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Project Description I

Title:

Essays on Admissions Matching and Associated Outcomes in the Market for Higher Education in the United States

Statement of the research problem and national importance:

This proposal comprises two essays, the first an investigation of the impact of institutional characteristics on students' admissions decisions, with an emphasis on "undermatching" (students' attendance at less selective institutions than they are able to attend), and the second an analysis of completion rates, time to degree, pursuit of advanced degrees, and labor market outcomes arising from admissions match quality (Bowen, Chingos, & McPherson, 2009, p. 88). Conducting these investigations in tandem will underscore the relationships between institutional decisions and student access and between students' admissions decisions and future outcomes.

The price to attend institutions represents an obstacle to access for many students. Annual percentage growth in tuition and fees across institutional types has exceeded annual percentage growth in median household income since 1980 (Heller, 1997; Hughes, 2011). Between 1984 and 2008, participation rates rose for all family income quintiles, and between 1975 and 2008, participation rates rose for male and female students and for Black, Hispanic, and White students, despite rising prices (Baum, Ma, & Payea, 2010). Still, these participation rates exhibit stratification by income and race/ethnicity, and students' selection into two- and four-year institutions exhibits stratification by income (Baum et al., 2010). Access only illustrates part of the picture; in a study of 1999 high school graduates in North Carolina, Bowen, Chingos, and McPherson (2009) report students enrolling in selective institutions had a six-year (four-year) graduation rate of 81% (59%), while students who undermatched had a 66% (44%) six-year (four-year) graduation rate. Bowen et al. (2009) also suggest that declining to attend selective institutions may introduce costs later in life, such as reduced likelihood of earning an advanced degree and lower earnings.

Regardless of their selectivity, institutions have incentives to market themselves and enroll the best students they can attract. Despite decades of rising tuition and fees, institutions continue to rely on tuition and fees to generate revenue. Public institutions have faced appropriations reductions, and market volatility has reduced the stability of endowment income, while health care and retirement costs continue to rise (Kiley, 2011a; Lewin, 2010; Kiley, 2011b; Keller, 2010). In order to generate tuition revenue, institutions must invest in programs, services, and financial aid to entice students to attend. So far, these factors and anticipated higher earnings have driven enrollments higher despite higher tuition, but median real earnings for female bachelor's and advanced degree holders held roughly stagnant between 1971 and 2008, and the same figure for males fell over this period (Baum et al., 2010). How long can institutions raise tuition and expect students to pay or borrow to finance attendance? Do any programs or services appear to insulate institutions from some of the negative enrollment effects of rising prices?

Students' access to higher education and higher education institutions' financial health reflect issues of national importance. Institutions must understand how to invest limited resources optimally to attract prospective students and also understand how their investments influence student outcomes. For students, President Obama has articulated a vision for higher education that would see the United States lead all other nations in the proportion of citizens graduating from college by 2020 (Perna, 2010). In order to increase the proportion of individuals graduating from college, policymakers and institutions might seek to increase the number of individuals entering college or increase the completion rate for individuals who already enter. The proposed analysis of the admissions process will shed light on entry, and the proposed analysis of outcomes may illustrate opportunities to improve match quality and subsequent completion rates.

New methods, appropriate data, and pressing implications suggest this proposal is timely as well as important. Recent developments in the industrial organization literature, namely models that can account for differences in students' characteristics and the importance of different institutional characteristics to different kinds of students, have supported important insights in other markets but have yet to appear in the higher education literature (Berry, 1994; Goldberg, 1995; Draganska & Klapper, 2011). Employing these developments requires detailed information about students' admissions experiences, and the National Longitudinal Survey of Youth offers this along with associated outcomes data and a link to IPEDS for institutional information. These data illustrate the new methods and lend themselves well to analysis of matching, but institutions can emulate these methods with local data to ask more specific questions, including assessing the enrollment impact of institutional investments or examining the impact across different students of a tuition increase. At the same time, students and institutions need to weigh tuition, fees, and borrowing risks against expected future returns from enrollment decisions.

Review the literature and establish a theoretical grounding for the research:

A review of the literature related to matching in the admissions process and outcomes (specifically completions and earnings) related to institutional characteristics follows. I begin with a description of undermatching and possible causes then look for

additional plausible causes in the literature on price sensitivity and college choice, and I identify limitations in existing studies and opportunities to overcome them to frame my investigation. I close with a discussion of the impact of institutional characteristics on outcomes and an opportunity to apply a key methodological insight to nationally representative data.

Bowen, Chingos, and McPherson (2009) find evidence of undermatching in their analysis of North Carolina high school seniors for 1999. In the data, 6,217 students met the authors' conditions for presumptive eligibility to UNC-Chapel Hill or NC State, but 30% attended a less selective institution, 3% attended a two-year institution, 1% attended a historically Black college or university (HBCU), and 9% chose not to attend any institution (Bowen et al., 2009). In a study of Chicago public high school seniors in 2005, Roderick et al. (2008) find that among students with aspirations for four-year or graduate degrees, only 59% applied to four-year institutions, 51% were accepted, and 41% enrolled. Roderick et al. (2008) suggest that obstacles include failure to apply, failure to gain admission, decisions not to enroll if offered admission, and plans to pursue work, military service, or two-year degrees.

The literature on price sensitivity and college choice offers additional reasons students may not choose to attend the most selective institutions available to them. At least four decades of research on price sensitivity (Leslie & Brinkman, 1987; Heller, 1997; Kim, 2010) suggests lower-income students tend to be more price-responsive than higher-income students (St. John, 1990; Behrman, Kletzer, McPherson, & Schapiro, 1992) and Black and Hispanic students tend to be more price-responsive than White and Asian students (St. John & Noell, 1989; Wetzel, O'Toole, & Peterson, 1998; Perna & Titus, 2005). More broadly, models of college choice (Chapman, 1981; Perna, 2006) identify student characteristics, including academic ability, high school performance, demographics, socioeconomic status, and degree aspirations, and institutional characteristics, including tuition and fees, location, program offerings, and marketing efforts, that drive students' decisions, modulated by high school environment and a context of society, the economy, and public policy. Importantly, in a study of students' interest in a selective private university among competitors, Weiler (1996) finds "non-monetary institutional characteristics" play a key role, with residential and recreational amenities about as significant as academic characteristics (p. 34).

Given these findings, most studies suffer from at least one of the following limitations: first, most price sensitivity studies ignore institutions' supply constraints (Zhang, 2007), and second, multinomial logit discrete-choice models (Chapman, 1979; Fuller, Manski, & Wise, 1982; Brewer, Eide, & Ehrenberg, 1999) impose unrealistic substitution patterns based on observed market shares rather than product characteristics (Berry, Levinsohn, & Pakes, 1995; Nevo, 2000). A series of industrial organization studies has overcome these limitations by grounding preferences and substitution patterns in interactions between observable consumer characteristics and product characteristics (so price changes or changes in product characteristics affect consumers differently based on their individual differences) and modeling supply-side price setting endogenously (Berry et al., 1995; Goldberg, 1995; Nevo, 2001). These models also allow researchers to simulate responses to changes in price or other characteristics and conditions once preference parameters are estimated (Petrin, 2002; Epple, Romano, & Sieg, 2006; Fu, 2010). Finally, Draganska and Klapper's (2011) recent contribution to this literature can eliminate the assumption that all students are able to choose from all institutions and reflects differences across students in available options based on applications and admissions. These methodological developments create an opportunity to refine models of price sensitivity and college choice while specifically exploring factors associated with undermatching in enrollment decisions using nationally representative data.

Research also illustrates examines the choices students make in the admissions process with respect to their effects on academic and economic outcomes. Braxton (2003) suggests the link between institutional characteristics and persistence is unclear, and Titus (2004) finds that institutional size and selectivity matter but not as much as complex student characteristics such as goals and experiences. Financial aid appears to affect persistence insofar as grants and work-study awards help more than loans, with more pronounced effects for underrepresented students (St. John, 2002; Swail, 2003; Pell Institute, 2004; Kuh et al., 2006). Dale and Krueger (2002) find that selectivity has a negligible effect on earnings, also suggesting the student matters more than the institution. Using tuition and expenditures per student to capture institutional quality, however, Dale and Krueger (2002) find positive returns to attending more expensive institutions and institutions that invest more in their students. Whereas Dale & Krueger (2002) study a dataset with a sample of about thirty selective and largely elite private institutions, Monks (2000) and Zhang (2005) analyze nationally representative datasets and find positive returns to attendance at selective institutions, enough in Zhang's (2005) case to compensate for differences in tuition and fees across institutions.

Dale and Krueger (2002) identify a source of bias in their analysis of labor market outcomes by selectivity: more selective institutions admit more capable students, sometimes for reasons that researchers cannot observe. Insofar as unobservable characteristics support students' earnings after college, they bias estimates of the return to selectivity upward (Dale & Krueger, 2002). In order to address this, the authors employ matched sampling techniques to group students who are accepted to and rejected by the same institutions or include own SAT and the SAT of institutions where students apply as controls, expecting that students' application patterns reveal something about their unobserved characteristics. This stands as the preferred adjustment for selection on unobservables as long as detailed admissions data are available, and I will apply this adjustment to analysis of completions and time to degree as well. Analysis of these outcomes based on student and institutional characteristics is consistent with Tinto's (1993) seminal research on completions and subsequent critiques (Metz, 2004; Kuh et al., 2006).

Describe the research method that will be used:

As a nationally representative dataset, NLSY requires aggregation of institutions to improve precision, because some institutions may have only one or two applicants or attendees (Goldberg, 1995; Fu, 2010). IPEDS and other public data

sources allow for grouping by level, control, selectivity, and non-academic characteristics. I refer to “non-academic characteristics” because I will capture features including but not limited to facilities, athletics, and social environment in an index rather than include these variables individually (Chapman, 1979; Weiler, 1996). These groups form the basis for both the admissions matching study and the outcomes study.

A growing matching literature (Roderick et al., 2008; Bowen, Chingos, & McPherson, 2009) suggests unclear plans, misinformation, and failure to apply may derail students’ attendance at appropriately challenging institutions. I will investigate the role of institutional factors as well as students’ sensitivity to competing financial aid offers from institutions where they receive offers of admission. Thus, do differences in the price of attendance lead some students to undermatch? Are there differences across students in the importance of price relative to other characteristics? Conversely, are there some institutional characteristics that insulate against the negative enrollment effects of tuition increases?

To answer these questions, I will follow Goldberg’s (1995) investigation using data on individuals and their purchases along with population weights to estimate a demand system. I offer Figure 1 as an attachment to illustrate the nesting structure I have developed in parallel to Goldberg’s (1995) model. A student s has an objective function given by equation 1 (attached), where E , L , C , A , and N designate vectors of explanatory variables specific to the choices of enrollment, level, control, academic selectivity, and non-academic offerings, including both student and institutional characteristics as well as their interactions, and the Greek letters denote parameter vectors to be estimated. The joint probability of attending an institution of type $\{e, l, c, a, n\}$ is given by equation 2 (attached), and the marginal probability of any step (or stage in Figure 1) is given by a multinomial logit formula (Goldberg, 1995). I will include Draganska and Klapper’s (2011) extension of variation in choice sets across students such that the multinomial logit formulas will only compare characteristics of institutions for students that have offered those students admission, and I will perform extensive specification testing of the distribution of the error term ϵ and the structure of the nests.

My conception of institutions’ objectives again follows Goldberg (1995) with insights from Paulsen (2001) such that institutions seek to maximize their discretionary budgets, taking endowments, appropriations, and admissions standards as given for one pricing decision. Departing slightly from Goldberg (1995), costs for institution i are given by equation 3 (attached), where C represents total costs, Q represents a minimum acceptable student quality, N represents enrollment, F represents a fixed cost, and c represents a constant marginal cost of admitting an additional student. Institutions maximize the expected discretionary budget by choosing a price according to equation 4 (attached). With student demand and institutional supply in equilibrium, parameters can be estimated using sequential maximum likelihood estimation (Goldberg, 1995). Once parameters are estimated, I can create a measure of presumptive eligibility for students in admissions and identify characteristics associated with undermatching (Bowen, Chingos, & McPherson, 2009) and also use the estimated parameters to carry out simulation exercises by changing institutional characteristics and examining resulting changes in enrollment patterns (Petrin, 2002; Fu, 2010).

In the second essay, I will investigate the “personal and societal cost” of undermatching to which Bowen and his coauthors (2009, p. 109) refer. Specifically, as Bowen et al. (2009) suggest in North Carolina, do nationally representative data suggest attendance at selective institutions helps similarly qualified students to complete degrees more quickly? Does attendance at these institutions help similarly qualified students find places in jobs more quickly upon graduation or to secure higher initial earnings? For students in the 1979 cohort of NLSY, does attendance at these institutions help similarly qualified students to garner higher earnings five or ten years after college?

Dale and Krueger (2002) raise an important point relevant to analysis of outcomes arising from admissions matching. If there are student characteristics observable to admissions officers but unobservable to researchers, and more selective institutions attract students with better unobservable characteristics correlated with future earnings, then the estimated regression relationship between selectivity and earnings will be biased upward. In order to address this, Dale & Krueger (2002) offer two approaches, one comparing outcomes for students accepted to and rejected by *the same* institutions, leaving more of the observable variation in outcomes to arise from differences in the institutional experience and less due to the admissions process, and the second including the average SAT score of institutions where each student applied and the SAT score of the institution each student attended as controls, assuming student application patterns reveal something about their unobservable characteristics. Here, I will use the self-revelation approach as presented and use exact matching based on institutional groupings, comparing outcomes for students accepted to and rejected by at least one institution in corresponding groups. I may need to use other methods for NLSY79 (Brewer, Eide, & Ehrenberg, 1999; Monks, 2000) if admissions data are unavailable.

To analyze initial and subsequent earnings, I will employ weighted least squares regressions as in equation 5 (attached), where W_i is the wage for individual i ; X_{1i} is a vector of individual characteristics including SAT score, average SAT at the institution attended, and demographics; and X_{2i} is a vector including the average SAT score of institutions where student i applied and dummies for the number of applications submitted, included in the specification of the self-revelation model (Dale & Krueger, 2002). To analyze degree completion and pursuit of advanced degrees, I will employ a binary model such as a probit as in equation 6 (attached), where Y_i^* is latent. To analyze time to degree and time to job placement, I will estimate Cox proportional hazards models as in equation 7 (attached), where $h(t)$ is non-parametric.

Uploaded Appendix Document(s):

- [Figure 1](#)
- [Equations](#)

Project Description II

Will you use NCES target dataset? Yes

Please check all NCES datasets that apply

- IPEDS 12-Month Enrollment (E12)
- IPEDS Finance (F)
- IPEDS Institutional Characteristics (IC)

Explain why each dataset best serves this research. Include a variable list for each dataset used.

My use of NCES data will center on IPEDS through the enrollment, finance, and institutional characteristics surveys. I will use IPEDS in conjunction with the Bureau of Labor Statistics' National Longitudinal Survey of Youth (NLSY) for the 1979 (NLSY79) and 1997 (NLSY97) cohorts, with public and restricted-access data for each cohort. NLSY97 is a nationally representative survey that includes information about students' applications, admissions results, and enrollment decisions, along with institution-specific financial aid offers. Further, both NLSY97 and NLSY79 follow students past college to permit analysis of student outcomes associated with the characteristics of institutions students choose to attend. I can introduce other public information about institutions available from sources beyond IPEDS to improve the analysis as well.

Specific variables from IPEDS will include at least tuition and fees, level, control, Barron's admissions selectivity rating, and investments in facilities. I may use additional cost data to check new specifications of the estimation of institutional marginal costs and draw on other public institutional data to develop an index of non-academic offerings. Specific variables from NLSY will include at least institutions where students applied, were accepted, and enrolled (NLSY97); financial aid offers; gender; race/ethnicity; family income; parents' education; number of siblings in college; test scores; high school grades; monthly enrollment status; degrees earned; employment status; and wages.

This project does not address the current NPEC focus topic but addresses access and success issues that NPEC recently has identified as important.

Will you use NSF target dataset? No

Explain why each dataset best serves this research. Include a variable list for each dataset used.

Will you address the NPEC focus topic? No

If yes, please briefly describe:

Project Description III

Provide a timeline of key project activities:

Winter/Spring 2012

Estimate preliminary results for admissions matching study using NLSY97 data

Receive NLSY79 data

Submit updated plan for IRB review

February 2012

Submit abstract to present preliminary design and results of admissions matching study at Penn State's *Higher Education in Review* Symposium

March 2012

Give presentation at Penn State's *Higher Education in Review* Symposium

May 2012

Submit two research paper proposals for 2012 ASHE annual meeting, one for the admissions matching study and one for the outcomes study

Summer 2012

Conduct research for ASHE research papers/dissertation essays

October 2012

Submit two conference papers to readers for 2012 ASHE annual meeting

November 2012

Give two presentations at 2012 ASHE annual meeting

Winter/Spring 2013

Update research based on ASHE feedback

Prepare AIR Forum final paper and presentation

May 2013

Give final presentation at 2013 AIR Forum

June/July 2013

Prepare and submit two articles for peer-reviewed scholarly journals

List deliverables such as research reports, books, and presentations that will be developed from this research initiative:

This research project will lead to the production of nine major deliverables. First, I will submit an abstract to present the preliminary design and estimation results of the admissions matching study that comprises the first essay of my dissertation at Penn State's March 2012 *Higher Education in Review* Symposium. Second, I will propose to write two conference papers and deliver two presentations based on the admissions matching study and the outcomes study at the 2012 annual meeting of the Association for the Study of Higher Education (ASHE). After that, I will write a final research report and deliver a presentation at the 2013 AIR Forum, incorporating feedback from ASHE presentations and presenting fully refined model specifications and estimation results. Finally, I will write and submit two articles to peer-reviewed education journals, one for the admissions matching study and the other for the outcomes study.

Describe how you will disseminate the results of this research:

I will propose to begin dissemination of the results of this research by offering a presentation of preliminary results from the admissions matching study at Penn State's 2012 *Higher Education in Review* Symposium. From there, I will propose to submit research papers and offer presentations at the 2012 ASHE annual meeting to share the development and results of both the admissions matching study and the student outcomes study. After receiving feedback and investing more time into the development of both, I will share my final results at the 2013 AIR Forum. Moving forward from that point, I will finalize and submit two journal articles, one arising from each essay. At this stage, I anticipate submitting the admissions matching study to a higher education-specific field journal or an economics of education journal, and I will submit the second to a higher education-specific field journal.

Provide a reference list of sources cited:

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IRB Statement

Statement of Institutional Review Board approval or exemption:

I have applied for and received IRB approval through Penn State's Office of Research Protections under request #38428 for the project entitled, "A Model of Matching and Associated Outcomes in the Market for Higher Education Admissions". This IRB approval governs my use of NLSY97 data for this project, and the IRB application process requires an outline of measures to protect confidentiality and submission of copies of institutional agreements. I have not yet entered into an agreement with the Bureau of Labor Statistics to secure access to restricted NLSY79 data, so once I do this, I will update my IRB application by describing the terms of my access to this dataset and the components of the project in which I intend to use it.

Statement of Use of Restricted Datasets

My research will employ the restricted Geocode Data File associated with the National Longitudinal Survey of Youth. I already have access to the restricted data associated with NLSY97, and I have requested the addition of the restricted Geocode data associated with NLSY79 to my existing license. My agreement with the Bureau of Labor Statistics to gain access to the Geocode Data File includes a number of arrangements in place to maintain respondents' confidentiality: I will only conduct analysis in 407 Rackley Building, a secure office on Penn State's University Park campus; I will store the original data files in a locked receptacle inside that office; I will conduct analysis only on a computer in that office that is password-protected and disconnected from outside networks; I will refrain from storing original data or data files derived from original data on any portable media; a representative of Penn State has signed an institutional agreement with BLS; and my advisor and the administrators for 407 Rackley have signed BLS agent agreements. I have informed the BLS representative who signed my institutional letter of agreement that I intend to analyze restricted NLSY79 data in addition to the NLSY97 data, and BLS will update my active license to reflect this.

Biographical Sketch

As a student, I developed a foundation in economics before moving into training in higher education. In 2007, I earned a bachelor's degree in Economics at Penn State University through the Schreyer Honors College, and I completed minors in Mathematics and Philosophy. To complete Honors in Economics, I wrote a thesis applying game theory to agricultural trade negotiations. I won a thesis prize from Penn State's chapter of Phi Beta Kappa for the outstanding honors thesis in the arts and sciences, and I won the James Rodgers Award in Economics for the outstanding graduating senior. In 2009, I completed a master's degree in Economics, also at Penn State, having completed doctoral coursework with fields in Microeconomics, Macroeconomics, and International Trade. After that, I entered Penn State's Ph.D. program in Higher Education, where I have completed coursework and am set to begin dedicated dissertation research. I have earned a Dissertation Research Initiation Grant through Penn State's College of Education as well as the Martorana Family Award in the college to support doctoral research in education.

Assistantships in Economics and Higher Education have supported my development as a teacher and a researcher. In Economics, I served as a teaching assistant and instructor for courses in intermediate microeconomics and advanced international trade theory. During my first two years in Higher Education, I served as a research assistant for Dr. John Cheslock through the Center for the Study of Higher Education. I have been able to learn from Dr. Cheslock's use of NCES datasets in his work, especially NPSAS and IPEDS, and I have learned how to manage restricted NCES data in a secure environment. This year, I serve as a teaching assistant for Dr. Cheslock in Penn State's AIR-supported Institutional Research Certificate program.

Outside the classroom, I served for three and a half years as the student member of Penn State's Board of Trustees. I applied for this position as a graduate student in Economics because I thought I could draw from my background to contribute to the board's work and develop interesting research questions, but I underestimated how much this would be true. Serving on the board amid declining public financial support for Penn State and rising tuition motivated my dual interest in institutional pricing strategies and the impact of rising prices on access and also motivated my pursuit of a formal degree in Higher Education. While on the board, I served for a year as chair of the board's Committee on Campus Environment, and after my appointment to the board concluded I agreed to serve as the student representative on Penn State's special committee to make recommendations to the university after allegations against former coach Jerry Sandusky.

Overall, my coursework and experiences in higher education have prepared me well to conduct my dissertation research. Through courses in statistics, I learned the regression methods that underlie many models in the higher education literature, and as a graduate student, I have learned about maximum likelihood and method of moments estimation and seen these techniques used in structural models, specifically in industrial organization. I have also learned computational techniques in statistics and gained experience programming in Matlab and Stata. Through coursework in higher education, I have studied research methods and learned about validity in education research, and I participated in the NCES/NSF/AIR National Summer Data Policy Institute and the ASHE Graduate Student Policy Seminar in 2010. I am confident my experiences as a trustee at a flagship public university have prepared me well to understand the strategic pricing decision institutions face and the importance of the corresponding challenge of access, and I am well positioned to employ quantitative methods to make a contribution to the higher education literature and glean important insights for institutions and their prospective students.

So far, I have participated in two projects with Dr. Cheslock using national datasets. The first examined differences across states and changes over time in public tuition and state grants. This research relied on data from IPEDS, NCES' Digest of Education Statistics, and the National Association of State Student Grant and Aid Programs Annual Survey. The second, an active project (with Dr. Cheslock, Dr. Don Heller, and Rachel Frick Cardelle), investigates patterns of institutional grant awards and the impact of these grants on unmet need. This research focuses on 2007-08 NPSAS data, and we are preparing a journal submission based on this work. These research experiences have helped me to become very comfortable with national datasets while deepening my appreciation of the tuition pricing and access issues.

Budget Requirements

Salary/Stipend: \$16557.00
Tuition and fees: \$0.00
Travel: \$1700.00
Other travel related expenses: \$1300.00
Other research expenses: \$200.00
Total Request: \$19757.00

Funding History

I applied for and received a Dissertation Research Initiation Grant in the amount of \$300 from Penn State's College of Education to carry out this project. The grant will fund purchases of Matlab, Stat Transfer, and Microsoft Office, and I will use these to conduct analysis and disseminate my results. I also received the Martorana Family Award in the amount of \$2,400 from the college, and this award is designated for students who have passed the dissertation proposal phase but is not linked specifically to the project I am proposing. I do not have any pending funding applications for this project.

I have not received support from AIR for any projects in the past, but AIR did sponsor me to attend the National Summer Data Policy Institute in 2010.

Letter of Support from Dissertation Faculty Advisor

- [Letter of Support](#)

Essay #1

$$U_{e,l,c,a,n}^S = \alpha' E_e^S + \beta' L_{e,l}^S + \gamma' C_{e,l,c}^S + \delta' A_{e,l,c,a}^S + \zeta' N_{e,l,c,a,n}^S + \varepsilon_{e,l,c,a,n}^S \quad (1)$$

$$P_{e,l,c,a,n}^S = P_e^S * P_{l|e}^S * P_{c|l,e}^S * P_{a|c,l,e}^S * P_{n|a,c,l,e}^S \quad (2)$$

$$C_i(Q_i, N_i) = F_i(Q_i) + c_i N_i \quad (3)$$

$$\max_{p_i|Q_i} (p_i - c_i) E N_i - F(Q_i) \quad (4)$$

Essay #2

$$\log W_i = \beta_1 X_{1i} + \beta_2 X_{2i} + \varepsilon_i \quad (5)$$

$$Y_i^* = \beta_1 X_{1i} + \beta_2 X_{2i} + \varepsilon_i \quad (6)$$

$$h(t|X) = h(t) \exp(\beta_1 X_{1i} + \beta_2 X_{2i}) \quad (7)$$

Figure 1: Institutional Choice Model

