When They Will Pay: Understand Deposit Decisions in College Admission

Chuan Cai, Adam Fleischhacker

## Abstract

Using data from out-of-state students at the University of Delaware, this study investigates effects of various factors on students’ deposit decisions who were admitted for Fall 2020, Fall 2021, and Fall 2022. The effects are estimated from three Bayesian hierarchical piecewise exponential models, one model for each year. Piecewise exponential models faciliate the estimation of the baseline hazard and time-varying effects. The Bayesian hierarchical framework is introduced to balance between underfitting and overfitting, especially on the time-varying effects. The baseline hazard represents students’ baseline desire to pay deposits, and we find they consistenly grows as the deposit deadline approaches, but the growth path differs each year. Findings suggest that some factors such as gender and recruitment events consistently have time-varying effects during the admission season between February and May, while the effects of some other factors such as financial aid are relatively stable within a year but can change over years. We discuss the potential reasons for the change of the effects from economic, sociological, and psychological perspectives. The findings are shared with the Admissions Office to better understand when students would like to pay deposits, so they can adjust marketing and recruitment stratigies promptly.

Keywords: college admission yield, time-varying effect, piecewise exponential model, Bayesian hierarchical model

## Introduction

Recruitment of new students is a challenging task of enrollment management for many higher education institutions, since they need to meet revenue goals, ensure academic ability, and promote diversity of the student body (Adams-Johnson et al. 2019; Maldonado, Armelini, and Guevara 2017). The recruitment process includes several general stages, searching and answering inquries of propsective applicants, reviewing application materials and making admission decisions, encouraging admitted students to pay deposits, and assisting with students’ matriculation (Litten et al. 1983). Although matriculation is the final outcome, the deposit stage is really the last focus of the Admissions Office, because most students paying deposit will eventually matriculate. Other offices/departments in an institution also pay attention to deposit situation. The Budget Office would like to use deposits paid to estimate the tuition revenue from new students. The Budget Office have to update budgetary planning in the spring, if the deposits paid are far away from the admission targets. Similarly, the Department of Residence Life and Housing need to work on the potential shortage of dorm space in the spring, if too many deposits are paid. As a result, the Admissions Office track deposits usually by week in the spring and desire to understand admitted students’ decision to pay deposits, not only whether they will pay, but also when they will pay, so they can adjust marketing and recruitment stratigies promptly (DesJardins 2002; Goenner and Pauls 2006).

Previous studies have provided valuable insights to understand students’ enrollment decisions and assist with marketing and recruitment stratigies. DesJardins (DesJardins 2002) used predictive models to segment admitted students, and he suggested enrollment managers to focus on student groups who have enrollment probabilities close to 0.5. Maldonado et al. (Maldonado, Armelini, and Guevara 2017) developed nested logit models to predict admitted students’ enrollment probabilities, and the decision makers utilized the models to allocate resources for admission activities. Goenner and Pauls (Goenner and Pauls 2006) predicted the enrollment probabilities of inquirers to help University of North Dakota allocate recruitment efforts by geographic area. Braunstein et al. (Braunstein, McGrath, and Pescatrice 1999) focused on the effects of student financial factors on enrollment decisions of admitted students, so the particular institution could understand how various kinds of financial aid affected students differently from different socio-economic backgrounds. Johnson (Johnson 2019) studied various factors associated with the enrollment decisions of out-of-state students. He identified multiple potential destinations of the students and provided insights on why the students accepted their offer of admission or chose another instittion.

Similar to many previous studies, we investigate factors to affect admitted students’ decisions, but we focus on when they will pay deposits rather than whether they will matriculate. So instead of the cross-sectional methods used in previous studies, we use event history analysis to model the deposit decisions, which is a popular tool to model students’ journey from matriculation to graduation (Chen and Hossler 2017; Gross, Torres, and Zerquera 2013; Zhan, Xiang, and Elliott III 2018). However, we use piecewise exponential models for the event history analysis instead of proportional hazard models for two reasons. First, we want to estimate students’ baseline desire to pay deposits regardless of students’ characteristics. Second, we suspect that the factors related to deposit decisions could have time-varying effects. We further introduce Bayesian hierarchical framework to the models, because the framework provides balance between overfitting and underfitting of the time-varying effects (McElreath 2020). We estimate the effects using three years’ admission data between 2020 and 2022 provided by the Admissions Office at the Unversity of Delaware (UD). We refer to the previous studies (Paulsen 1990) and suggestions from the Admissions Office to gather the input variables to the Bayesian hierarchical piecewise exponential models. The variables can be grouped into economic factors such as offered financial aid, sociological factors such as gender, and psychological factors such as delaying to review admission decisions.

This study investigates the following two research questions in order to understand students’ deposit decisions and assist with the Admissions Office’s recruitment efforts:

1. Do factors related to deposit decisions have time-varying effects during a year?

2. If they are time-independent in the year, do the factors’ effects change over years?

## Theoretical Backgound and Pratical Application

### Admission Funnel

From institution perspective, an admission funnel includes students from six stages, prospects, inquiriers, applicants, admittants, depositors and matriculants (Litten et al. 1983). In the prospect stage, the Admissions Office search for high school students who might be interested to the institution. In the inquiry stage, the Admissions Office communicate with students who expressed interests, attempt to further increase their interests, and encourage them to apply. In the application stage, the Admissions Office notify students with incomplete application forms, process and review completed applications. In the admit stage, the Admissions Office make decisions to offer admission, put students on a wait list, or reject applications. In the deposit stage, the Admissions Office interact with admitted students in campus tours and other admission events, and Student Financial Services (SFS) offer financial aid packages, in order to encourge the students to accept the offers. In the enrollment stage, the Admissions Office collaborate with other offices to help with new student orientation, course registration and on-campus residency. There are several important rates to monitor in the admission funnel, conversion rate, selection rate, yield rate and melt rate. Conversion rate is the proportion of applicants from inquiries. Selection rate is the proportion of admittants from applicants. Yield rate is the proportion of deposits from admittants. Melt rate is the proportion of matriculants from deposits. With melt rate typically closed to 100% at UD, the deposit stage or yield rate largely determines the number of new students each fall.

### College Choice

From student perspective, students’ college choices have three broad stages, college aspiration formation, search and application, and selection and attendance (Hossler and Gallagher 1987; Paulsen 1990). Students decide whether to go to college in the stage of college aspiration formation. The stage typically starts in early childhood and finishes in high school but can last beyond high school. Various factors can influence students’ decisions in the stage, such as family background (Stage and Hossler 1989; Carpenter and Fleishman 1987), encouragement of teachers (Portes and Wilson 1976) and counselors (Conklin and Dailey 1981), and students’ academic aptitude and achivement (Tuttle 1981; Davies and Kandel 1981). Students decide which colleges to apply in the search and application stage. Most students start to create a list of institutions to apply in junior years of high school and finish the applications in their senior years (Gilmour Jr et al. 1981). In addition to information from parents, counselors and peers, institutions reach out to the students with college publication such as guidebooks and invite them to campus events (Goenner and Pauls 2006). After being admitted, students decide which college to attend in the final stage. Students make decisions based on their demographic background, socio-economic status, academic preparation, and institution characteristics such as cost, financial aid, academic programs, academic reputation, and location (DesJardins 2002; Goenner and Pauls 2006).

Many studies have investigated students’ enrollment decisions in the selection and attendance stage with cross-sectional methods. DesJardins (DesJardins 2002) used a logistic regression model to predict the enrollment probabilities of students who were admitted to a public institution in the Midwest in Fall 1999 and Fall 2001. The variables include students’ demographic and socio-economic background, high school characteristics, when they applied, and personal intension. The students were grouped into deciles according to the predicted enrollment probabilities. He suggested that it was more effcient to target the “fence-sitting” groups than the groups with very high enrollment probabilities. Goenner and Pauls (Goenner and Pauls 2006) used logistic regression models with Bayesian model average techniques to predict the enrollment probabilities of 15,827 inquirers who were interested to attend the University of North Dakota in Fall 2003, to help allocate recruitment efforts by geographic areas. They investigated the effects of inquiry contact methods, geographic factors, geodemographic factors, academic factors, and some interaction terms. They suggested to concentrate recruitments effort to geographic areas where enrollment probabilities were high. Johnson (Johnson 2019) focused on 42,950 out-of-state students who were admitted to a public research univiersity from Fall 2012 to Fall 2016 and used mixed multinomial models to investigate their enrollment decisions. He used National Student Clearinghouse data to identify whether the students chose to attend one of five destinations: the study institution, another out-of-state public institution, an in-state public institution, a private institution, or a 2-year college. The factors included demographic characteristics, high school information, family background, financial aid offered and admitted academic discipline. He found that students were more likely to attend the institution if family incomes were 85,000 or higher, a family member was an alumnus or an alumna, graduated from a feeder high school, being offered higher merit scholarship, or borrowed more loans. A surpursing finding was Pell-eligible students’ enrollment decisions were not affected by grants offered in financial aid packages. Maldonado et al. (Maldonado, Armelini, and Guevara 2017) used nested logit models to predict enrollment decisions of 25,325 prospective students to four bachelor’s programs in a small private Chilean university. The three possible outcomes of the students were applied, admitted but not enrolled, and admitted and enrolled. They argued that the hierarchical models were necessary, because the last two outcomes were more similar than the first outcome and should be grouped together. Three groups of factors were included, marketing efforts from the institution, students’ socio-economic background, and stated preferences of the students. They found that on-campus activities and talks at secondary schools were more effective than career fairs to encourage enrollment, male students were more likely to attend engineering and law programs, and students’ online activities and stated preferences indicated their interests to attend the institution or individual programs. Braunstein et al. (Braunstein, McGrath, and Pescatrice 1999) used logistic regression to model the enrollment decisions of 7,104 students admitted to Iona College in three academic years. They included three groups of variables, demographic and social background, academic achievment and academic preparation, and financial aid. They found that the demographic and social background did not affect the students’ enrollment decisions, but the financial aid had positive effect. The enrollment probability increased between 1.1% and 2.5%, for every additional $1,000 offered. Within the financial aid offered, loans borrowed had more influence than grants offered, and work study had the least influence.

### Conceptual Framework

Our conceptual framework is developed from the theory of college choice (Chapman 1979; Hossler, Braxton, and Coopersmith 1989) and previous studies on students’ enrollment decisions. Students decide whether to accept admission offers, according to economic, sociological, and psychological factors (Paulsen 1990). Based on the theory of human capital (Becker 2009), the economic factors help students evaluate whether an institution provides the highest potential benefit versus cost. From sociological perspective, students choose the best institution for status attainment (Hossler, Schmit, and Vesper 1999), and the choice is affected by their sociological background (Johnson 2019). The psychological factors impact students’ opinions on institutional environment and climate, and students decide whether it is a good fit to the institution (Paulsen 1990). We hypothesis that these factors not only affect whether students would like to pay deposits, but also when they would like to pay. For admitted students, they are willing to pay deposits sooner than later if they are admitted to an institution with the best potential investment, status attainment, and/or student-institution fit.

With the guidance of the college choice theory and previous studies, we group variables into the three categories. The economic factors include offered financial aid and socio-economic status, i.e., Pell eligibility and expected family contribution (EFC). Financial aid affects students’ choices by reducing the cost of attendence, so we hypothesize that students are more likely to pay deposits with more financial aid. We use total financial aid offered rather than by aid type such as grant and scholarship, loan, and work study (Braunstein, McGrath, and Pescatrice 1999), because SFS suggests that the amounts of different aid types correlated with each other. For example, the amount of federal loans is affected by the grants and scholarships already offered. We also hypothesize that the economic factors affect the choices differently in the three years, because people tend to have more concerns about Covid-19 than financial burden in 2020, but this may not apply in the recent two years. The sociological factors include students’ demographic characteristics, i.e., home distance from UD, gender, and racial ethnicity. They reflect the influence on students’ choice from parents, peers, counselors and teachers in high school (Johnson 2019). We hypothesize that they have various effects on students’ deposit decisions. The psychological factors reflect students’ desire to attend the institution (Paulsen 1990), which include whether admitted to the Honors program, whether applied major and admitted major are different, whether attend recruitment events, and whether postpone to review admission decision (Maldonado, Armelini, and Guevara 2017). Students are more likely to pay deposits in early periods, if they have high interests to the institution. We hypothesize that students have more interests to the institution, if they apply and are admitted to the Honors program, are willing to be admitted to a different major from the applied one, attend recruitment events, and review the admission decisions promptly.

## Data and Variables

The study institution, University of Delaware, is a public research university (Carnegie classification: R1) with a population of about 18,000 undergraduate students. The Admissions Office provided the admission data of 60,285 admitted students who were out-of-state and intended to matriculate as first-time first-year students in Fall 2020, Fall 2021, and Fall 2022. The information related to student financials is added from UD’s enterprise data warehouse. We track their deposit decisions from February 1 to the deposit deadline May 1. We use February 1 as the starting point, because the Admissions Office have made most admission decisions by then. We divide the time between February 1 and May 1 into eight periods, February, March 1 to March 15, March 16 to March 31, April 1 to April 7, April 8 to April 14, April 15 to April 21, April 22 to April 28, and April 29 to May 1. The dataset is constructed as a student-period file with one row per student and period. Table 1 shows the number of observations and deposits by period each year. The number of observations increases from period 1 to period 3 or period 4, because some students were admitted after February. The number of observations decreases afterwards, because we stop to track students who paid deposits. The numbers of deposits increase in April, especially after April 21, indicating the deadline effect on students’ deposit decisions.

[Insert Table 1 Here]

Table 1. Number of Observations and Deposits by Period Each Year

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | 2020 | | 2021 | | 2022 | |
| Period | N | Deposit | N | Deposit | N | Deposit |
| 1 - February | 16076 | 238 | 18010 | 159 | 18328 | 208 |
| 2 - March 1 to March 15 | 16702 | 191 | 18703 | 136 | 19152 | 197 |
| 3 - March 16 to March 31 | 16972 | 308 | 19584 | 294 | 19700 | 315 |
| 4 - April 1 to April 7 | 16824 | 263 | 19525 | 293 | 20034 | 264 |
| 5 - April 8 to April 14 | 16597 | 299 | 19302 | 371 | 19785 | 386 |
| 6 - April 15 to April 21 | 16345 | 338 | 18841 | 462 | 19401 | 390 |
| 7 - April 22 to April 28 | 16322 | 473 | 18257 | 646 | 18583 | 853 |
| 8 - April 29 to May 1 | 15945 | 395 | 17806 | 452 | 18052 | 551 |

Table 2 describes the depedent and independent variables in the models. The depedent variable is whether a student paid deposit by May 1. Out of the 60,285 admitted students, 8,482 or 14.1% of them paid deposits. The independent variables include the economic factors, sociological factors, and psychological factors. Three variables are continuous, Financial Aid, EFC, and Home Distance, and Financial Aid is the only variable with time-varying values by period. The other variables are binary. The financial aid amount is standardized by cost of attendance (COA), and it covers 28.6% of COA on average. EFC is also standardized by COA, it covers 118.1% of COA on average. Of the 60,285 admitted students, 6,256 or 10.4% are Pell eligible, 21,732 or 36.0% are male, 2,280 or 3.8% are African American, 3,457 or 5.7% are Asian, 5,072 or 8.4% are Hispanic, 44,164 or 73.3% are White, 1,813 or 3.0% are multi-ethnic, 17,478 or 29.0% attend early events for prospects, 6,998 or 11.6% are admitted to the Honors program, 2,913 or 4.8% are admitted to majors different from applied majors, 3,443 or 5.7% visit campus, 3,127 or 5.2% attend the Decision Day event for admitted students, and 24,449 or 40.6% do not review the admission decisions within 2 days.

[Insert Table 2 Here]

Table 2. Description of the Dependent and Independent Variables

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variables | Description | N | Mean/Pct | S.D. |
| Dependent Variable | |  |  |  |
| Deposited | 1 if deposited, 0 otherwise | 8,482 | 14.1% |  |
| Economic factors |  |  |  |  |
| Financial Aid | Total offered financial aid over COA |  | 0.286 | 0.162 |
| EFC | Expected family contribution over COA |  | 1.181 | 1.602 |
| Pell | 1 if Pell eligible, 0 otherwise | 6256 | 10.4% |  |
| Sociological factors |  |  |  |  |
| Home Distance | Home distance from UD |  | 177.6 | 340.9 |
| Male | 1 if male, 0 if female | 21732 | 36.0% |  |
| African American | 1 if African American, 0 otherwise | 2280 | 3.8% |  |
| Asian | 1 if Asian American, 0 otherwise | 3457 | 5.7% |  |
| Latino | 1 if Latino/Hispanic/Chicano, 0 otherwise | 5072 | 8.4% |  |
| White | 1 if Caucasian, 0 otherwise | 44164 | 73.3% |  |
| Multi-Ethic | 1 if multi-ethnicity, 0 otherwise | 1813 | 3.0% |  |
| Psychological factors | |  |  |  |
| Early Event | 1 if attending early events for prospects | 17478 | 29.0% |  |
| Honor | 1 if admitted in the honors program, 0 otherwise | 6998 | 11.6% |  |
| Major Change | 1 if admitted major is different from applied major | 2913 | 4.8% |  |
| Campus Tour | 1 if attending campus tour, 0 otherwise | 3443 | 5.7% |  |
| Decision Day | 1 if attending Decision Day event, 0 otherwise | 3127 | 5.2% |  |
| Delay Review | 1 if not reviewing admission decision within 2 days | 24449 | 40.6% |  |

## Statistical Model

We develope Bayesian hierarchical piecewise exponential models to understand students’ deposit decisions. Piecewise exponential models are a kind of discrete event history analysis with constant hazard function within each discrete time interval (Austin 2017; DesJardins et al. 1994; Friedman 1982). In this study, an event occurs if a student pays deposit between Februrary 1 and May 1. Otherwise, the admitted student is censored on May 1 or “survives” from the desire to pay deposit. Equation (1) defines the logarithm of the hazard (rate) function to be the sum of two parts, baseline hazard and a linear combination of student attributes, where denotes the value of variable j for student i in a period, and [Period] denotes the effect of the variable j in the period. The cumulative hazard is the product of the hazard function and the period length , and the logrithm of survival function is defined to be the negative cumulative hazard as shown in Equation (2). And finally, Equation (3) defines the probablity of the student i paying deposit in a period () to be one minus the survival function , i.e., the probability of the student not surviving in the period. If we think the hazard function reflects the driving force to encourage the student to pay deposit, cumulative hazard is the accumlated force over time, i.e., impulse in term of physics. If a variable has positive effect on the deposit decision, then the higher the variable value, the higher driving force, the higher impulse, and thus the higher probablity to pay deposit according to three equations.

(1)

(2)

(3)

We introduce the Bayesian hierarchical framework to estimate the unknown coefficients and in Equation (1). In a Bayesian analysis, our initial uncertainty, known as a prior distribution, is modelled using the language of probability distributions (McElreath 2020). For the baseline hazard , we model the initial uncertainty using normal distributions as shown in Equation (4). The is the maximum likehood estimates for . We choose to be 0.1 to make it a strong prior distribution. That is to say, when the prior distributions are updated to posterior distributions using data observed, the data must show strong evidence to let the posterior distribution deviate from prior distribution. The hierarchical structure is setup for estimating . At the higher level, the variables have time-independent effects , i.e., the average effects over all periods. We assume are normally distributed with means being 0 as shown in Equation (5). This is to reduce overfitting for the higher-level effects, because the observed data need to show enough support for non-zero parameter estimates. At the lower level, the variables have time-varying effects . We assume are normally distributed with means being as shown in Equation (6). This is to reduce overfitting for the lower-level effects, because the observed data need to show enough support for to deviate from . The uncertainty of our assumptions is controlled by the standard deviations, and , respectively. We model the uncertainty of and with expoential prior distributions with rate parameter 0.5 as shown in Equation (7) and (8). In summary, if the observed data provide enough support, the posterior distributions of the higher-level effects will deviate from the zero-mean prior distributions, and the posterior distributions of the lower-level effects will deviate from the prior distributions centered at the higher-level effects, so we will have variables with time-varying effects on the deposit decisions.

(4)

(5)

(6)

(7)

(8)

## Results and Discussion

We use the DynamicHMC package in Julia (version 1.7.2) to estimate the posterior distributions of the variable coefficients, and their means as point estimates and credible intervals are derived from the posterior distributions. Three Markov chains are used to estimate the posterior distributions. Each chain contains 1,000 samples, after a series of warmup steps to find proper stepsize for the “No-U-Turn Sampler” (Betancourt 2017; Hoffman, Gelman, et al. 2014).

The results are interpreted using the credible intervals of estimated coefficients and the corresponding hazard functions. The variable is considered not important on deposit decision, if all credible intervals span across zero. A variable is defined to have time-varying effect, if the credible intervals do not overlap in at least two periods. Otherwise, the variable is defined to have time-independent effect. The effect of a variable is measured by hazard ratio, the quotient of two hazard functions due to the change of the variable. According to Equation (1), the hazard ratio is the exponential of the product of the variable change and its estimated coefficient, holding other variables and their coefficient constant. For the baseline hazard, the ratio is the exponential of the difference of the estimated hazards between two periods. For binary variables, the ratio is the exponential of the estimated coefficient in the period, i.e., the ratio is positively related to the estimated coefficient. A variable has postive effect on the deposit decision, if the hazard ratio is larger than 1 or the estimated coefficient is larger than 0, and vice versa.

### Fall 2020

Table 5 shows the lower bounds of 95% credible intervals, the means, and the upper bounds of 95% credible intervals of parameter estimates for students who were admitted for Fall 2020, including the baseline hazard and the variables. The baseline hazard differs among periods. For example, the 95% credible interval (-8.22, -7.88) in first period does not overlap with interval (-5.98, -5.65) in the last period. The baseline hazard shows an increasing trend from period 1 to period 8 with some fluctuation in the middle periods. The biggest jump is between period 6 and period 7, indicating students start to feel the deadline pressure in the fourth week in April. The hazard ratio is 9.30 between the first and the last periods, indicating students are much more likely to pay deposits in the last period than the first period.

[Insert Table 3 Here]

Table 3. Parameter Estimates for Fall 2020, 2.5% percentile, mean and 97.5% percentile

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Variable | Period 1 | Period 2 | Period 3 | Period 4 | Period 5 | Period 6 | Period 7 | Period 8 |
| Baseline | -8.22, -8.05, -7.88 | -8.55, -8.37, -8.19 | -7.68, -7.51, -7.34 | -7.45, -7.27, -7.1 | -7.09, -6.91, -6.74 | -7.31, -7.14, -6.97 | -6.14, -5.98, -5.83 | -5.98, -5.82, -5.65 |
| Financial Aid | -0.9, -0.47, -0.09 | -0.7, -0.23, 0.21 | -0.54, -0.13, 0.28 | -0.3, 0.07, 0.46 | -0.48, -0.07, 0.37 | -0.3, 0.12, 0.54 | -0.59, -0.21, 0.16 | -0.38, 0.02, 0.41 |
| Pell | -0.27, 0.09, 0.41 | -0.17, 0.19, 0.52 | -0.02, 0.24, 0.51 | -0.17, 0.15, 0.44 | -0.11, 0.19, 0.47 | -0.12, 0.16, 0.45 | -0.04, 0.19, 0.43 | 0.29, 0.55, 0.8 |
| EFC | -0.23, -0.13, -0.04 | -0.12, -0.03, 0.06 | -0.06, 0.0, 0.06 | -0.13, -0.05, 0.03 | -0.18, -0.09, -0.01 | -0.13, -0.05, 0.01 | -0.18, -0.11, -0.04 | -0.14, -0.06, 0.01 |
| Home Distance | -0.26, -0.06, 0.12 | -0.6, -0.29, -0.02 | -0.22, -0.06, 0.08 | -0.12, 0.02, 0.15 | -0.37, -0.17, -0.0 | -0.19, -0.04, 0.09 | -0.21, -0.08, 0.03 | -0.23, -0.09, 0.04 |
| Gender | -0.56, -0.34, -0.11 | -0.3, -0.07, 0.15 | -0.52, -0.31, -0.11 | -0.42, -0.2, 0.01 | -0.26, -0.06, 0.13 | -0.0, 0.2, 0.38 | -0.12, 0.03, 0.18 | 0.23, 0.41, 0.59 |
| Asian | -0.65, -0.21, 0.17 | -0.6, -0.14, 0.31 | -0.6, -0.17, 0.2 | -0.42, -0.0, 0.4 | -0.58, -0.17, 0.21 | -0.52, -0.1, 0.31 | -0.59, -0.22, 0.12 | -0.44, -0.08, 0.28 |
| African American | -0.47, -0.02, 0.4 | -0.48, -0.01, 0.44 | -0.46, -0.06, 0.36 | -0.26, 0.17, 0.61 | -0.32, 0.09, 0.49 | -0.24, 0.2, 0.6 | -0.37, 0.01, 0.35 | -0.14, 0.26, 0.61 |
| Hispanic | -0.22, 0.13, 0.47 | 0.02, 0.37, 0.75 | -0.08, 0.22, 0.53 | -0.0, 0.35, 0.7 | -0.21, 0.14, 0.49 | -0.0, 0.31, 0.62 | -0.17, 0.12, 0.42 | 0.02, 0.32, 0.62 |
| White | -0.2, 0.07, 0.32 | 0.23, 0.48, 0.76 | -0.09, 0.14, 0.38 | 0.1, 0.35, 0.61 | 0.25, 0.48, 0.71 | 0.15, 0.38, 0.59 | -0.19, 0.01, 0.21 | 0.1, 0.31, 0.53 |
| Multi-Ethic | -0.48, -0.02, 0.4 | -0.44, 0.02, 0.46 | -0.32, 0.09, 0.45 | -0.16, 0.27, 0.68 | -0.41, -0.01, 0.41 | -0.29, 0.12, 0.52 | -0.14, 0.2, 0.57 | -0.02, 0.39, 0.78 |
| Early Event | 0.74, 0.96, 1.17 | 0.72, 0.95, 1.18 | 0.52, 0.71, 0.91 | 0.61, 0.82, 1.03 | 0.39, 0.59, 0.79 | 0.7, 0.88, 1.07 | 0.36, 0.52, 0.68 | 0.12, 0.31, 0.51 |
| Honor Program | -0.34, -0.06, 0.18 | -0.36, -0.05, 0.24 | -0.1, 0.15, 0.38 | 0.07, 0.33, 0.57 | -0.21, 0.07, 0.34 | -0.21, 0.03, 0.27 | 0.0, 0.21, 0.4 | -0.1, 0.14, 0.37 |
| Change Major | 0.75, 1.05, 1.33 | 0.66, 0.98, 1.33 | 0.82, 1.08, 1.37 | 0.75, 1.05, 1.35 | 0.79, 1.08, 1.36 | 0.92, 1.16, 1.41 | 0.82, 1.08, 1.32 | 0.83, 1.12, 1.41 |
| Campus Tour | 1.59, 1.9, 2.2 | 1.36, 1.69, 2.01 | 1.5, 1.72, 1.94 | 1.61, 1.84, 2.05 | 1.46, 1.69, 1.9 | 1.55, 1.75, 1.96 | 1.52, 1.71, 1.89 | 1.48, 1.68, 1.88 |
| Decision Day Event | 1.56, 1.78, 2.0 | 1.59, 1.84, 2.09 | 1.39, 1.6, 1.82 | 1.17, 1.41, 1.68 | 1.21, 1.45, 1.7 | 1.44, 1.67, 1.9 | 1.11, 1.33, 1.55 | 1.07, 1.34, 1.58 |
| Delay Review | -0.62, -0.38, -0.16 | -0.49, -0.25, 0.01 | -0.51, -0.29, -0.09 | -0.29, -0.08, 0.13 | -0.37, -0.14, 0.07 | -0.3, -0.11, 0.09 | -0.17, -0.0, 0.15 | -0.09, 0.08, 0.24 |

Five of the sixteen variables have time-varying effects, and they are Gender, White, Early Event, Decision Day, and Delay Review. The 95% credible intervals of Gender do not overlap between the first (-0.58, -0.04) period and the last period (-0.01, 0.32), indicating the effects are different in the two periods. The parameter estimates of Gender shows an increasing trend, indicating the female students tend to pay deposit earlier than the male students. For example, the hazard ratio is 0.73 in the first period, indicating female students are more likely to pay deposits in the period. However, the hazard ratio changes to 1.16, indicating male students are more likely to pay in the last period. This finding would be neglected, if we assume variables to have time-independent effects. The point estimate for Gender would be close to 0 at -0.0079, indicating gender plays little role for deposit decisions. The parameter estimates of Delay Review also shows an increasing trend. Students tend not to pay deposits in early periods, if they postpone to review admission decisions for at least two days, but the delay does not matter in latter periods. In contrast, the parameter estimates are positive but with a declining trend for early events and decision day event, indicating that the encouragement from attending the events fades over time. The parameter estimates of White fluctuate among periods. White students are more likely to pay deposits in some periods but not in the other periods.

Eight variables have time-independent effects on deposit decisions, and they are Financial Aid, Pell, EFC, Home Distance, Hispanic, Honors Program, Major Change, and Campus Tour, because all corresponding 95% credible intervals overlap with each other. Financial aid does not matter except in the first period. It is not surprising in 2020, because students’ decisions are more affected by Covid-19 than financial burdens. In contrast, Pell eligibility does not matter until the last period. The hazard ratio is 1.45 in the last period, indicating Pell elgilible students are more likely to pay deposits than non-Pell elgilible students. This makes sense to the Admissions Office, because Pell eligible students would like to delay any financial expense until they cannot. This also suggests to them that the recruitment effort for Pell students may not appear effective until the last period. Other variables have important effects in more than one period. The parameter estimates of EFC and Home Distance are negative in some periods, indicating students with lower income and those closer to UD are more likley to pay deposits. On the other hand, the parameter estimates of Hispanic and Honor Program are positive in some periods, indicating Hispanic students and students who are admitted to the Honors program are more likely to pay deposits. Lastly, the parameter estimates of Major Change and Campus Tour are positive in all periods, indicating students are consistently more likely to pay deposits if they are willing to be admitted a major different than an applied major, or they attend campus tours.

Three variables do not have important effect on deposit decisions in any period, and they are Asian, African American, and Multi-Ethnic. The credible intervals of the parameter estimates span across zero in all periods, indicating the three factors do not matter when making deposit decisions.

### Fall 2021

Table 6 shows the lower bounds of 95% credible intervals, the means, and the upper bounds of 95% credible intervals of parameter estimates for students who were admitted for Fall 2021, including the baseline hazard and the variables. Similar to 2020, the baseline hazard differs among periods. For example, the 95% credible interval (-8.39, -8.04) in first period does not overlap with interval (-6.10, -5.78) in the last period. The baseline hazard shows an increasing trend, indicating students are more and more likely to pay deposits over time. The hazard ratio is 9.68 between the first and the last periods, indicating students are much more likely to pay deposits in the last period than the first period.

[Insert Table 4 Here]

Table 4. Parameter Estimates for 2021, 2.5% percentile, mean and 97.5% percentile

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Variable | Period 1 | Period 2 | Period 3 | Period 4 | Period 5 | Period 6 | Period 7 | Period 8 |
| Baseline | -8.39, -8.21, -8.04 | -7.72, -7.55, -7.38 | -7.69, -7.51, -7.34 | -6.9, -6.74, -6.57 | -6.6, -6.43, -6.26 | -6.74, -6.59, -6.42 | -6.64, -6.49, -6.33 | -6.1, -5.94, -5.78 |
| Financial Aid | 0.54, 1.03, 1.52 | 0.64, 1.13, 1.62 | 0.71, 1.12, 1.53 | 0.85, 1.26, 1.68 | 0.82, 1.24, 1.63 | 1.08, 1.49, 1.88 | 1.34, 1.7, 2.08 | 1.12, 1.5, 1.9 |
| Pell | -0.64, -0.25, 0.12 | -0.78, -0.4, -0.03 | -0.42, -0.11, 0.21 | -0.71, -0.37, -0.06 | -0.49, -0.17, 0.12 | -0.58, -0.32, -0.04 | -0.33, -0.09, 0.15 | -0.06, 0.19, 0.44 |
| EFC | -0.15, -0.05, 0.04 | -0.33, -0.18, -0.04 | -0.04, 0.03, 0.09 | -0.11, -0.03, 0.05 | -0.12, -0.04, 0.03 | -0.15, -0.07, -0.0 | -0.05, -0.0, 0.04 | -0.13, -0.05, 0.01 |
| Home Distance | -0.3, -0.09, 0.07 | -0.41, -0.17, 0.03 | -0.31, -0.13, 0.0 | -0.07, 0.04, 0.13 | -0.27, -0.12, 0.01 | -0.38, -0.22, -0.08 | -0.26, -0.15, -0.04 | -0.21, -0.09, 0.02 |
| Gender | -0.47, -0.21, 0.03 | -0.53, -0.25, 0.02 | -0.45, -0.25, -0.05 | -0.39, -0.18, 0.04 | -0.4, -0.2, 0.0 | -0.25, -0.08, 0.11 | 0.09, 0.23, 0.37 | 0.15, 0.32, 0.49 |
| Asian | -0.86, -0.39, 0.04 | -0.96, -0.49, -0.06 | -0.99, -0.56, -0.13 | -0.85, -0.41, -0.02 | -0.87, -0.46, -0.06 | -0.68, -0.29, 0.07 | -0.61, -0.27, 0.06 | -0.77, -0.38, 0.01 |
| African American | -0.85, -0.35, 0.11 | -0.68, -0.24, 0.19 | -0.64, -0.23, 0.15 | -0.61, -0.2, 0.25 | -0.92, -0.48, -0.06 | -0.76, -0.37, -0.02 | -0.39, -0.05, 0.28 | -0.5, -0.12, 0.25 |
| Hispanic | -0.42, -0.03, 0.34 | -0.32, 0.04, 0.39 | -0.32, -0.0, 0.31 | -0.23, 0.09, 0.41 | -0.22, 0.08, 0.36 | 0.02, 0.29, 0.58 | 0.03, 0.28, 0.54 | -0.1, 0.18, 0.46 |
| White | -0.3, -0.03, 0.22 | -0.41, -0.16, 0.1 | -0.21, 0.02, 0.25 | -0.17, 0.03, 0.26 | -0.23, -0.01, 0.2 | -0.19, 0.02, 0.21 | -0.1, 0.07, 0.26 | -0.03, 0.18, 0.41 |
| Multi-Ethic | -0.54, -0.11, 0.33 | -0.62, -0.15, 0.26 | -0.37, 0.04, 0.42 | -0.53, -0.13, 0.29 | -0.3, 0.11, 0.47 | -0.28, 0.13, 0.49 | -0.61, -0.22, 0.15 | -0.36, 0.02, 0.4 |
| Early Event | 0.09, 0.34, 0.57 | 0.07, 0.33, 0.61 | 0.11, 0.3, 0.51 | 0.3, 0.51, 0.74 | 0.03, 0.23, 0.42 | -0.06, 0.13, 0.33 | -0.14, 0.03, 0.18 | -0.38, -0.2, -0.01 |
| Honor Program | -0.85, -0.5, -0.15 | -0.9, -0.51, -0.18 | -0.71, -0.42, -0.13 | -0.61, -0.32, -0.06 | -0.56, -0.3, -0.05 | -0.36, -0.12, 0.1 | -0.33, -0.12, 0.08 | -0.33, -0.07, 0.16 |
| Change Major | 0.63, 0.96, 1.28 | 0.24, 0.58, 0.91 | 0.39, 0.66, 0.93 | 0.45, 0.71, 0.98 | 0.51, 0.76, 0.99 | 0.55, 0.76, 0.98 | 0.38, 0.61, 0.82 | 0.57, 0.82, 1.04 |
| Campus Tour | 1.25, 1.6, 1.96 | 1.31, 1.62, 1.95 | 1.2, 1.46, 1.7 | 1.3, 1.52, 1.76 | 1.19, 1.4, 1.6 | 1.2, 1.41, 1.59 | 1.24, 1.42, 1.59 | 1.51, 1.7, 1.91 |
| Decision Day Event | 1.03, 1.36, 1.66 | 0.74, 1.09, 1.43 | 0.91, 1.2, 1.5 | 0.59, 0.93, 1.23 | 0.72, 0.99, 1.26 | 1.25, 1.45, 1.66 | 1.37, 1.55, 1.72 | 1.09, 1.31, 1.52 |
| Delay Review | -0.66, -0.39, -0.13 | -0.77, -0.46, -0.2 | -0.3, -0.12, 0.07 | -0.41, -0.21, 0.0 | -0.29, -0.1, 0.09 | -0.11, 0.06, 0.24 | -0.08, 0.06, 0.2 | -0.06, 0.1, 0.26 |

Five variables have time-varying effects, and they are Home Distance, Gender, Early Event, Decision Day, and Delay Review. Within them, Home Distance, Gender, Early Event, and Delay Review show similar patterns with the previous year. That is to say, students closer to UD are more likely to pay, female students tend to pay deposits earlier than male students, the encouragement from attend early events fades away, and in the first two periods students tend not to pay deposits if delaying to review admission decisions. The variable Decision Day has a new pattern. Attending Decision Day events is still a positive factor on deposit decisions, but the effect does not show a decreasing trend. The hazard ratio decreases from 3.90 in period 1 to 2.53 in period 4, and then increases to 4.71 in period 7. This is because UD has another Decision Day event in April in addition to the one in February, causing the effect to fade after February and then increase in April.

The other variables have time-independent effects except White and Multi-Ethnic, and they are Financial Aid, Pell, EFC, Asian, African American, Hispanic, Honors Program, Major Change, and Campus Tour. Different from the previous year, students are encouraged by financial aid in all periods, indicating that students worry less about Covid-19 and pay more attention to financial burden. For example, the hazard ratio is 1.19 in period 7, if the financial aid increases by 10% or about $5.3K with COA being $53,422 in 2021. If we further assume a student has 15% chance to pay deposit, it increases to 17.5% with the extra 10% financial aid, holding other factors constant. Honors Program also shows a different pattern. The parameter estimates become negative in most periods, indicating students are less likely to pay deposits if being admitted to the Honors program. This change could be due to the change of admission policies, according to the Admissions Office. Asian and African American become important factors in 2021, and students with the two raical ethnicities are less likely to pay deposits in some periods. The folllowing variables have similar effects with the previous year, EFC, Hispanic, Change Major, and Campus Tour. That is to say, students are more likely to pay deposits, if they are from lower income family, are Hispanic students, have admitted majors different than applied majors, or attend campus tours.

### Fall 2022

Table 7 shows the lower bounds of 95% credible intervals, the means, and the upper bounds of 95% credible intervals of parameter estimates for students who were admitted for Fall 2022, including the baseline hazard and the variables. The baseline hazard still shows an increasing trend, and students are mostly likely to pay deposit in the last period. The hazard ratio between the first and the last periods is 74.44, which is much higher than the previous two years. This is mostly due to the much lower baseline hazard in the first period, i.e., is -9.79 in 2022 vs -8.21 and -8.05 in 2021 and 2020, respectively.

[Insert Table 5 Here]

Table 5. Parameter Estimates for 2022, 2.5% percentile, mean and 97.5% percentile

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Variable | Period 1 | Period 2 | Period 3 | Period 4 | Period 5 | Period 6 | Period 7 | Period 8 |
| Baseline | -9.98, -9.79, -9.61 | -8.42, -8.24, -8.07 | -7.77, -7.58, -7.41 | -6.76, -6.59, -6.4 | -7.49, -7.3, -7.13 | -7.55, -7.39, -7.21 | -6.49, -6.33, -6.16 | -5.65, -5.48, -5.32 |
| Financial Aid | 0.23, 0.73, 1.25 | -0.22, 0.29, 0.77 | -0.04, 0.41, 0.89 | -0.27, 0.2, 0.63 | 0.02, 0.5, 0.96 | 0.26, 0.7, 1.13 | 0.24, 0.62, 0.99 | -0.03, 0.41, 0.85 |
| Pell | -0.06, 0.32, 0.65 | -0.26, 0.09, 0.44 | -0.38, -0.06, 0.25 | -0.34, 0.01, 0.32 | -0.02, 0.29, 0.57 | -0.16, 0.15, 0.44 | -0.08, 0.14, 0.36 | 0.15, 0.37, 0.58 |
| EFC | -0.04, 0.03, 0.09 | -0.09, -0.0, 0.07 | -0.1, -0.03, 0.05 | -0.07, 0.0, 0.06 | -0.09, -0.02, 0.04 | -0.08, -0.02, 0.05 | -0.1, -0.04, 0.01 | -0.25, -0.17, -0.09 |
| Home Distance | -0.55, -0.26, -0.02 | -0.63, -0.35, -0.1 | -0.3, -0.12, 0.03 | -0.19, -0.04, 0.09 | -0.42, -0.23, -0.04 | -0.29, -0.13, 0.01 | -0.11, -0.02, 0.06 | -0.22, -0.09, 0.03 |
| Gender | -0.58, -0.31, -0.04 | -0.48, -0.22, 0.01 | -0.32, -0.1, 0.1 | -0.33, -0.11, 0.11 | -0.27, -0.08, 0.1 | -0.14, 0.06, 0.24 | -0.15, -0.03, 0.09 | -0.01, 0.15, 0.32 |
| Asian | -0.63, -0.09, 0.4 | -0.47, -0.0, 0.49 | -0.53, -0.11, 0.31 | -0.56, -0.16, 0.23 | -0.3, 0.14, 0.58 | -0.07, 0.31, 0.68 | -0.57, -0.24, 0.1 | -0.52, -0.13, 0.24 |
| African American | -0.38, 0.17, 0.7 | -0.57, -0.06, 0.44 | -0.68, -0.22, 0.23 | -0.68, -0.21, 0.27 | -0.58, -0.1, 0.34 | -0.31, 0.12, 0.56 | -0.23, 0.09, 0.42 | -0.49, -0.11, 0.24 |
| Hispanic | 0.06, 0.48, 0.89 | -0.14, 0.26, 0.65 | -0.24, 0.1, 0.45 | -0.21, 0.13, 0.48 | -0.05, 0.28, 0.62 | 0.07, 0.41, 0.74 | -0.13, 0.12, 0.35 | -0.1, 0.19, 0.47 |
| White | 0.67, 0.95, 1.25 | 0.09, 0.34, 0.62 | -0.12, 0.13, 0.37 | -0.38, -0.15, 0.1 | 0.24, 0.46, 0.72 | 0.14, 0.36, 0.6 | -0.17, 0.03, 0.24 | -0.23, -0.01, 0.2 |
| Multi-Ethic | -0.57, -0.01, 0.55 | -0.86, -0.26, 0.28 | -0.67, -0.15, 0.32 | -0.92, -0.37, 0.18 | -0.64, -0.1, 0.44 | -0.34, 0.17, 0.64 | -0.51, -0.08, 0.31 | -0.51, -0.07, 0.39 |
| Early Event | 0.86, 1.11, 1.37 | 0.55, 0.78, 1.03 | 0.59, 0.79, 0.98 | 0.62, 0.84, 1.07 | 0.38, 0.58, 0.75 | 0.53, 0.72, 0.91 | 0.28, 0.43, 0.59 | 0.03, 0.21, 0.38 |
| Honor Program | -0.77, -0.45, -0.14 | -0.74, -0.4, -0.09 | -0.52, -0.25, 0.03 | -0.31, -0.02, 0.27 | -0.36, -0.11, 0.13 | -0.31, -0.04, 0.21 | -0.27, -0.1, 0.09 | -0.36, -0.13, 0.1 |
| Change Major | 0.97, 1.28, 1.6 | 0.56, 0.91, 1.25 | 0.8, 1.07, 1.36 | 0.57, 0.9, 1.2 | 0.57, 0.85, 1.12 | 0.64, 0.92, 1.18 | 0.55, 0.74, 0.92 | 0.86, 1.1, 1.35 |
| Campus Tour | 1.42, 1.71, 2.0 | 1.49, 1.75, 2.03 | 1.27, 1.53, 1.78 | 1.14, 1.39, 1.67 | 1.35, 1.55, 1.76 | 1.65, 1.84, 2.05 | 1.51, 1.65, 1.79 | 1.54, 1.72, 1.89 |
| Decision Day Event | 1.63, 1.89, 2.14 | 1.47, 1.75, 2.03 | 1.34, 1.6, 1.84 | 1.19, 1.5, 1.78 | 2.19, 2.39, 2.59 | 1.73, 1.94, 2.14 | 2.24, 2.37, 2.5 | 1.99, 2.15, 2.32 |
| Delay Review | -0.45, -0.17, 0.07 | -0.35, -0.1, 0.13 | -0.36, -0.17, 0.02 | -0.54, -0.31, -0.09 | -0.42, -0.22, -0.03 | -0.13, 0.07, 0.26 | 0.1, 0.22, 0.35 | 0.12, 0.27, 0.42 |

Seven variables have time-varying effects, and they are EFC, Gender, White, Early Events, Change Major, Decision Day, and Delay Review. EFC, Gender, Early Events, and Decision Day have similar effects with the previous year. That is to say, female students tend to pay deposits earlier than male students, the encouragement from attend early events fades away, and students are encouraged to pay deposits from individual Decision Day events. EFC and Change Major become variables with time-varying effects, but their general patterns do not change much from the previous years. The parameter estimates of EFC indicate students from lower income family are more likely to pay deposits in the last period, and those of Change Major still indicate students are more likely to pay deposits when admitted majors are different from applied majors. Similar with 2020, White students are more likely to pay deposits in some periods and behave similarly with non-White students in other periods.

Six variables have time-independent effects, and they are Financial Aid, Pell, Home Distance, Hispanic, Honor Program and Campus Tour. Financial Aid remains as a positive factor, although only in half of the periods. The hazard ratios are smaller than those in 2021. For example, it decreases from 1.19 in 2021 to 1.06 in 2022 for period 7. With the same assumption with 2021, the chance to pay deposit increases from 15% to 15.9%, if extra 10% financial aid is offered. Pell eligible students behave similarly with those in 2020, who are more likely to pay deposits in the last period. Other variables have similar patterns with the previous year. That is to say, students are more likely to pay, if they live closer to UD, they are Hispanic, and they attend campus tours, but being admitted to the Honors program does not encourage them to pay deposits in the early periods.

Three variables do not have important impact on deposit decisions, and they are Asian, African American, and Multi-Ethnic. The list is the same with 2020.

### Comparison Among the Three Years

For the comparison of the results among the three years, we focus on the baseline hazard, and one variable from each of three factor groups, i.e., Financial Aid from economic factors, Gender from sociological factors, and Decision Day from psychological factors. The boxplots in Figure 1 compare the distributions of their parameter estimates. The baseline hazard shows an increasing trend in all three years, i.e., students are less likely to pay deposits in the early periods and more likely in the latter periods. This is within expectation, because students would like to compare institutions’ admission offers but do not want to miss the deposit deadline. However, the growth path of the baseline hazard differs among the years. In 2020, the hazard slowly increases in the first six periods, jumps in period 7, and the difference between period 7 and period 8 is not large. In 2021, the hazard slowly increases in the first three periods, jumps in period 4, and maintains relatively stable until the jump in the last period. In 2022, the hazard is much lower in the first period, catches up and fluctuates in the following several periods, and jumps to the strongest in the last period. The uncertainty of the baseline hazard makes it difficult for the Admissions Office to decide how many students to admit after February. For example, the first six periods suggest that the yield will be low in 2022, so more students need to be admitted to hit admission targets, but the last two periods especially the last period does not support the decision.

[Insert Figure 1 Here]

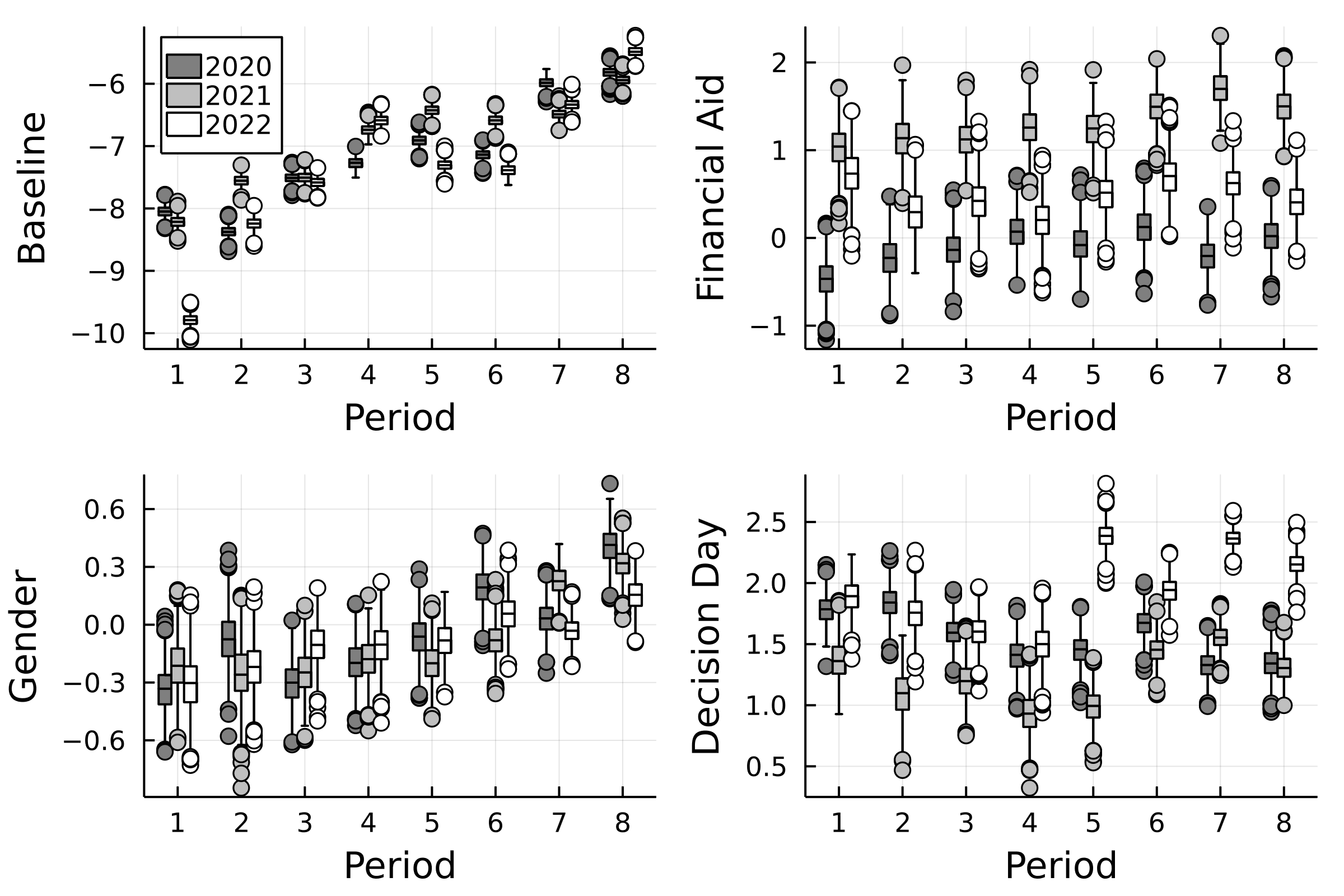


Figure 1. Boxplots of the distributions of the parameter estimates of baseline force, Financial Aid, Gender and Decision Day among the three years

Financial aid encourages students to pay deposits in recent two years but not in 2020. In 2020, the boxplots locate close to zeros, indicating financial aid does not affect students’ deposit decisions after February. Financial aid is supposed to reduce students’ cost of attendence, but financial burden was not what students paid attention to due to Covid-19. As the concern with Covid-19 decreases in 2021, the boxplots move up above zero, indicating financial aid becomes a positive factor. Institutional grants and scholarships are the major source for the total financial aid. It is good news to the Admission Office that students appreciate the institution’s financial help and are encouraged to accept admission offers. However, although the influence from financial aid is relatively stable within a year, the effect changes by year. The boxplots in 2022 barely overlap with those in 2021 except the first period, and they move closer to zero, indicating students have weaker response to financial aid in 2022 than 2021. This posts a hard question to SFS who package students’ financial aid. If the budget for institutional aid is stable but its effect is not stable over years, how can they work better with the Admissions Office to optimize the distribution of the grants and scholarships to enhance yield? We suggest to observe early the effect of financial aid on deposit depositions, and adjust the financial aid policies promptly, or adjust the expectation of the financial aid to enhance deposits.

Different from Financial Aid, Gender has similar effects in the same periods among the three years, but the effects change by period in a year. In all three years, female students prefer to pay deposits in earlier periods than male students, according to the rising boxplots over periods. The boxplots locate mostly below zero in the first periods, indicating male students tend not to pay deposits at the beginning. The boxplots gradually move up afterwards, and they are mostly above zero in the last periods, indicating male students are more likely to pay deposits at the end. That is to say, the deadline effect plays a more important role to male students than females, or female students are more eager to accept UD’s admission offers. We suspect this is due to the larger population of female students at UD, e.g., 59% of undergraduate students pursing bachelor’s degrees are female at UD in Fall 2021. For comparison, it is 47% and 49% in Penn State University and University of Maryland in Fall 2021, respectively. According to the College Choice thoery, students perfer an institution with matching sociological pattern, so female students are more likely consider UD as a good fit and thus have more desire to pay deposits early. The effect of Gender is a surprising finding to the Admissions Office, but this finding would be neglected, if we assume factors do not have time-varying effects by period. Models under this assumption essentially estimate the average effect among periods, which would claim that gender does not matter on deposit decisions, because the average parameter estimates would be close to zero as shown by the boxplots.

The Decision Day event is designed by the Admissions Office to convince admited students to pay deposits, and it works. All boxplots locate above zero, indicating the Decision Day event is a positive factor on deposit decisions in all periods in the three years. Moreover, the boxplots reflect stimulation from individual events from Februaries and Aprils. In 2020, UD has only one Decision Day event in February and cancels the ones in April due to Covid-19. The boxplots indicate that the effect from Decision Day event gradually decreases over time. We suspect that the event succefully raise students’ desire to pay deposits, but the desire decreases over time if they did not pay shortly after the event. In 2021, UD has multiple Decision Day events in February and April. The boxplots indicate that the effect fade after February but increase again in April. This phenomenon is more obvious in 2022. After the decrease from period 2 to period 4, there is a large jump in period 5, indicating another stimulation from the event in April.

Other variables are briefly discussed here, and their boxplots can be found in the appendix. In 2020 and 2022, Pell eligibility does not affect the deposit decisons until the last period when Pell eligible students are more likely to pay deposits. However, this does not apply to 2021. EFC does not matter in most periods in the three years, but the negative parameter estimates in a few periods indicate that students in higher income families are less likely to pay deposits. The parameter estimates for Home Distance tend to be negative in the three years, indicating students living closer to UD are more likely to pay deposits. In terms of racial ethnicity, Hispanic students are more likley to pay deposits in at least two periods each year, Multi-Ethnic students do not show preference in all three years, Asian and African American students are less likely to pay deposits in some periods in 2021 but they do not show preference in 2020 and 2022, and White students are more likely to pay deposits in half of the periods in 2020 and 2022 but they do not show preference in 2021. Students who attended early events are more likely to pay deposits in all three years, but the effect tend to be stronger in 2020 and 2022 than 2021. Students who are admitted to the Honors program are more likley to pay deposits in some periods in 2020, but it becomes a negative factor in 2021 and 2022. Students with admitted majors different than applied majors are more likley to pay deposits in all three years. Campus tours encourage students to pay deposits in all three years. Lastly, students who delay to review admission decisions are less likely yo pay deposits in the early periods, but this effect fades over time especially in 2022.

## Limitations

Our study is limited to one institution for out-of-state students who intended to matriculate between Fall 2020 and Fall 2022. The inferences may not apply to other institutions in different time periods, even not for the in-state students who applied UD. Students may have distinctively different socio-demographic background and may respond admission policies differently. Nevertheless, we want to introduce this first effort to study the time-varying effects on students’ deposit decisions and hopefully help other institutions to understand their recruitment efforts better.

Second, this study is not able to include all potential factors in the models due to data availability. In 2022, we begin to have week by week data on students’ online activities in the admission websites, which potentially represent their interests to the institution. We look forward to including them in our future analysis to understand how the activities affect students’ decisions.

## Conclusion

This study helps the Admissions Office to better understand admitted students’ deposit decisions and how their recruitment efforts work, so they can adjust their strategies promptly. The results from the Bayesian hierarchical piecewise exponential models validate our hypothesis that students behave or respond to recruitment efforts differently in different periods during the admission season. Female students are more likely to pay deposits in early periods than male students, while in later periods male students become more likely to pay. This finding would be neglected if we assume time-independent effects in the event history analysis. Moreover, Pell eligible students are most likely to pay deposits in the last period, because they would like to delay any financial expense as much as possible. The Admission Office can design some policies to potentially help the Pell eligible students to pay earlier, such as partially or fully waive their deposits. In terms of campus events, the students indeed respond to the early events for prospects and the Decision Day events for admitted students. The events act as impulse force to encourage students to pay deposits and their effects decrease over time. Therefore, the encouragement from the early events fades over time, because they all happen before the first period, and the strongest effects of the Decision Day events are observed in the periods when the events occur. These findings confirm the Admission Office’s effort to help students to recognize UD as an excellent institution for their undergraduate study.

Students’ behaviors can change among the three years due to the change of macro environment or admission policies. Financial aid changes from a non-important factor to positive factor from 2020 to 2021 and 2022. It is not surprising that students do not pay much attention to financial aid in 2020 due to Covid-19, and then they appreciate the financial aid to reduce the cost of attendance when Covid-19 is a less concern. It is a surprise to the Admissions Office that being admitted to the Honors program changes from encouragement to disencouragement from 2022 to 2021 and 2022. There was indeed a policy change for the admissions of the Honors program since 2021, and they would like to review and potentially improve the policy. Students’ racial ethnicities do not play an important role in their deposit decisions in many periods, but the roles can change among years. Asian and African American students do not show preference to pay deposits or not in 2020 and 2022, but they tend not to pay during some periods in 2021. On contrast, White students are more likley to pay deposits in 2020 and 2022, but they do not show preference in 2021. The change does not apply to Hispanic students though, who are more likely to pay deposits in all three years.

On the other hand, some consistent patterns exist among the three years. Students are more likely to pay deposits in the latter periods, because they want to wait for the best admission offers but do not want to miss the deposit deadline. Students are more likely to pay deposits if they show interests to UD, including being willing to be admitted to majors different than the applied majors, and attending campus events such as campus tours and events for prospects and admitted students. Students are less likely to pay deposits, if being from higher income families, living further away from UD, or delay to review the admission decisions. Although students’ socio-economic and demographic backgrounds cannot be changed, we suggest the Admissions Office to survey students who show interests to UD and better target future prospects with similar characteristics.

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