Complexifying Asian American student pathways to STEM majors: Differences by ethnic subgroups and college selectivity

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Abstract

Despite growing diversity among Asian Americans, little attention has been given to the diverse experiences and outcomes of Asian American subgroups in science, technology, engineering, and mathematics (STEM) fields. Using a nationally representative dataset, High School Longitudinal Study of 2009 (HSLS:09), this study examines Asian American students' various pathways of entrance into STEM majors by college selectivity. Results show different patterns of STEM major selection among Asian ethnic subgroups that are not uniformly applied to all types of college selectivity, thereby revealing the heterogeneity within Asian American populations and suggesting the peril of the monolithic stereotype of Asian American students in STEM fields. Analyses further disclose that disparities of STEM major selection among Asian ethnic subgroups can be partially but not fully explained by high school math achievement.

Keywords**:** Asian Americans, ethnicity, college major choice, STEM, college selectivity

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Introduction

Science, technology, engineering, and mathematics (STEM) fields are increasingly viewed as one way to open up opportunities for upward social mobility in the evolving US economy (Arcidiacono, 2004; Creusere, Zhao, Bond Huie, & Troutman, 2019). With the growing importance of STEM education for career opportunities, researchers have predominantly documented that historically marginalized students in the U.S. are underrepresented in STEM fields because of structural inequalities with regard to STEM entrance and STEM-related college degree completion (e.g., Chang, Sharkness, Hurtado, & Newman, 2014; McGee, 2016; Mensah & Jackson, 2018). Despite the significant contribution of this body of literature, however, much of the research on inequalities in the STEM pipeline has construed Asian American students, if taking them into account at all, as simply an undifferentiated group that is *overrepresented* in STEM fields. In other words, researchers have not yet investigated the varied experiences and outcomes of *specific* Asian American subgroup populations within the Asian American student group. Indeed, only a few studies have partially addressed the complexities and gaps in STEM fields among Asian American students, in terms of academic achievement (Pang, Han, & Pang, 2011), college enrollment (Jang, 2018), and STEM major selection (Lowinger & Song, 2017).

In this regard, it is particularly important to consider issues of STEM entrance in terms of potential future pathways. Specifically, research suggests that STEM opportunities for low-income historically underrepresented minorities are largely limited to career and technical

education, which result in pathways to two-year institutions and entry-level work (Weis et al., 2015). While recognizing the importance of such pathways to two-year institutions and resultant work outcomes, this simultaneously means that pathways to alternative institutions and outcomes are markedly constrained by available opportunity structures in high school. Given that varying STEM pathways are linked to different levels of educational and occupational trajectories, a careful examination of Asian American students' STEM major selection and their postsecondary destinations can offer a new perspective on pathways and outcomes for Asian American students, as well as heterogeneity among Asian American subgroups with regard to subsequent educational and occupational outcomes. This exploratory study seeks to examine the heterogeneity of STEM major selection one year after college entrance among Asian American students from different ethnic subgroups, as well as the variation in such selection across college selectivity levels.

Theoretical Framework

Model Minority Myth in the Era of STEM

In American society, the model minority myth has strongly contributed to a racial stereotype of Asian Americans as a monolithic group which is closely associated with academic and social success (Museus & Kiang, 2009; Osajima, 1988). The myth asserts that Asian immigrants in the United States took full advantage of opportunities for upward social mobility, thereby achieving the American dream based on their *own* efforts and struggles without accompanying institutional support. In the context of critical race theory (CRT), however, the myth of the model minority has been sharply criticized by numerous researchers as being used to legitimate existing social inequalities tied to pervasive racial discrimination (Poon et al., 2016;

Warikoo & Carter, 2009). Ultimately, the perpetuation of the myth attributed the poverty of poor and working-class people of color, particularly African Americans and Latinx, to their own cultural deficits rather than embedded structural inequalities and pervasive anti-Black sentiments in the United States, thereby stunting a potential coalition of Asian and Black communities (Lee, Xiong, Pheng, & Vang, 2017). In this sense, the model minority stereotype was used to prop up existing inequalities while simultaneously championing the status quo around an ostensible meritocracy.

In this regard, Iftikar and Museus (2018) stress the necessity of Asian critical (AsianCrit) theory for "complex and holistic understandings of Asian American racial realities in education" (p. 939). Specifically, they indicate that the application of CRT tenets to non-Black communities of color requires extra work, and suggest that revised tenets of the AsianCrit perspective will enable enhanced exploration of the process of *Asianization* that racializes Asian Americans into stereotypes such as perpetual foreigners, yellow perils or model minorities in the context of White supremacy. Accordingly, it is useful to investigate the realities of Asian American students in the field of STEM education from the perspective of AsianCrit theory, given that the continued underrepresentation of a range of racial minorities, women, and socioeconomically disadvantaged students (Legewie & DiPrete, 2014; National Science Board, 2018) serves to buttress the model minority stereotype of Asian American populations, thereby *excluding* Asian Americans from the discussion of inequality in STEM fields. This subsequently renders particular Asian American subgroups the "invisible American" who are not invited to the discussion on the issues of justice and equality in American society (Teranishi, Ceja, Antonio, Allen, & McDonough, 2004). In other words, Asian Americans have been largely misrepresented as a homogeneous racial group that achieves greater academic success in STEM fields than other

groups--one that does not need to be considered with respect to narrowing gaps among students in the STEM pipeline. While it is the case that Asian Americans are overrepresented in STEM fields relative to other non-white groups, the question remains, *who are these Asian Americans who are overrepresented?* More specifically, what subgroups are represented in this constructed Asian American *model minority* group in STEM fields, and, to what extent do a range of Asian subgroups in the United States similarly excel in STEM fields?

Heterogeneity in Asian American Populations

The term *Asian American* includes more than 20 different ethnic subgroups with a broad range of languages, cultures, and histories (Hoeffel, Rastogi, Kim, & Shahid, 2012), and it suggests that, given the heterogeneity, hybridity, and multiplicity in Asian American populations (King, 2000; Lowe, 1991), Asian Americans cannot be racialized as a uniform cohort. By way of example, contrary to the prevalent model minority stereotype, over 10% of Asian Americans are categorized as living in poverty in 2017, and this figure is higher than the poverty rate of non-Hispanic Whites (Fontenot, Semega, & Kollar, 2018). Not insignificantly, differences of socioeconomic conditions as well as immigration patterns press towards deconstruction of the category "Asian American," potentially debunking the model minority myth while simultaneously uncovering the heterogeneity within Asian American populations.

In this regard, recent literature has criticized the monolithic image of the model minority stereotype in terms of students' educational outcomes (e.g., Covarrubias & Liou, 2014; Lee, 2006; Nguyen, Noguera, Adkins, & Teranishi, 2019; Ocampo & Soodjinda, 2016). In the United States, for example, most Southeast Asian populations age 25 and older, including Cambodian (16.4%), Laotian (18.0%), Hmong (18.4%), Burmese (21.3%), and Vietnamese (29.5%), attained bachelor's or higher degrees at rates significantly lower than the average of the national

population (31.3%) in 2016, whereas several other Asian American groups such as Asian Indian (74.2%), Korean (56.3%), Pakistani (56.2%), Chinese (55.4%), and Japanese (51.6%) reported overall higher figures (Snyder, de Brey, & Dillow, 2019). In a similar vein, there has been evidence of educational gaps in Asian American populations due to the significant connection between students' postsecondary destinations and their socioeconomic backgrounds (Kim, 2014; Museus & Vue, 2013).

Yet, with only a few exceptions, there is a dearth of empirical studies on existing inequalities with regard to the processes of STEM entrance from high school to postsecondary education institutions across different ethnicities within Asian American student groups. Using large-scale census data, Min and Jang (2015), for example, analyzed varied patterns of higher levels of concentration in STEM fields among Asian American students across gender and generations. However, this study is still limited in explaining the heterogeneity in STEM major selection among Asian American subgroups, as it did not systemically address pre-college factors and socio-demographic background, such as math achievement, high school setting, gender, and parental income and education levels, that have been historically considered in predicting the likelihood of choosing STEM major (Riegle-Crumb & King, 2010; Simon, Wagner, & Killion, 2017; Wang, 2013). Further, previous studies argue that the high rates of STEM major for Asian American students may be attributed to their family environment in which parents tend to recognize that success in the STEM field along with high educational performance can be a carrier of social mobility (Chung, 1992; Min, 1998). Using a nationally-represented dataset, the Educational Longitudinal Study:02, Lowinger and Song (2017) also showed that, among Asian American students, the higher academic achievement, male, and higher socio-economic status of their parents, the more likely they are to choose STEM major,

not business or humanities. However, such studies did not account for the differences in STEM major selection among Asian American ethnic subgroups. Given that Asian American students' socio-demographic background and academic performances are heterogeneous (Nguyen et al., 2019), it is important to examine the degree to which the associations between these factors and STEM major selection vary across Asian American subgroups.

Importance of Different Types of College Selectivity

Given dramatic expansion in postsecondary education in the postwar period, coupled with markedly increased internal stratification in the U.S. postsecondary sector (Roksa, Grodsky, Arum, & Gamoran, 2007), competition for more selective college admissions has accelerated. More students than ever attend college, but admissions, particularly at the most selective colleges and universities, has become increasingly competitive, wherein the most highly valued postsecondary destinations in the U.S. report markedly increased numbers of applications and lower acceptance rates. In light of intensifying calls of *college for all*, competition for more highly ranked institutions is increasingly fierce. Rising college selectivity has become a key issue in the current American education system, with the rapid growth of a winner-take-all system (Frank & Cook, 1995; Weis, Cipollone, & Jenkins, 2014). As Hoxby (2009) describes, "only the top 10 percent of colleges are substantially more selective now than they were in 1962" (p. 95), whereas "at least 50 percent of colleges are substantially *less* selective" (ibid.). In the same vein, Bowen, Chingos, and McPherson (2009) also underline the seriousness of the intensified competition for entry into competitive public universities, and indicate that "flagship universities have become much more selective over time" (p. 34). This *bipolarization* of college selectivity suggests the growing significance of increasing *qualitative* distinctions among postsecondary educational institutions in the era of postsecondary massification (Long, 2008; Lucas, 2001;

Shavit, Arum, & Gamoran, 2007), and ultimately requires careful consideration of different college selectivity by postsecondary sector so as to better understand the unequal structure of educational opportunities and related outcomes in the U.S., in this case, for a range of Asian American subgroups.

With regard to inequalities in the STEM pipeline, a close look at the disparity of college selectivity plays a critical role in that students from varied racial/ethnic and socioeconomic backgrounds can have different opportunities to participate in divergent occupational trajectories, depending on the characteristics of their postsecondary destinations. Together with the question of whether historically marginalized students enter the doors of postsecondary education in STEM fields or not, the issues related to *which* college they attend and what they study are increasingly paramount. Through the examination of outcomes in STEM-focused high schools for low-income underrepresented minoritized students, for example, Weis and colleagues (2015) determine that the seemingly positive growth of STEM participation among minoritized students masks the unequal structure in the STEM pipeline. To be specific, opportunities for lower-level STEM careers and access to two-year colleges are predominantly offered to particular populations, by virtue of high school math and science course availability and content at the high school level. This is in sharp contrast to the more demanding and advanced-level opportunities offered to other populations. In a similar vein, Chen and Buell (2018) also indicate that the Asian model minority stereotype conceals the heterogeneity of Asian American employment in the STEM system, thereby contributing to reinforcement of the neoliberal racial project justifying white supremacy in the name of meritocracy. Therefore, an in-depth inquiry into disparities in the STEM pipeline and college selectivity rates among Asian American students serves to

advance and markedly broaden our knowledge of existing racial and ethnic inequalities in STEM education and potential outcomes.

The Present Study

Based upon this review of the literature, we analyze the different patterns of STEM major selection by college selectivity among Asian American students from different ethnic subgroups. The analysis is guided by two following research questions:

Research Question 1: What are the patterns of college major selection in STEM fields among Asian American ethnic subgroups?

Research Question 2: What is the role of students' academic achievement level, demographic and school characteristics in the heterogeneity in STEM major selection among Asian American ethnic subgroups?

Research Question 3: To what extent does STEM major selection among Asian American students vary across college selectivity?

The significance of this work is threefold. First, this research provides empirical evidence that there are significant disparities of STEM major selection among Asian American students, in sharp contrast to the monolithic image of the model minority stereotype. Second, it provides a new lens to interpret the heterogeneity of STEM major selection among students from diverse backgrounds. This highlights the importance of understanding the specific needs of a range of underrepresented Asian American ethnic subgroups in the STEM pipeline. It will further help educators in higher education to identify which factors could be considered in encouraging STEM major choice according to the subgroup of Asian American. Third, by emphasizing the

gap in STEM major selection based on college selectivity, this study highlights the need for discussion of the different career tracks within the STEM-related job market.

Method

Data

In this study, we use the National Center for Education Statistics (NCES) High School Longitudinal Study of 2009 (HSLS:09), which contains observations of 26,305 students from 9th grade in 2009 through eight years after high school graduation. It is the most up-to-date, nationally representative dataset that specifically provides data regarding the paths into and out of STEM fields of study and careers, as well as information of students' individual background, achievement level, and high school. Above all, this dataset oversamples Asian American students, allowing us to conduct analyses of nationally representative Asian Americans. To obtain unbiased estimates for Asian American students and take into account the structure of panel data, we utilize the second follow-up longitudinal weight variable. We focus only on students who finished high school in the spring of 2012 and enrolled in a postsecondary institution by 2016, in order to measure the differences of STEM major selection.

Asian American subgroups are differentiated based on geographical location of their origin country, and ethnicity (Tran & Birman, 2010). Based on information from HSLS:09, we distinguish (1) Chinese, (2) Filipino, (3) Vietnamese, Thai, etc. (Vietnamese/Thai), (4) Indian, Sri Lankan, etc. (Indian/Sri Lankan), and (5) Korean and Japanese (Korean/Japanese) students. We try to leave as much detail with regard to racial/geographic division as possible provided by HSLS data because the characteristics of Asian Americans are different by countries of origin, and it is the purpose of this study to examine this heterogeneity to the fullest. For example,

although the Philippines is located in Southeast Asia, it is distinguished from other Southeast Asian countries in that the Philippines has a relatively high percentage of ethnic groups in the United States (Hoeffel et al., 2012). The limitations of the data set (i.e., racial/ethnic classifications used by the HSLS) do not allow us to drill further into very detailed geographical and ethnic subgroup information. However, it is still valuable to analyze these data, which include information from various students, despite the lack of detailed information on ethnicity for each Asian-American student. The weighted analytic sample size is 1,367 students. Among the full sample, 314 Chinese, 302 Filipino, 264 Vietnamese/Thai, 211 Indian/Sri Lankan, 276 Korean/Japanese students are analyzed.

Analytic Strategy

To address the first, and second research questions, we utilize stepwise binary logistic regression models. Stepwise logistic regression has the advantage of being able to sequentially identify how total variation in interest factor can be explained depending on the exploratory variables researchers want to consider. In this study, the stepwise logistic regression includes three sequential models: the model first identifies the difference in probability of selecting a STEM major between the Asian American subgroups, and then investigates in two steps to what extent the explanatory variables, such as individual academic achievement, and demographic and high school background, account for the difference.

Because students were nested within high schools, we report clustered robust standard error, which adjusts for the overestimated standard errors resulting from the violation of independent errors assumption (Rogers, 1994).

The dependent variable for this study is a dichotomous variable, indicating whether or not students chose a STEM field as major in the first or second year in college. It also includes those who were admitted into a STEM major at the point of application. Previous studies have defined STEM in various ways due to lack of consensus on what constitutes STEM. Thus, we specify the definition here, in line with our primary research questions and interest to avoid confusion about the definition of STEM. Following previous approaches (Riegle-Crumb & King, 2010; Riegle-Crumb, King, Grodsky, & Muller, 2012), we distinguish Mathematics, Computer Science, Physical and Life Sciences, Engineering, and Technology, from non-STEM.

The first model includes only a set of dummy variables of Asian American subgroups, and we defined Chinese students as reference group. Because there is not a normative group in a logical sense, for convenience, we take the largest group, Chinese students, as a reference group. Thus, the results show the likelihood of each different Asian ethnic group choosing a STEM major compared to Chinese students.

Next, we examined whether differences in students' academic performance among Asian American subgroups can account for the STEM major choice trend among them. The student's academic performance level was measured by the standardized mathematics scores at 12th grade and the selectivity of the higher education institution the student enrolled in. The standardized math scores at 12th grade are derived from NCES, and it indicates the relative level of achievement within the population. We use this score as a proxy variable for the mathematics performance at the college entrance period. In terms of college selectivity level, NCES derives the classification of college selectivity from the 2012 IPEDS Institutional Characteristics file, and it is a typical term of the ratio measured by students who are admitted. To optimally maintain the statistical power to verify the interaction between the Asian group and college

selectivity, we classify the college selectivity level into three categories. To specify the academic qualification for college students, we distinguish college selectivity level into 2-year college, non-highly selective 4-year college, and highly selective 4-year college based on their first postsecondary destination. The selectivity level is derived by HSLS data that comes from the Integrated Postsecondary Education Data (IPEDS 2010-2011), which is based on the Carnegie classification. Thus, we can expect that more academically qualified students tend to enroll in highly selective 4-year colleges. Only 10.76% of students were enrolled in highly selective 4-year colleges among the HSLS:09 total sample.

After considering the level of academic achievement, we analyze whether the differences in STEM major choices among Asian American subgroups could be further explained by their demographic background, such as gender, family income, immigration status, and parental education level, and high school settings (location, and type). Gender is a dichotomous variable, and the reference group is male. Family income level is based on annual income levels that range from one to thirteen, with a difference of $20k per year between each score. Parental education level consists of three dichotomous variables that show the higher education level among father mother, and guardians. The reference group is high school or below, and the other three variables are associates degree, bachelor's degree, and master's degree or above. Immigration status indicates whether the student is first generation or not. The first-generation is defined as the students who were foreign-born citizens, resident aliens, or eligible non-citizens. The reference for this variable is the non-first generation. We also include high school setting variables such as high school location, and type.

To answer the third research question, we investigate the conditional differences of Asian subgroups in STEM major selection by college selectivity: 2-year college, non-highly selective

4-year college, and highly selective 4-year institutions. We estimate two models: the first model includes Asian ethnic subgroup indicators, college selectivity levels and the interaction terms between Asian ethnic subgroups and college selectivity levels; and the second model adds the factors of individual and high school backgrounds as well as academic preparation. The interaction terms between Asian subgroups and college selectivity assess if STEM major selection among Asian American student groups are uniform across college selectivity level. Thus, it allows us to examine the extent to which Asian ethnic subgroups choose STEM majors by college selectivity. To show results more intuitively, we present the marginal effect both with and without holding other factors at their means. These marginal effects show a change of probabilities in STEM major selection across Asian ethnic subgroups by institutional selectivity.

Descriptive statistics for all variables across Asian ethnic subgroups are presented in Table 1. It presents that Chinese and Indian/Sri Lankan students show relatively higher parents` socio-economic status than other Asian American subgroups. For example, in terms of the percentage of parents whose educational level is above bachelor's degree, Chinese and Indian/Sri Lankan students are 70%, and 76%, respectively, while in the Vietnamese/Thai group, only 36 percent of parents have an educational level above bachelor's degree. When it comes to college selectivity level, Chinese and Indian/Sri Lankan students are more likely to enroll in highly selective 4-year colleges than other Asian American groups. Similarly, on average, Chinese, Indian/Sri Lankan, and Korean/Japanese students have higher 12th grade math performance than Filipino and Vietnamese/Thai students.

Table 1. Descriptive Distribution of Independent Variables across Asian American Subgroups

	Chinese	Filipino	Vietnamese/ Thai	Indian/ Sri Lankan	Korean/ Japanese
	Mean(*SD*)	Mean(*SD*)	Mean(*SD*)	Mean(*SD*)	Mean(*SD*)
Female	0.58(0.49)	0.48(0.50)	0.51(0.50)	0.49(0.50)	0.52(0.50)

Income	5.60(3.46)	5.42(2.96)	4.22(2.82)	5.73(3.70)	5.31(3.05)
Parental Education Level (ref. High School or Below)					
Associate Degree	0.07(0.25)	0.13(0.34)	0.15(0.36)	0.05(0.22)	0.15(0.36)
Bachelor's Degree	0.24(0.43)	0.47(0.50)	0.27(0.44)	0.27(0.45)	0.31(0.46)
Master's Degree or Above	0.46(0.50)	0.28(0.45)	0.09(0.29)	0.49(0.50)	0.31(0.46)
Math Score at 12th Grade	63.91(9.41)	56.51(9.10)	56.13(9.40)	60.94(10.17)	59.18(9.54)
First Generation Immigrant	0.43(0.50)	0.31(0.46)	0.29(0.46)	0.44(0.50)	0.37(0.48)
High School Type (ref. Public)					
Catholic	0.10(0.30)	0.26(0.44)	0.11(0.32)	0.09(0.29)	0.13(0.33)
Other Private	0.10(0.30)	0.04(0.19)	0.02(0.13)	0.09(0.28)	0.06(0.24)
High School Urbanicity (ref. Urban)					
Suburban	0.43(0.50)	0.30(0.46)	0.30(0.46)	0.45(0.50)	0.39(0.49)
Rural	0.22(0.42)	0.21(0.41)	0.21(0.40)	0.25(0.43)	0.23(0.42)
Enrolled College Selectivity (ref. 2-year College)					
4-year College	0.29(0.46)	0.48(0.50)	0.42(0.49)	0.34(0.47)	0.36(0.48)
Highly Selective 4-year College	0.58(0.49)	0.24(0.43)	0.22(0.41)	0.51(0.50)	0.38(0.49)

Note. The sample consists of 314 Chinese, 302 Filipino, 264 Vietnamese/Thai, 211 Indian/Sri Lankan, 276 Korean/Japanese, respectively.

Results

Pattern of Asian Subgroups in Choosing STEM Majors

Table 2 presents the results of the sequential logistic regression models that predict the likelihood of choosing STEM majors for Asian American subgroups, when Chinese students are reference group. In the baseline model without any exploratory variable (Model 1), the results indicate that the odds of Chinese students choosing STEM majors were not significantly different from those of Indian/Sri Lankan, Vietnamese/Thai, and Korean/Japanese students. However, Filipino students showed approximately 60 percent lower odds of choosing STEM major than Chinese students (*odds ratio*=*exp*(-0.90)=0.41, $p<0.05$).

The results of achievement model (Model 2) reveal that the difference between Chinese and Filipino students have disappeared, if we assume that math scores at 12th grade, and college selectivity level are equal. It suggests that Chinese students tended to show higher achievement

levels than Filipino students, thereby potentially driving them to choose STEM majors in college. Next, it appears that, assuming the same academic performance, Indian/Sri Lankan students were choosing STEM major more than Chinese students, but Chinese and Korean/Japanese students show no significant difference in the likelihood of majoring in STEM.

Contrary to our expectations, individual demographic and high school backgrounds did not untangle the difference of STEM major choice among Asian American students when their achievement level is equal. In the full control model (Model 3), we found only small changes of the values of coefficients, but it was almost identical to the initial values in the Achievement model (Model 2). At the same time, for Asian American students, higher academic achievement, and parents with master's degree or above, were positively associated with the odds of selecting STEM majors. In particular, as shown in Model 5 of Table 2, the female students had a 46 percentage lower odds of choosing STEM major than the male students (*odds ratio* = *exp*(-0.61)=.54, $p<.05$), suggesting that gender gaps in STEM among Asian Americans are still strikingly large. However, whether a student is first generation, high school urbanicity and type, are not significantly related to the likelihood of choosing STEM majors among Asian American students.

Table 2. Results of Logistic Regression to Predict the Likelihood of STEM Major Choice

Variables	Model 1 Baseline model	Model 2 Achievement model	Model 3 Full Control	Model 4 Interaction with baseline	Model 5 Interaction with full control
Asian Subgroups (ref. Chinese)					
Filipino	-0.94**	-0.39	-0.39	0.65	0.29
Vietnamese/Thai	0.17	0.72	0.98*	3.01***	3.32***
Indian/Sri Lankan	0.67	0.80*	0.76*	2.82***	2.45**

Korean/Japanese	-0.23	0.16	0.18	1.86**	1.28
College Level (ref. 2-year College)					
Non-Highly Selective 4-yr College		-0.02	0.07	2.17**	1.79*
Highly Selective 4-yr College		0.47	0.70	3.11***	2.10**
Math Score at 12th Grade		0.06**	0.06**		0.07***
Female			-0.61*		-0.56*
Income			-0.09		-0.08
Parental Education Level (ref. High School or Below)					
Associate Degree			-0.73		-0.68
Bachelor`s Degree			-0.01		-0.10
Master's Degree or Above			0.59		0.40
First Generation Immigrant			0.05		-0.02
High School Urbanicity (ref. Urban)					
Suburban			0.39		0.32
Rural			0.34		0.34
High School Type (ref. Public)					
Catholic			0.14		0.12
Other Private			-0.54		-0.61
Interaction Terms					
Filipino*Non-Highly Selective 4-yr				-1.02	-0.77
Filipino*Highly Selective 4-yr				-1.21	-0.58
Vietnamese/Thai*Non-Highly Selective 4-yr				-2.68**	-2.96**
Vietnamese/Thai*Highly Selective 4-yr				-3.58***	-3.41**
Indian/Sri Lankan*Non-Highly Selective 4-yr				-1.97*	-1.81*
Indian/Sri Lankan*Highly Selective 4-yr				-2.63**	-1.83
Korean/Japanese*Non-Highly Selective 4-yr				-2.51**	-1.96
Korean/Japanese*Highly Selective 4-yr				-1.64*	-0.60
Constant	-0.61*	-4.89***	-4.60***	-3.12***	-6.40***

Note: *** $p<0.001$, ** $p<0.01$, * $p<0.05$. Total N is 1,367

Next, by adding the interaction terms between Asian subgroups and college selectivity levels into previous logistic regression model 1, and 3 in Table 2, respectively, we analyzed the heterogeneity of STEM major selection by depending on college selectivity for the Asian American subgroup students. The results are reported in Model 4, and Model 5, respectively. We

found that Chinese students are more likely to choose STEM majors when they are enrolled in more selective postsecondary institutions. In both Model 4 and Model 5, most interaction terms between the college selectivity level and other Asian subgroups showed significantly negative direction. In other words, it represents that other Asian subgroup students are more likely to choose STEM majors in 2-year colleges than Chinese counterparts.

Because it is hard to have a sense of the magnitude of STEM major choice according to the college selectivity level from the results of the logistic regression with interaction terms (Williams, 2012), we alternatively estimated, and visualized the probabilities of STEM major choice over Asian American subgroups in Figure 1. Using the result of the baseline model in Table 2, we represent the probabilities to choose STEM major by Asian subgroups across college selectivity. Next, using the result of the Achievement model which takes into account demographic characteristics, high school setting, and academic achievement level, we show the probabilities of STEM major choice of the Asian American subgroups if all factors hold at their mean values. Thus, it presents the trend of STEM major choice across college selectivity when all students have similar individual and school backgrounds.

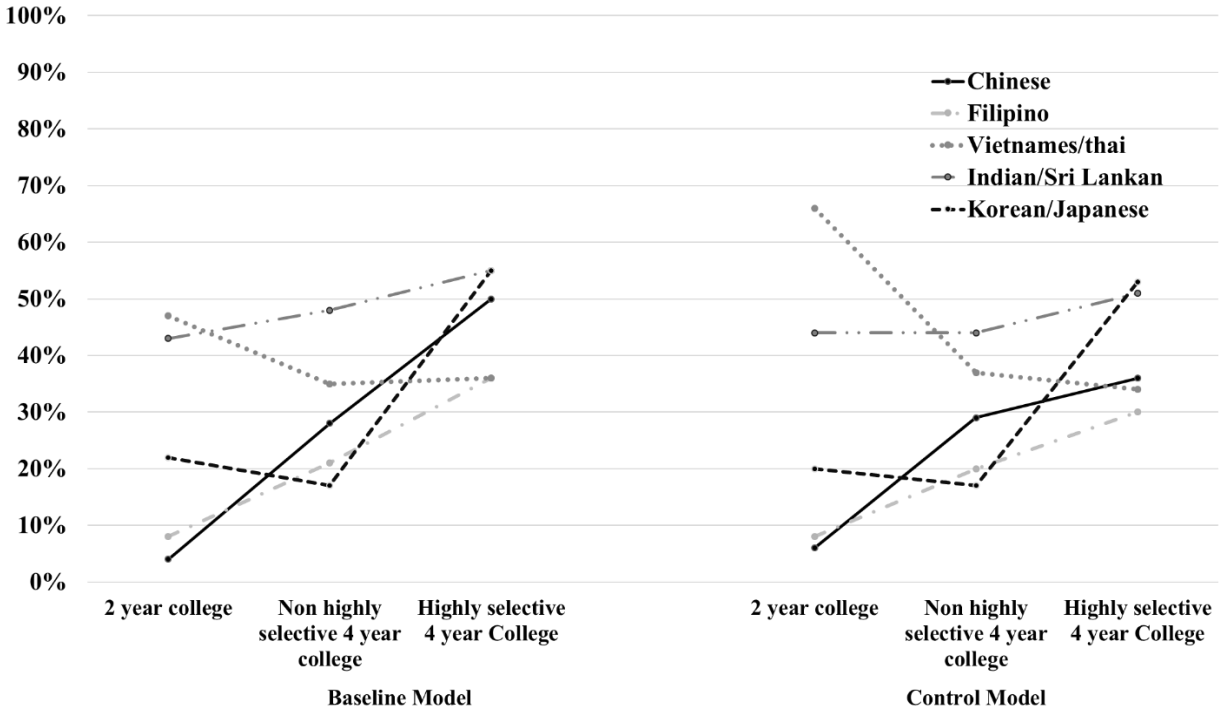

Figure 1. Predicted Probability of STEM Major Choice by Asian American Subgroups, By College Selectivity

As described above, the differences of STEM major selection among Asian ethnic subgroups were not uniformly applied to the 2-year, non-highly selective 4-year, and highly selective 4-year college students. Chinese students tended not to choose STEM majors when attending 2-year colleges. In contrast, the higher the selectivity level of colleges and universities, the more likely Chinese students were to choose STEM majors. This tendency was reduced, but still maintained, after fixing the value of variables at their mean values. Second, Filipino students are also more likely to select STEM majors as the college selectivity level is higher, like the case of Chinese students. At the same time, overall, Filipino students are less likely to choose STEM majors than other Asian ethnic subgroup students. After taking account for the individual and school backgrounds, such trends turned out to be similar. Third, Vietnamese/Thai students were more likely to choose STEM majors when they enroll in a less selective institution, in particular,

at 2-year colleges. Moreover, this gap remains even after controlling for all other variables, while the probability that they choose STEM majors at four-year colleges tends to dramatically decrease. Fourth, Indian/Sri Lankan students tended to choose STEM majors compared to other Asian ethnic subgroups across all college level. The predominance of STEM major selection in the Indian/Sri Lankan population persisted, even assuming all else is equal. It is noteworthy that Indian/Sri Lankan students attending 2-year institutions seemed to choose STEM majors at a similar level as Indian/Sri Lankan students attending 4-year institutions did, if they had a similar background. Finally, for the Korean/Japanese group, 2-year and non-highly selective 4-year college students tended to choose fewer STEM majors, whereas highly selective college students had a high probability of STEM major selection.

Discussion

Although a large number of important studies have examined the *overrepresented* Asian Americans in STEM fields (Chang et al., 2014; Ong, Wright, Espinosa, & Orfield, 2011), the heterogeneity of STEM major selection among Asian American students from different ethnic subgroups has not been adequately addressed. As Chen and Buell (2018) point out, "Asian (Americans) in STEM have variously been positioned simplistically as the yellow peril, talented workers, docile workers, a model minority, dangerous, desirable, not-Black, near White, and decidedly not-White" (p. 619). In this regard, based on the perspective of AsianCrit theory (Iftikar & Museus, 2018), our findings debunk the widely held belief racializing Asian Americans as a monolithic *model minority* group by analyzing different realities of STEM entrance among various Asian American ethnic subgroups, and suggest a need for a more careful look at the complexity and heterogeneity underlying the process of *Asianization* in the United

States. To address this issue, here, we update the trends previously established in studies that drew on large-scale databases such as census data (e.g., Min & Chang, 2015), and extend work in this area by considering the heterogeneity among the Asian American ethnic subgroups and using the most up-to-date, nationally representative high school cohort dataset that allows us to take into demographic and pre-college factors in STEM major selection by college selectivity.

The results show that there are significant disparities in STEM major selection among Asian American students, in sharp contrast to the prevailing notions of the model minority stereotype. When differences in college selectivity are not considered, Indian/Sri Lankan students seem to choose STEM majors the most, while Filipino students seem to choose STEM majors the least. There seems to be no significant difference in choice of STEM major among Chinese, Vietnamese/Thai and Korean/Japanese students. At the same time, it is noteworthy that Indian/Sri Lankan students showed higher likelihood of choosing STEM majors than Chinese students, even after we assume that the all students have similar academic performance (i.e., math score at 12th grade, and enrolled college selectivity) and backgrounds (i.e., immigration status, gender, parental education level, family income, high school urbanicity, and type). In a follow-up analysis with Indian/Sri Lankan student group as reference group, we consistently found that Indian/Sri Lankan students were more likely to choose STEM majors in comparison to other Asian American subgroups, even assuming all else is equal.

Further, the analysis shows a need for careful consideration of the widespread perspective that Asian American students have uniformly high academic performance, and that such tendencies are an important mechanism of STEM major selection. Previous studies argue that, based on their parents' expectation of high-status STEM occupations for socioeconomic rewards, Asian American students tend to pursue the goal of high academic performance and place

emphasis on investment in education as a main channel of upward social mobility (Chung, 1992; Min, 1998). However, our findings suggest that such stereotypes of Asian American students can only partially explain differences in STEM major selection among Asian American ethnic subgroups. Though Chinese American students showed higher math scores at 12th grade, and tended to enroll in more selective colleges than other Asian American subgroups, their high academic performance was not closely related to the difference in the likelihood of STEM major selection among Asian ethnic subgroups. For instance, in the case of Vietnamese/Thai and Indian/Sri Lankan students, they tended to choose more STEM majors than Chinese students even if we assume their academic performance is similar. On the other hand, there was no significant difference between Filipino and Chinese students in the probability of majoring in STEM after controlling for math achievement. The relatively lower math achievement level of Filipino students is an important factor potentially explaining their lower possibility of STEM major selection. Accordingly, this result indicates the need to investigate various factors beyond academic achievement in order to comprehensively examine differences in STEM major preferences among Asian ethnic subgroups.

Rather than continuing to assume uniformity of STEM experience and outcomes among Asian American students from the perspective of model minority in the United States, a key implication of our research is that we must consider the complexities of Asian American experiences with respect to students' pathways to STEM majors. Such a model minority myth both incorrectly flattens the experiences and outcomes of Asian American students, while simultaneously leading us to ignore underrepresented subpopulations within this broad category. Importantly, the model minority myth in STEM fields is a testament to the racialized reality of invisible Americans under the influence of racial stereotypes in American society today. In

particular, the stereotype has been facilely applied to the group named "Asian students" in the field of education, without consideration for complexity and heterogeneity. If the complexity and heterogeneity of Asian American populations in STEM fields is not sufficiently examined, the current mechanism categorizing Asian American populations into the stereotype of model minority will become more entrenched, and could have an adverse impact on the future outcomes of underrepresented Asian American students in STEM fields.

Here, it is noteworthy that gender is strongly related to the probability of choosing STEM major. Even after assuming that other conditions, such as academic achievement, demographic characteristics, and high school backgrounds are all equal, Asian American female students showed approximately *46% less odds of choosing STEM majors than male students*. The gender gap in the STEM pathway was evident in Asian American students as well as other racial groups, suggesting that further research is required in order to better understand and mitigate the effects of the gender gap in marginalized Asian American subgroups.

Further, we also emphasize a careful effort to understand the nature of STEM major selection, in that the choice of college and college major is not only a product of individual will and interest, but also a result of external forces including socioeconomic backgrounds and school contexts (e.g. Wells & Serna, 1996; Yonezawa, Wells, & Serna, 2002). Given that a variety of practical reasons lead Asian American students from different backgrounds to stratified educational and occupational trajectories in STEM fields, the details of students' postsecondary destinations should be meticulously examined. In this regard, the analysis shows in further detail the heterogeneity of STEM major selection within the Asian American population, in light of the difference of college selectivity. To be specific, Chinese and Korean/Japanese students showed a greater chance of choosing STEM majors when attending highly-selective 4-year institutions, but

otherwise their chances of majoring in STEM fields were relatively low. This tendency was especially evident in Korean/Japanese students. On the contrary, Vietnamese/Thai students in 2-year institutions were *most likely* to choose STEM majors among Asian ethnic subgroups, while their counterparts in 4-year institutions showed a comparatively lower likelihood of STEM major selection. Furthermore, this trend was more pronounced when the student background was assumed to be equal. Importantly, again, Filipino students tended to be less likely to major in STEM fields than other Asian American students at all college selectivity levels. This evidence suggests that the dominance of Asian American students in STEM fields cannot be understood without consideration of college selectivity.

These findings raise questions about a range of underrepresented Asian American students in the STEM pipeline. Emphasizing the gap of STEM major selection in conjunction with college selectivity, this study reveals the need for further discussion on the stratification of occupational trajectories in the STEM-related job market for Filipino and Vietnamese/Thai students. While researchers have predominantly focused on underrepresented minorities, including Black and Latinx students in two-year colleges in STEM fields (e.g., Jackson, Starobin, & Laanan, 2013; Reyes, 2011), little attention has been paid to underrepresented Asian ethnic subgroups such as Southeast Asian American students. Future studies can profitably investigate underrepresented Asian ethnic subgroups, in addition to continuing to focus on underrepresented Black and Latinx students, so as to maximize opportunities for a broadened range of underrepresented populations who are constrained by existing opportunity structures and the STEM pipeline.

A greater focus on reasons for these differences within the Asian American population is also required. Why do Asian ethnic subgroups show different patterns in STEM major selection

depending on college selectivity? Though our analysis does not aim to address this question specifically, it is important to look more closely into the cultural and structural factors shaping the different patterns across Asian ethnic subgroups. In this regard, existing studies argue that Asian American students tend to get higher achievement scores and go to selective 4-year colleges, because of their preference for STEM occupations, based on their beliefs that fewer barriers interrupt fair competition (Roysircar, Carey, & Koroma, 2010; Xie & Goyette, 2003). This view partially explains the preference of Chinese and Korean/Japanese students for STEM entrance, as their dominance in STEM majors is observed only in the highly selective college sector. However, this view is still somewhat lacking in understanding the different patterns of STEM major selection among Asian ethnic subgroups. For example, whereas Indian/Sri Lankan students show higher proportions in STEM majors across all college selectivity levels regardless of their academic performance, Vietnamese/Thai and Filipino students do not exhibit dominance in STEM majors in the highly selective 4-year colleges. These findings indicate that the existing accounts of the predominance of Asian American students in STEM fields cannot fully explain this phenomenon. In future investigations, more empirical evidence should be presented with regard to the diverse and specific cultural and historic contexts of migration for varying Asian American subpopulations, as well as consideration of the economic and labor conditions for varying subgroup populations in current U.S. society.

Policy makers and administrators in higher education also need to acknowledge the heterogeneity of STEM major selection among Asian American students and come up with sustainable solutions. Although STEM education reform policies have focused on providing opportunities for STEM entrance to historically marginalized students including low-income, Black and Latino/a, and female students, our findings draw attention to the fact that

underrepresented Asian American students in STEM fields are rendered *invisible* by the model minority construction, despite their own socioeconomic disadvantages. In this regard, we must critique the model minority perspective that reads off only a part of the Asian population and makes many other Asian American students invisible victims of racism and social inequality. Moreover, given the practical influence of the model minority myth (McGee, Thakore, & LaBlance, 2017), these underrepresented Asian American students are more likely to be under a double burden in terms of their entrance into STEM fields. Importantly, the current result shows that many underrepresented Asian American students in the STEM pipeline are more likely to choose pathways to two-year institutions and entry-level work than their other Asian American counterparts, suggesting that for many underrepresented Asian ethnic subgroup students upward social mobility via STEM education is still limited in the United States.

Limitations and Future Directions

This study has two weaknesses due to the limitations of data, and we offer several suggestions for further research in what follows. First, although this study divided Asian American subgroups in the most detail allowed by the data, a more in-depth examination by further disaggregating the groups is required. Nationally representative high school longitudinal datasets collected by the NCES (e.g., HSLS:09) oversampled Asian students to ensure sufficient size for analysis. However, questions about race/ethnicity and national origin in the national educational databases did not allow researchers to examine educational experiences at granular ethnicity categories and national origin. For example, in our analysis, Korean Americans and Japanese Americans are classified into one group. This classification makes it impossible to investigate the significant differences between the two groups, even though the two subgroups

have divergent career paths, parenting practices, cultural backgrounds, and immigration histories. Similarly, with the exception of the Chinese American case, all other subgroups are mixed with various ethnicity groups. Therefore, these data themselves have limitations in displaying the results that most closely reflect potential differences between groups. In order to solve the problem of general misreading of the Asian American population with respect to STEM pathways, and critically identify what is actually happening to a range of Asian American students, data should be collected in a way that allows for further disaggregation of the variation within the Asian American subgroups. In addition to oversampling Asian students from varying national and ethnic subgroups, it is important that survey questions include granular ethnicity categories and national origin in the future.

Second, future research needs to consider more diverse factors when examining the differences in the STEM pipeline among Asian American subgroups. For example, several studies determined that characteristics of particular Asian American ethnic communities, such as accumulated college knowledge, prevalence of private supplementary education services, and interclass social relations can have positive impacts on their students' educational outcomes, and occupational aspirations (Paik, Kula, Saito, Rahman, & Witenstein, 2014; Park, 2012; Zhou & Kim, 2006). Given that information about various Asian American ethnic subgroups derived from the data in the current study is limited, it is obvious that more detailed and nuanced information about each Asian American subgroup, including cultural norms, social stereotypes, experiences of discrimination, and intergenerational interactions is needed not only for better understanding of the heterogeneity of STEM pathways among Asian American ethnic subgroups, but to better enable and sustain a challenge to the old dogmas including White supremacy and colorblindness.

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