SURVIVE THEN THRIVE: DETERMINANTS OF SUCCESS IN THE ECONOMICS PH.D. PROGRAM

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This study investigates the completion of the Ph.D. in economics. We use ex ante information, based upon reviewing individual applications from former doctoral students. Students need different skills to succeed at each distinct stage of the doctoral program. Significant determinants for passing the comprehensive exams include Graduate Record Exam (GRE) verbal and quantitative scores, a Masters degree, and prior focus on economics. By contrast, research motivation and math preparation play significant roles in completing the dissertation. GRE scores become insignificant for completion in the generalized ordered logit estimates, which emphasize the sequential nature of the Economics Ph.D. program. (JEL I210)

I. INTRODUCTION

Every spring, admission committees review a pile of applications to select candidates for their Ph.D. programs. Beyond normal attrition, Economics departments clearly have a stake in seeing a significant proportion of students finish the program. Aside from whatever resources may accrue to departments with high completion rates, they receive prestige from the placement and success of their completed Ph.D. students in academic institutions or private sector jobs. Obtaining a Ph.D. in economics requires clearing a series of distinct hurdles and constitutes a riskier venture than attending medical school, an MBA program,

or law school.[1] Thus, information that helps identify success in completing the Ph.D. has significant value to doctoral admission committees, departments, and administrators.

This paper empirically investigates what determines successful completion of the Economics Ph.D. The data are retrieved from individual files of former Ph.D. students at Syracuse University (Carnegie Classification: Doctoral Research Universities II—Extensive). Our study breaks new ground in several areas. First, it represents an ex ante study of variables that determine doctoral degree completion since it uses only information known by the admission committee at the time of the selection process.[2] Second, in addition to demographic information and Graduate Record Exam (GRE) scores, we extract several important variables which have not been used in doctoral success studies. Third, we examine success for each of the distinct sequential stages of the Ph.D. program.

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1. Ehrenberg (1992) reports completion rates of 40%–70% for economics students, over 90% at medical schools, over 98% at law schools, and 80%–95% at MBA programs.

2. Nearly all studies in this area investigate how variables like financial support during the course of their study affect completion rates (see, e.g., Booth and Satchell 1995; Ehrenberg and Mavros 1995; Van Ours and Ridder 2003). Another ex ante study is Krueger and Wu (2000), who examine what characteristics of Princeton applicants determine admission and subsequent job placement.

ABBREVIATION

GOL: Generalized Ordered Logit

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Fourth, it provides results for a midlevel program rather than an elite one. In so doing, it focuses on the class of programs that produce the vast majority of Ph.D.s in economics.[3]

Section II introduces the models and discusses the data and variables. In Section III, we investigate the determinants of doctoral student success using logit and generalized ordered logit (GOL) estimations. Students who pass the comprehensive exams exhibit intellectual firepower (high verbal and quantitative GRE scores), have a Masters degree, and had a strong prior background in economics. But having passed the comps, completing the degree requires strong research motivation and math preparation. Research motivation, measured by whether the student mentioned in their personal statement a paper they had done, is a significant indicator for completion of the dissertation. The significant determinants of passing the comps generally become insignificant for the dissertation step. Section IV concludes the paper.

II. MODELS AND DATA

The models can all be expressed in the following form. For the ith student, $i = 1, 2, \ldots, T$, the probability of success in the jth step is $P(\text{Success}_i|x_i) = F(x_i' \beta_j)$, where the qualitative variable Success is a measure of success which may be binary or ordinal, F is a cumulative distribution function, x is a vector of exogenous variables, and β is the parameter vector. Explicit descriptions for each of the estimated models appear in the Appendix.

The specification falls into the class of limited dependent variable models. The underlying latent dependent variable can be regarded as the cumulative number of unobservable "performance units" that determine success. If the student's units meet or exceed the standard, the student succeeds or passes; otherwise, he/she fails. Given the individual's ex

ante characteristics, the student acquires these performance units in the graduate program based upon academic ability, work ethic, and behavioral characteristics.

We obtain the data by reviewing all the available files of recent Ph.D. students in the Syracuse University economics department. The sample consists entirely of students who either completed all the requirements, failed the theory or field comprehensive exam in two attempts, or left the program voluntarily. It includes no current students, even if they have finished one or more steps. As a result, the sample size is the same for all our estimations. Extracting this detailed individual information from well over 100 files yields 78 observations with data for all the outcome variables and determinants.

Summary statistics appear in Table 1. The first three rows of data consist of the Success or outcome variables, which encompass the major steps in the Ph.D. program. The variable Theory Comp equals 1 if the student passed the theory comprehensive exam, 0 otherwise. Field Comp and Completed are defined correspondingly based upon the field comprehensive exam and the dissertation. We do not distinguish between whether the student passed the Theory or Field Comp on the first or second attempt.

Students who left the program before attempting a given step receive a value of 0 for this outcome. Some students in this group decided that they do not have the performance units to reach the expected standard and chose not to try. Others who transferred before attempting the outcome (they receive a value of 1 on any previous outcomes in which they succeeded) may have the academic abilities to succeed but did not seek to obtain the necessary performance units through study. We do not distinguish between voluntary and involuntary leavers, since our goal is to evaluate what determines which students completed the degree in this program.

The sequential structure of the Economics Ph.D. program implies that the steps appear in a distinct order—theory comprehensive exam, field exam, and completion (of dissertation). The program does not allow a student to even attempt a step until they have succeeded in all the previous ones. Therefore, observations where Completed equals 1 necessarily have values of 1 for the other two outcome variables. For the same reason, observations with

3. The output of Economics Ph.D.s was extremely concentrated in the early 1920s but since the late 1970s constitutes a much more diverse market. Scott and Anstine (1997) find that a Herfindahl-Hirschman Index of the output of economics doctorates exceeded 1,000 in the early 1920s but has hovered around 200 in the last three decades. National Science Foundation (2005) and Roessler (2005) report that in 2003, programs outside the top ten produced 78% of doctorates in economics.

TABLE 1
Summary Statistics (Sample Size = 78)

Variable	Mean	Standard Deviation	Minimum	Maximum
Theory Comp	0.628	0.486	0	1
Field Comp	0.551	0.501	0	1
Completed	0.410	0.495	0	1
GRE Verbal	522.821	123.034	280	780
GRE Quantitative	692.051	80.362	440	800
GRE Analytic	646.154	110.773	290	800
Math Courses	2.910	2.649	0	15
Econ Courses	9.654	6.976	0	40
Masters	0.295	0.459	0	1
Mention Paper	0.462	0.502	0	1
Specific Topic	0.667	0.474	0	1
Specific Member	0.064	0.247	0	1
Female	0.397	0.492	0	1
Age	25.730	4.856	20	50
American	0.590	0.495	0	1
Chinese	0.154	0.363	0	1
Other Pacific Rim	0.051	0.222	0	1
Other Asian	0.103	0.306	0	1
European	0.064	0.247	0	1
Middle Eastern/African	0.038	0.194	0	1

values of 0 for any outcome have zeros as well for subsequent outcomes.

The remaining variables in Table 1 make up the determinants of success. The first three variables are the student's GRE scores—verbal, quantitative, and analytic.[4] These variables represent performance on standardized tests and are required for all applicants to the Syracuse Ph.D. program. They might be regarded as measures of innate aptitude.

The variable Math Courses refers to the number of mathematics department courses of Calculus I or above that appears in the student's transcript(s). Similarly, Econ Courses denotes the number of economics courses the student has taken. With either variable, we do not distinguish whether the student had taken them as a matriculated undergraduate, after graduation, or in a graduate program. Consequently, one student who majored in economics as an undergraduate and completed two Masters programs amassed 40

courses in the subject.[5] The variable Masters equals 1 if the student had a postbaccalaureate degree (typically a Masters) coming into the Ph.D. program.

The next three variables come from careful reading of the individual student's personal statement. The variable Mention Paper equals 1 if the student referred to a paper they had done, and 0 otherwise. The paper they mention could be from an undergraduate course, a senior thesis, a Masters thesis, or a project in which they had participated as a research assistant. This variable is an indicator of the student's demonstrated interest in doing economics research, which possibly motivated them to pursue the Ph.D.

We extracted data from the personal statements on two other determinants. Specific Topic equals 1 if the statement mentions one or more topics that the student wishes to study,

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4. Beginning in 2003–2004, the analytic part of the GRE was replaced with a writing section with scores of 1.0–6.0.

5. Another student took 36 economics courses, with the next highest 26. Estimations removing either one or two of these outlying observations generated identical qualitative results. We also recorded grade point averages in math, economics, and overall when available but lost too many observations when we included these data.

0 otherwise. Although it may not be the topic they ultimately will pursue for their dissertation, the variable provides a measure of research focus. Specific Member equals 1 if the personal statement lists one or more department members whose work interests the student, 0 otherwise. This variable measures departmental familiarity and the potential for effective matching with a dissertation advisor.[6] The next two variables are standard demographic measures—Age denotes the student's age when he/she began the Ph.D. program, and Female equals 1 if female.[7]

The last six variables consist of dummy variables for citizenship. Our classifications are American, Chinese, Other Pacific Rim (e.g., South Korea), Other Asian (e.g., India, Pakistan), European (including Turkey), and Middle Eastern/African. The sample consists of nearly 60% American students. This percentage may be higher than found in many Ph.D. programs but is historically representative of the Syracuse program, especially with its emphasis within the Maxwell School of Citizenship and Public Affairs on policy-oriented research.[8]

We also include several interaction terms, interacting GRE Quantitative with GRE Analytic, Math Courses, and Econ Courses. These terms test for a possible "compensation effect," involving students who seek Ph.D. study in economics but have a low GRE Quantitative score. If the GRE Quantitative exam measures quantitative aptitude, demonstrating analytic ability or bulking up on math or economics courses may increase the

probability of success more strongly for students deficient in this attribute.

To illustrate how this behavior works within our model, consider for example the effect of Math Courses. Let α_1 and α_2 be the parameters corresponding to Math Courses on its own and the interaction of Math Courses and GRE Quantitative. Then, the marginal effect of Math Courses on the probability of success includes the term $\alpha_1 + \alpha_2$ (GRE Quantitative) and carries the same sign as well.

The compensation effect implies that $\alpha_1 > 0$ and $\alpha_2 < 0$. The marginal effect has a positive sign only if GRE Quantitative is less than the threshold value of $-\alpha_1/\alpha_2$. Thus, math courses only help students with relatively low GRE Quantitative scores. In addition, a lower GRE Quantitative score generates a marginal effect with larger magnitude. Math courses taken beforehand have a stronger effect on the probability of success for students who are more deficient in quantitative aptitude.

III. EMPIRICAL RESULTS: DETERMINANTS OF SUCCESS

This section presents findings from estimating limited dependent variable models involving the distinct steps in the Ph.D. program. For purposes of examining as many determinants as possible, we include all the characteristics for each outcome.

Before proceeding, we address a potential selection problem, which involves decisions by students who receive an offer but choose not to enter Syracuse. If students who enroll in the Syracuse program are systematically different from students who do not come, then selection would be done on unobservable characteristics and the estimated coefficients could be biased. For example, a student's success may be based not only on characteristics observed by the admission committee but others such as ambition. If students have an offer from a higher ranked program, the more ambitious ones may systematically choose these programs over Syracuse. But like most studies in this area, we do not attempt to correct for this problem. We assume that the unobservable characteristics for selection are not correlated with the independent variables in the model. In this way, we estimate the

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6. We also examined letters of recommendation but could not come up with any usable measures based upon this information. Although Krueger and Wu (2000) find that having a letter from a prominent economist is a key determinant of later career success, we cannot identify a straightforward criterion for prominence, much less prominence across different fields.

7. Our observations do not include a minority student who completed the dissertation.

8. Nearly all students in the Syracuse program receive an assistantship or fellowship, unless they request to be self-funded. The latter category is almost totally comprised of Middle Eastern students, especially from Kuwait and Saudi Arabia. We do not include any funding variables in the estimations to remove any influence that the funding choice may have had on success. Estimations with a fellowship dummy variable generated very similar results.

TABLE 2
Logit Estimates: Determinants of Success

Determinant/Outcome	Theory Comp	Field Comp	Completed
GRE Verbal	0.0107 (0.0039)**	0.0085 (0.0039)**	0.0039 (0.0030)
GRE Quantitative	0.0849 (0.0360)**	0.0964 (0.0448)**	0.0928 (0.0337)**
GRE Analytic	0.0532 (0.0353)	0.0606 (0.0407)	0.0618 (0.0297)**
GRE Analytic × GRE Quantitative	−0.00009 (0.00005)*	−0.00009 (0.00006)	−0.000088 (0.000043)**
Math Courses	−0.3739 (1.4599)	2.0141 (1.4429)	3.7170 (1.4386)**
Math Courses × GRE Quantitative	0.0002 (0.0021)	−0.0032 (0.0021)	−0.0050 (0.0021)**
Econ Courses	0.6411 (0.6065)	1.0523 (0.6023)*	0.9254 (0.7460)
Econ Courses × GRE Quantitative	−0.0011 (0.0009)	−0.00152 (0.00085)*	−0.0013 (0.0010)
Masters	2.4420 (0.9575)**	0.4334 (0.8876)	−0.3658 (1.0003)
Mention Paper	1.2925 (0.8660)	1.1106 (0.7983)	1.9105 (0.8105)**
Specific Topic	0.6835 (0.8093)	0.5272 (0.7239)	0.0602 (0.7201)
Specific Member	0.2772 (1.0965)	−0.2595 (0.9807)	0.4582 (1.0762)
Female	−0.1993 (0.7026)	0.0027 (0.6540)	−0.4339 (0.7711)
Age	−0.0906 (0.0736)	−0.0089 (0.0808)	0.1030 (0.0723)
Pseudo R^2	0.3393	0.3100	0.2792
Log Likelihood	−34.0078	−37.0196	−38.0615

Notes: Standard errors appear in parentheses. All estimated models include an intercept and dummy variables for citizenship, except for Other Asian. The symbols * and **denote significance at the 10% and 5% levels, respectively.

effects observed for individuals who have chosen to join the Syracuse program.[9]

We begin by estimating the probability of success at each of the three stages in the Ph.D. program. Table 2 reports logit estimations for determinants of success. The models are estimated using Version 7 of Stata. All models employ the Huber-White robust sandwich variance-covariance estimator to produce standard errors that correct for heteroskedasticity. Estimated models include a constant and citizenship dummy variables for all groups except Other Asian.[10]

9. Another potential selection problem arises because only a limited set of individuals is chosen for the Syracuse program. To receive an offer, a student must meet certain threshold criteria including credentials and fit within the department's major fields. But since students who did not get accepted are screened on their applications materials alone, the selection is based purely on observable factors. So, controlling for observed characteristics in the estimations should mitigate this problem, as discussed in Angrist and Krueger (1999).

10. Estimates for the citizenship variables are not reported in the tables. The results show evidence of greater success in the early steps for the Middle Eastern/African group. We find little if any significance in the citizenship variables in the estimations for completion. A complete set of results is available from the authors upon request.

For the theory comprehensive exam, the findings for Table 2 show significantly positive effects for GRE Verbal and Quantitative exams and for having a Masters degree. The effect of GRE Verbal is smaller in magnitude relative to GRE Quantitative. The results suggest a possible compensation effect for GRE Analytic but not for either math courses or economics courses. None of the personal statement variables show significant effects.

Moving to the field comprehensive exam yields similar results. The variables GRE Verbal and GRE Quantitative again have significantly positive effects, with magnitudes similar to the estimates for the Theory Comp. None of the personal statement variables turn up significant as well. But several results differ from those of the theory comprehensive exam. Possession of a Masters degree does not significantly help to pass the field exam. And the results indicate that economics courses provide a compensation effect for those with lower GRE Quantitative scores.

Estimates for success in the last step, Completion, generate several notable distinctions as well. GRE Quantitative remains a significant determinant, but GRE Verbal is no

TABLE 3
GOL Estimates: Determinants of Success

Determinant/Outcome	Passed Comp(s) Did Not Complete	Completed
GRE Verbal	0.0180 (0.0057)**	0.0088 (0.0065)
GRE Quantitative	0.1537 (0.0923)*	0.0128 (0.0468)
GRE Analytic	0.1168 (0.0876)	−0.0417 (0.0523)
GRE Analytic × GRE Quantitative	−0.00019 (0.00013)	0.00006 (0.00008)
Math Courses	−5.8363 (4.2372)	8.1193 (4.3874)*
Math Courses × GRE Quantitative	0.0076 (0.0063)	−0.0118 (0.0062)*
Econ Courses	2.6792 (1.1400)**	1.2422 (0.9330)
Econ Courses × GRE Quantitative	−0.0040 (0.0017)**	−0.0015 (0.0013)
Masters	4.9254 (1.7898)**	−1.4344 (1.4721)
Mention Paper	1.3296 (1.1660)	2.3931 (1.2968)*
Specific Topic	2.1582 (0.8237)**	−0.2801 (1.2415)
Female	2.3709 (1.2823)**	−2.3585 (1.8263)
Age	−0.5749 (0.3400)*	0.6538 (0.2997)**
Pseudo R^2	0.4783	
Log Likelihood	−43.3575	

Notes: Standard errors appear in parentheses. The estimated model includes an intercept and citizenship dummy variables (except for Other Asian and European) in each outcome equation. The symbols * and ** denote significance at the 10% and 5% levels, respectively.

longer significant. Coefficients for GRE Analytic and Math Courses are significant with evidence of compensation effects, but the results provide little evidence regarding economics courses. In addition, the variable Mention Paper has a significantly positive effect on the probability of completion. The results indicate that quantitative talent and preparation along with interest in writing research papers are the most important determinants of completing the Ph.D. program.

The estimations for passing the field exam generate a compensation effect for taking economics courses with a plausible threshold GRE Quantitative score of approximately 692, just about equal to the sample average. The threshold GRE Quantitative score for the GRE Analytic approximately equals 702 for Completion.

The logit estimations investigate at the entry stage the significant determinants for success at each step but have little to say about where the student ultimately ends up in the program. Our next estimation emphasizes the sequential nature of the Ph.D. program, by employing GOL.

GOL extends a two-step procedure, as explained in Maddala (1998). In our context,

Step 1 consists of logit estimation of Passed Comp(s) Did Not Complete versus Exam Failures.[11] Step 2 consists of logit estimation of Completed versus Passed Comp(s) Did Not Complete, respectively, assigned values of 1 and 0. Therefore, we simultaneously estimate the probabilities:

$$\begin{cases} P(\text{Success} = \text{Passed Comp(s) Did Not} \\ \quad \text{Complete, versus Failure} = \text{Exam Failure}); \\ P(\text{Success} = \text{Completed, versus Failure} = \\ \quad \text{Passed Comp(s) Did Not Complete}). \end{cases}$$

GOL offers a particularly interesting interpretation for the probability depicted on the

11. We need to make a couple of compromises from the original specification due to data limitations. Since we do not have enough observations for students who passed the Theory Comp but not the Field Comp, we use three categories—Exam Failures; Passed Comp(s) Did Not Complete; and Completed. The middle classification consists of students with a 1 on Theory Comp and a 0 on Completed. We find very similar results for estimations when we replace the middle category with Passed Field Comp Did Not Complete. In addition, since all variables in the estimation must be represented in all categories, we drop the variables European and Specific Member.

bottom row: Given that a student passes the theory comprehensive exam, what are the significant determinants to help him/her complete the dissertation?

Findings for the estimated GOL model, which appear in Table 3, speak to the different skills needed in the two stages. Significant determinants of passing the Theory Comp with positive effects include GRE Verbal and GRE Quantitative, Masters, Female, and Specific Topic. The estimated coefficient for Age is negative and significantly different from zero. In this stage, Econ Courses show a significant compensation effect, with a threshold GRE Quantitative = 670.

The results put forth a considerably smaller number of significant determinants for Completion. The estimates for GRE scores, Econ Courses, Masters, and Female become insignificant. On the other hand, the findings suggest a significant compensation effect for completion with regard to Math Courses, with an estimated threshold of GRE Quantitative = 695. They also indicate a significantly positive effect for Age. The results indicate that while Age may be a detriment to passing the Theory Comp, it becomes an asset for Completion. The effect of Female presents another contrast. The estimate is positive and significant for the stage of Passing Comp(s) Did Not Complete but negative and insignificant for Completion.[12]

A more robust finding is the significantly positive effect of the Mention Paper variable. Even after controlling for talent and acquired skills, an applicant's interest in writing economics papers remains a significant determinant of completing the Ph.D.

The effect of GRE scores disappears in the completion stage only within the sequence-driven GOL model. The finding suggests that the logit estimates that generated a significant effect of GRE scores are due to not separating the Comp(s) stages from the modeling of the Completion stage. While the logit compares

completers to both comp failures and comp passers, GOL compares completers to noncompleters who passed the theory comprehensive exam.[13]

IV. CONCLUSIONS

Our findings tell a coherent story about what determines success in the Economics Ph.D. program. They strongly indicate that students need different skills at various stages. Along with the necessary talent and acquired tools that enable them to survive the comprehensive exams, interest in doing economics research plays a significant role for them to thrive in completing the dissertation. With the intensity of these data and the deliberate study of each step in the Economics Ph.D. program, these results provide scientific evidence that supports anecdotal suspicions regarding what it takes for students to succeed. It provides a blueprint for departments that wish to examine their own Ph.D. programs in economics, and possibly other disciplines, in this way. This issue becomes particularly important in an era of greater program assessment.

Clearly, our study has limitations in its scope, especially in focusing on a single program and not having access to a huge sample. Short of a cross-department series of investigations, what results might be peculiar to Syracuse or similar programs? To begin with, Syracuse features only four Ph.D. fields—Public Economics, Urban Economics, Labor Economics, and International Trade. It may be more important for success at Syracuse to identify applicants with definitive interests in these areas. In addition, the Syracuse program emphasizes applied research. This characteristic may be important in explaining the significance of mentioning a paper. The research in which nearly all these applicants would have been involved would have used data and estimated models. The variable may not be important for those pursuing dissertations in pure theory.

Caveats aside, our study provides a number of inherently appealing findings regarding

12. To examine possible effects of the warning by the Educational Testing Service over the integrity of GRE scores from China, we estimate models including interaction variables with the Chinese citizenship dummy variable and all three GRE scores. With the exception of the completion stage of the GOL, the Chinese citizenship dummy variable is significantly negative and the interaction term with GRE Quantitative is significantly positive. We interpret this result as lower GRE Quantitative scores reduce the probability of success particularly for Chinese students. The other findings are qualitatively unaffected. For Completion in the GOL model, the parameters are both insignificant.

13. In Grove, Dutkowsky, and Grodner (2007), a substantially longer version of this study, we use factor analysis to extract seven "factors," or underlying latent behavioral variables, from our data. Logit and multinomial logit results indicate that overall intelligence plays a significant role in success for each step, but completing the dissertation also requires motivation and research desire. The findings from GOL estimation affirm these results and provide evidence that passing the comprehensive exams additionally requires math talent.

success in the Ph.D. Economics program. Both talent and interest in doing economics research play a significant role in success, especially completion. It brings to mind a recent conversation between one of us as a Director of Graduate Studies and an applicant with outstanding academic credentials. The student stated that admission directors at several Ph.D. programs had informed him/her that "Nobody reads the personal statements." Perhaps they are missing something.

APPENDIX

EXPLICIT SPECIFICATIONS FOR THE ESTIMATED MODELS

The structural models are based upon the latent variable Success*, defined as the number of performance units. All models are described in terms of the ith student and the jth step, with u denoting the residual and x and β defined previously.

LOGIT

The structural model for success is given by:

$$Success_i^* = x_i'\beta_j + u_i.$$

We define $Success_i = 1$, if $Success_i^* \geq 0$,

and 0 otherwise,

and model probability as:

$$P(Success_i = 1|x_i) = 1 - F(-x_i'\beta_j),$$

where $F(x_i'\beta_j) = e^{x_i'\beta_j}/(1 + e^{x_i'\beta_j})$.

GENERALIZED ORDERED LOGIT

The structural model for $j = 0, 1, 2$, is given by:

$$Success_i^* = x_i'\beta_j + u_i, \quad with \begin{cases} Success_i = 0, \text{ if } Success_i^* < 1; \\ Success_i = 1, \text{ if } 1 \leq Success_i^* < 2; \\ Success_i = 2, \text{ if } Success_i^* \geq 2. \end{cases}$$

The model is estimated using the probability specification:

$$\begin{cases} P(Success_i = 0|x_i) = F(-x_i'\beta_1), \\ P(Success_i = 1|x_i) = F(-x_i'\beta_2) - F(-x_i'\beta_1), \\ P(Success_i = 2|x_i) = 1 - F(-x_i'\beta_2), \end{cases}$$

where $F(x_i'\beta_j) = e^{x_i'\beta_j}/(1 + e^{x_i'\beta_j})$.

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