

Postsecondary Institutions [Expenses](#) and Student Attendance [Costs](#): Trends and Impact on Degree Completion, 2015-2021

Citadel Data Open Championship

Team 13

December 12, 2022

Our Team



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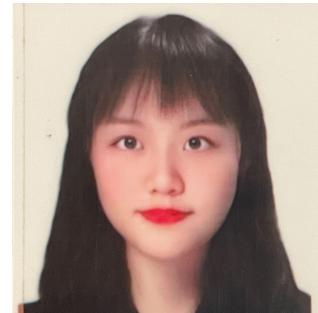
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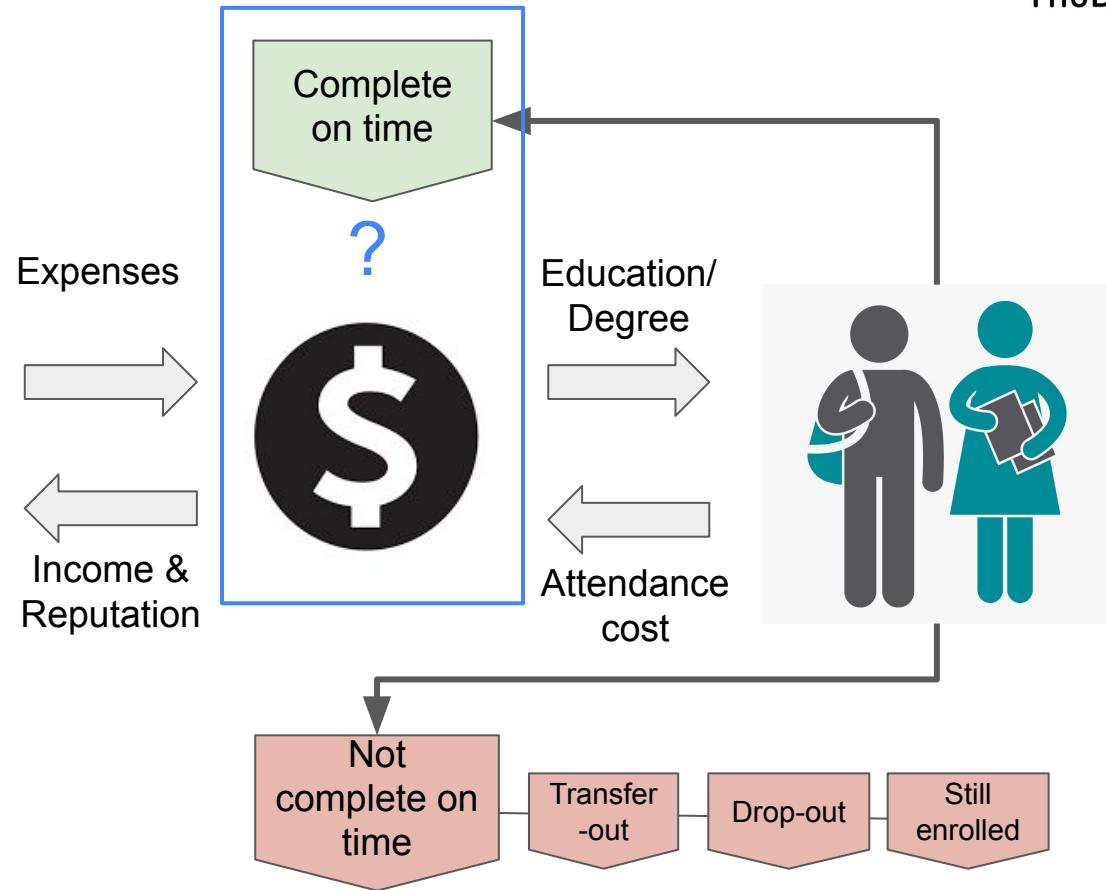
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Motivation

Recent studies showed that **39 million** Americans hold some postsecondary education or training **without completion**.

About **one out of three** students **drop out** from college in the US, and **two out of five** were due to **financial issues**.

Motivation



Overview

Part I

What are the 2015-2021 **trends** of institutional **expenses** and attendance **costs**?

Total \$\$ and change % of **institution financials**, **student fees**, and **financial aid**

Part II

How have changes in expenses/costs impacted **completion**, especially the **underrepresented** students?

Statistical test of linear regression coefficients

Part III

How accurate can expense/costs and institutional charac. **predict completion**?

What are the key predictors?

Machine learning (PCA, PLS, XGBoost, Encoder-decoder neural network) and **SHAP**

Key Findings

- Drop out rate has decreased over the last decade, but still >30%!
- Overall trends of 2015-2021:
 - Attendance cost and living expenses increased steadily
 - Institutional expenses increased steadily
 - But financial aid did not increase, large fluctuations and drops
- Large regional differences across states in terms of grants/completion

Key Findings

Important

Currently increasing >4%

- % undergrad. students receiving Awards /grants, such as Pell grant **(public, private non-profit)**

Affects more some underrepresented groups

Currently decreasing or increasing slowly (<4%)

- Auxiliary enterprises **(public)**
- Equipment, including art and library **(private non-profit)**
- Institutional support **(public)**
- Academic support **(public, private for profit)**

Not as important

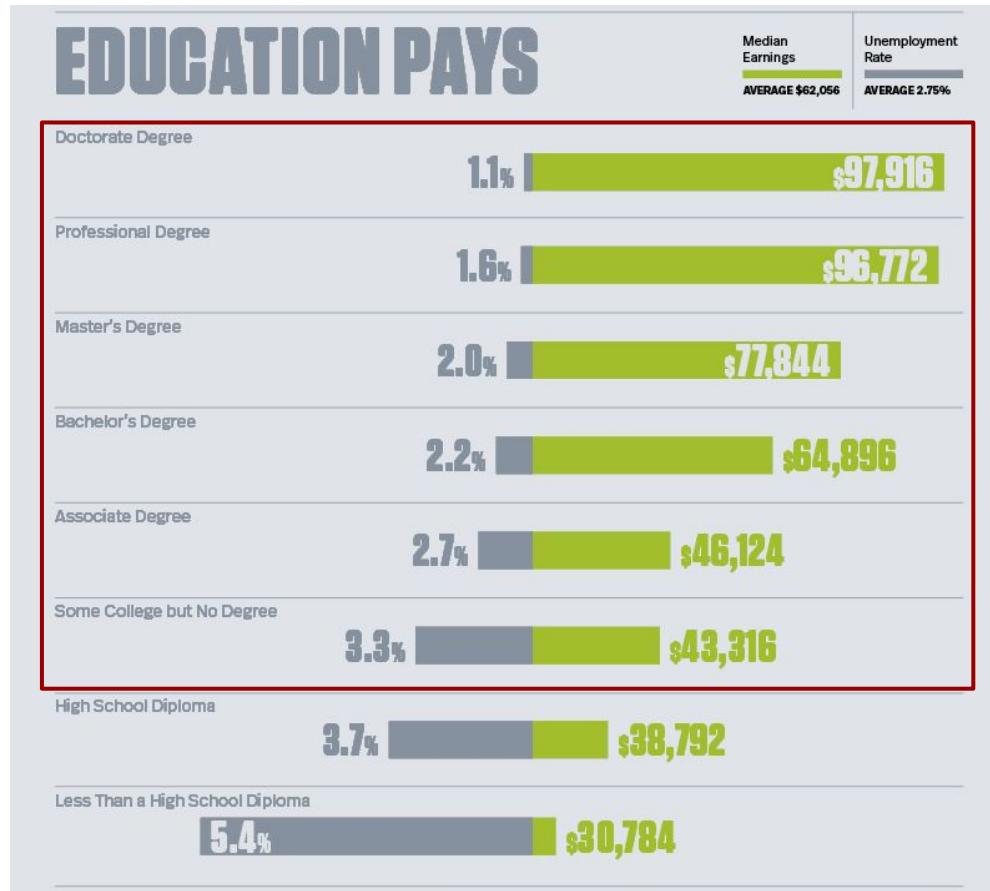
- Public service **(public)**

- Student services **(public)**

Backup Slides

- **Motivation**
- Overview
- Part 1 - What are the recent trends of institutional expense/costs?
- Part 2 - How does expense/costs impact completion rate?
- Part 3 - Predicting completion
- Summary of Findings

Motivation



Questions

What are recent trends in [institutional expenses](#) and [attendance costs](#)?

How have the changes in institutional financials and attendance costs impacted post-secondary education [completion](#), especially the [underrepresented](#) communities?

Data

- Scope: 2015-2021
- National Center for Education Statistics (NCES)
 - Completions
 - Graduation Rates
 - Institutional Characteristics
 - Institution Finances
 - Student Financial Aid
 - Outcome Measures
- United States annual CPI data from FRED

Agenda

- Motivation
- Overview
- **Part 1 - What are the recent trends of institutional expense/costs?**
- Part 2 - How does expense/costs impact completion rate?
- Part 3 - Predicting completion
- Summary of Findings

Institutional Characteristics

Characteristic		Number of institutions	% of total
All institutions		2511	
Control	Public	1439	57.3%
	Private not-for-profit	928	37.0%
	Private for-profit	144	5.7%
Category	Primarily baccalaureate or above	1396	55.6%
	Associate's and certificates	862	34.3%
	Not primarily baccalaureate or above	245	9.8%
	Graduate with no undergraduate degrees	7	0.3%
Special Learning programs	Study abroad	1623	64.6%
	ROTC	946	37.7%
	Distance course	2330	92.8%
	Distance program	1905	75.9%
	Part-time	2405	95.8%
Student registered with disabilities	>3%	8	0.3%
	less than 3%	1185	47.2%
	None or not applicable	1312	52.3%
Programs and Affiliations	Member of National Athletic Association, football, basketball, cross-country*	1825	72.7%
	Programs for veterans and their families**	2448	97.5%
Services	Remedial	1932	76.9%
	Counseling	2495	99.4%
	Employment	2352	93.7%
	Day care	733	29.2%
	Placement	2089	83.2%
	On campus housing	1600	63.7%
	Hospital	53	2.1%
	Library	2498	99.5%

Exclusions:

- No longer active in 2021
- Non-degree granting institutions
- Distance-only
- Special focus institutions under Carnegie classification (art schools, law schools, etc.)

Institution Expenses - Public

Category	Expense Name	2015	2016	2017	2018	2019	2020						
		Amount	Amount Change										
Instruction	Current year total	18,004,721	-	17,514,724	-2.7%	18,056,402	3.1%	18,314,640	1.4%	18,386,901	0.4%	18,647,768	1.4%
	Salaries and wages	9,946,383	-	10,174,616	2.3%	10,307,035	1.3%	10,470,554	1.6%	10,593,305	1.2%	10,630,983	0.4%
Institutional Support	Current year total	6,691,303	-	6,594,253	-1.5%	6,920,047	4.9%	7,113,420	2.8%	7,324,796	3.0%	7,482,997	2.2%
	Salaries and wages	2,618,707	-	2,726,337	4.1%	2,865,155	5.1%	2,987,988	4.3%	3,054,255	2.2%	3,177,210	4.0%
Student Services	Current year total	4,561,653	-	4,569,822	0.2%	4,815,047	5.4%	5,013,106	4.1%	5,136,941	2.5%	5,141,970	0.1%
	Salaries and wages	2,197,460	-	2,228,686	1.4%	2,353,456	5.6%	2,465,754	4.8%	2,570,889	4.3%	2,586,756	0.6%
Scholarships & Fellowship Expenses	Current year total	3,211,238	-	2,887,964	-10.1%	2,820,478	-2.3%	2,928,742	3.8%	2,955,997	0.9%	3,648,863	23.4%
	Total gross scholarships and fellowships	9,752,022	-	9,215,261	-5.5%	9,049,198	-1.8%	9,426,125	4.2%	9,517,126	1.0%	10,029,996	5.4%
Academic Support	Current year total	3,694,728	-	3,759,797	1.8%	3,789,349	0.8%	3,908,351	3.1%	3,894,877	-0.3%	4,045,553	3.9%
	Salaries and wages	1,703,700	-	1,775,318	4.2%	1,779,558	0.2%	1,828,506	2.8%	1,899,967	3.9%	1,973,789	3.9%
Auxiliary Enterprises	Current year total	2,921,024	-	2,774,338	-5.0%	2,856,363	3.0%	2,761,637	-3.3%	2,685,691	-2.8%	2,486,521	-7.4%
	Salaries and wages	519,191	-	537,315	3.5%	542,988	1.1%	539,609	-0.6%	541,154	0.3%	522,576	-3.4%
Public Service	Current year total	209,984	-	214,023	1.9%	224,677	5.0%	235,517	4.8%	226,031	-4.0%	238,078	5.3%
	Salaries and wages	77,252	-	72,623	-6.0%	71,929	-1.0%	76,788	6.8%	77,000	0.3%	82,375	7.0%
Grants	Federal nonoperating grants	6,829,311	-	6,206,913	-9.1%	5,851,205	-5.7%	6,166,174	5.4%	6,149,517	-0.3%	6,857,412	11.5%
	Federal operating grants and Grants by state government	1,031,706	-	1,012,234	-1.9%	980,823	-3.1%	1,081,972	10.3%	1,054,324	-2.6%	1,270,223	20.5%
	Instituitaionl grants	502,286	-	527,885	5.1%	571,291	8.2%	652,227	14.2%	712,387	9.2%	799,609	12.2%
	Local/private operating grants	388,335	-	437,233	12.6%	475,788	8.8%	537,379	12.9%	572,311	6.5%	669,682	17.0%
	Other federal grants	93,637	-	94,114	0.5%	96,862	2.9%	105,366	8.8%	117,168	11.2%	110,774	-5.5%
	Pell grants (federal)	174,037	-	174,601	0.3%	172,004	-1.5%	183,091	6.4%	205,970	12.5%	563,745	173.7%
	State operating grants and	6,370,288	-	5,776,781	-9.3%	5,412,361	-6.3%	5,710,489	5.5%	5,707,081	-0.1%	5,495,532	-3.7%
		512,077	-	483,005	-5.7%	476,879	-1.3%	528,640	10.9%	533,834	1.0%	552,838	3.6%

Institution Expenses - Private for-profit

Category	Item Name	2015		2016		2017		2018		2019		2020	
		Amount	Change	Amount	Change	Amount	Change	Amount	Change	Amount	Change	Amount	Change
Instruction	Current year total	751,616	-	691,168	-8.0%	664,206	-3.9%	585,272	-11.9%	592,581	1.2%	571,742	-3.5%
	Salaries and wages	423,500	-	370,491	-12.5%	367,752	-0.7%	326,873	-11.1%	325,000	-0.6%	340,958	4.9%
Institutional Support	Current year total	431,003	-	406,507	-5.7%	387,985	-4.6%	339,089	-12.6%	315,061	-7.1%	319,860	1.5%
	Salaries and wages	162,007	-	149,018	-8.0%	135,412	-9.1%	121,263	-10.4%	112,096	-7.6%	112,096	0.0%
Academic Support	Current year total	114,709	-	112,829	-1.6%	109,033	-3.4%	93,791	-14.0%	90,469	-3.5%	86,555	-4.3%
	Salaries and wages	54,245	-	52,406	-3.4%	48,011	-8.4%	42,000	-12.5%	39,237	-6.6%	39,473	0.6%
Grants	Total student grants	657,857	-	578,147	-12.1%	538,137	-6.9%	495,084	-8.0%	493,099	-0.4%	511,415	3.7%
	Pell grants	580,613	-	496,764	-14.4%	465,497	-6.3%	434,918	-6.6%	430,964	-0.9%	437,640	1.5%
	Other federal grants	5,366	-	3,750	-30.1%	2,809	-25.1%	0	-100.0%	0	-	0	-

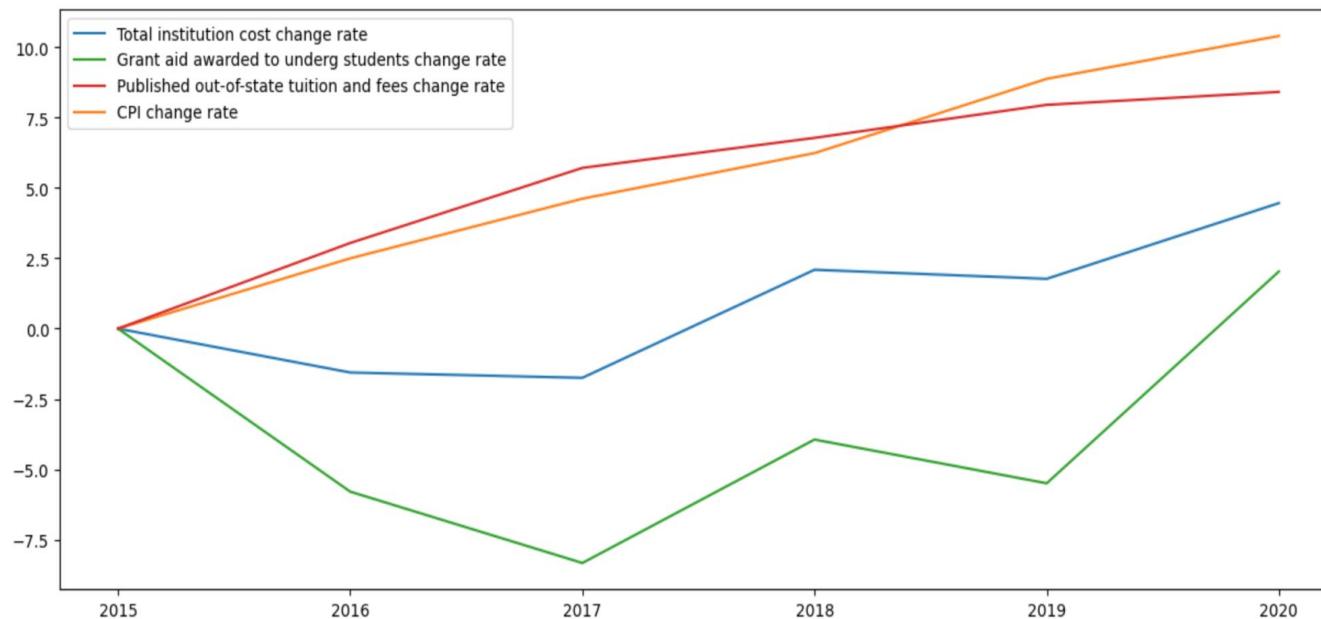
Institution Expenses - Private non-profit

Category	Item Name	2015		2016		2017		2018		2019		2020	
		Amount		Amount	Change	Amount	Change	Amount	Change	Amount	Change	Amount	Change
Academic Support	salaries and wages	632,501	-	686,888	8.6%	684,872	-0.3%	722,342	5.5%	744,238	3.0%	758,000	1.8%
	total amount	1,472,000	-	1,545,289	5.0%	1,548,832	0.2%	1,608,511	3.9%	1678402	4.3%	1,680,880	0.1%
Auxiliary Enterprises	salaries and wages	148,915	-	158,361	6.3%	159,758	0.9%	156,092	-2.3%	163740	4.9%	177,668	8.5%
	total amount	2,206,743	-	2,227,162	0.9%	2,249,330	1.0%	2,230,870	-0.8%	2411047	8.1%	2,388,691	-0.9%
Institutional Support	salaries and wages	1,628,670	-	1,753,944	7.7%	1,793,219	2.2%	1,857,282	3.6%	1920373	3.4%	1,938,072	0.9%
	total amount	4,545,586	-	4,664,393	2.6%	4,741,189	1.6%	4,847,273	2.2%	5174516	6.8%	5,088,260	-1.7%
Instruction	salaries and wages	3,772,326	-	4,002,546	6.1%	4,063,547	1.5%	4,245,132	4.5%	4442516	4.6%	4,497,858	1.2%
	total amount	6,426,170	-	6,837,172	6.4%	6,974,828	2.0%	7,357,899	5.5%	7576673	3.0%	7,648,981	1.0%
Grants	total student grants	6,076,481	-	6,251,361	2.9%	6,906,706	10.5%	7,857,608	13.8%	8119368	3.3%	8,338,630	2.7%
	federal grants and contracts - total	222,115	-	217,435	-2.1%	196,064	-9.8%	196,623	0.3%	216764	10.2%	761,560	251.3%
	federal grants and contracts - unrestricted	94,189	-	106,123	12.7%	103,530	-2.4%	94,454	-8.8%	106569	12.8%	391,921	267.8%
	institutional grants (funded)	324,000	-	358,566	10.7%	337,906	-5.8%	380,284	12.5%	404810	6.4%	419,619	3.7%
	institutional grants (unfunded)	1,553,878	-	1,782,641	14.7%	2,235,708	25.4%	2,753,633	23.2%	2983154	8.3%	2,954,955	-0.9%
	other federal grants	97,585	-	102,938	5.5%	100,429	-2.4%	109,530	9.1%	119565	9.2%	196,368	64.2%
	pell grants	1,218,181	-	1,226,728	0.7%	1,239,020	1.0%	1,317,794	6.4%	1348037	2.3%	1,334,749	-1.0%
	private gifts, grants and contracts - temp. restricted	402,855	-	432,206	7.3%	449,328	4.0%	498,111	10.9%	418091	-16.1%	434,928	4.0%
	private gifts, grants, and contracts - perm. restricted	62,676	-	70,831	13.0%	74,667	5.4%	78,074	4.6%	16099	-79.4%	6,248	-61.2%
	private gifts, grants, and contracts - total	1,900,648	-	2,041,484	7.4%	2,100,292	2.9%	2,209,112	5.2%	2206016	-0.1%	2,286,307	3.6%
	private gifts, grants, and contracts - unrestricted	824,741	-	837,756	1.6%	831,484	-0.7%	912,741	9.8%	921552	1.0%	908,971	-1.4%
	state grants	98,825	-	96,217	-2.6%	129,400	34.5%	152,521	17.9%	150652	-1.2%	169,058	12.2%

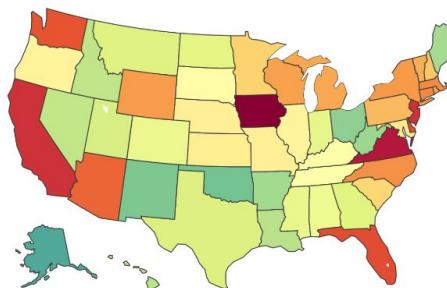
Student Attendance Costs

Category	Item name	2015		2016		2017		2018		2019		2020		2021		
		Amount		Amount	Change	Amount	Change	Amount	Change	Amount	Change	Amount	Change	Amount	Change	
In-district	Average tuition for full-time undergraduates	8,791	-	9,000	2.4%	9,360	4.0%	9,490	1.4%	9,576	0.9%	9,828	2.6%	10,065	2.4%	
	Required fees for full-time undergraduates	576	-	600	4.2%	620	3.3%	660	6.5%	695	5.3%	716	2.9%	720	0.6%	
	Per credit hour charge for part-time undergraduates	294	-	300	2.0%	310	3.3%	320	3.2%	324	1.1%	329	1.7%	329	0.0%	
	Average tuition full-time graduates	11,376	-	11,610	2.1%	12,000	3.4%	12,154	1.3%	12,240	0.7%	12,600	2.9%	12,600	0.0%	
	Required fees for full-time graduates	432	-	459	6.3%	490	6.8%	500	2.0%	546	9.2%	550	0.7%	570	3.6%	
	Per credit hour charge part-time graduates	543	-	559	2.9%	578	3.4%	587	1.6%	600	2.2%	613	2.2%	622	1.5%	
In-state	Average tuition for full-time undergraduates	8,926	-	9,128	2.3%	9,381	2.8%	9,552	1.8%	9,790	2.5%	9,960	1.7%	10,200	2.4%	
	Required fees for full-time undergraduates	576	-	600	4.2%	622	3.7%	662	6.4%	700	5.7%	716	2.3%	720	0.6%	
	Per credit hour charge for part-time undergraduates	298	-	305	2.3%	315	3.3%	325	3.2%	329	1.2%	333	1.2%	337	1.1%	
	Average tuition full-time graduates	11,376	-	11,610	2.1%	12,000	3.4%	12,154	1.3%	12,240	0.7%	12,600	2.9%	12,600	0.0%	
	Required fees for full-time graduates	432	-	459	6.3%	490	6.8%	500	2.0%	546	9.2%	550	0.7%	570	3.6%	
	Per credit hour charge part-time graduates	543	-	559	2.9%	578	3.4%	587	1.6%	600	2.2%	613	2.2%	622	1.5%	
Out-of-state	Required fees for full-time undergraduates	596	-	616	3.4%	650	5.5%	696	7.1%	730	4.9%	750	2.7%	741	-1.2%	
	Average tuition for full-time undergraduates	13,931	-	14,086	1.1%	14,240	1.1%	14,400	1.1%	14,616	1.5%	14,646	0.2%	14,775	0.9%	
	Per credit hour charge for part-time undergraduates	477	-	492	3.0%	497	1.0%	500	0.7%	500	0.0%	500	0.0%	501	0.2%	
	Average tuition full-time graduates	15,240	-	15,660	2.8%	16,200	3.4%	16,203	0.0%	16,128	-0.5%	16,320	1.2%	16,368	0.3%	
	Required fees for full-time graduates	432	-	460	6.5%	500	8.7%	500	0.0%	550	9.9%	550	0.1%	570	3.6%	
	Per credit hour charge part-time graduates	691	-	701	1.4%	716	2.2%	723	1.0%	726	0.4%	734	1.1%	740	0.8%	
Living Expenses and Supplies	Published out-of-state tuition and fees	14,966	-	15,091	0.8%	15,305	1.4%	15,558	1.7%	15,518	-0.3%	15,493	-0.2%	15,718	1.5%	
	Books and supplies	1,200	-	1,200	0.0%	1,206	0.5%	1,220	1.2%	1,200	-1.6%	1,200	0.0%	1,200	0.0%	
	On campus, other expenses	2,863	-	2,887	0.9%	2,938	1.7%	2,989	1.8%	3,000	0.4%	3,026	0.9%	3,046	0.6%	
	Off campus (not with family), room and board expenses	8,652	-	8,859	2.4%	9,100	2.7%	9,240	1.5%	9,514	3.0%	9,626	1.2%	9,892	2.8%	
	Off campus (not with family), other expenses	3,668	-	3,687	0.5%	3,696	0.2%	3,754	1.6%	3,800	1.2%	3,892	2.4%	3,942	1.3%	
Financial Aid and Loans	# undergrad awarded federal, state, local, institutional / other aid	371	-	382	3.0%	383	0.3%	397	3.7%	411	3.5%	430	4.6%	436	1.4%	
	% undergrad awarded federal, state, local, institutional / other aid	71%	-	69%	-2.8%	69%	0.0%	68%	-1.4%	66%	-2.9%	70%	6.1%	69%	-1.4%	
	Total # of federal, state, local, institutional / other aid awarded to undergrad	1,735,114	-	1,859,169	7.1%	1,880,119	1.1%	2,060,117	9.6%	2,232,888	8.4%	2,449,900	9.7%	2,449,925	0.0%	
	% undergrad awarded Pell grants	51%	-	48%	-5.9%	46%	-4.2%	45%	-2.2%	44%	-2.2%	43%	-2.3%	41%	-4.7%	
	Total # of Pell grant aid awarded to undergrad	1,130,622	-	11,373,442	90.5%	905,996	1,122,213	-90.1%	1,167,639	4.0%	1,253,599	7.4%	1,248,985	-0.4%	125,117	-90.0%
	% undergrad awarded federal student loans	57%	-	55%	-3.5%	54%	-1.8%	51%	-5.6%	50%	-2.0%	49%	-2.0%	46%	-6.1%	
	Total # of federal student loans awarded to undergrad	1,652,841	-	1,589,373	-3.8%	1,565,946	-1.5%	1,475,790	-5.8%	1,422,065	-3.6%	1,356,804	-4.6%	129,117	-90.5%	
	% of full-time, first-time undergrad awarded other student loans	6	-	5	-16.7%	6	20.0%	6	0.0%	6	0.0%	6	0.0%	6	0.0%	
	Total # of other student loans awarded to full-time, first-time undergrad	103,198	-	120,126	16.4%	123,501	2.8%	139,838	13.2%	165,195	18.1%	146,317	-11.4%	141,649	-3.2%	

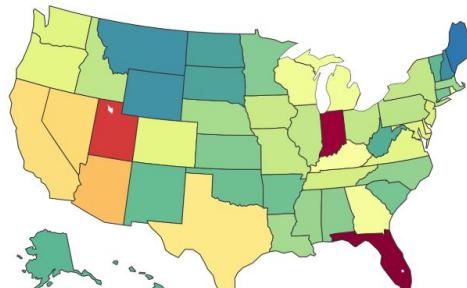
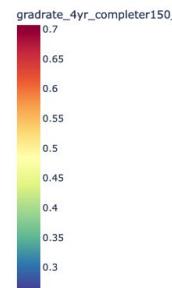
CPI vs Inst. Expense, Student fee, Financial aid



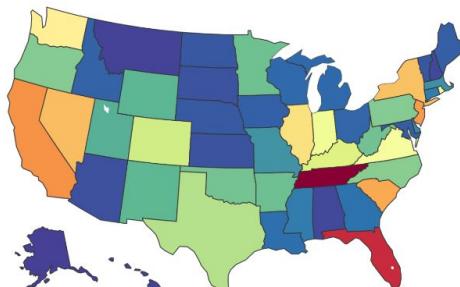
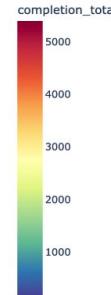
Visualization by State



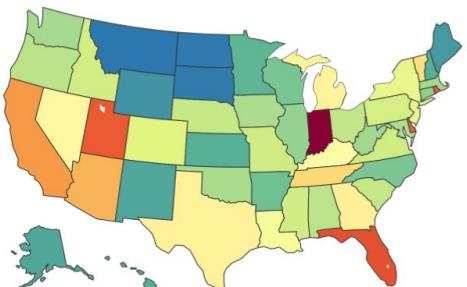
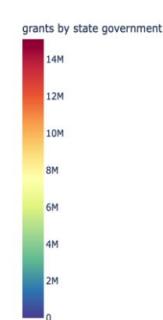
4-YR Degrees Completion Rate



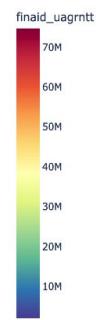
Total Completion



Grants by State Gov.



Grant aid awarded to underg students



Agenda

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Cost/Expense Variables:

- Institutional Finance
- Financial Aid
- Student Fees

Response Variable

Completion/Graduation Rate:

- By degree duration (2 or 4 years)
- By Gender
- By Race
- Total

Test Process

- Lots of variables both in Cost and Graduation rate to parse through and understand
- Run Linear Regressions on each cost variable within categories (Cost: Fee, Institutional Finance, Aid; Graduation rate: by race, by gender, total)
- Select the ones that have significance under 0.05 type 1 error accounting for multiple testing issues.
-

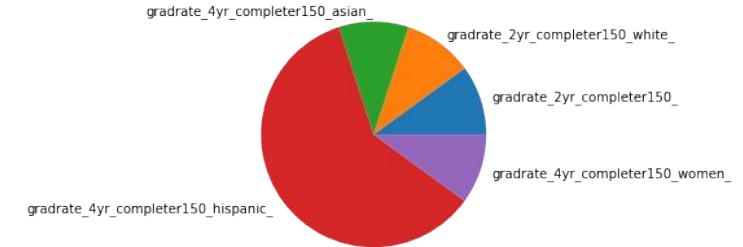
$$\text{relative change} = \frac{(\text{current year value} - \text{previous year value})}{\text{previous year value}} \cdot 100\%$$

$$y_{avg} = \beta_1 x_{avg} + \beta_0$$

Public School

Public

Financial Aid Variable	Outcome	Coefficient	P-value
Percent of undergraduate students awarded Pell grants	completion rate-4yr-hispanic	1.2264	0.0000
Number receiving Post-9/11 GI Bill Benefits - all students	completion rate-4yr-hispanic	0.3853	0.0000
Number receiving Post-9/11 GI Bill Benefits - undergraduate students	completion rate-4yr-hispanic	0.3639	0.0000
Number of undergraduate students awarded Pell grants	completion rate-4yr-hispanic	0.7937	0.0000
Number of undergraduate students awarded federal student loans	completion rate-4yr-women	0.3055	0.0000
Total amount of federal, state, local, institutional or other sources of grant aid awarded to undergraduate students	completion rate-2yr-white	0.2378	0.0000
Percent of undergraduate students awarded federal, state, local, institutional or other sources of grant aid	completion rate-4yr-asian	1.4022	0.0000
Total amount of federal, state, local, institutional or other sources of grant aid awarded to undergraduate students	completion rate-4yr-hispanic	0.5239	0.0000
Total amount of Post-9/11 GI Bill Benefits awarded - graduate students	completion rate-4yr-hispanic	0.1521	0.0001
Percent of undergraduate students awarded Pell grants	completion rate-2yr	-0.2493	0.0001



Grants seem to show up more often as well as the effects of aid on specifically hispanic population

Public

Finance Variable	Outcome	Coefficient*	P-value*
investment income	completion rate-4yr-hispanic	0.0000	0.0000
institutional support - all other	completion rate-2yr_hispanic	0.2140	0.0000
institutional support - all other	completion rate-4yr-hispanic	0.2072	0.0000
state operating grants and contracts	completion rate-4yr-black	0.1964	0.0000
auxiliary enterprises -- current year total	completion rate-2yr-black	0.0000	0.0000
academic support - interest	completion rate-4yr	0.2708	0.0000
pell grants (federal)	completion rate-4yr-hispanic	0.3126	0.0000
independent operations - operations and maintenance of plant	completion rate-4yr-white	0.0063	0.0000
total all revenues and other additions	completion rate-2yr_men	-0.1235	0.0000
institutional support - employee fringe benefits	completion rate-4yr-hispanic	0.3717	0.0000
academic support - salaries and wages	completion rate-4yr-hispanic	0.0989	0.0000
net scholarships and fellowship expenses	completion rate-4yr-hispanic	0.3025	0.0000
total noncurrent liabilities	completion rate-other	0.1659	0.0000

Finance Variable	Outcome	Coefficient	P-value*
Off campus (not with family), room and board	completion rate-4yr	-0.6499	0.0000
Tuition and fees of 5th largest program	completion rate-4yr	0.3590	0.0000
Tuition and fees of 6th largest program	completion rate-4yr	0.3551	0.0000

Non-Profit

Financial Aid Variable	Outcome	Coefficient	P-value*
Percent of undergraduate students awarded Pell grants	completion rate-4yr-white	0.4778	0.0000
Total amount of federal, state, local, institutional or other sources of grant aid awarded to undergraduate students	completion rate-4yr-asian	0.7223	0.0000
Percent of undergraduate students awarded federal, state, local, institutional or other sources of grant aid	completion rate-4yr-white	0.5606	0.0000
Number of undergraduate students awarded federal, state, local, institutional or other sources of grant aid	completion rate-4yr-asian	0.8467	0.0000

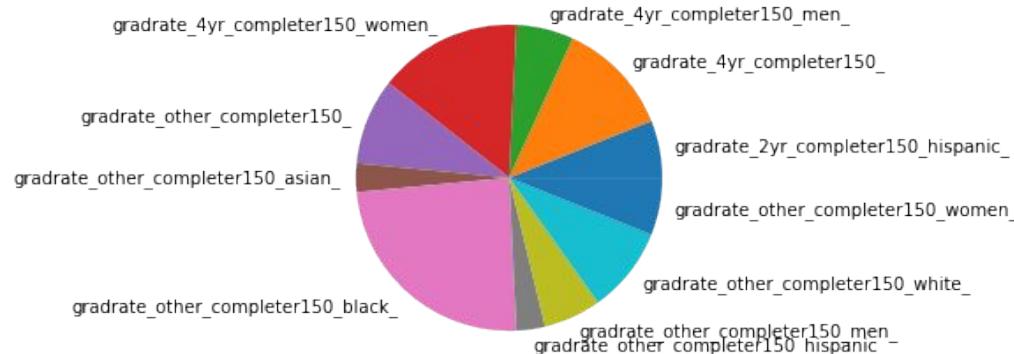
Student Fee Variable	Outcome	Coefficient	P-value*
On campus, other expenses 2021-22	completion rate-4yr	-0.2200	0.0000

Non-Profit

Finance Variable	Outcome	Coefficient*	P-value*
private gifts - temporarily restricted	completion rate-4yr-women	0.0000	0.0000
private gifts, grants and contracts - temporarily restricted	completion rate-4yr-white	0.1229	0.0000
private gifts - temporarily restricted	completion rate-4yr	0.0000	0.0000
discounts and allowances from pell grants applied to auxiliary enterprises	completion rate-4yr	0.1097	0.0000
auxiliary enterprises-total amount	completion rate-4yr	0.1082	0.0000
permanently restricted net assets included in total restricted net assets	completion rate-4yr	0.1882	0.0000
buildings - end of year	completion rate-4yr	0.1619	0.0000
equipment, including art and library collections - end of year	completion rate-4yr	0.2090	0.0000
private gifts - temporarily restricted	completion rate-4yr	0.0000	0.0000
equipment, including art and library collections - end of year	completion rate-4yr-men	0.2311	0.0000
equipment, including art and library collections - end of year	completion rate-4yr	0.1700	0.0000
discounts and allowances from pell grants applied to auxiliary enterprises	completion rate-4yr	0.0781	0.0000
auxiliary enterprises-total amount	completion rate-4yr	0.0968	0.0000
other revenue - permanently restricted	completion rate-4yr-white	0.0000	0.0000
total assets	completion rate-4yr	0.2649	0.0000
private gifts, grants and contracts - temporarily restricted	completion rate-4yr-men	0.0576	0.0000
discounts and allowances from pell grants applied to auxiliary enterprises	completion rate-4yr-white	0.1269	0.0000
tuition and fees - unrestricted	completion rate-4yr-men	-0.2589	0.0000
hospital revenue - unrestricted	completion rate-4yr-women	0.1942	0.0000

For Profit

Finance Variable	Outcome	Coefficient*	P-value*
federal appropriations	completion rate-2yr	0.0000	0.0000
discounts and allowances from state government grants applied to auxiliary enterprises	completion rate-2yr	0.4279	0.0000
federal appropriations	completion rate-2yr-black	0.0000	0.0000
equity, beginning of year	completion rate-other-women	0.2892	0.0000
academic support-total amount	completion rate-2yr_men	0.4788	0.0000



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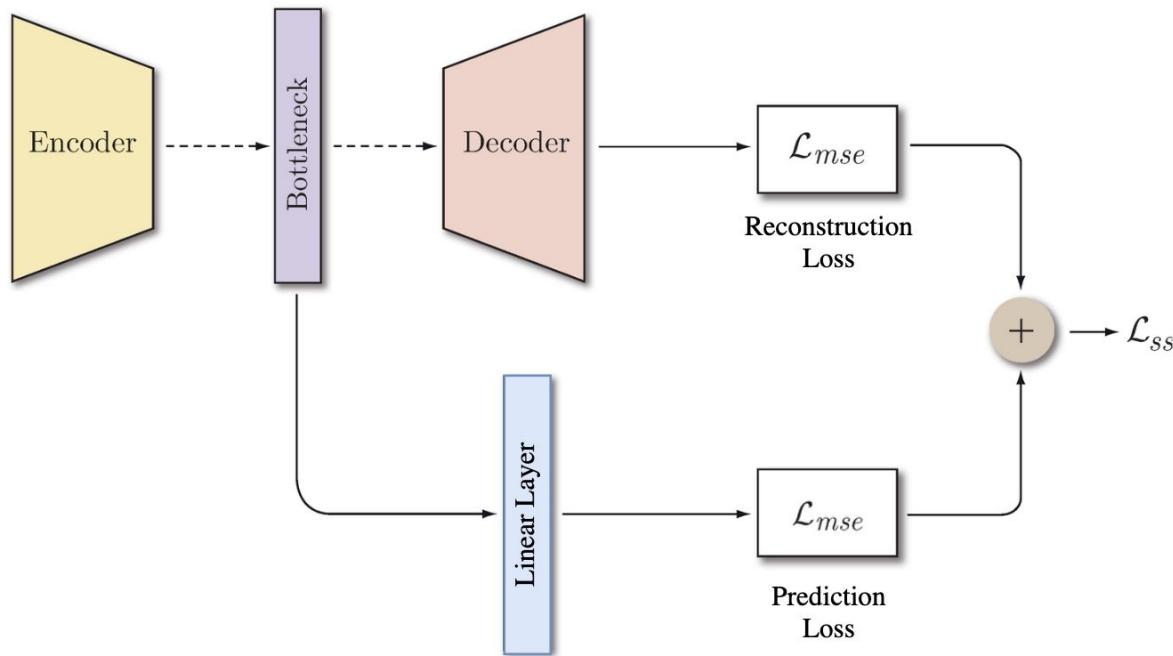
Predicting Completion

- Why?
 - Not modeling the complex relationship among the variables
 - How accurate the cost and financial aid could indicate the completion rate
 - What are key predictors
- Data:
 - Institutional characteristics (special learning, distance only, part time, institution size, etc.)
 - Institutional Finance (Expense items)
 - Financial aid
 - Student tuition and fees
- Covariate:
 - Time $t = 0, 1, 2, 3, 4, 5, 6$

Comparison of Machine Learning models

Model	Description and Hyperparameters	Test performance	
		MSE	Corr
XGBoost	learning_rate=0.015, max_depth=4, n_estimators=600	195779	0.952
PCA + Linear regression	n_components=10	858271	0.931
PLS Regression	n_components=10	787288	0.936
Encoder-decoder MLP	learning_rate = 0.01, batch_size=256, latent_dimension=5, weight_reconstruction=0.2	839227	0.945

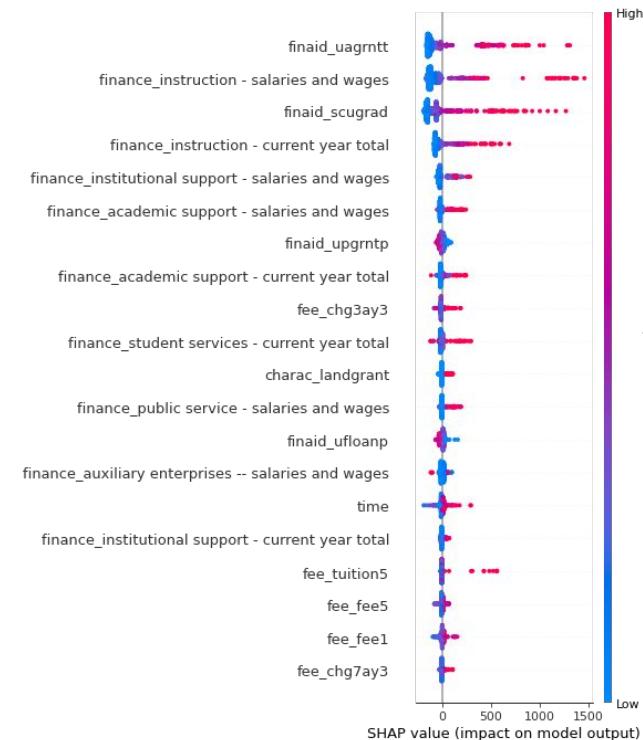
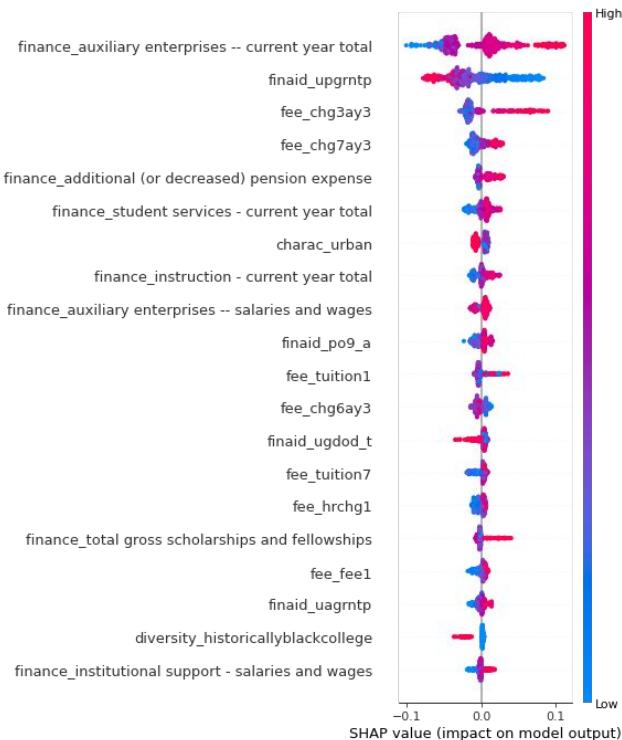
Encoder-Decoder Neural Network



Predicting Completion and Completion Rate

Outcome Measure	Subpopulation	Sample size		Test performance	
		Training	Test	MSE	Corr
Completion	Total	8043	2009	195779	0.952
	STEM	7886	1964	126499	0.943
	Non-STEM	8043	2009	691470	0.909
	Certificate	3677	899	465123	0.955
	Undergraduate	8043	2009	2424365	0.979
	Graduate	2220	523	103244	0.950
Completion rate	4 year programs	3101	697	0.00642	0.838
	2 year programs	4342	1150	0.00801	0.597

SHAP: Most Contributing Predictors



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Definitions

Instruction - total expenses is the sum of all operating expenses associated with the colleges, schools, departments, and other instructional divisions of the institution and for departmental research and public service that are not separately budgeted. This would include compensation for academic instruction, occupational and vocational instruction, community education, preparatory and adult basic education, and remedial and tutorial instruction conducted by the teaching faculty for the institution's students.

Research - total expenses is the sum of all operating expenses associated with activities specifically organized to produce research outcomes and commissioned by an agency either external to the institution or separately budgeted by an organizational unit within the institution. The category includes institutes and research centers and individual and project research. This function does not include non-research sponsored programs (e.g., training programs).

Public service - total expenses is the sum of all operating expenses associated with activities established primarily to provide non-instructional services beneficial to individuals and groups external to the institution. Examples are conferences, institutes, general advisory services, reference bureaus, and similar services provided to particular sectors of the community. This function includes expenses for community services, cooperative extension services, and public broadcasting services.

Definitions

Academic support - total expenses is the sum of all operating expenses associated with activities and services that support the institution's primary missions of instruction, research, and public service.

Student services - total expenses is the sum of all operating expenses associated with admissions, registrar activities, and activities whose primary purpose is to contribute to students' emotional and physical well-being and to their intellectual, cultural, and social development outside the context of the formal instructional program. Examples include student activities, cultural events, student newspapers, intramural athletics, student organizations, supplemental instruction outside the normal academic program (remedial instruction for example), career guidance, counseling, financial aid administration, and student records.

Institutional support - total expenses is the sum of all operating expenses associated with the day-to-day operational support of the institution. Includes expenses for general administrative services, central executive-level activities concerned with management and long range planning, legal and fiscal operations, space management, employee personnel and records, logistical services such as purchasing and printing, and public relations and development.

Definitions

Scholarships and fellowships - total expenses is the sum of all operating expenses associated with scholarships and fellowships treated as expenses because the institution incurs an incremental expense in the provision of a good or service. Thus, payments made to students or third parties in support of the total cost of education are expenses if those payments are made for goods and services not provided by the institution. Examples include payments for services to third parties (including students) for off-campus housing or for the cost of board provided by institutional contract meal plans. The amount of expense in this function is the total of all institutional scholarships reduced by the amount that is classified as discounts and allowances.

Auxiliary enterprises - total expenses is the sum of all operating expenses associated with essentially self-supporting operations of the institution that exist to furnish a service to students, faculty, or staff, and that charge a fee that is directly related to, although not necessarily equal to, the cost of the service. Examples are residence halls, food services, student health services, intercollegiate athletics (only if essentially self-supporting), college unions, college stores, faculty and staff parking, and faculty housing.

Hospital services - total expenses is the sum of all operating expenses associated with a hospital operated by the postsecondary institution (but not as a component unit) and reported as a part of the institution. This classification includes nursing expenses, other professional services, general services, administrative services, and fiscal services.

Key Findings

Important

Currently increasing >4%

- % underg. students receiving Awards/grants (public, private non-profit), such as Pell grant

Currently decreasing or increasing slowly (<4%)

- Auxiliary enterprises (public)
- Equipment, including art and library (private non-profit)
- Institutional support (public)
- Academic support (public, private for profit)

Not as important

- Public service

- Student services