+03  2.233e+02   6.700 4.11e-11 ***
UniversityNorth Shore Community College            2.830e+03  2.390e+02  11.839  < 2e-16 ***
UniversityNortheastern University                 -2.642e+03  5.946e+02  -4.443 1.02e-05 ***
UniversityNorthern Essex Community College         3.188e+03  2.321e+02  13.734  < 2e-16 ***
UniversityNorthwestern Connecticut Community College  9.463e+02  2.201e+02   4.299 1.94e-05 ***
UniversityNorwich University                       6.873e+01  2.024e+02   0.340 0.734313
UniversityPlymouth State University               -2.891e+02  2.273e+02  -1.272 0.203774
UniversityProvidence College                      -2.310e+02  1.842e+02  -1.254 0.210103
UniversityQuincy College                           1.343e+03  2.446e+02   5.489 5.54e-08 ***
UniversityQuinnipiac University                   -6.184e+02  2.565e+02  -2.411 0.016156 *
```

```
UniversitySalem State University                          -1.122e+02  2.811e+02  -0.399 0.689933
UniversitySimmons University                               2.524e+03  1.943e+02  12.990  < 2e-16 ***
UniversitySouthern Connecticut State University           -6.049e+02  3.147e+02  -1.922 0.054951 .
UniversitySuffolk University                               2.913e+02  2.533e+02   1.150 0.250484
UniversityUniversity of Connecticut at Avery Point         3.743e+02  1.839e+02   2.035 0.042208 *
UniversityUniversity of Connecticut at Stamford            3.580e+02  1.832e+02   1.954 0.051071 .
UniversityUniversity of Connecticut at Storrs             -4.263e+03  6.899e+02  -6.178 1.07e-09 ***
UniversityUniversity of Connecticut at Waterbury           2.188e+02  1.869e+02   1.171 0.241907
UniversityUniversity of Maine at Augusta                   2.269e+03  2.102e+02  10.798  < 2e-16 ***
UniversityUniversity of Maine at Farmington               -4.604e+02  2.036e+02  -2.261 0.024023 *
UniversityUniversity of Maine at Fort Kent                 4.772e+02  2.151e+02   2.219 0.026807 *
UniversityUniversity of Maine at Machias                   4.855e+02  1.995e+02   2.434 0.015180 *
UniversityUniversity of Maine at Orono                    -1.029e+03  3.080e+02  -3.340 0.000881 ***
UniversityUniversity of Maine at Presque Isle              2.141e+02  2.100e+02   1.019 0.308411
UniversityUniversity of Massachusetts at Amherst          -4.370e+03  6.911e+02  -6.323 4.42e-10 ***
UniversityUniversity of Massachusetts at Boston            7.691e+02  3.640e+02   2.113 0.034952 *
UniversityUniversity of Massachusetts at Dartmouth        -1.093e+03  2.734e+02  -3.996 7.07e-05 ***
UniversityUniversity of Massachusetts at Lowell            1.261e+03  3.336e+02   3.779 0.000170 ***
UniversityUniversity of New England                        1.438e+03  2.762e+02   5.204 2.53e-07 ***
UniversityUniversity of New Hampshire at Durham           -3.858e+03  4.292e+02  -8.987  < 2e-16 ***
UniversityUniversity of New Hampshire at Manchester        3.161e+02  1.896e+02   1.667 0.095904 .
UniversityUniversity of New Haven                          1.251e+02  2.192e+02   0.571 0.568432
UniversityUniversity of Rhode Island                      -2.110e+03  4.321e+02  -4.883 1.28e-06 ***
UniversityUniversity of Southern Maine                     1.494e+03  2.583e+02   5.785 1.07e-08 ***
UniversityUniversity of Vermont                           -2.932e+03  3.475e+02  -8.437  < 2e-16 ***
UniversityWellesley College                               -2.513e+02  1.688e+02  -1.489 0.137023
UniversityWestern Connecticut State University            -7.378e+02  2.355e+02  -3.133 0.001798 **
UniversityWestern New England University                   3.118e+02  1.880e+02   1.658 0.097676 .
UniversityWestfield State University                      -1.168e+03  2.483e+02  -4.702 3.07e-06 ***
UniversityWorcester State University                      -6.844e+01  2.394e+02  -0.286 0.775092
UniversityYale University                                 -9.244e+00  5.246e+02  -0.018 0.985945
UniversityYork Community College                           7.587e+02  2.334e+02   3.250 0.001206 **
ClassificationPrivate                                             NA         NA      NA       NA
ClassificationPublic                                              NA         NA      NA       NA
Total.Full.Time                                            7.509e-01  7.581e-02   9.906  < 2e-16 ***
First.Time.Full.Time.Undergraduates                        4.805e-02  1.542e-01   0.312 0.755436
Transfer.In.Full.Time.Undergraduates                       1.621e+00  2.234e-01   7.256 1.00e-12 ***
Continuing.Full.Time.Undergraduates                        9.322e-01  9.348e-02   9.972  < 2e-16 ***
Non.Degree.Non.Certificate.Seeking.Full.Time.Undergraduates  4.555e+00  2.481e-01  18.357  < 2e-16 ***
Undergraduate.Tuition...Fees                              -2.188e-02  4.328e-03  -5.055 5.42e-07 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 401 on 745 degrees of freedom
Multiple R-squared:  0.9967,    Adjusted R-squared:  0.9964
F-statistic:  2951 on 76 and 745 DF,  p-value: < 2.2e-16
```

Figure 5. The output from the mlr function in R Studio, having removed Southern New Hampshire University

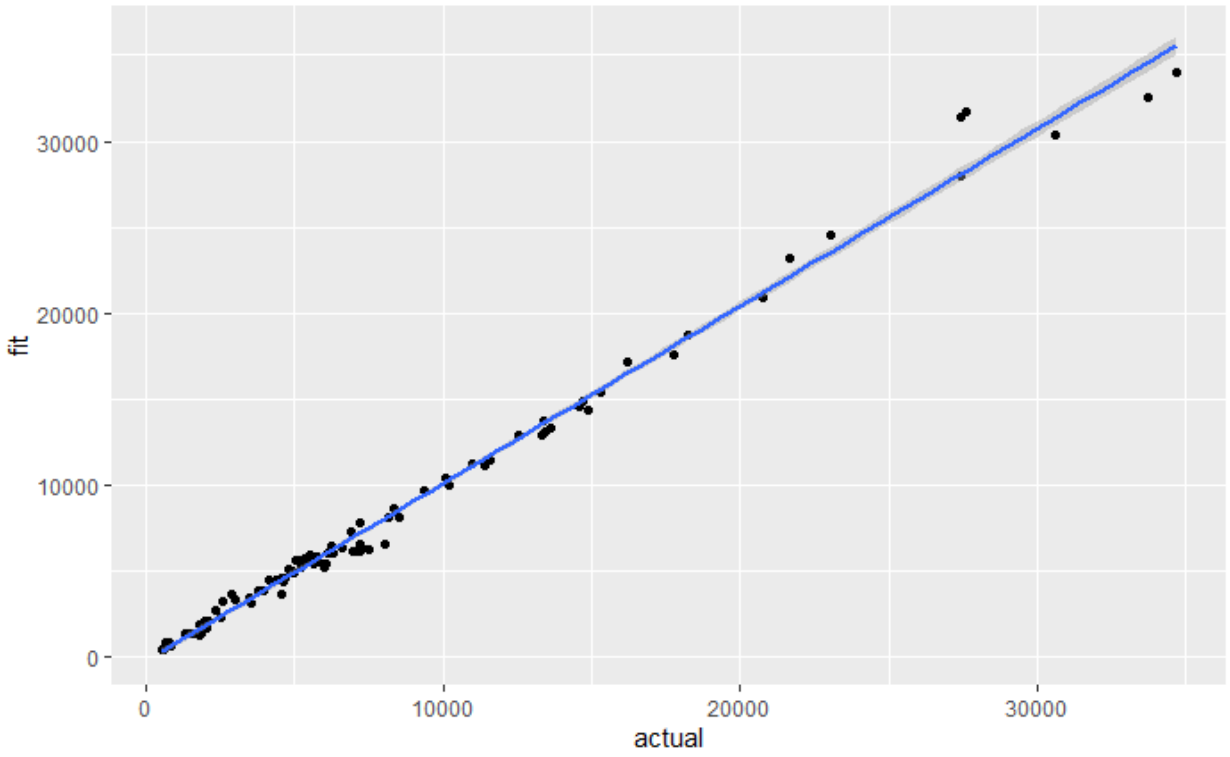

Figure 6. A scatterplot comparing the actual total enrollment vs. the predicted total enrollment using the linear regression model, having removed Southern New Hampshire University

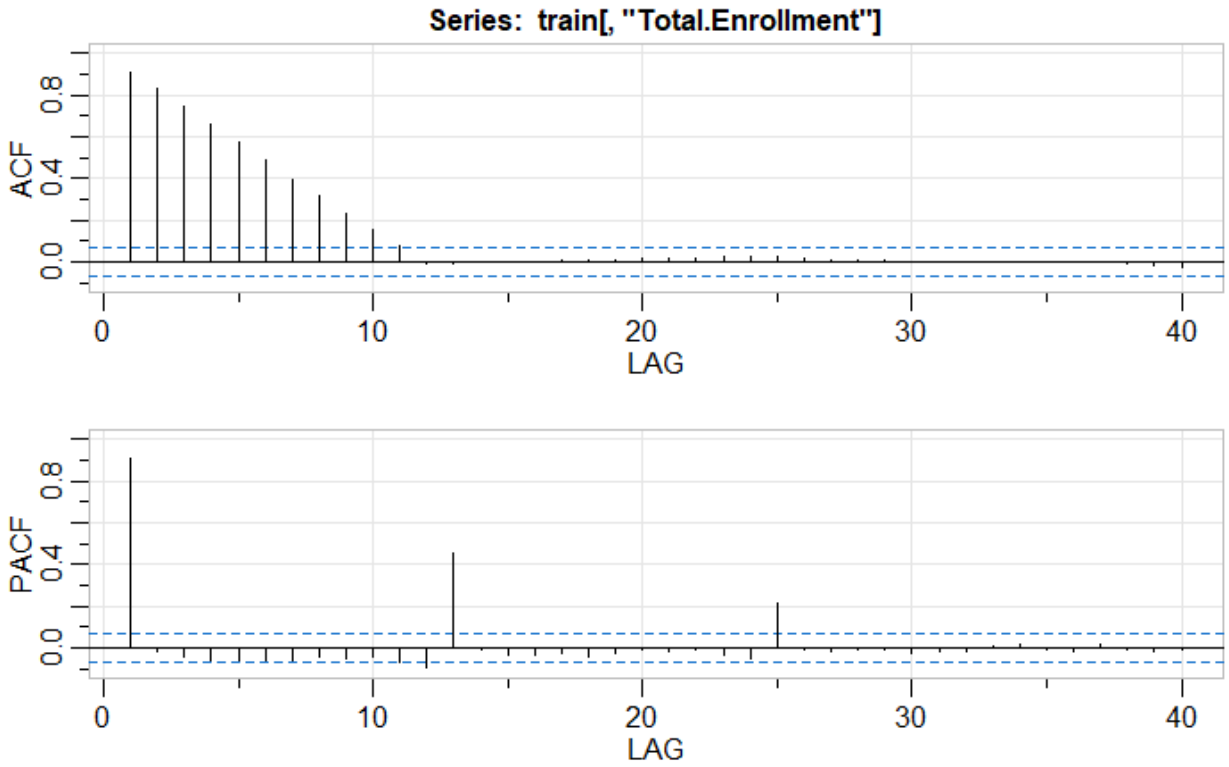

Figure 7. The ACF and PACF plot of the Total Enrollment variable in the training set.