

Counting Out Time:

Utilizing Zero Modified Count Regression to Model Time-to-Degree Attainment

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Motivation to study time to degree

- External
 - Department of Education
 - Higher Education Act reauthorization
 - AAU Institutional Data Committee
- Internal
 - Transforming the U
 - Provost's Task Force on Financial Aid, Retention, Graduation and Student Success



Transforming the U: Framework

VISION: Improve the Human Condition
Through the Advancement of Knowledge

MISSION: Extraordinary Education • Breakthrough Research • Dynamic Public Engagement

GOAL: Become one of the Top Three Public Research Universities in the World

EXCEPTIONAL STUDENTS

Recruit, educate, challenge, and graduate outstanding students who become highly motivated lifelong learners, leaders, and global citizens.

EXCEPTIONAL FACULTY AND STAFF

Recruit, mentor, reward, and retain world-class faculty and staff who are innovative, energetic, and dedicated to the highest standards of excellence.

EXCEPTIONAL ORGANIZATION

Be responsible stewards of resources, focused on service, driven by performance, and known as the best among our peers.

EXCEPTIONAL INNOVATION

Inspire exploration of new ideas and breakthrough discoveries that address the critical problems and needs of the University, state, nation, and world.



MAY 2006

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Advance Interdisciplinary Frontiers • Build Diverse Community • Generate Critical Resources • Account for Results

UNIVERSITY OF MINNESOTA



UNIVERSITY OF MINNESOTA
Driven to DiscoverSM

Critical metrics/measures

- Retention/graduation rates/time to degree
- Satisfaction levels
 - Advising and career support
 - Quality of instruction
 - Sense of community and support within the UMNTC environment
- Participation in “deep” learning experiences
 - Study abroad, internships, service learning, student government/leadership
- Learning and development outcomes—assessment issues
- Inclination to recommend UMNTC to others
- Alumni success factors



Project Background

- Building on our previous research on duration of enrollment for drop-outs
- Continued refinement of our institutional model of probability of graduation
- Elaborating the paths students take on their journey through higher education



Research Questions

- How many semesters does it take to earn a bachelors degree from the University of Minnesota?
- What are the factors that increase or decrease a student's time-to-degree?
- Do these factors differ from those that relate to non-degree attainment?



TTD: Let me count the ways

- Elapsed time
 - From HS graduation or time of matriculation to degree?
- Enrolled time
 - Number of semesters (summers or not)
 - Credit hours earned (native & transfer)
 - Calendar time (years, months)

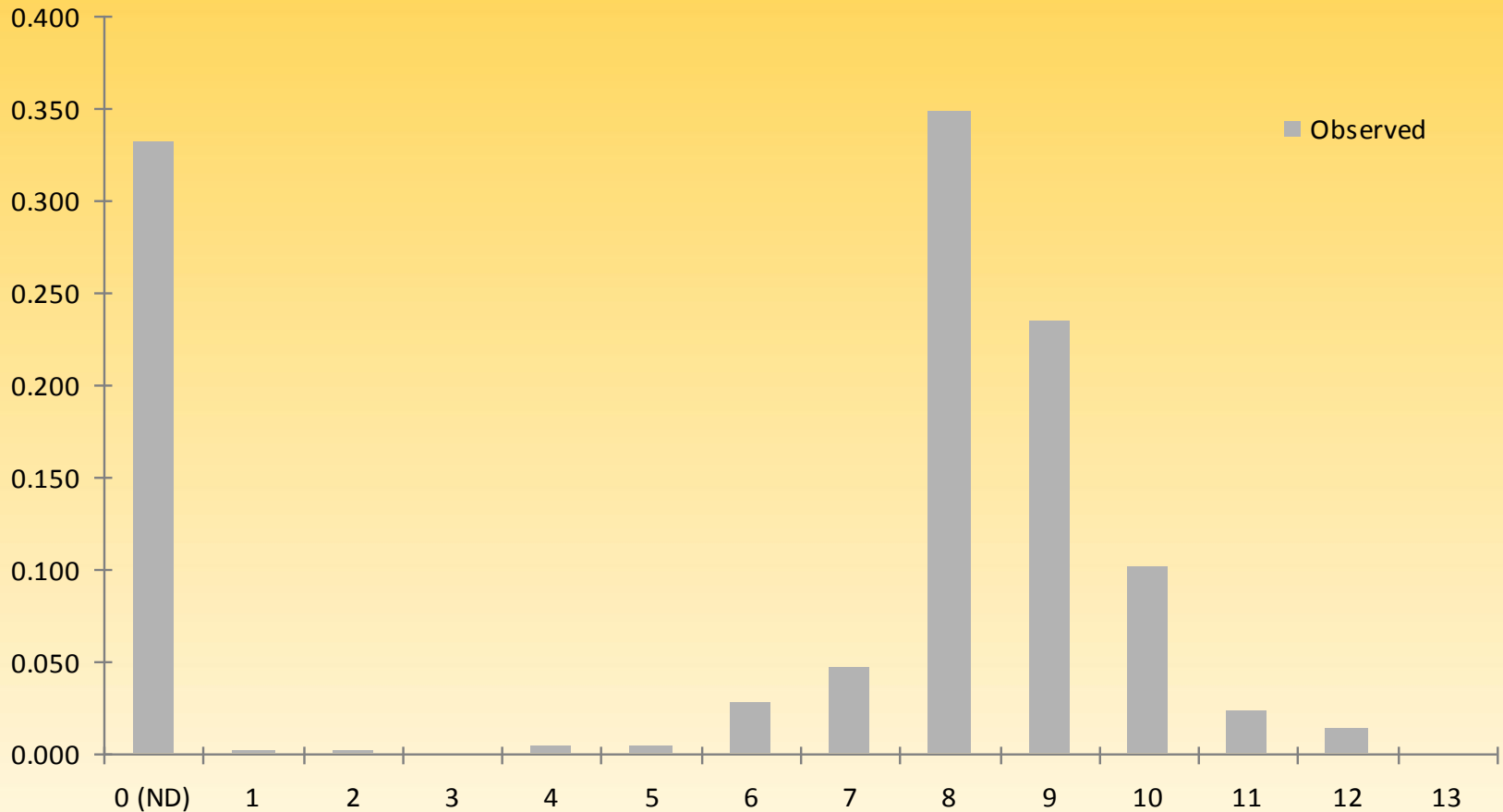


Measuring Time-to-Degree: The Semester Count Method

- Semester count is a natural measurement of time as it reflects a student's experience.
- Semester count is relatively immune to stopout behavior that complicates elapsed time measurements.
- Semester count better captures the pace of enrollment than credit hour counts as most programs require similar total credit hours.



Time-to-degree Descriptive Statistics



Independent Variables

- **Academic Background:** ACT Score, First Generation College, First Choice College, AP Credits, and Remedial Course.
- **First Semester Performance:** Course Completion Ratio, C Count, D Count, and W Count
- **Demographic Characteristics:** Female, Asian, Underrepresented Minority, Nonresident/International, and Athlete
- **Geographic Origin:** Out-of-state, Reciprocity



Independent Variables (cont.)

- **Social Integration:** On-campus Housing, Living Learning Community (LLC), Federal Work Study, and On-campus employment.
- **Financial Aid:** Need Aid Award, Loan Award, Merit Aid Award, and Remaining Unmet Need.
- **Post Matriculation Enrollment Patterns:** Inter-Program Transfer, Transfer Credits, Study Abroad, Number of Summer Sessions, Number of Semesters Under 13 Credits



Methodology

- Adopt a multivariate approach to modeling time-to-degree.
- Because our dependent variable takes a non-negative, interval value, OLS is not appropriate
 - What's wrong with a little OLS? Long (1997) tells us that application of OLS for count data leads to “inefficient, inconsistent, and biased estimates.”



Modeling Count Data

- While count models appear to be infrequently applied to higher education literature, they are used in many of other fields
- Examples include models of:
 - Beverage consumptions (Mullahy, 1986)
 - Consumer loan default (Greene, 1994)
 - Publications by doctoral student (Long, 1997)



Methodological Issues

- Poisson is rarely appropriate model specification for data
- Two problems with Poisson:
 - Overdispersion
 - Excess Zeros
- Negative Binomial is common solution to overdispersion, it is unable to solve our problem with excess zeros



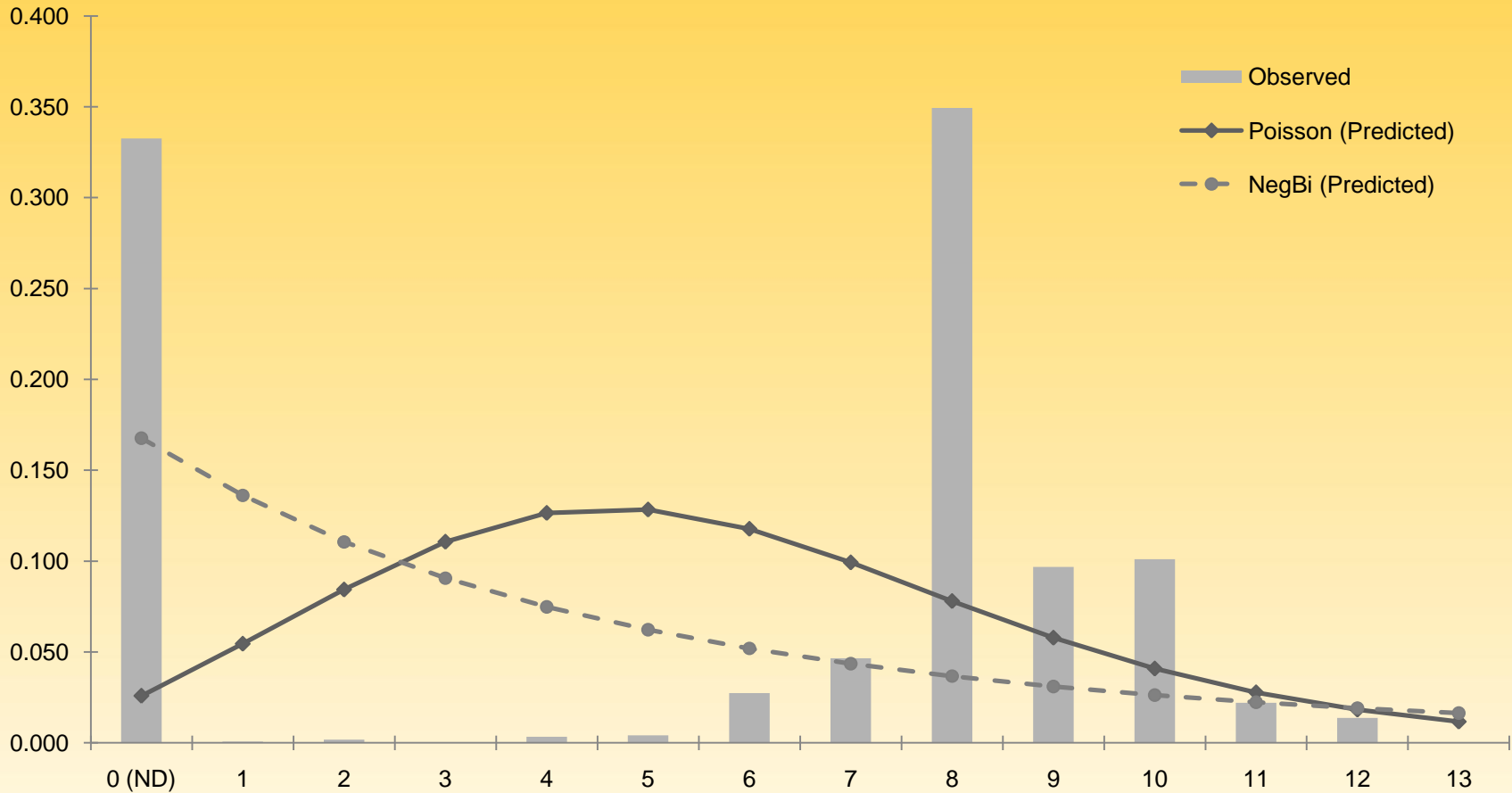
Count Models

- The Poisson model is the starting place for models of count data.
- The model is represented by the equation

$$\Pr(Y = y|\mu) = \frac{e^{-\mu}\mu^y}{y!}, \quad y = 0, 1, 2, \dots$$



Count Models



Zero Modified Count Regression

- Zero inflated count models
- Hurdle models
 - Zero inflated models “change the mean structure to allow zeros to be generated by two distinct processes, compared with one process generating zeros in the hurdle model” (Long & Freese, 2003, p. 394)



Hurdle Models

- Our data is represented by **two distinct** data generating processes (graduation and time to degree)
- When this is the case hurdle models are preferred to zero inflated models (although the results for the two models have been demonstrated to be similar).



Hurdle Model

- Part 1 models the binary outcome and indicates if the hurdle is crossed.

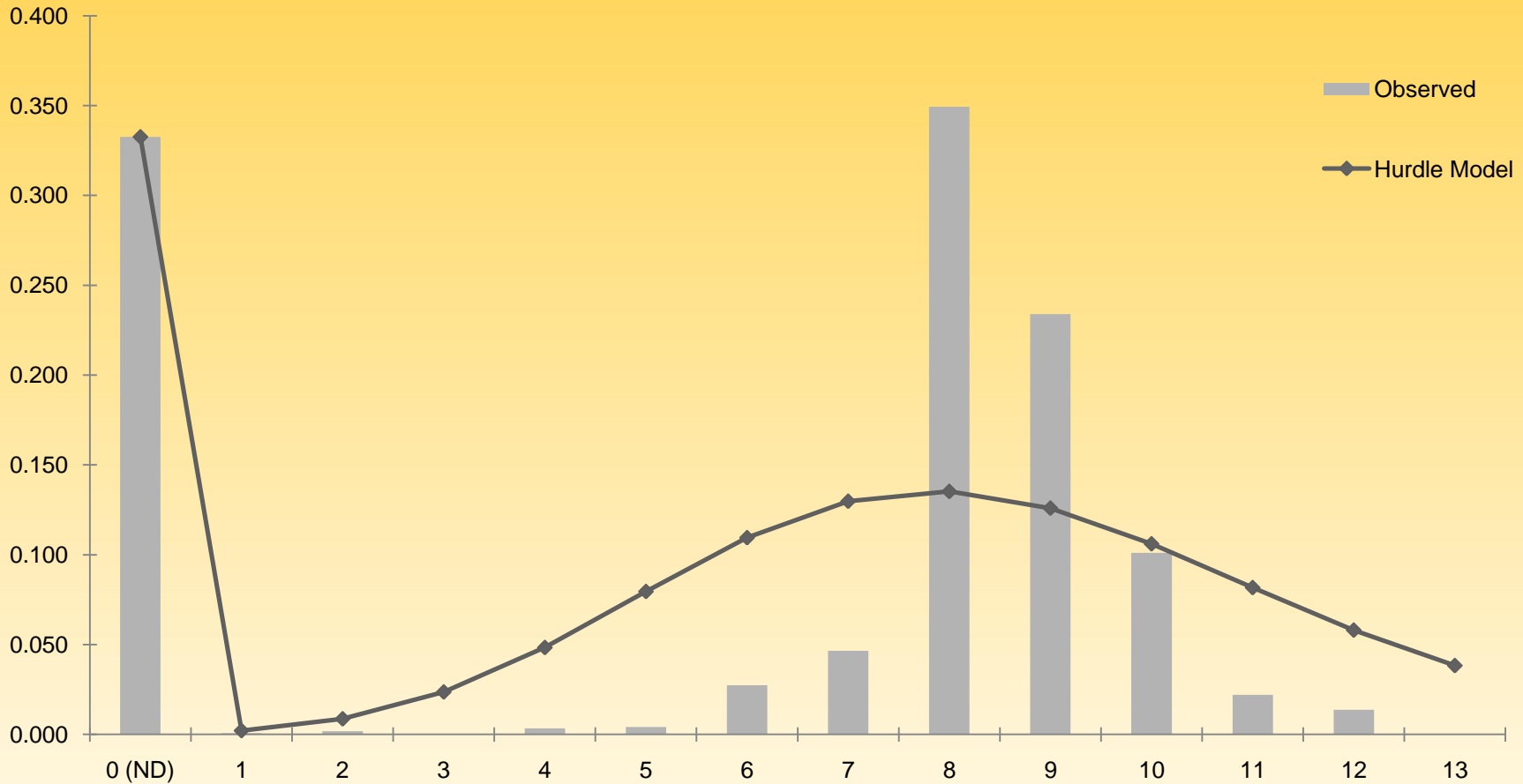
$$\Pr(y_i = 0 | \mathbf{x}_i) = \frac{\exp(\mathbf{x}_i \gamma)}{1 + \exp(\mathbf{x}_i \gamma)} = \pi_i$$

- Part 2 models the truncated count:

$$\Pr(y_i | \mathbf{x}_i) = (1 - \pi_i) \Pr(y_i | y_i > 0, \mathbf{x}_i) \text{ for } y > 0$$



Hurdle Model



Results

- The following table presents the regression coefficients and standard errors.
- Recall that applications of regression analysis assume that observations are independent of one another
- Because we are worried about independence within different colleges, we provide *cluster robust standard errors*.
- Robust standard errors protect against type 1 errors when evaluating t statistics



Results: Academic Background

Hurdle Model

Truncated Count

	Coef.	Rob. SE	Sig.		Coef.	Rob. SE	Sig.
Composite ACT Score	0.001	0.012			-0.001	0.001	
First Generation Student	0.245	0.097*			0.002	0.003	
First Choice College	-0.125	0.032***			0.002	0.010	
Advance Placement Credits	-0.034	0.006***			-0.002	0.001**	
Remedial Course	0.805	0.170***			0.038	0.006***	



Results: First Semester Performance

Hurdle Model

Truncated Count

	Coef.	Rob. SE	Sig.		Coef.	Rob. SE	Sig.
Course Completion Ratio	-0.032	0.002	***		-0.002	0.000	***
C Count	0.310	0.022	***		0.007	0.006	
D Count	0.600	0.088	***		-0.004	0.005	
W Count	0.799	0.047	***		-0.023	0.013	



Results: Demographic Characteristics

Hurdle Model

Truncated Count

	Coef.	Rob. SE	Sig.		Coef.	Rob. SE	Sig.
Female	-0.044	0.109			-0.026	0.005	***
Asian	-0.014	0.086			0.023	0.017	
Underrepresented Minority	0.300	0.145	*		0.002	0.003	
Nonresident/Internati onal	-0.433	0.481			-0.011	0.026	
Athlete	-0.586	0.178	**		0.024	0.008	**



Results: Geographical Origin

Hurdle Model

Truncated Count

	Coef.	Rob. SE	Sig.		Coef.	Rob. SE	Sig.
Out-of-State	0.350	0.132	***		-0.007	0.012	
Reciprocity State	0.155	0.137			0.017	0.007	*



Results: Social Integration

Hurdle Model

Truncated Count

	Coef.	Rob. SE	Sig.		Coef.	Rob. SE	Sig.
Living On Campus	-0.310	0.076	***		0.014	0.008	
Living Learning Community	-0.347	0.076	***		0.023	0.007	***
Federal Work Study	0.056	0.134			-0.035	0.008	***
On-Campus Job	0.037	0.037			-0.012	0.005	*



Results: Financial Aid

Hurdle Model

Truncated Count

	Coef.	Rob. SE	Sig.		Coef.	Rob. SE	Sig.
Unmet Need Amount (in \$100)	0.003	0.001	***		0.000	0.000	
Need Aid Award	-0.079	0.082			0.004	0.002	*
Loan Award	0.292	0.091	**		0.002	0.007	
Merit Award Award	-0.813	0.192	***		-0.010	0.013	



Results: Post Matriculation Enrollment Patterns

Hurdle Model

Truncated Count

	Coef.	Rob. SE	Sig.		Coef.	Rob. SE	Sig.
Within College Transfer					0.016	0.012	
Credits Transferred In					-0.004	0.000	***
Study Abroad					0.026	0.008	**
No. of Summer Semesters Enrolled					0.013	0.003	***
No. of Semester with < 13 Credits					0.047	0.002	***



Overview of findings

- Less is known about time-to-degree than probability of graduation
- Rigor of previous curricula can give students a head start or force them to play catch-up
- On-campus work speeds time-to-degree
- Merit aid associated with increased likelihood of graduation, loans with decreased likelihood.
- Study abroad, summer enrollment, and part-time attendance associated with slower graduation



How have we responded?

- Instituted a 13-credit minimum and flat-rate tuition for full-time students
 - Credit loads have increased
 - Summer enrollment has decreased
- Founders Free Tuition Program
 - Aims to reduce reliance on loans for needy students
 - Now instituting a middle-class scholarship program



Current and future actions

- Focus on improving student engagement
- Increasing expectations for entering students to be prepared for college-level work
- Improving responsiveness of advising to keep students on track
- Curricular audit to identify and remove obstacles to program completion



Future research

- Expand specification of model with additional post-matriculation student experiences
- Compare results using alternative measures of time to degree (elapsed time or credits completed)
- Apply methodology to faculty career progression and time in rank



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