When an undergraduate is faced with a decision to enroll into a T7 economics department, female seniors choose to enroll at 2.7x times male seniors do (2021-2022 admission cohorts, $N = 314$**,** $p = 0.02247$**,** ***CI=entirely positive*****). Why?** Written up 2026.

1 Statistics of Counterfactual Decision-Making

The decision to enroll into a PhD program is a simple binary yes-no, but it is consequential to the applicant; the personally-collected observational data set below reveals a difference in counterfactual decision-making by gender.

1.1 Introduction

Aspiring graduate students are often nervous about the application process to graduate study, most not having connections and mentorships with experience in the field. And of those who do, many of such first-person information references are self-aware enough to state: "the field is changing so fast, I can give you some advice but much would be outdated."

Indeed, between an undergraduate senior and a newly minted assistant professor (whether in Economics or in other disciplines) is a potential mountain: a research assistantship, a pre-doctoral position, perhaps a masters, potentially another research position, a PhD of up to 6 years, and maybe year(s) as a post-doctoral researcher. The case of an undergraduate student asking tenured faculty a broader application question (unless the said faculty is very involved with many new graduate students) is risky. The tenured faculty, while potentially involved in the admissions process in their own institution, may unintentionally introduce biases that stem from outdated generalizations.

It is thus imperative to have a recent, unbiased source of information regarding applications to graduate programs. Such a compilation of data could help determine departmental biases, create a profile of a modal successful enrollee, uncover preferences, shape expectations, and reveal decision-making.

2021-2022 Enrollment Statistics into Top 16 US Economics PhD Programs was created with this in mind. While a wide range of an application's details are unobservable (such as all colleges where a student was granted admission - not trivial, as all applicants form the same annual pool, and enrollment of A at X may *cause* an admission denial of B, who is now enrolling into Y..., specific grades, etc.), an inquisitive reader should be able to loosely grasp a fragment of an admission cycle picture in Economics.

1.2 Methodology

The data source document: phd_list_2021_2022.csv.
Institutions common abbreviations used from here on.

Which institutions are worth to track? Geographical preferences? Prestige? Academics? In a perhaps simplistic way, USNews' "2022 Best Economics Schools" was utilized. Non-US schools were ignored. The prior USN version is accessible for verification via the Wayback Machine.

N=547 enrollees. 2021=265, 2022=282.

Tracked (Lists cohort years)	**No cohort data**
Harvard, MIT, Stanford, Princeton, Berkeley, Chicago, Northwestern, Columbia, UCLA, UCSD, John Hopkins, Rochester, Vanderbilt, MSU, Georgetown, Rice	Yale, Penn, NYU, Michigan, Brown, CalTech, Cornell, Wisconsin, Duke, Minnesota, CMU, UT-Austin, BU, UC Davis, UMD, Penn State, Boston College, UVA, WUStL, UIUC, UNC, USC, ASU, OSU, UCSB, IU, Arizona, UCI
16 departments (top-heavy)	28 departments

Schools attempted to track. ***Note*** ***that some departments, e.g., Yale, started listing years since.***

The available data sources were finalized. Further considerations: what variables are to be tracked?

Variables

`student_name`	Student name; some shortened or anglicized.
`phd_institution`	PhD institution.
`us_rank`	US News 2022-2023 institution rank.
`start_year`	Year of PhD cohort entry.
`gender_assumption`	Male / Female. *Note: assumption from photo/name. Incomplete binary classification.*
`race_assumption`	White, White_Hispanic, Asian, Arabic, Black. *Note: same assumption; same limitation.*
`resume_site`	Personal academic site, if available.
`linkedin`	LinkedIn profile, if available.
`time_difference`	Years between undergraduate completion and PhD start (BS '21 (june) → PhD '22 start = 1).
`undergrad_institution`	Undergraduate institution; anglicized where necessary.
`undergrad_country`	Country of undergraduate institution.
`undergrad_end_year`	Year undergraduate degree was conferred.
`undergrad_type`	Public, Private, or LAC.
`undergrad_major_1`	Applied Mathematics collapsed to Mathematics; business-adjacent degrees collapsed to Economics.
`undergrad_major_2`	For triple majors, closest to Economics or Mathematics selected.
`predoc_1`	Pre-doctoral program ("Stanford" > "SIEPR", "Harvard" > "Opportunity Insights", etc.).
`predoc_1_type`	University, Government, or Private.
`predoc_1_duration`	Approximate duration in months.
`predoc_2`	same.
`predoc_2_type`	same.
`predoc_2_duration`	same.
`masters_institution`	Masters institution, if applicable.
`masters_country`	Country of masters institution.
`masters_end_year`	Year masters degree was conferred.
`masters_major`	Masters field; simplified and normalized to Economics where analogous.
`research_field_1--4`	Up to four research fields per student. *Note: not all institutions consistently list research interests.*

1.3 2021-2022 Enrollment Statistics into 16 Top US Economics PhD Programs

1.3.1 Descriptive Demographics

I acknowledge that a passive collection of demographics involves a degree of simplifying classifications.

547 Data Points	
Male	Female
359	188
65.6%	34.4%

Race Assumption	**Female**	**Male**	**Total**
White	73	151	224
Asian	76	129	205
White-Hispanic	28	63	91
Arabic	6	13	19
Black	5	3	8
Total	**188**	**359**	**547**

R: tables and mutates

Not a significant result: for 100 Asian males, there are 59 Asian females. For 100 White males, there are 48 White females. Small sample, $p = 0.3828$. *prop.test()*

# (countries)	Countries
242	US
146	N/A
18	India
16 (2)	China, UK
10	Brazil
8 (2)	Italy, Mexico
7 (3)	Colombia, Canada, Chile
⋮	⋮
1 (14)	Azerbaijan, Costa Rica, Cyprus, (...), UAE

39 unique countries

(R: sorts, tables, unique lengths)

Data interpretation: Out of 547 students, 146 do not have information on their undergraduate institution location. Out of 401 that do have it, 60.3% (242) (44.2% of total) come from the US. A hypothesis is that international students are more likely to lack any kind of online information easily found, thus out of the remaining 146 unknown students, the **share** of American undergrads is probably less than 60.3%. **Therefore assume**: the proportion of American undergraduates in US Econ PhDs is 44.2%-60.3%.

	Male	Female
USA	150	92
¬USA	209	96

(This groups N/A countries into "¬USA".)

(R: new conditional variable mutation)

Underpowered to confirm: observe that while the number of men increased, the number of women stayed the same. It's likely that "international relocation" is psychologically and culturally difficult for women and is more acceptable for international men. Alas, $p = 0.1312$. *chisq.test()*

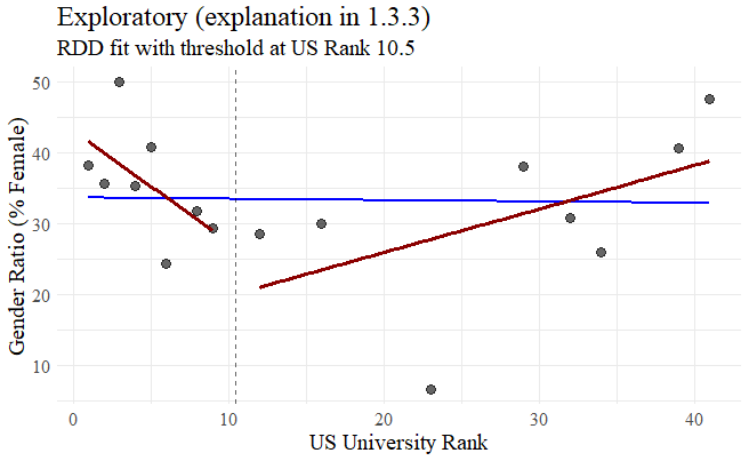
Zeroing in on tracked 2021-2022 cohorts at the "best" departments (8 of the top 10 available); Gender Ratio:

Institution	us_rank	Gender Ratio
Stanford	3	50
Berkeley	5	40.9
Harvard	1	38.3
MIT	2	35.7
Princeton	4	35.4
Northwestern	8	31.8
Columbia	9	29.4
Chicago	6	24.4
the lowest ratio:		
John Hopkins	23	6.7

Immediate: Bay Area leads efforts to equalize representation in Economics

(R: group_by, sort)

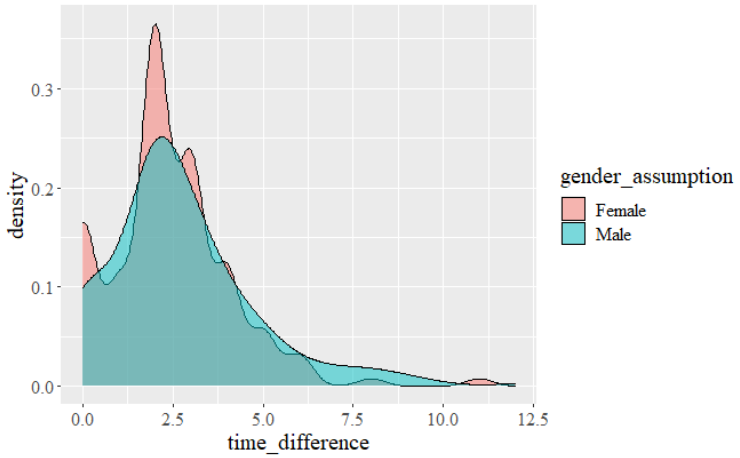
Exploring gender parity further, creating a new variable "Gender Ratio" (% of Female), and regressing it on "us_rank", three regressions: all 16 schools, "best" 8 (concentrated towards the top, were all the USN tracked T10), lowest 8, RDD finds exploratory discontinuity patterns, elaborated in 1.3.3:



I hesitate to label John Hopkins an outlier: from my consideration, it is a symptom of departments chasing international students who are mostly men (discussed above in ¬USA "Underpowered to confirm").

1.3.2 Finding a Significant Result

"**time_difference**" is a variable of great interest. Broad knowledge of how long it takes an applicant to find a PhD institution the applicant is satisfied to attend and enroll into, is a useful reference point.
159/547 entries are missing the time_difference data. No gender bias on missing data.



density > bin stylistic choice; years between end of undergraduate and enrollment into PhD, by gender

t_d Moments	Male	Female
Mean	2.73	2.41
Variance	4.20	2.99
Skew	1.25	1.20
Kurtosis	2.33	3.73

Kurtosis in female t_d is speculated to be due to gender norms:

Broader society has fundamentally different expectations of the two genders: females are expected to "settle in" on a lifestyle (which is psychologically understandable if the female wants her own kids) versus males, who are to be more industrious and take more risks (e.g., the biggest $t\_d = 12$ was a male applicant, males had a greater right tail). Therefore, a female applicant has a significant societal and, by extension, psychological pressure on their reasoning after graduation: "do they commit to an X or Y lifestyle"? This is a counterfactual question.

Is the *t_d=0* (left tail) spike for Female Enrollees significant?

Initially inconsequential ($p = 0.55$). But (!) recall the regression lines on the previous page. There, the overall trend was moot, but by breaking the dataset up into two parts, there might be a statistically significant result. Take the steeper slope:

Let's take just the "best" 8 tracked schools: Harvard, MIT, Stanford, Princeton, Berkeley, Chicago, Northwestern, Columbia.

p=0.077, N=348, -0.01 to 0.127 CI.

Close. Raising its average department rank by removing the lowest ranked school from the list (Columbia).

p=0.02247, N=314, 0.003 to 0.149 CI

Note the 0.003 to 0.149 CI. But the direction always favors females. (more in 1.4)

Direct Significant Result:

In 2021 and 2022 Economics Graduate (PhD) Admission Cycle, Harvard, MIT, Stanford, Princeton, Berkeley, Chicago, Northwestern admit an unknown number of persons with unknown demographics. Some of those unknown "admits" **choose to enroll**:	
199 Males	115 Females
9/199 enroll directly from ugrad	14/115 enroll directly from ugrad
4.523%	12.174%
Faced with a T7 admit, Females enrolled at a 2.7 times higher rate out of ugrad than males. This is statistically significant ($p = 0.02$).	

1.3.3 Causal Inference? RDD, Endogeneity, IVs

The data is observational and is not experimental or quasi-experimental. Interpretation is limited.

The exploratory Regression-Discontinuity Design (RDD)[1] that was performed and started exploration towards the significant result that followed, is loosely unfounded. The **forcing variable** *us_rank* was discrete, not continuous (though technically some papers allow a discrete variable to be used). The most important assumption needed to discuss is the "no-manipulation-with-precision". Could there be an "elite", "prestigious" point around the Top 10 departments that arbitrarily cuts off after; **which female applicants disproportionately seek?** It is unlikely. Hence exploration continued.

A "prestige" variable is **endogeneous** with the *direct_admit* variable, therein both are correlated with the error term. The variable, while interesting, doesn't yield much. An **Instrumental Variable**[2] could be created to address the endogeneity, had there been more data. E.g., enrollee geographic distance to an "academically elite" location during HS and BA studies could approximate influence. Linking datasets:

[1] Hahn, Jinyong, et al. "Identification and Estimation of Treatment Effects with a Regression-Discontinuity Design." Econometrica, vol. 69, .no 1, Econometric Society, 2001, pp. 201-209, https://doi.org/10.1111/1468-0262.00183

[2] Correlated with the treatment BUT not the outcome. Angrist, J.D., Imbens, G.W. and Rubin, D.B. (1996) Identification of Causal Effects Using Instrumental Variables. Journal of the American Statistical Association, 91, 444-455.

Gender	Valid N	Mean U.S. Rank	Median U.S. Rank	% from Top 10 Undergrad
Female	32	8.09	2.5	81%
Male	44	9.11	5.0	84%

1.3.4 Causal Inference? Maximum Likelihood Estimation

In the spirit of counterfactuals (outcomes are binary, either direct admit or not), here we are to run a **Logistic Regression**. The goal is to predict the probability of direct enrollment into Harvard, MIT, Stanford, Princeton, Berkeley, Chicago, Northwestern given: 1) just *gender_assumption*, 2) just *prestige*, 3) just *econ_math_2major*, and 4-7) some combination together. **"Prestige", of course, was thrown out**:

Beyond "prestige"'s **endogeneity**, it is hard to assign values to schools not ranked on 2022 US News. E.g., how to evaluate "University of Cyprus", a female from which enrolled into one of the seven schools directly out of undergraduate? For US Universities, US News ranking could be (and was) used, but Liberal Arts Colleges are not present on the ranking of graduate schools either. How do you judge how prestigious is Wellesley College relative to universities with graduate schools? International, e.g., Bocconi, LSE, Tsinghua?

Thus iterations of the "Prestige" variable decimated the observations (3/4 removed) and indeed yielded no significance. (With better data and IVs it'd be great.) Focusing on the gender and the double major:

Call: $direct\_admit = gender\_assumption/econ\_math/both$

Logistic Regression Estimates for HMSPBCN Direct Admissions

	Dependent variable:		
	Direct Admit (Logit)		
	(1)	(2)	(3)
Male	-0.968^{**}		-0.918^{**}
	(0.450)		(0.455)
Econ+Math Double		0.912^{**}	0.856^{*}
		(0.444)	(0.449)
Intercept	-1.718^{***}	-2.586^{***}	-2.094^{***}
	(0.290)	(0.313)	(0.373)
Observations	233	233	233
Akaike Inf. Crit.	149.409	149.991	147.805
Note:			*p<0.1; **p<0.05; ***p<0.01

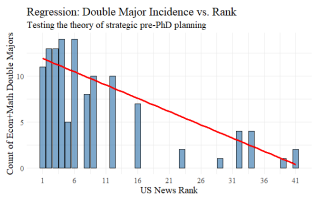
[3]

Economics and Mathematics double major does not explain why gender is so influential in admission. It only explains about 5% of the *gender_assumption* variable. But there might be a **psychological** explanation.

1.3.5 Counterfactual and Psychological Explanation

Behavioral and Psychological understanding of gender difference is important. How females and males approach academics is different: in the *phd_HMSPBCN* dataset, 34/115 (29.6%) females double majored in Economics and Mathematics. Only 44/199 (22.1%) males did so. A double major (Economics, Mathematics), as seen, was one of the strongest predictors of high-rank graduate study in economics; econ/math have limited overlap and majoring in both requires some academic planning — assume a person who graduated with an econ+math major at least contemplated graduate economics study.

[3] Hlavac, Marek (2022). stargazer: Well-Formatted Regression and Summary Statistics Tables. R package version 5.2.3. https://CRAN.R-project.org/package=stargazer



(R: Quick econ+math double major on rank)

Women take less financial risks than men (Sapienza, 2009)[4] An academic pathway decision has direct implications on a future career and, subsequently, finances. To plan ahead in academic study is to anticipate risks and attempt to control them (wherein the objective function focuses on the minimization of costs rather than the maximization of benefits). **Females do this "counterfactual simulation" more than males**.

Unobservable variables (e.g., recommender personal connections) could explain most of the direct admits. With their risk aversion and heightened preparation, females would have on average more avenues to impress faculty and solicit a private recommendation. Conversely, the males who can get admitted into a top STEM PhD program, likely also hold outside industry offers and entertain those at a greater rate than the females.

With greater maturity, *responsibility*, preparation than 21-22 years old males, it is not surprising to see females enroll into econ graduate programs at a higher rate. It is also notable, from the male perspective, a top male admit (who is more risk-prone) likely ponders a transition from academia to a private role, e.g., a hedge fund, whereas females consider the transition risky and are less likely to attempt it (some still do). Social expectations of elite industry positions that vie for the same candidates could also influence this result.

1.4 Conclusion

Tracking *2021-2022 Enrollment Statistics into 16 Top US Economics PhD Programs* identified a statistically significant disparity: **if admitted straight from undergraduate**, females enrolled into Harvard, MIT, Stanford, Princeton, Berkeley, Chicago, Northwestern at a rate 2.7x higher than the males. The observational study could not come up with an explanation backed by data; the result CI could be negligible (not 2.7x but could range 0.06x to 4.3x) and instead focused on the *direction* (female > male no matter what) and hypothesized a psychological counterfactual decision-making difference between the genders.

There was no link between the *gender_assumption* and other variables — the effect the assumption had on enrollment superseded other ones such as "prestige" and "specialized education". Therefore, a psychological explanation related to gender differences in decision-making and risk was suggested. Due to a higher risk tolerance, a male college graduate is more willing to explore industry rather than continue an academic career. Equvalently, females tend to value counterfactual reasons more, and commit to a more predictable lifestyle. Society broadly is more conditioned & accepting of ambivalent behavior in males than in females.

The data set offers unexplored variables, such as undergraduates' major(s), master, predoc(s). Preliminary results for those areas of interest exist in a descriptive way.

I dove into Biological sex Counterfactual Reasoning (e.g., Psychoneuroendocrinoimmunology) in a separate (unpublished) document.

[4] Sapienza P, Zingales L, Maestripieri D. Gender differences in financial risk aversion and career choices are affected by testosterone. Proc Natl Acad Sci U S A. 2009 Sep 8;106(36):15268-73. doi: 10.1073/pnas.0907352106. Epub 2009 Aug 24. PMID: 19706398; PMCID: PMC2741240.