

**KCTCS Student Success: An
Outcome Analysis of
KCTCS First-time
Freshmen Entering
Fall 2001**

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Executive Summary

Problem Statement

Since its creation in 1997, the Kentucky Community and Technical College System (KCTCS) has excelled in many areas of its open enrollment or open access mission. Yet, many KCTCS students do not persist to graduate with a credential or transfer to a 4-year postsecondary institution. The Kentucky Council on Postsecondary Education (CPE), reports that of the fall 2001 students who entered KCTCS colleges, only 50.2 percent earned a degree, transferred to a 4-year college or university, or were still enrolled in a KCTCS college within three years. CPE further reports that more than half of Kentucky's 2004 entering postsecondary freshmen were underprepared in at least one subject. The majority of these students enrolled in one of 16 colleges comprising KCTCS. When all KCTCS first-time, 2004 credential seeking freshmen are included (such as adult learners), 82 percent of students entering KCTCS colleges required developmental education at an estimated cost of more than \$15.6 million. It is estimated that Kentucky's General Fund costs for remediation instruction during the 2004-05 academic year totaled over \$13.2 million dollars.

Research Strategy

Using a multinomial logit analysis, the paper focuses on identifying statistically significant variables that affect the conditional probability of KCTCS students succeeding. The study sample includes 10,007 first-time KCTCS students entering fall 2001 and examines the affect that 13 predictor variables have on the odds of KCTCS students achieving one of four success outcomes relative to not achieving success. Defining success as credential attainment (earning an associate degree, certificate, or diploma) or transfer to a 4-year institution, the following questions guide the research:

- Does a student's ACT score increase the likelihood of success?
- Is a student's first semester GPA a significant predictor of student success?
- How likely are nontraditional students to succeed?
- Are students who are offered Pell Grants less likely to succeed than students who do not receive such aid?

Major Findings

The analysis suggests that age, race, GPA achieved during the student's first semester, and ACT test scores are statistically significant predictors influencing the odds of student success across the four success outcomes. Although statistically insignificant for the three KCTCS outcomes related to earning a credential, eligibility for Pell Grant aid is statistically significant for transfer success. The study found that being Pell Grant eligible decreased the odds of KCTCS students transferring to 4-year colleges and universities relative to not transferring.

Recommendations

It is recommended that KCTCS expand services for adult students and that more emphasis be placed on student success during the first semester of enrollment. It is further recommended that policymakers use the findings when considering program specific admission requirements, and the study the usefulness of the ACT test for evaluating remedial status of students pursuing occupational/technical credentials. A statewide, robust study of transfer to occur with special emphasis on developing strategies to ensure low income students' ability to finance the second half of a baccalaureate degree. To keep costs for transfer students as low as possible, universities should exam their course transfer criteria and be more accepting of KCTCS coursework.

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I. Problem Statement

My research will examine Kentucky's policy on open access to postsecondary education. The research will consider whether entry to public postsecondary education should be restructured through its system of comprehensive community and technical colleges, especially for those requiring remedial or developmental education.¹ Current research within the state fails to provide insight into the unique characteristics contributing to Kentucky students' progression and success through higher education. Defining success as attainment of an associate degree, certificate,² diploma,³ or transfer to a 4-year college or university, my research adds to existing knowledge by testing the following hypotheses:

- 1) Student ACT scores will be positively correlated with student success.
- 2) Low income students, as measured by their receipt of federal Pell Grants, will be less likely to succeed than students who are ineligible for Pell Grants.
- 3) Student GPA (based on a 4-point scale) earned during the first semester of enrollment will correlate with student success: higher GPA's will increase the likelihood of success.
- 4) Student age at initial entry to a KCTCS college will be negatively correlated with student success.

The following research questions will guide the hypotheses' testing:

- Does a student's ACT score increase the likelihood of success?
- Is a student's first semester GPA a significant predictor of student success?
- How likely are nontraditional students to succeed?
- Are students who are offered Pell Grants less likely to succeed than students who do not receive such aid?

¹ For the 2001 student cohort, Kentucky students were determined to be underprepared (in need of remediation) if they scored below 18 on any of the three ACT subtests of English, Math, and Reading or at an equivalent level on the SAT or a standardized on-campus placement exam (like the ACT COMPASS exam). However, effective December 7, 2007, the classification scores were increased. Now, students are classified as underprepared if they score below 18 on the English, 21 on the Reading, or 19 on the Math ACT subject exams or at an equivalent level on the SAT or a standardized on-campus placement exam.

² Certificate programs equip students with marketable skills and range from 12 to 36 credit hours. In general, certificates are applicable to the requirements of a diploma or associate degree in the same or a related field of study.

³ Diploma programs serve a dual purpose of preparing students for specific occupations in technical fields while earning credit toward an associate degree or continued training for certificate program graduates. Designed to be completed within a one- to two-year period, diploma programs are 36 to 68 credit hours and include both technical and general education courses.

At a time when human capital is needed to ensure individual, state, and national competitive advantages in a knowledge-based, global economy, Kentucky's educational levels are declining or remaining stagnant relative to the nation. Per capita personal income (PCPI) or per capita income (PCI) provides evidence of the decline and has a positive correlation with educational attainment. PCPI is a standard of living measure and serves as a quality of life indicator. The percentage of college graduates is the single factor with the greatest power to explain differences in per capita income between states. Since Kentucky ranks near the bottom in terms of educational attainment, it also ranks poorly in terms of per capita income and, therefore, standard of living. In 2004, Kentucky's state ranking in terms of per capita income was 41. (Bureau of Economic Analysis, March 2005) However, Kentucky's rank fell to 46 in just two years and, even though the state saw per capita income growth, it continues to lag behind the nation's average annual growth:

In 2006 Kentucky had a per capita personal income (PCPI) of \$29,719. This PCPI ranked 46th in the United States and was 81 percent of the national average, \$36,629. The 2006 PCPI reflected an increase of 4.8 percent from 2005. The 2005-2006 national change was 5.6 percent. In 1996 the PCPI of Kentucky was \$19,854 and ranked 42nd in the United States. The 1996-2006 average annual growth rate of PCPI was 4.1 percent. The average annual growth rate for the nation was 4.2 percent. (Bureau of Economic Analysis, 2007)

If the current educational trends continue, it will take Kentucky 154 years to reach the national average for per capita income. (SRI International, September 2006)

Contributing to the low number of college graduates is the low number of citizens over 25 who do not have high school diplomas or General Equivalency Diplomas (GED). In 2006, only 34.7 percent of Kentucky's population over 25 years old had a high school diploma or GED. Of that population, a mere 11.8 percent had a bachelor's degree compared to the national average of 17.1 percent. (CPE, 2007) The Kentucky Council on Postsecondary

Education or CPE (the state’s higher education coordinating entity) reports that more than half of Kentucky’s 2004 entering postsecondary freshmen were underprepared in at least one subject. Underprepared students’ first-year drop-out rate for the 2004 freshmen class cohort was twice that of their college-ready peers. Table 1 illustrates that while the statewide total percentage of entering students having remedial/developmental status declined slightly between 2002 and 2004, the percentage of adult and GED postsecondary entrants with such status grew from over 80 percent to nearly 90 percent.

Table 1: 2004 Traditional and Nontraditional Credential Seeking Students Entering Postsecondary Education and Percentage Underprepared

Age	2002 Enrollment		2004 Enrollment	
	Number Enrolled	Percent Underprepared in 2002	Number Enrolled	Percent Underprepared in 2004
17-24 (Traditional)	23,358	50.2%	23,529	49.1%
25+ (Nontraditional)	2,884	80.3%	2,178	89.8%
Statewide Total	26,242	53.5%	25,707	52.6%

Source: Kentucky Council on Postsecondary Education’s Developmental Education Update: The Preparation of Students Entering Kentucky’s Public Colleges and Universities in 2002 and 2004 (dated October 5, 2006). Students missing data are excluded from the table and total 403 in 2002 and 380 in 2004.

Because of legislative requirements that result in the Kentucky Community and Technical College System (KCTCS) being an open access postsecondary education institution, it inherently enrolls more underprepared students than the state’s other eight public institutions. For example, Table 2 shows that of the approximate 13,826 college freshmen who entered one of Kentucky’s public postsecondary institutions in 2004 requiring remediation, an estimated 7,553 or 54 percent enrolled in a KCTCS college. When all KCTCS first-time, 2004 credential seeking (associate degree, certificate, or diploma) freshmen are included (such as adult learners), more than 82 percent of students entering KCTCS colleges required developmental education.

Underprepared students' first-year drop-out rate for the 2004 cohort was twice that of their college-ready peers. Nearly 40 percent of the 2004 entering freshmen who held Kentucky Educational Excellence Scholarships (KEES) lost their scholarships because they failed to maintain the mandatory minimum 2.5 grade point average (based on a 4.0 scale). The crisis is exacerbated when research equating workforce readiness with college readiness is added into the quagmire of Kentucky's P-20 educational system.

Table 2: Underprepared Credential-Seeking Students: Incoming Classes of 2002 and 2004

Institution	2002 Credential-Seeking Freshmen			2004 Credential-Seeking Freshmen		
	Number Enrolled	Percent Unprepared	Number* Unprepared	Number Enrolled	Percent Unprepared	Number * Unprepared
KCTCS (two-year colleges)	10,545	76.0	8,014	9,144	82.6	7,553
Eastern Kentucky University	2,163	47.9	1,036	2,550	47.3	1,206
Kentucky State University	313	85.3	267	363	80.7	293
Morehead State University	1,418	61.0	865	1,318	62.2	820
Murray State University	1,434	38.8	556	1,366	31.6	432
Northern Kentucky University	1,907	59.1	1,127	2,032	54.4	1,105
University of Kentucky	3,671	14.5	532	3,952	10.8	427
University of Louisville	2,260	23.1	522	2,339	19.3	451
Western Kentucky University	2,935	47.6	1,397	3,023	50.5	1,527
Total Universities	16,101	39.2	6,312	16,943	37.0	6,269
Statewide Total	26,646	53.7	14,309	26,087	53.0	13,826

**Estimate based on percent unprepared. Totals may not add due to rounding.*

Note: In 2002 – 2004, students were categorized as underprepared if they scored 17 or less on one or more ACT subject exams in math, English, or reading, or at an equivalent level on the SAT or a standardized on-campus placement exam.

Source: Kentucky Council on Postsecondary Education's Developmental Education Update: The Preparation of Students Entering Kentucky's Public Colleges and Universities in 2002 and 2004 and dated October 5, 2006.

As Table 3 illustrates, KCTCS' costs associated with remedial instruction for the 2004-05 academic year were estimated in excess of \$15.6 million. Overall, approximately 45 percent of higher education's remediation costs were paid by the student, with the other 55 percent paid from state General Fund appropriations.

It is at this juncture where the policy dilemma becomes apparent. Some believe that higher education’s provision of remedial services is asking taxpayers to double pay for education that they believe should have been obtained in the secondary system. (Roach, 2000). “There has always been a tension between those who would provide access and those who fear it will lower standards. There have always been and always will be students who are very capable of succeeding but simply need additional assistance.” (Casazza, 1999) Such beliefs raise the question of whether underprepared students should be required to enroll in a KCTCS college before pursuing education at 4-year university.

**Table 3: Estimated Remedial Instructional Costs by Institution 2004-05
Academic Year (Summer 2004, Fall 2004, and Spring 2005)**

Institution	Estimated Remedial Instructional Costs	Estimated % Paid by Students	Estimated Cost Paid by Student Revenue	Estimated Cost from General Fund
KCTCS	\$15,639,096	40%	\$ 6,286,916	\$ 9,352,180
Eastern KY University	1,505,263	50	758,652	746,611
Kentucky State University	549,655	41	223,160	326,495
Morehead State University	1,164,979	48	560,355	604,624
Murray State University	600,399	54	322,414	277,985
Northern KY University	1,726,859	64	1,108,643	618,216
University of Kentucky	184,996	46	84,728	100,268
University of Louisville	678,927	47	317,738	361,189
Western KY University	1,996,356	56	1,111,970	884,386
Total	\$24,046,530	45%	\$10,774,576	\$13,271,954

Source: Council on Postsecondary Education January 23, 2006, Memorandum from former CPE Vice President Sandra K. Woodley to Mr. Jonathan Lowe of the Legislative Research Commission regarding Remedial Costs.

Several states or higher education systems, including California, Colorado, Georgia, South Carolina, and City Colleges of New York (CUNY), have already determined that their community colleges will be responsible for ensuring that students pursuing a bachelor degree have the skills needed to succeed in that endeavor. (Roach, 2000; Hebel, 1999; Wright, 1999) Other states or higher education systems have, or are considering, requiring

local school districts to reimburse colleges and universities for the cost of remediating their respective high school graduates who receive remediation services. (Wright, 1999) Some argue that eliminating remedial programs “place exaggerated hope on only one solution, which may be no solution at all.” (Glazer, 1999) Kentucky faces similar decisions as we move forward in educating and equipping our citizens to compete in the global marketplace. Some Kentucky policymakers already are of the opinion that the community and technical colleges should provide remedial instruction for those who need it, as the following quote from a 2007 legislative committee meeting indicates:

A university is not the place to deal with remedial education... 50 percent of incoming freshman are in need of developmental education upon entering college, and they should not be there. ...They should be at a community college to get the appropriate instruction needed for success upon enrolling at a university. (LRC, 2007)

II. Background and Relevant Facts

As believers that positive externalities are associated with public higher education, the Kentucky legislators and former Governor Paul E. Patton approved the *Kentucky Postsecondary Education Improvement Act of 1997*, also known as “House Bill 1” or the “Act.” Raising Kentuckians’ standard of living and quality of life to at least the national average by 2020 were two goals of the legislation. Achievement of those goals ensures that Kentucky’s citizens are able to compete nationally and globally. The legislature charged the state’s higher education coordinating board, the Kentucky Council on Postsecondary Education (CPE), with developing the plan for achieving the goals. The Council’s plan, “Double the Numbers,” focuses on producing more Kentucky graduates with bachelor’s degrees.

Another of the Act's overarching goals was to create a seamless system of K-16 education, which can be broken into two parts:

- 1) Seamless transitions from secondary to postsecondary institutions (KRS 164:0203 (7)).
- 2) Seamless transitions from community and technical colleges to 4-year institutions (KRS 164:203 (2)(e)).

The seamless goal was partially accomplished through the creation of KCTCS as Kentucky's ninth institution of public postsecondary education. As a result, 13 of the state's community colleges⁴ formerly under the University of Kentucky, and the state's 15 postsecondary technical institutions⁵ formerly under Workforce Development Cabinet's Kentucky Tech Branch, were moved as separate branches under KCTCS. Achieving its statutory mission to "create a comprehensive system of community and technical colleges," KCTCS is now a System of 16 comprehensive community and technical colleges with 67 campuses statewide and numerous virtual learning offerings. Among the many KCTCS-specific mandates found in the Act, Kentucky Revised Statute 164.580 mandates the mission of KCTCS, indicating that KCTCS is to:

"...be responsive to the needs of students and employers in all regions of the Commonwealth with accessible education and training to support the lifelong learning needs of Kentucky citizens in order to..."

- Increase access to higher education and workforce training.
- Increase transfer of community college students to 4-year universities.
- Provide adult basic and remedial education to improve the academic and literacy skills of Kentucky's citizens.

⁴Thirteen of the 14 University of Kentucky Community College System institutions were transferred to KCTCS on January 14, 1998. The remaining college, Lexington Community College, was transferred from the University of Kentucky to KCTCS by House Joint Resolution 214 (HJR 214) signed by Governor Ernie Fletcher in April 2004. In 2005, the General Assembly enacted House Bill 239, which codified HJR 214 into statute.

⁵ The 15 postsecondary technical institutions transferred to KCTCS on July 1, 1998.

To address the issue of underprepared students, the 2006 Kentucky General Assembly enacted *Senate Bill 130*, requiring all high school juniors to be administered the ACT test or the ACT WorkKeys. The goal of the legislation was to identify areas where remedial assistance may be needed and provided before students leave high school. Why use the ACT test as a predictor of success? According to ACT, Inc., individuals who score at least 18 in English and 22 in math have a 75-80 percent chance of earning a “C” or better in these classes during their freshmen year of college. Those who score 21 on the reading subtest have more than a 75 percent chance of earning a “C” or better in social science classes. Individuals achieving these ACT “benchmark” scores (Allen & Sconing, 2005) are highly likely to return for their second year of college.

Kentucky Administrative Regulations (13 KAR 2:020 (3)) require students applying to baccalaureate degree programs to meet minimum scores on the ACT (or similar college entrance test) as well as complete a pre-college curriculum in high school. On the other hand, Section 2 of the regulation mandates that students applying to KCTCS:

...shall have fulfilled the minimum requirements for admission to a degree program established by the Kentucky Community and Technical College System consistent with this administrative regulation if the applicant has: 1. Graduated from a public high school or a certified nonpublic high school; or 2. Earned a high school general equivalency certificate (GED)....(b) The Kentucky Community and Technical College System may choose to exempt students who are eligible to pursue a GED from the requirements of paragraph (a) of this subsection if the KCTCS publishes the exemption policy in the student catalog.

Recent research related to Kentucky students being unprepared for college is not based on sound social science techniques that include robust statistical analysis of Kentucky’s postsecondary students’ unique characteristics. For example, the CPE-appointed a *Kentucky Developmental Education Task Force* to study the underprepared student issues facing the

state and to develop recommendations for resolving those issues. The task force worked with state and national leaders and reviewed current efforts and research on best practices related to remedial education instead of engaging in a robust, statistical study of the problem. At a legislative committee meeting, CPE officials testified that the task force did not "...examine the relationship between poverty, economics, and educational outcomes." (LRC, 2007)

In order for policy to be effective, efficient, just, and of value to society, policymakers must know "who" the policy's target audience is and the characteristics or variables influencing the target audience's education decisions. Policymakers must know "how likely" Kentucky's postsecondary students are to be retained or transfer to a 4-year institution. A comprehensive study based on more than best practices borrowed from other states, advice from state and national remedial/developmental education leaders, and basic statistical averages and percentages is needed to answer the policymakers' questions related to the relationship between students' poverty, economics, and educational outcomes. Failure to do so does not promote good stewardship of tax dollars, social justice, or quality.

III. Research Design and Literature Review

A. Hypotheses and Research Questions

Since its creation in 1997, KCTCS has excelled in many areas of its open enrollment or open access mission, but improvement is needed related to student retention, graduation, and transfer rates. Many KCTCS students do not persist to graduate with a credential or transfer to a 4-year postsecondary institution. CPE reports that of the 12,857 Kentucky residents who entered a KCTCS college in fall 2001 seeking associate degrees,

certificates, or diplomas:

- Only .3 percent transferred within three years to a 4-year college or university in Kentucky with a degree, while 12.1 percent transferred within three years without a degree.
- Only 18.2 percent of the students graduated within three years of entering a KCTCS college.
- Only 19.6 percent were still enrolled three years after their initial enrollment in fall 2001.

These percentages combine for a persistence rate of only 50.2 percent for the fall 2001 entering class who were Kentucky residents.⁶

One hypothesis for the low persistence rate of KCTCS students relates to the number of students who enroll in KCTCS colleges who have remedial/developmental status based on ACT scores. It is believed that ACT scores will be positively correlated with student success. As ACT scores increase so will the likelihood of student success. Another hypothesis is that Pell Grant financial aid will be negatively correlated with student success, that is, low income students, as measured by their being offered federal Pell Grants, will be less likely to succeed than students who are ineligible for Pell Grants. Students who are offered federal Pell Grants are believed to succeed (transfer to a 4-year institution or earn an associate degree, certificate, or diploma) at lower rates than those who are not offered aid. The rationale for the hypothesis is that students, especially nontraditional students who are offered Pell Grants, are more likely to work outside of college and accumulate fewer credit hours per term. Because of the slow pace at which the college credit is earned, it is believed that students lose motivation to persist and choose to stop working toward their educational goal.

⁶ The CPE 2001 cohort differs from the KCTCS cohort of the study presented in this paper. The CPE analysis considers all entering degree seeking freshmen who are Kentucky residents. The KCTCS cohort of interest in this paper is comprised of first-time freshmen, including both degree- and nondegree-seeking students as well as out-of-state students. The KCTCS cohort also excludes 1,400 students who were minors or whose age was unknown, prisoners, or possibly not first time students.

Two additional hypotheses relate to student GPA (based on a 4-point scale) and age at initial enrollment in a KCTCS college. It is hypothesized that student GPA earned during the first semester of enrollment will correlate with student success, that is, higher GPA's will increase the likelihood of success. The logic behind the hypothesis is that students who earn higher GPA's are more prepared with the knowledge and skills needed to succeed in higher education. In contrast, student age at initial entry to a KCTCS college is hypothesized to be negatively correlated with student success. As age increases, the likelihood of success decreases. The rationale is that older students' responsibilities with work and family are thought to hinder their successful completion of earning a credential or continuing their education at a 4-year college or university.

Therefore, the goal of this research is to analyze the likelihood of success for the fall 2001 first-time students entering KCTCS colleges to identify statistically significant characteristics that predict the likelihood that a typical KCTCS student succeeds to graduate with an associate degree, diploma, or certificate or transfers to a 4-year college or university. The study findings can be used by KCTCS leadership to develop policies or intervention strategies to enhance student success. In addition, results also can be used to identify those students who are most likely to benefit from remedial or developmental education. State-level policymakers may find the results useful in designing accountability measures that better reflect the comprehensive mission of KCTCS. Based upon the results of the study, policymakers will be more informed to address the remedial education issue and whether it would be good policy to assign postsecondary remedial/developmental education solely to Kentucky's community and technical college system.

The research will be guided by the following questions:

- Does a student's ACT score increase the likelihood of success?
- Is a student's first semester GPA a significant predictor of student success?
- How likely are nontraditional students to succeed?
- Are students who are offered Pell Grants less likely to succeed than students who do not receive such aid?

B. Research, Units of Analysis, and Dataset

While some literature suggests that a five-year observation period is appropriate for a longitudinal study of student academic behavior (Leinbach & Jenkins, 2008), many two-year college students take up to six years to complete their programs. Since the focus of the study is to identify which KCTCS students are likely to succeed, it was determined that it would be advantageous to use the student cohort that coincides with the most recent six-years of performance. The dataset that will be used is the first-time students who entered KCTCS colleges in fall 2001.⁷ Using the 2001 cohort allows us to track students across six consecutive years or 18 trimesters. (One year consists of three trimesters. A trimester is equivalent to a fall, spring, or summer term.) With the basic unit of analysis being the individual student, the study will use multinomial logits to identify correlations and the likelihood that various independent categorical variables contribute to student success (earning a credential or transferring to another college or university). The goal of the study is not to predict precise probabilities or odds of success, but to identify statistically significant variables that influence student success.

In order to ensure data integrity, accuracy, and inclusion of key variables, staff in the KCTCS Office of Research and Policy Analysis created a multivariate or person-level record for each student in the cohort sample. The dataset was built by hand matching student information collected from CPE, the National Student Clearinghouse, and the

⁷ The dataset excludes 1,400 students who were identified as not being first-time entering freshmen, minors, or prisoners.

KCTCS Student Administrative Module of PeopleSoft for each of the 10,007 first-time students entering a KCTCS college in fall 2001. In summary, the cohort's average age was 24.84 years. There were 5,390 females, 4,581 males, and 36 students whose gender was not identified. In-state residents comprised 9,436 of the cohort's students, and the cohort's remaining 571 students were out-of-state residents. Students having high school diplomas totaled 8,105. The number of students with GEDs was 1,603; and 299 students' high school credentials were unknown.⁸ Variables included in the dataset include:

- Birth Year
- Age at Enrollment
- Gender
- Race/Ethnicity
- County
- High School
- High School Diploma Recipients
- GED Recipients
- Terms Enrolled
- Semester Hours Enrolled by Term
- KCTCS Program Area (Major declared at initial enrollment and by term)
- Pell Grant Offer by Term and Amount
- Financial Aid by Term and Amount (other federal aid like student loans and state aid, including merit-based scholarships like KEES)
- ACT Highest Test Score
- COMPASS Test Scores by Subject – Math, English, and Reading (upon entering college and best score obtained)
- GPA (by term and cumulative)
- KCTCS Credentials Obtained by Term
- Transfer Status

C. Research Structure and Literature Review

The research presented in this paper fits nicely with current efforts to identify factors associated with postsecondary student behavior, specifically longitudinal studies of two-year college students. A review of the literature reveals a void related to the survival (success) of community college students. In addition, evidence of analysis focusing on Kentucky's two-year college students is missing from peer reviewed literature. Ehrenberg and Smith indicate that community colleges are more complex than 4-year universities,

⁸ For this study, students with unknown high school credentials were classified as having a high school diploma.

including research universities. They state:

Two-year colleges are as complex, or more complex, than their research university counterparts. Their missions include adult education, providing contract courses for companies and different levels of government, training students for careers, and preparing students for transfer to 4-year institutions. (Ehrenberg & Smith, 2004, p. 12)

With the increasing important roles two-year colleges are playing and the colleges' complexity, Ehrenberg and Smith suggest that researchers and policymakers give more attention to the study of two-year colleges. (Ehrenberg & Smith, 2004) One research option is to examine community college success using survival or hazard models.

While survival or hazard models are most often used in the medical and biological fields, they also have proven useful in the social sciences, including economics and education. Zwick used survival and regression analysis to examine the tendency to predict the effect of college freshmen's grade point average and college graduation. The analysis results indicate that high school GPA is statistically significant in predicting college graduation for the White/English group in the study, but SAT scores significantly predict graduation in the study's Hispanic/English and White/English groups. (Zwick & Sklar, 2005)

In a survival study examining behavior of 4-year university students, DesJardins indicates research effectively describes student attrition but is ineffective at describing the process by which they depart. (DesJardins & Moye, 2000) Echoing the DesJardins observation is a study conducted by Calcagno and associates that examined nontraditional student behavior in Florida. Results of the Florida study indicate that Floridian community college students were more likely to complete their programs if developmental education is controlled in the analysis. (Calcagno, Crosta, Bailey, & Jenkins, 2007) Lesik found similar results when studying placement scores and participation in developmental math. (Lesik, 2007) Both the Calcagno (et.al.) study and the DesJardins study leave questions related to

the level of required remediation and the role that developmental English and reading play in student completion or attrition of two-year college students, as well as the effect of requiring developmental coursework in more than one subject.

Ehrenberg and Smith further indicate that linear probability regression models do not consider the unique characteristics of time studies analyzing postsecondary education completions. For example, linear regression equations do not account for the characteristic that each success probability varies between 0 and 1. They further indicate that linear regression models do not account for the inherent ordering of probabilities; for example, transferring to a 4-year postsecondary education institution is better than dropping out of college. Ehrenberg and Smith note that “using a multinomial logit model takes the first into account, while using either an ordered probit or logit model takes the second into account.” (Ehrenberg & Smith, 2004) Evidence of the model’s use to answer questions about Kentucky postsecondary student academic success or completion patterns was not found in the literature. Therefore, an analysis using multinomial logits would add to the body of knowledge related to Kentucky postsecondary education student success.

Multinomial logits are used to calculate the odds of success or failure relative to a base case. The analytical tool also aids researchers in describing relationships between predictor (independent) variables and dependent variables as well as making inferences about those relationships. For purposes of this paper, the tool is used to identify statistically significant independent variables that likely increase or decrease the odds of students achieving success (earning a credential or transferring to a 4-year college or university) relative to failure (not earning a credential or transferring to a 4-year college or university). The study will examine the conditional probability that a student will graduate or transfer to a 4-year college or university relative to not graduating or

transferring. As a reminder, the purpose is not to calculate the actual probabilities and odds of success, but rather to analyze the statistical significance of key variables that can be used to inform policymaker decisions.

Defining success as credential (associate degree, certificate, or diploma) attainment or transfer to a 4-year college or university, the research will add to existing knowledge by testing the following hypotheses:

- Student ACT scores will be positively correlated with student success. As ACT scores increase, so will the likelihood of the student succeeding.
- Low income students, as measured by being offered federal Pell Grants, will be less likely to succeed than students who are ineligible for Pell Grants.
- Student GPA (based on a 4-point scale) earned during the first semester of enrollment will correlate with student success: higher GPAs will increase the likelihood of success.
- Student age at initial entry to a KCTCS college will be negatively correlated with student success. The older the student is when entering college, the less likely the student will be to succeed.

IV. Analysis, Findings, and Limitations

A. Analysis

To begin, a listing of “typical” KCTCS student characteristics and the independent variables included in the analysis are presented in Table 4. In general, the typical student in the dataset was a white, NonHispanic female aged 24.8 years old with a Kentucky high school diploma. If she took the ACT, her composite score would be slightly higher than 18.5⁹. During her first semester, she likely was not offered a Pell Grant, but she was a financial aid recipient. If she did receive Pell Grant aid, it averaged approximately \$571, and her overall financial aid was about \$900. In her first semester (fall 2001), she enrolled for a little more than 11 hours in the Liberal Arts and Sciences

⁹ The average ACT score was calculated using only the number of students taking the ACT in the denominator (n=3,945). When the average ACT score is calculated including all students (N=10,007), even those who did not take the ACT, the average ACT is slightly higher than 7.

program, which is also known as the “transfer” degree. At the end of her first semester, she had a 2.27 GPA (based on a 4.0 scale). How likely is this typical student to:

- 1) Earn a certificate?
- 2) Earn a diploma?
- 3) Earn an associate degree?
- 4) Transfer to a -year college or university?

Those four “success outcomes” are the dependent variables for the multinomial logit model used in this analysis to identify independent variables that likely increase the odds of students success relative to failure (the base case in the analysis). In Table 4, the success outcomes are labeled “Degree_Revised” and are represented by $s, s=1, 2, \dots, S$. Predictor variables (independent variables) that will be used in the multinomial logistic regression are also listed in the table. For the purposes of this study, success was achieved in one of the four ways previously discussed. Borrowing from Toma’s and Houston’s work in 1999, the logit specification was used and effects estimated by separating success into four, two-outcome scenarios. (Houston and Toma, 1999) The outcomes are:

- 1) Earn a certificate or don’t earn a certificate.
- 2) Earn a diploma or don’t earn a diploma.
- 3) Earn an associate degree or don’t earn an associate degree.
- 4) Transfer to a 4-year college or university or don’t transfer to a 4-year college or university.

The probability that random student K will have success “ s ” is represented by

$$P(s) = \text{Prob} [V_{ks} + \varepsilon_{ks} > V_{sf} + \varepsilon_{sf}]$$

for all $f \neq s$ where V is a linear function of the independent explanatory variables described in Table 4, and ε is a standard error term used to capture unobserved

Table 4: Independent Variables and Descriptive Statistics

Variable Name	Variable Description	Count & (%)	Mean	Standard Deviation	Min Value	Max Value
Age_at_Entry	Age upon entering a KCTCS college in fall 2001		24.84	9.441	18	84
Female	Gender variable, with Female = 1.				0	1
	Male	4,581 (45.78%)				
	Female	5,390 (53.86%)				
	Unknown	36 (0.36%)				
Race_Black_NonHispanic ¹⁰	Race variable, with Members = 1.				0	1
	Black, NonHispanic	718 (7.17%)				
Race_Minority_Unknown ⁸	Race variable, with members = 1.				0	1
	American Indian, Alaskan Native	28 (0.28%)				
	Asian, Pacific Islander	57 (0.57%)				
	Hispanic	100 (1.00%)				
	Unknown	667 (6.67%)				
	Category Total	852 (8.51%)				
Kentucky_Resident	Kentucky state residency status, Residents = 1.				0	1
	In-State Resident	9,436 (94.29%)				
	Reciprocity Student ¹¹	302 (3.02%)				
	Out_of_State NonReciprocity	269 (2.69%)				
GED	High school credential or GED, with GED = 1.				0	1
	Unknown	299 (2.99%)				
	GED	1,603 (16.02%)				
	Diploma NonState HS	1,191 (11.90%)				
	In-State HS	6,914 (69.09%)				

¹⁰ The race category of “White, NonHispanic” is not measured using a unique variable. The group totals 8,437 and represents 84.31 percent of the cohort population.

¹¹ Out-of-state student who pays in-state tuition.

Variable Name	Variable Description	Count & (%)	Mean	Standard Deviation	Min Value	Max Value
ACT_Missing	Identifies the overall significance of the ACT test as a predictor of KCTCS student success. ACT missing =1.				0	1
	Students with ACT Scores	3,945 (39.42%)				
	Students without ACT Scores	6,062 (60.58%)				
ACT_High_Score	Highest composite score achieved on the ACT .					
	Total Cohort	10,007	7.304	9.325	0	33
	Those with ACT scores	3,945 (39.42%)	18.53	3.549	0	33
GPA_Missing	Identifies the significance of not earning a GPA during the initial enrollment trimester. It is the absence of a GPA for fall 2001. Missing GPA = 1.				0	1
	Students with GPA	7,519 (75.14%)				
	Students without GPA	2,488 (24.86%)				
GPA_Term_F01	Grade Point Average (based on a 4.0 scale) achieved at the end of the fall 2001 semester.		2.271	1.525	0	4.0
Pell_Student	Identifies the significance of Pell Grants as a predictor of income on KCTCS student success. Members were offered Pell Grant aid in fall 2001. Pell_Student=1.				0	1
	Number Offered Pell Grant Aid	4,073 (40.70%)				
	Number Not Offered Pell Aid	5,934 (59.30%)				
Pell_Amt_Inf	Influence the amount of Pell Grant aid offered has on student success. Pell_Amt_Inf= (Pell_Student) * (Pell_Offer_Amt_F01)		\$571	\$772	\$0	\$1,875
Fin_Student	Identifies significance of the presence of overall financial aid related to success and includes aid from all federal and state sources, like merit based scholarships like KEES. Fin_Student=1.				0	1
	Number Not Receiving Financial Aid	3,661 (36.58%)				
	Number Receiving Financial Aid	6,346 (63.42%)				
Fin_Amt_Inf	Influence the amount of overall Financial Aid from state and federal sources has on student success. Fin_Amt_inf = (Fin_Student) * (Fin_Aid_Amt_F01)		\$898	\$1,026	\$0	\$5,210

attributes contributing to student success. If it is assumed that ϵ_{sf} are independently and identically distributed, the conditional probability that a student obtains success s is

$$P_s = e^{V_j} / (e^{V_1} + e^{V_2} + e^{V_3} + e^{V_4})$$

And the relative odds of the success outcomes satisfies $\log P_s / P_f = V_f - V_s$ for all $f \neq s$.

The dependent variables become the log of the odds ratio of achieving success or failing to achieve success for each of the four paired outcomes. As a reminder, the actual odds or risk of failure and success are not included in the analysis findings presented in this paper. Results of the analysis follow.

B. Findings

Overall, the model proved to be statistically significant at the 99 percent confidence level, yielding a $P(\chi^2) = 0.0000$ and Likelihood Ratio χ^2 with 56 degrees of freedom of 3195.95.¹² Five predictor variables were statistically significant at the 95 percent confidence level ($P < 0.05$) across the four success outcomes and include Age at Entry; Race Black, NonHispanic; ACT High Score; GPA Fall 2001 Term (GPA at the end of the first semester); and Financial Aid Recipient (whether the student received financial aid). Three other predictors were statistically significant across three success outcomes: Kentucky Resident, ACT Missing (the presence of an ACT score), and Pell Offer Amount Fall 2001. A general summary of the predictor variables is presented in Table 5.

¹²Goodness of fit for multinomial logit models is not measured using R^2 .

Table 5: Summary of Predictor Variable Statistical Significance* by Success Outcome

Predictor Variables	Associate	Transfer	Certificate	Diploma	Total Significant*
Age at Entry	✓ +	✓ ↓	✓ +	✓ +	4
Female	X	X	✓ ↓	X	1
Race, Black, NonHispanic	✓ ↓	✓ +	✓ +	✓ ↓	4
Race, Other Minorities ¹³	X	X	X	✓ ↓	1
Kentucky Resident	X	✓ ↓	✓ ↓	✓ ↓	3
GED	✓ ↓	✓ ↓	X	X	2
ACT Missing	X	✓ +	✓ ↓	✓ ↓	3
ACT High Score	✓ +	✓ +	✓ ↓	✓ ↓	4
GPA Missing Fall 2001	X	✓ +	X	X	1
GPA Fall 2001 Term	✓ +	✓ +	✓ +	✓ +	4
Pell Grant Offered	X	✓ ↓	X	X	1
Pell Offer Amount Fall 2001	✓ ↓	✓ ↓	✓**	X	3
Financial Aid Recipient	✓ +	✓ +	✓ +	✓ +	4
Financial Aid Amount Fall 2001	✓**	✓*	X	X	2

*p<.05 ✓ Statistically Significant X Statistically Insignificant + Increases Success Odds ↓ Decreases Success Odds

** Statistically significant, but the logit coefficient is not different than zero.

As indicated in Table 6, 3,781 students (37.78 percent) of the 10,007 students comprising the 2001 KCTCS first-time freshmen cohort in the analysis obtained one of the four success outcomes. A discussion of the analysis findings for each success outcome follows.

¹³ “Other Minorities” include the race/ethnic categories of American Indian/Alaskan Native, Asian Pacific Islander, Hispanic, and Race/Ethnicity Unknown (n = 852).

Table 6: 2001 KCTCS First-Time Freshmen Achievement by Success Outcome

Outcomes	No Success	Associate Degree	Certificate	Diploma	Transfer to 4-Yr		Total Cohort	% of Cohort
					Transfer Total	% of Transfer		
Associate Degree	-	907	-	-	447	26.50	1,354	13.53
Certificate	-	-	686	-	54	3.20	740	7.39
Diploma	-	-	-	501	30	1.78	531	5.31
Transfer	-	-	-	-	1,156	68.52	1,156	11.55
<i>Subtotal Success Outcomes</i>	-	907	686	501	1,687	16.86	3,781	37.78
No Success	6,226	-	-	-	-	-	6,226	62.22
Total Cohort	6,226	907	686	501	1,687	100.00	10,007	100.00
Percent of Cohort	62.22	9.06	6.86	5.01	16.86			100.00

Associate Degree Success

For the fall 2001 entering KCTCS students included in the analysis, 1,354 or 14 percent earned an associate degree. Of those earning an associate degree, 447 (or 4 percent) transferred to a 4-year college or university during the six years included in the analysis. For the remaining 907 associate degree students, eight variables proved to be statistically significant at the 99 percent confidence level and likely useful for predicting student odds of successfully earning an associate degree relative to not earning a degree. However, six variables had P-values higher than 0.05 and were determined statistically insignificant predictors for the associate degree success outcome, including: Female; Race, Other Minorities; Kentucky Resident; ACT Missing (whether a person took the ACT); GPA Missing Fall 2001 (not earning a GPA during the first semester of enrollment); and Pell Grant Offered (being Pell Grant Eligible, that is, being offered a Pell Grant). Table 7 provides detailed regression results.¹⁴

¹⁴ The results of the multinomial logit regression as generated in Stata are provided in the Appendix. The results for each outcome accompany the narrative as separate tables and for the reader's convenience.

Table 7: Multinomial Logit Results for Associate Degree Success

Independent Variable	Coefficient	Standard Error	z	P> z	95% Confidence Interval	
Age at Entry	0.024	0.005	4.70	0.000***	0.014	0.034
Female	0.128	0.079	1.62	0.105	-0.027	0.284
Race, Black, NonHispanic	-0.628	0.235	-2.67	0.008***	-1.090	-0.167
Race, Other Minorities ^A	-0.297	0.166	-1.79	0.074*	-0.623	0.029
Kentucky Resident	-0.217	0.211	-1.03	0.305	-0.631	0.197
GED	-0.520	0.141	-3.68	0.000***	-0.797	-0.243
ACT Missing	-0.128	0.300	-0.43	0.669	-0.717	0.460
ACT High Score	0.045	0.015	2.99	0.003***	0.016	0.075
GPA Missing Fall 2001	0.378	0.268	1.41	0.158	-0.147	0.904
GPA Fall 2001 Term	0.847	0.058	14.50	0.000***	0.732	0.961
Pell Grant Offered	-0.184	0.174	-1.06	0.288	-0.525	0.156
Pell Offer Amount Fall 2001	-0.001	0.000	-3.99	0.000***	-0.001	0.000
Financial Aid Recipient	0.775	0.135	5.72	0.000***	0.510	1.041
Financial Aid Amount Fall 2001	0.000	0.000	5.97	0.000***	0.000	0.001
cons	-5.577	0.408	-13.68	0.000***	-6.376	-4.778

*** p<.01, **p<.05, *p<.1

^A“Other Minorities” include the race/ethnic categories of American Indian/Alaskan Native, Asian Pacific Islander, Hispanic, and Race/Ethnicity Unknown (n = 852).

Based on the multinomial logit model used, the odds of completing an associate degree increase as the student ages. Race proved to be a statistically significant predictor of likely success for Black NonHispanic students; however, race was a statistically insignificant predictor of other minorities’ successful attainment of associate degrees relative to not attaining associate degrees. As expected, whether the student had a high school diploma or a GED also was statistically significant; the odds of students who have GEDs earning an associate degree are lower than those who have high school diplomas. In addition, the odds of a student obtaining an associate degree increase with higher ACT scores. However, the presence of an ACT score was statistically insignificant, curtailing the test’s usefulness in predicting success. The significance of the ACT at informing KCTCS of students’ likely associate degree success was measured using a dummy variable (ACT Missing). The variable

accounted for students who did not take the ACT or who had missing ACT scores and returned a P-value of 0.669.

Surprisingly, being offered Pell Grant aid also returned a P-value that was statistically insignificant (0.288) as measured by a dummy variable (Pell_Student). It was expected that students who were eligible to participate in the Pell Grant program would be less likely to obtain an associate degree, but the results indicate otherwise. Even though the variable measuring the effect that the amount of the Pell Grant offered was statistically significant (likely completion decreases as the amount of the offer increases), overall eligibility is statistically insignificant at identifying the likely completion of an associate degree. What this finding means is that holding other variables constant, KCTCS students seeking associate degrees and who are eligible for Pell Grants are as likely to succeed as those who are ineligible for such aid. It should be noted that both participation in and the amount of overall financial aid, which includes need based, state merit awards, and federal loans, are statistically significant. Participation in financial aid programs increases the likelihood of students obtaining associate degrees. While the interaction variable (Fin_Amt_Inf) measuring the influence that the amount of aid has on associate degree success was statistically significant, its coefficient was not different than zero.

Other variables receiving statistically insignificant P-values are gender, whether a student was a Kentucky resident, and whether the student earned a GPA during the first semester of enrollment. Of the three, the most surprising outcome was the insignificance of missing GPA during the first semester (measured by a dummy variable GPA_Missing_F01). It was anticipated that students who fail to earn a GPA

during the first semester would be less likely to succeed in earning an associate degree. Because of the statistical insignificance of this variable, it appears that whether a student earns a GPA during their first semester is irrelevant in terms predicting the odds of obtaining an associate degree relative to not obtaining an associate degree. However, the variable measuring the contribution that students' actual GPA scores make to associate degree attainment was significant. As a student's GPA increases, so does the student's likelihood of successfully completing an associate degree. What this tells policymakers is that extra student support services may be needed to increase the odds of obtaining associate degrees.

Transfer Success

For the fall 2001 entering KCTCS students included in the analysis, 1,687, or 16.86 percent, of the 10,007 students transferred to a 4-year college or university. Of those transferring:

- 30 (or 1.78 percent) also earned a diploma.
- 54 (or 3.20 percent) also earned a certificate.
- 447 (or 26.50 percent) also earned an associate degree.
- 1,156 (or 68.52 percent) transferred without earning a credential.

Using the multinomial logit model to predict the odds of KCTCS students transferring to 4-year colleges or universities relative to not transferring, 12 of the model's 14 variables yielded statistically significant P-values at the 95 percent confidence level or lower ($P < 0.01$). Only two variables returned statistically insignificant P-values: gender (represented in the model by the variable "Female") and students who were minorities or for whom race was unknown (represented in the model by the variable `Race_Minority_Unknown`). Table 8 lists the regression results

for the transfer success outcome, including the variables' standard errors, z- and P-values, and the 95 percent confidence interval.

Table 8: Multinomial Logit Results for Transfer to 4-Year Institution

Independent Variable	Coefficient	Standard Error	z	P> z	95% Confidence Interval	
Age at Entry	-0.055	0.006	-9.77	0.000***	-0.066	-0.044
Female	-0.038	0.060	-0.62	0.532	-0.155	0.080
Race, Black, NonHispanic	0.481	0.116	4.14	0.000***	0.253	0.709
Race, Other Minorities ^A	0.186	0.107	1.74	0.083	-0.024	0.396
Kentucky Resident	-0.452	0.135	-3.34	0.001***	-0.717	-0.187
GED	-0.215	0.105	-2.04	0.042**	-0.421	-0.008
ACT Missing	0.946	0.234	4.03	0.000***	0.487	1.406
ACT High Score	0.090	0.012	7.50	0.000***	0.066	0.113
GPA Missing Fall 2001	0.364	0.144	2.53	0.011**	0.082	0.645
GPA Fall 2001 Term	0.414	0.040	10.38	0.000***	0.336	0.493
Pell Grant Offered	-0.420	0.145	-2.90	0.004***	-0.704	-0.137
Pell Offer Amount Fall 2001	-0.001	0.000	-4.37	0.000***	-0.001	0.000
Financial Aid Recipient	0.191	0.093	2.06	0.040**	0.009	0.373
Financial Aid Amount Fall 2001	0.000	0.000	5.47	0.000***	0.000	0.001
_cons	-2.003	0.301	-6.65	0.000***	-2.593	-1.413

*** p<.01, **p<.05, *p<.1

^A“Other Minorities” include the race/ethnic categories of American Indian/Alaskan Native, Asian Pacific Islander, Hispanic, and Race/Ethnicity Unknown (n = 852).

As with students who earned an associate degree, age at entry into a KCTCS college and race for students who were Black, NonHispanic were statistically significant in predicting the odds of KCTCS students transferring to a 4-year college or university. Kentucky residency status also was a statistically significant indicator of transfer, with Kentucky residents being less likely to transfer than nonresidents. The odds of a student transferring to a 4-year college or university decreases as the student's age increases. Contrary to the outcome in the associate degree analysis, students who are Black, NonHispanic are more likely to transfer than other students. An expected result was obtained related to whether students who transfer have a GED or high school credential – students with GEDs are less likely to transfer than students with high school credentials.

Similar to students who earn an associate degree, the odds of students succeeding (in this case, transferring to a 4-year college or university) increases as their ACT scores and GPAs increase. However, unlike students who earn an associate degree, the presence of an ACT score and whether the student earned a GPA during the first semester of enrollment were statistically significant for KCTCS students who transfer. What this means is that the ACT test along with the ACT test scores and GPA are likely strong tools for predicting KCTCS students' likelihood of transferring to a 4-year college or university.

Perhaps the most surprising finding was the significance of financial aid and student success as it relates to transfer. Being offered a Pell Grant award and the amount of the Pell Grant offer were statistically significant and decreased the likelihood of success, with the odds of students transferring decreasing with the award amount. The presence of financial aid in general was statistically significant at determining the odds of students transferring to a 4-year institution, increasing the likelihood of success if the student received financial aid. Yet, the amount of overall financial aid, which includes need based, state merit based (KEES), and federal loan awards, was statistically significant but did not have a coefficient different than zero. These findings suggest that policymakers should consider increasing merit based financial aid to offset the financial barrier that low income students face when considering transferring to a 4-year college or university.

Certificate Success

The number of students included in the analysis who earned certificates was 740, or 7.39 percent of the cohort. Of those earning certificates, 54 (7.30 percent) also transferred to a 4-year college or university. For the remaining 686 certificate earners,

nine of the model’s predictor variables were statistically significant in predicting student odds of success at the 95 percent confidence level, including:

- Age at entry
- Female (Gender)
- Race Black, NonHispanic
- Kentucky Resident
- ACT Missing
- ACT High Score
- GPA earned fall 2001 (the first semester GPA)
- Financial Aid Participation (including need based and merit based scholarships like the Kentucky Education Excellence Scholarship)
- Amount of Pell Grant offered

Variables yielding statistically insignificant P-values for certificate success include race for other minorities and students for whom race was unknown, whether the student had a high school diploma or GED, whether the student earned a GPA during the first semester of enrollment, and whether the student was offered a Pell Grant. The amount of overall financial aid a student received was statistically significant, but its logit coefficient was not different than zero. Table 9 lists the analysis results for certificate success relative to not attaining a certificate, including the predictor variables’ standard errors, z- and P-values, and the 95 percent confidence interval.

Table 9: Multinomial Logit Results for Certificates

Independent Variable	Coefficient	Standard Error	z	P> z	95% Confidence Interval	
Age at Entry	0.019	0.005	4.06	0.000***	0.010	0.029
Female	-0.477	0.089	-5.38	0.000***	-0.651	-0.303
Race, Black, NonHispanic	0.425	0.146	2.90	0.004***	0.138	0.712
Race, Other Minorities ^A	-0.172	0.154	-1.11	0.267	-0.474	0.131
Kentucky Resident	-1.912	0.124	-15.39	0.000***	-2.156	-1.669
GED	-0.100	0.122	-0.82	0.410	-0.339	0.139
ACT Missing	-1.414	0.409	-3.46	0.001***	-2.214	-0.613
ACT High Score	-0.074	0.023	-3.30	0.001***	-0.118	-0.030
GPA Missing Fall 2001	0.103	0.246	0.42	0.674	-0.379	0.585
GPA Fall 2001 Term	0.584	0.061	9.54	0.000***	0.464	0.704
Pell Grant Offered	-0.404	0.236	-1.72	0.086	-0.866	0.058
Pell Offer Amount Fall 2001	0.000	0.000	2.23	0.026**	0.000	0.001
Financial Aid Recipient	0.382	0.156	2.44	0.015**	0.076	0.688
Financial Aid Amount Fall 2001	0.000	0.000	-1.16	0.245	0.000	0.000
cons	-1.084	0.461	-2.35	0.019**	-1.986	-0.181

*** p<.01, **p<.05, *p<.1

^A“Other Minorities” include the race/ethnic categories of American Indian/Alaskan Native, Asian Pacific Islander, Hispanic, and Race/Ethnicity Unknown (n = 852).

Once again, age at entering college was statistically significant; the odds of student success likely increase with age. Gender and race for students who were Black, NonHispanic also were statistically significant, with the odds of male students completing certificates being higher than the odds for female students. Another statistically significant variable was residency, with the odds of KCTCS students who are in-state residents completing certificates are lower than for those who are not Kentucky residents. An unexpected result is the statistical insignificance of whether a student has a high school diploma or a GED, which tells us that the odds of success for students earning certificates are as likely for students with high school diplomas as for students with GEDs.

Another point of interest in the analysis related to certificate success is the statistical significance of both ACT predictor variables. Based on the analysis, the presence of an ACT decreases the likely completion of a certificate and, as a student's ACT score decreases, so does the likelihood of the student's successful completion of certificates. The finding is surprising because the ACT test is noted for predicting academic success. Many of the certificates KCTCS students earn focus on the applied learning of skill sets needed in the workplace (for example, welding and plumbing). The significance of the ACT as a predictor of certificate success suggests that additional research be conducted related to claims that: 1) the skills needed to be successful in college are the same or similar to the skills needed to be successful in the workforce (Callan, et.al, 2006; Achieve, Inc., 2004) and 2) the test is usefulness for predicting success in occupational and technical programs. .

Also of interest is the statistical insignificance of whether students were offered Pell Grant aid, the amount of overall Financial Aid a student received, and missing first semester GPAs. The multinomial logit model indicates that students who qualify for federal financial aid or who receive other types of financial aid are as likely to succeed and earn certificates as those who do not qualify or receive aid. And, even though statistically significant, the logit coefficient for the influence that the amount of Pell Grant aid offered has on certificate success does not differ from zero. The findings related to the four financial aid variables in the model indicate that the amount of financial aid a student receives is inconsequential to achieving certificate success. Note that while earning a GPA in the first semester of enrolling is statistically insignificant, the size of the first semester GPA is significant. The finding tells us that if a student earns a GPA during the initial semester of enrollment, the odds of completing a certificate increase as GPA increases.

Diploma Success

Students in the analysis cohort who earned diplomas totaled 531 (or 5.31 percent), of whom 30 (or 4.05 percent) transferred to a 4-year institution. Table 10 lists the results for the diploma program, including the variables' standard errors, z- and P-values, and the 95 percent confidence interval. For the remaining 501 certificate earners, eight of the model's variables were statistically significant in predicting the odds of diploma success at the 95 percent confidence level, including age at entry, race, Kentucky residency status, whether a person took the ACT, ACT test score, first semester GPA, and participation in state and federal financial aid programs (including merit based scholarships like the Kentucky Education Excellence Scholarship).

Table 10: Multinomial Logit Results for Diplomas

Independent Variable	Coefficient	Standard Error	z	P> z	95% Confidence Interval	
Age at Entry	0.025	0.005	4.75	0.000***	0.015	0.036
Female	-0.015	0.099	-0.15	0.883	-0.210	0.180
Race, Black, NonHispanic	-0.818	0.282	-2.90	0.004***	-1.370	-0.266
Race, Other Minorities ^A	-0.702	0.213	-3.29	0.001***	-1.119	-0.284
Kentucky Resident	-0.534	0.217	-2.47	0.014**	-0.958	-0.110
GED	0.009	0.131	0.07	0.948	-0.248	0.265
ACT Missing	-2.089	0.449	-4.65	0.000***	-2.969	-1.209
ACT High Score	-0.116	0.025	-4.63	0.000***	-0.165	-0.067
GPA Missing Fall 2001	0.223	0.352	0.63	0.526	-0.466	0.912
GPA Fall 2001 Term	0.874	0.075	11.60	0.000***	0.726	1.021
Pell Grant Offered	-0.235	0.240	-0.98	0.328	-0.705	0.235
Pell Offer Amount Fall 2001	0.000	0.000	1.56	0.120	0.000	0.001
Financial Aid Recipient	0.815	0.176	4.62	0.000***	0.469	1.161
Financial Aid Amount Fall 2001	0.000	0.000	-1.12	0.262	0.000	0.000
cons	-3.406	0.548	-6.22	0.000***	-4.479	-2.332

*** p<.01, **p<.05, *p<.1

^A“Other Minorities” include the race/ethnic categories of American Indian/Alaskan Native, Asian Pacific Islander, Hispanic, and Race/Ethnicity Unknown (n = 852).

Surprisingly, six of the model’s variables were found to be insignificant and include gender, whether the student had a high school diploma or GED, whether the student earned a GPA during the first semester of enrollment, Pell Grant eligibility, amount of Pell Grant offers, and amount of overall financial aid awards.

Age had a positive correlation with the likely completion of diploma programs, while race and residency status were negatively correlated. As a student’s age increases, the likelihood of earning a diploma increases. However, both race variables (representing all minority groups and students for whom race was unknown) and Kentucky residency status were negatively correlated with diploma success. Non minorities and nonKentucky residents were more likely to complete a diploma program than residents and minorities. Gender was statistically insignificant in determining the likelihood of student success related to diploma programs. Similarly and comparable to successful certificate attainment, whether a student had a high school diploma or GED was statistically

insignificant, meaning students with GEDs were equally likely to earn diplomas as those with high school diplomas.

Two unexpected results of the analysis related to successful diploma completion are the statistical significance of the ACT variables and the statistical insignificance of one of the GPA variables. Parallel to certificates, diplomas generally are considered to be more occupational/technical focused and less academic in nature. The model indicates that a high ACT score decreases the likelihood that a student completes a diploma. Also, if the ACT is missing, the student is more likely to complete a diploma program, which could be a reflection of the occupational/technical nature of most diploma programs and the student's educational goals. As with the other three success outcomes, first semester GPA correlates positively with success. Higher first semester GPAs increase the odds of earning a diploma.

Perhaps the most unexpected result of the analysis for diplomas completion is the statistical insignificance of three of the four financial aid variables. The analysis found that students receiving Pell Grant offers, amount of Pell Grant offers, and the amount of overall financial aid awards were insignificant in predicting student attainment of diplomas. Only participation in overall financial aid programs was statistically significant. Students receiving financial aid are more likely to earn diplomas relative to not earning a diploma.

Analysis Conclusion

In conclusion, the multinomial logit analysis indicates the following results for the hypotheses:

Hypothesis 1: Student ACT scores will correlate positively with student success.

Result 1: While statistically significant across the four success outcomes, the analysis found the hypothesis to be true only for associate degree and transfer success. A negative correlation was found between ACT scores and certificate and diploma success.

Hypothesis 2: Low income students, as measured by their being offered federal Pell Grants, will be less likely to succeed than students who are ineligible for Pell Grants.

Result 2: The analysis indicates this hypothesis true only for students who transfer to 4-year colleges and universities. It was statistically insignificant for students success related to earning a credential.

Hypothesis 3: Student GPA (based on a 4-point scale) earned during the first semester of enrollment will correlate with student success: higher GPAs will increase the odds of success.

Result 3: The analysis found the hypothesis to be true. Higher GPAs increased the odds of a successful outcome. However, earning a GPA itself was statistically significant at the 95 percent confidence level only for students achieving transfer success. In sum, it is not the presence of a GPA, but the quality of the GPA that matters during the first semester.

Hypothesis 4: Student age at initial entry to a KCTCS college will be negatively correlated with student success.

Result 4: The analysis found this true only for transfer success. As age increases, the odds of student transfer success decrease. For students seeking credentials, the odds of success increase with student age.

C. Study Limitations

Limiting the study to only those first-time students entering a KCTCS college in fall 2001 excludes students who enrolled in the spring and summer 2002 terms. Another limitation relates to military personnel, National Guard members and other reservists, and their family members. The data set does not have an identifier that flags these students who might have interrupted their studies because of being called or having family members called to active military duty. Being unable to control for these students might over represent the influence that other variables might have on success. The potential affect may be significant because of the September 11, 2001, terrorist attacks and the wars in Afghanistan and Iraq along with several natural disasters (like Hurricane Katrina). Such events required KCTCS students in the armed services to interrupt their studies because of being called to active duty or sent to serve overseas. The effects of this limitation are Systemwide but more pronounced for colleges serving military bases and National Guard units (for example, Elizabethtown, Hopkinsville, and Jefferson).

Perhaps the most significant limitation of the study is the successful evolution of KCTCS. As previously discussed, KCTCS was created by the *Kentucky Postsecondary Education Improvement Act of 1997*. Between calendar years 2001 and 2003, the initial 28 KCTCS colleges (13 of the 14 community colleges from the University of Kentucky Community College System¹⁵ and 15 technical institutions from the Kentucky Workforce Development Cabinet) consolidated into 16 comprehensive community and technical colleges based upon the communities (service regions) served by the colleges. The last

¹⁵ Lexington Community College did not become part of KCTCS until 2004. Because students enrolled at Lexington Community College were not under the governance of KCTCS policies nor receiving KCTCS services, they were excluded from the study cohort.

consolidation occurred June 2005, when the KCTCS governing board gave final approval for Lexington Community College (which did not become part of KCTCS until summer 2004) and Central Kentucky Technical College to consolidate in June. The impact of consolidation on the study's student cohort is immeasurable.

V. Conclusion and Recommendations

This paper has explored the likelihood of KCTCS student success using 13 independent variables considered important to community college student success and of interest to the *KCTCS Mission*. The findings outlined in the paper can be used by policymakers when considering program specific admission requirements and establishing or reviewing program curricula.

Given the correlations between the presence of standardized tests and student success, policymakers should reconsider the usefulness of the ACT test for placing students seeking occupational/technical credentials. While the findings from the analysis might be indicative of academic aptitude, KCTCS student performance on the ACT may reflect career interest rather than ability. Nevertheless, an instrument is needed for earlier identification of students who need remediation in order to facilitate more timely intervention strategies and improve the odds of student success. In addition, the findings suggest more research is needed to determine the ACT's usefulness for KCTCS students, especially during their first semester of enrollment. Similarly, attention should be given to students' first semester GPAs. Requiring or strongly encouraging academic tutoring or study skill classes during the first semester may result in higher success rates for students.

In addition, the study also can be used to inform decisions related to tuition and financial aid. The analysis found that Pell Grant eligibility was statistically insignificant at

the 95 percent level for students obtaining KCTCS credentials. What this means is that low income students who are eligible to receive federal financial aid are as likely to succeed in KCTCS colleges as students who do not receive financial aid. However, it was statistically significant for students transferring to 4-year colleges and universities. As CPE, the nine public postsecondary education institutions, and other stakeholders continue discussion and analysis of student transfer issues, strategies should be developed to ensure low income students ability to finance the second half of a baccalaureate degree. In order to keep costs for transfer students as low as possible, universities should exam their course transfer criteria and perhaps be more flexible in course substitution for KCTCS students transferring to the universities.

Additionally, continued emphasis on adult learners should be at the forefront of decision making as the study found age to be a statistically significant predictor of success. Policymakers should continue to provide special programming to meet the needs of the nontraditional student, perhaps exploring adding more distance learning courses, flexible course offerings, child care facilities, etc. Similarly, the unique needs of traditional students should not be overlooked, especially in light of younger students increased likelihood of transferring to 4-year institutions.

In closing, the study does add credence to making KCTCS the primary provider of remedial education for first-time postsecondary students. KCTCS is the most affordable and most accessible public higher education institution in the state. Additional research should be completed that specifically focuses on student success and its relationship with remedial/developmental education coursework and the variables used in the multinomial analysis presented in this paper.

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APPENDIX

Multinomial Logit Regression as Presented in Stata

Iteration 0: log likelihood = -11474.392
 Iteration 1: log likelihood = -10179.824
 Iteration 2: log likelihood = -9887.107
 Iteration 3: log likelihood = -9876.5727
 Iteration 4: log likelihood = -9876.4158
 Iteration 5: log likelihood = -9876.4157

Multinomial logistic regression

Number of obs = 10007
 LR chi2 (56) = 3195.95
 Prob > chi2 = 0.0000
 Pseudo R2 = 0.1393

Log likelihood = -9876.4157

Degree_ Revised	Coef.	Std. Err.	z	P> z	95% {Conf. Interval}	
Associate Degree Success						
Age_at_Entry	0.024	0.005	4.70	0.000	0.014	0.034
Female	0.128	0.079	1.62	0.105	-0.027	0.284
Race_Black_NonHispanic	-0.628	0.235	-2.67	0.008	-1.090	-0.167
Race_Minority_Unknown	-0.297	0.166	-1.79	0.074	-0.623	0.029
Kentucky_Resident	-0.217	0.211	-1.03	0.305	-0.631	0.197
GED	-0.520	0.141	-3.68	0.000	-0.797	-0.243
ACT_Missing	-0.128	0.300	-0.43	0.669	-0.717	0.460
ACT_High_Score	0.045	0.015	2.99	0.003	0.016	0.075
GPA_Missing	0.378	0.268	1.41	0.158	-0.147	0.904
GPA_Term_F01	0.847	0.058	14.50	0.000	0.732	0.961
Pell_Student	-0.184	0.174	-1.06	0.288	-0.525	0.156
Pell_Amt_Inf	-0.001	0.000	-3.99	0.000	-0.001	0.000
Fin_Student	0.775	0.135	5.72	0.000	0.510	1.041
Fin_Amt_Inf	0.000	0.000	5.97	0.000	0.000	0.001
_cons	-5.577	0.408	-13.68	0.000	-6.376	-4.778
Certificate Success						
Age_at_Entry	0.019	0.005	4.06	0.000	0.010	0.029
Female	-0.477	0.089	-5.38	0.000	-0.651	-0.303
Race_Black_NonHispanic	0.425	0.146	2.90	0.004	0.138	0.712
Race_Minority_Unknown	-0.172	0.154	-1.11	0.267	-0.474	0.131
Kentucky_Resident	-1.912	0.124	-15.39	0.000	-2.156	-1.669
GED	-0.100	0.122	-0.82	0.410	-0.339	0.139
ACT_Missing	-1.414	0.409	-3.46	0.001	-2.214	-0.613
ACT_High_Score	-0.074	0.023	-3.30	0.001	-0.118	-0.030
GPA_Missing	0.103	0.246	0.42	0.674	-0.379	0.585
GPA_Term_F01	0.584	0.061	9.54	0.000	0.464	0.704
Pell_Student	-0.404	0.236	-1.72	0.086	-0.866	0.058
Pell_Amt_Inf	0.000	0.000	2.23	0.026	0.000	0.001
Fin_Student	0.382	0.156	2.44	0.015	0.076	0.688
Fin_Amt_Inf	0.000	0.000	-1.16	0.245	0.000	0.000
_cons	-1.084	0.461	-2.35	0.019	-1.986	-0.181

Degree_ Revised	Coef.	Std. Err.	z	P> z 	95% {Conf. Interval}	
Diploma Success						
Age_at_Entry	0.025	0.005	4.75	0.000	0.015	0.036
Female	-0.015	0.099	-0.15	0.883	-0.210	0.180
Race_Black_ NonHispanic	-0.818	0.282	-2.90	0.004	-1.370	-0.266
Race_Minority_ Unknown	-0.702	0.213	-3.29	0.001	-1.119	-0.284
Kentucky_ Resident	-0.534	0.217	-2.47	0.014	-0.958	-0.110
GED	0.009	0.131	0.07	0.948	-0.248	0.265
ACT_ Missing	-2.089	0.449	-4.65	0.000	-2.969	-1.209
ACT_High_Score	-0.116	0.025	-4.63	0.000	-0.165	-0.067
GPA_ Missing	0.223	0.352	0.63	0.526	-0.466	0.912
GPA_Term_F01	0.874	0.075	11.60	0.000	0.726	1.021
Pell_Student	-0.235	0.240	-0.98	0.328	-0.705	0.235
Pell_Amt_Inf	0.000	0.000	1.56	0.120	0.000	0.001
Fin_Student	0.815	0.176	4.62	0.000	0.469	1.161
Fin_Amt_Inf	0.000	0.000	-1.12	0.262	0.000	0.000
_cons	-3.406	0.548	-6.22	0.000	-4.479	-2.332
Transfer Success						
Age_at_Entry	-0.055	0.006	-9.77	0.000	-0.066	-0.044
Female	-0.038	0.060	-0.62	0.532	-0.155	0.080
Race_Black_ NonHispanic	0.481	0.116	4.14	0.000	0.253	0.709
Race_Minority_ Unknown	0.186	0.107	1.74	0.083	-0.024	0.396
Kentucky_ Resident	-0.452	0.135	-3.34	0.001	-0.717	-0.187
GED	-0.215	0.105	-2.04	0.042	-0.421	-0.008
ACT_ Missing	0.946	0.234	4.03	0.000	0.487	1.406
ACT_High_Score	0.090	0.012	7.50	0.000	0.066	0.113
GPA_ Missing	0.364	0.144	2.53	0.011	0.082	0.645
GPA_Term_F01	0.414	0.040	10.38	0.000	0.336	0.493
Pell_Student	-0.420	0.145	-2.90	0.004	-0.704	-0.137
Pell_Amt_Inf	-0.001	0.000	-4.37	0.000	-0.001	0.000
Fin_Student	0.191	0.093	2.06	0.040	0.009	0.373
Fin_Amt_Inf	0.000	0.000	5.47	0.000	0.000	0.001
_cons	-2.003	0.301	-6.65	0.000	-2.593	-1.413