Identification of At-Risk Students and Analyses of Stopout & Re-enrollment at an Hispanic-Serving Institution to Develop Interventions for Improving Degree Attainment: A Survival Model Approach

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Presentation Outline

- UTEP’s Context
- Factors that affect departure and reenrollment
- Factors that affect graduation within six years
- Risk groups and associated trends
- Summary, implications and next steps
UTEP’s Context

El Paso, Texas

- El Paso County-3rd poorest large county in the US
- Population: 734,000
- 81% Hispanic
- Border community, very dynamic flow of residents and students across the border
- Limited educational opportunities

\(^1\) 2005 American Community Survey of the US Census
## UTEP Demographics

### Enrollment by Race/Ethnicity

<table>
<thead>
<tr>
<th>Race/Ethnicity</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>White Non-Hispanic</td>
<td>2,124</td>
<td>10.5%</td>
</tr>
<tr>
<td>Black Non-Hispanic</td>
<td>547</td>
<td>2.7%</td>
</tr>
<tr>
<td><strong>Hispanic</strong></td>
<td>14,826</td>
<td>73.6%</td>
</tr>
<tr>
<td>Asian/Pacific Islander</td>
<td>226</td>
<td>1.1%</td>
</tr>
<tr>
<td>Am. Indian or Alaskan</td>
<td>44</td>
<td>0.2%</td>
</tr>
<tr>
<td>International*</td>
<td>2291</td>
<td>11.4%</td>
</tr>
</tbody>
</table>

*includes Mexican Nat’l. students

### Total Enrollment by Residence

<table>
<thead>
<tr>
<th>Residence</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>El Paso County</td>
<td>16705</td>
<td>83.9%</td>
</tr>
<tr>
<td>New Mexico</td>
<td>243</td>
<td>1.2%</td>
</tr>
<tr>
<td>Mexico</td>
<td>1801</td>
<td>8.9%</td>
</tr>
<tr>
<td>Other Int’l</td>
<td>431</td>
<td>2.1%</td>
</tr>
</tbody>
</table>

Percent of financial aid awardees with family income of $20,000 or less: 43%
Percent of UTEP students with reported family income of $20,000 or less: 33%

### Nationally:

- % of students with family income of less than $20,000 at large public research (doctoral) universities: 10%¹
- % of students with family income of less than $20,000 at small & mid-sized private colleges and universities: 12%¹
- % of students with family income less than $20,000 at community colleges: 29%²

¹Council of Independent Colleges: [http://www.cic.edu/makingthecase/data/access/income/index.asp](http://www.cic.edu/makingthecase/data/access/income/index.asp)
²Lumina Foundation Focus, Fall 2005, p.5
President Diana Natalicio has rededicated UTEP’s mission to ensure the widest possible access to all students from the region, and to focus on serving the El Paso area.

Institution has made efforts to ensure success at all levels of the pipeline, with impressive results:
- K-12
- Admissibility/ Affordability
- Student engagement
UTEP’s Institutional Successes

- College of Engineering—identified as the top engineering school for Hispanics by *Hispanic Business Magazine*. UTEP “is changing the face of engineering and producing highly trained graduates heavily recruited by the industry’s leading companies”.

- NSSE and the American Association for Higher Education identified UTEP as one of 20 colleges and universities that was “unusually effective in promoting student success”.

- One of only six NSF Model Institutions for Excellence in the nation for its success in creating educational opportunities for non-traditional students.

- Rankings:
  - 3rd in the US for granting baccalaureate degrees to Hispanics
  - 6th in the US for granting Master’s degree to Hispanics

1 NSSE Institute for Effective Educational Practice, Project DEEP Final Report, p. 4
2 *Hispanic Business*, September 2007
Despite its Success, UTEP has More Work to Do

Six year, FTFT graduation rate:

- Fall 2001 cohort → 29.4%

One year retention rate:

- Fall 2006 cohort → 70.0%
What more can the institution do to improve retention and degree completion rates?

What more can the institution do to improve the effectiveness of our current initiatives?
The Range of Success

ACT

Frequency

Not Graduated
Graduated

Graduation Indication

ACT 18

0 5 10 15 20 25 30 35
5.00 10.00 15.00 20.00 25.00 30.00 35.00

0 5 10 15 20 25 30 35
5.00 10.00 15.00 20.00 25.00 30.00 35.00
Impact of Selectivity

ACT 18
Main Research Questions

1. What factors affect student departure?

2. What factors impact students’ return after an initial stopout?

3. What factors affect on-time graduation?

4. How can the institution identify (at the time of admission) students at-risk of departure?
Dataset

- 4,147 students who entered as first-time degree-seeking undergraduate freshmen during the 1999 and 2000 fall semesters*.

- The data set contained 12 semesters of fall and spring (six years) enrollments and non-enrollments arranged in a person-period format (where there are 12 records for each student, one for each semester).

*The size might differ from one model to the other due to case-wise deletion of missing values.
Factors That Explain Departure And Reenrollment
Methodology for Examining Factors that Predict Departure & Re-enrollment

Considerations:

☐ Student departure (dropout/stopout) and re-enrollment is a longitudinal process

☐ Critical to consider the timing of events and factors that affect these events at each point in time.

Approach:

☐ A multi-spell discrete-time logit model is used to analyze student departure and return separately.
Results: Factors That Explain Departure

Predictors of Departure:

- Low semester GPA will increase the risk of departure.
- Over time, the effect of semester GPA decreases.
- Failing a course will increase the risk of departure.
- Part-time enrollment increases the risk of departure.
- Financial aid (loans, grants, work study) will reduce the risk of departure.
- Students who stop-out are more likely to leave again.
Results: Factors That Explain Departure

- **Timing Factors Involved in Departure**
  - Risk of departure is higher in earlier semesters
  - Risk of departure is higher in spring semesters than fall semesters

- **Upon Re-enrollment:**
  - Risk of departure for returnees is higher in the semesters immediately after returning
  - Risk of departure for returnees increases with the length of the stop-out period
Results: Factors That Explain Reenrollment

The chances of returning to UTEP after stopping out:

- are higher for students with good academic standing at the time of departure
- are lower for older students (20 years or older when they first enrolled)
- increase as a student’s initial length of enrollment increases
- decrease as a student’s length of stopping out increases
Building the Multi-spell Discrete-time Logit Model
Departure and Return: Conceptual Framework

**Model 1 (examines periods of enrollment):**
- Failing Developmental
- Withdrawing Class
- S. GPA
- Financial Aid
- Ethnicity……etc

**Model 2 (examines periods of non-enrollment):**
- Lagged Failing Develop.
- Lagged S. GPA
- Lagged Financial Aid
- Ethnicity……etc
Multi-spell Discrete-time Logit Model

- Multi-spell: refers to spells, or spans of time, when students were enrolled and/or not enrolled (that is, stopped out).

- Discrete time: refers to our use of semesters as discrete units, or measures, of time for examining the timing of events. Due to the nature of the academic year, the discrete measure of time in terms of semesters was appropriate.

- Logit model: incorporates a logit-link function (inverse of the logistic function) that relates an outcome with relevant predictor variables.
Departure and Return: Logit Model

The population discrete-time hazard for student $i$ in semester $j$ is (Willett and Singer, 2003):

$$h(t_{ij}) = \Pr[T_i = j \mid T_i \geq j \land X_{1ij} = x_{1ij}, \ldots, X_{pij} = x_{pij}]$$

The hazard is modeled using a logit link function and captures

- The general shape of the hazard profile (baseline hazard)
- The heterogeneity of the hazard caused by different predictor variables.

$$\log \text{it}[h(t_{jk})] = [\text{baseline } \_ \text{hazard } \_ \text{profile }]$$
$$+ [\beta_1 X_{1jk} + \beta_2 X_{2jk} + \cdots + \beta_p X_{pj}]$$
# Departure: Empirical Results

## Effect of timing variables:

<table>
<thead>
<tr>
<th>Covariate</th>
<th>Coefficients (SE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-1.08(.07)***</td>
</tr>
<tr>
<td>year</td>
<td>-.54(.06)***</td>
</tr>
<tr>
<td>year(^2)</td>
<td>.04(.01)***</td>
</tr>
<tr>
<td>Returnee</td>
<td>1.86(.07)***</td>
</tr>
<tr>
<td>ln(semesters in spell)*Returnee</td>
<td>-.78(.07)***</td>
</tr>
<tr>
<td>ln(stopout length)* Returnee</td>
<td>.17(.06)**</td>
</tr>
<tr>
<td>Spring</td>
<td>.44(.07)***</td>
</tr>
<tr>
<td>Spring*year</td>
<td>-.09(.02)***</td>
</tr>
</tbody>
</table>

Significance codes: 0 '***' 0.001 '***' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## Departure: Empirical Results

### Effect of academic performance variables:

<table>
<thead>
<tr>
<th>Covariate</th>
<th>Coefficients (SE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part-Time Enrollment</td>
<td>0.65 (.05)**</td>
</tr>
<tr>
<td>Semester GPA (2.0+)</td>
<td>-2.26 (.07)**</td>
</tr>
<tr>
<td>Semester GPA*(\ln(t))</td>
<td>0.35 (.05)**</td>
</tr>
<tr>
<td>Developmental</td>
<td>-0.59 (.10)**</td>
</tr>
<tr>
<td>Developmental*(\ln(t))</td>
<td>0.73 (.09)**</td>
</tr>
<tr>
<td>Failing Developmental</td>
<td>0.72 (.07)**</td>
</tr>
<tr>
<td>Withdraw one class</td>
<td>0.49 (.05)**</td>
</tr>
<tr>
<td>Withdraw two or more classes</td>
<td>0.92 (.09)**</td>
</tr>
</tbody>
</table>

Significance codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
Return: Empirical Results

Effect of timing variables:

<table>
<thead>
<tr>
<th>Covariate</th>
<th>Coefficients (SE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-2.18(.07)***</td>
</tr>
<tr>
<td>ln(t)</td>
<td>-1.12(.04)***</td>
</tr>
<tr>
<td>Repeated Spell</td>
<td>-.26(.07)***</td>
</tr>
<tr>
<td>Fall</td>
<td>.54(.06)***</td>
</tr>
<tr>
<td>ln(Enrollment Spell length)</td>
<td>.51(.04)***</td>
</tr>
</tbody>
</table>

Significance codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 '' 1
## Return: Empirical Results

### Effect of lagged variables:

<table>
<thead>
<tr>
<th>Covariate</th>
<th>Coefficients (SE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lagged Part-Time</td>
<td>-.06(.06)</td>
</tr>
<tr>
<td>Lagged S. GPA</td>
<td>1.29(.14)***</td>
</tr>
<tr>
<td>Lagged S. GPA*ln(t)</td>
<td>-.42(.08)***</td>
</tr>
<tr>
<td>Lagged S. GPA*ln(spell one length)</td>
<td>-.47(.09)***</td>
</tr>
<tr>
<td>Lagged Failing Developmental</td>
<td>-.08(.06)</td>
</tr>
<tr>
<td>Lagged Withdraw one class</td>
<td>.03(.07)</td>
</tr>
<tr>
<td>Lagged Withdraw two or more classes</td>
<td>-.15(.09)</td>
</tr>
</tbody>
</table>

Significance codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
Research Question 3

Predictors of Graduation
Phase I: Factors That Explain Graduation

- Stepwise Logistic regression model
- Variables explored for a significant effect on graduation:
  - Demographics
  - Academic preparation
  - Student perception (New student survey)
  - First term Academic Performance
- 21 variables were used in the model.
Phase I: Factors That Explain Graduation

- Significant factors:
  - Failing class in the first term will decrease the probability of graduation.
  - Higher first term GPA will increase the probability of graduation.
  - Working 30 or more hours per week will decrease the probability of graduation.
  - Students from bottom half of their high school class rank are less likely to graduate.
  - Placing in below college level Math will decrease the probability of graduation.
Limitations of the Logistic Regression

The model did not consider, for instance, the effect of:

- GPA over time (cumulative GPA)
- # of Semesters enrolled Part-time
- # of Developmental courses Enrolled (& Failed)
- Financial aid over time
- Stopping out
Phase II: Longitudinal Approach

- We used a longitudinal approach to explore the effect of stopping out as well as time varying effect of academic performance and financial aid.

- A proportional sub-distribution hazards model (class of survival model) was used to model student graduation under a competing risk setting.
Factors That Explain Graduation

Competing risk model results:

- Higher cumulative GPA increases the probability of graduation
- Receiving financial aid (loans, grants, and work study) increases the probability of graduation
- Failing any class decreases the probability of graduation
- Enrolling and passing a developmental course did not decrease a student’s chance of graduation significantly
- Stopping-out decreases the probability of graduation
Modeling On-time Graduation
Graduation: Conceptual Framework

Modeling Graduation under Competing Risk Setting:
Cumulative GPA
No. of Developmental Enrolled
No. of Developmental Failed
Semesters Enrolled Part-time
Gender
Ethnicity……etc

Outcome 1

Enrolled

Depart
Continue
Graduate

Outcome 2

Not Enrolled
Non-return
Return

Outcome 2

Not Enrolled
Non-return
Return

Outcome 1

Enrolled

Depart
Continue
Graduate
Graduation: Competing Risk Model

- DesJardins et al. (2005) used a competing risk model to jointly model student departure and graduation.

- This study tries to model graduation under a competing risk setting without simultaneously estimating the departure model using the ‘Proportional Sub-distribution Hazards’ regression model described in Fine and Gray (1999).

- The model directly assesses the effect of covariates on the sub-distribution of a particular type of event (graduation) in a competing risks setting.
Graduation: Competing Risk Model

Our interest is modeling the cumulative incidence function for cause 1 (graduation) conditional on the covariates:

\[ F_1(t, Z) = \Pr(T \leq t, \varepsilon = 1 \mid Z) \]

To formalize the subdistribution hazard, Gray’s definition is:

\[ \lambda_1(t; Z) = \lim_{\Delta t \to 0} \frac{1}{\Delta t} \Pr\{t \leq T \leq t + \Delta t, \varepsilon = 1 \mid T \geq t \cup (T \leq t \cap \varepsilon \neq 1), Z\} \]

\[ = -d \log\{1 - F_1(t; Z)\} / dt. \]

Under a proportional hazards specification with

\[ \lambda_1(t; Z) = \lambda_{10}(t) \exp(Z^T \beta_0) \]
## Graduation: Empirical Results

<table>
<thead>
<tr>
<th>Covariates</th>
<th>Coefficients (Standard Error)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>.06(.07)</td>
</tr>
<tr>
<td>Black</td>
<td>.25(.29)</td>
</tr>
<tr>
<td>White</td>
<td>.07(.13)</td>
</tr>
<tr>
<td>Asian</td>
<td>.04(.32)</td>
</tr>
<tr>
<td>International</td>
<td>.86(.11)**</td>
</tr>
<tr>
<td>Age20 or Older</td>
<td>-.54(.23)*</td>
</tr>
<tr>
<td>No. of Part-time Semesters enrolled</td>
<td>-.02(.03)</td>
</tr>
<tr>
<td>Cumulative GPA</td>
<td>1.58(.06)**</td>
</tr>
<tr>
<td>No. of Developmental courses enrolled</td>
<td>-.04(.03)</td>
</tr>
<tr>
<td>No. of Failed Developmental courses</td>
<td>-.28(.08)**</td>
</tr>
<tr>
<td>No. of Withdrawals</td>
<td>-.11(.02)**</td>
</tr>
<tr>
<td>No. of terms received Grants</td>
<td>.12(.01)**</td>
</tr>
<tr>
<td>No. of terms received Loans</td>
<td>.06(.01)**</td>
</tr>
<tr>
<td>No. of terms received Work-Study</td>
<td>.02(.02)</td>
</tr>
</tbody>
</table>

Significance code: 0 '****' 0.001 '**' 0.01 '*' 0.05 ':' 0.1 ' ' 1
Graduation: Empirical Results

Estimated Graduation Rates by Developmental Term
Research Question 4

Identifying Students At Risk of Departure
Identifying Students At Risk of Departure

- One way of improving retention rates and promote student success is to identify those students at risk of leaving and implement an appropriate *early* intervention according to the level of risk of the students.

- Cox proportional hazards (PH) regression model is used to determine the risk of departure for each student.

- Significant factors at the *time of admission* that are used to identify level of risk:
  - Mathematics placement score
  - High school class rank percentile
  - Intended number of hours spent to work
  - Delayed matriculation from high school
Assigning Risk Score

- **Low risk group**: Students with 0 risk score
  - with college level math placement
  - top quartile of high school class
  - intend to work less than 20 hours per week
  - Directly matriculated from high school

- **Medium risk group**: Students with a score of less than 1.15 are assigned into medium risk group

- **High risk group**: Students with a score of 1.15 or higher are assigned into high risk group
Survival Trends Associated with Risk Groups

Kaplan-Meier Survival Curve for the Entire Sample

- High Risk
- Medium Risk
- Low Risk
Retention Trends for Risk Groups

- One year retention rates:
  - High Risk: 48%,
  - Medium Risk: 74%
  - Low Risk: 87%

- Three year retention rates:
  - High Risk: 20%
  - Medium Risk: 48%
  - Low Risk 67%
Graduation Trends for Risk Groups

- Six year graduation rates:
  - High Risk: 9%
  - Medium Risk: 30%
  - Low Risk: 60%

- Graduation rate upon persisting through the first year with cumulative GPA of at least 2.0
  - High Risk: 25%
  - Medium Risk: 43%
  - Low Risk: 70%
Process for Generating Risk Scores
A Cox Proportional Hazards (PH) model is a (semi-parametric) class of survival models that relates the hazard rate, \( h(t) \), with a set of predictor variables.

\[
h(t) = h_0(t) \exp(\beta'x)
\]

Where

- \( h_0(t) \) is the baseline hazard function. It is assumed to be unknown and is left unparameterized.
- \( \beta'x \) are the predictor variables and regression coefficients. It is also known as the Risk Score (RS) and can be used to stratify students into different risk groups.
Generating Risk Score

\[ RS = \beta_1 x_1 + \cdots + \beta_p x_p \]

Validating the model

- The data was first divided randomly (in the ratio 3:1) into a training data set and a validation data set.
- Using the derived model the risk scores was calculated for each student in the validation set.

For further analysis

- It is also possible to estimate the parameters by bootstrap sampling where we sample 75% of the data and estimate the Cox model. This sampling and estimating the Cox model can be repeated many times; and the average of the estimated parameters can be used to generate risk scores.
# Cox Regression Result

The Cox regression model and statistical test of the PH assumption

<table>
<thead>
<tr>
<th>Covariate</th>
<th>Coef.</th>
<th>SE (Coef.)</th>
<th>P</th>
<th>Rho</th>
<th>Chi. Sq.</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>BANM Level 2</td>
<td>0.216</td>
<td>0.1</td>
<td>0.031</td>
<td>0.011</td>
<td>0.135</td>
<td>0.714</td>
</tr>
<tr>
<td>BANM Level 1</td>
<td>0.441</td>
<td>0.09</td>
<td>0</td>
<td>0.005</td>
<td>0.031</td>
<td>0.86</td>
</tr>
<tr>
<td>HSP 2nd Quartile</td>
<td>0.5</td>
<td>0.08</td>
<td>0</td>
<td>-0.036</td>
<td>1.431</td>
<td>0.232</td>
</tr>
<tr>
<td>HSP Bottom Half</td>
<td>1.697</td>
<td>0.09</td>
<td>0</td>
<td>0.028</td>
<td>1.006</td>
<td>0.316</td>
</tr>
<tr>
<td>Work 20 to 30 hpw</td>
<td>0.307</td>
<td>0.07</td>
<td>0</td>
<td>-0.034</td>
<td>1.247</td>
<td>0.264</td>
</tr>
<tr>
<td>Work more than 30 hpw</td>
<td>0.596</td>
<td>0.09</td>
<td>0</td>
<td>-0.031</td>
<td>1.109</td>
<td>0.292</td>
</tr>
<tr>
<td>Delayed Matriculation</td>
<td>0.247</td>
<td>0.13</td>
<td>0.06</td>
<td>-0.042</td>
<td>2.026</td>
<td>0.155</td>
</tr>
<tr>
<td>HSP Bottom Half*time³</td>
<td>-0.003</td>
<td>0</td>
<td>0</td>
<td>0.194</td>
<td>78.12</td>
<td>0</td>
</tr>
<tr>
<td>N</td>
<td>1521</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Summary

- The major findings of this study shows the significant effect of:
  - Timing on departure and re-enrollment
  - (Length of) Stopping-out
  - Academic performance over time
  - Financial aid

- The study also:
  - Reveals the stratification of the student population into three risk groups with distinctive survival patterns
Implications and Further Research

- **Implications**
  - Evaluate efficacy of current interventions for each risk group, and modify interventions
  - Develop tools and methods to track progress during critical periods

- **Areas for further research**
  - Advance understanding of students within each risk group
  - Explore how ecosystems affect student performance
  - Explore factors that explain the success of transfer students
Changing the Face of Higher Education

“We are here to provide opportunities to a group of people who represent America's future. And it's such an awesome responsibility. And it's also an enormous satisfaction when you go to graduation and you see in front of you this group of graduates whose lives you know are going to be completely changed as a result of what's happened here. That's enormously exciting.”

--Diana Natalicio
President of UTEP

*Interview with Lumina Foundation for Education*
References


References


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