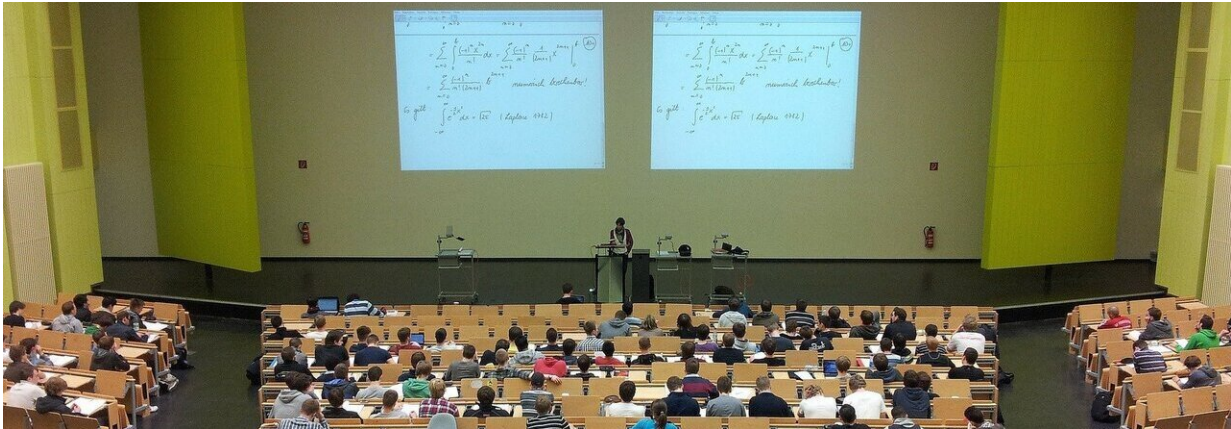


# Some colleges are mammals, others are cities

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Higher education in the United States spans five orders of magnitude, from the tiny institutions like the 26-person Deep Springs College in the high desert of eastern California to behemoths, like Arizona State University's city-sized 130,000. A new study by Santa Fe Institute researchers examines how scale affects factors like tuition, research production, and teaching salaries. The research, published this week in *PLOS ONE*, is the first to systematically look at interconnected scaling effects in U.S. higher education.

"The power of the paper is quantifying [scaling effects], and putting it into... a serious scientific framework," says Geoffrey West, a theoretical physicist, former president of SFI, and SFI's Distinguished Shannan

Professor of Complexity.

West and co-author Chris Kempes, a professor at SFI, have previously examined how scaling laws dictate tree height, animal sleep, bacteria, and even cities. Scaling effects govern all aspects of organisms (and organism-like entities such as cities) from their metabolism and growth to their longevity. Large mammals, for example, use energy more efficiently than their smaller counterparts because the vascular system scales sublinearly: the bigger they are, the less the infrastructure to circulate blood costs.

To tackle the question of scaling in [higher education](#), the SFI team, which included Ryan Taylor and Xiaofan Liang, two undergraduates and co-first authors, divided institutions into categories, such as for-profit colleges, community colleges, private research universities, and public research universities. They found that institutions were optimized for their function. For instance, in accordance with their goal to offer an affordable education to students, community colleges were very efficient; as they grew in size, tuition decreased and faculty salaries grew less. The largest community colleges spent less than half as much per student as the smallest ones did.

On the other hand, as prestigious research universities grew in size, tuition increased, faculty salaries increased, while research production dramatically increased. Kempes, who co-led the project with former SFI postdoctoral fellow Marion Dumas, noted that this superlinear growth—"everything is getting bigger, better, faster" was similar to the way cities follow scaling laws.

"Community colleges, in particular, are much more like organisms," says West. "They emphasize efficiency, and they deliver on that and they're mean and lean, and big universities are rich and fat and getting fatter."

Critically, this efficiency doesn't seem to come at any cost to completion rates—by that measure students are still graduating at the same rate, even though they're saving money. Using data from mid-career salaries of graduates from 1984 to 2014, the researchers were also able to compare the return on investment for institutions. Again, [community colleges](#) punched above their weight, competing with more expensive schools in terms of how tuition grows compared with graduate salaries as schools become larger.

Why exactly institutions of higher education follow the trends they do is still not clear. One mechanism, West suggests, is that institutions are trying to optimize education and research. Some schools also choose specifically to stay at a certain size. In future work, Kempes hopes to separate a genuine scaling effect of size and category from a strategy.

While the current paper does not address policy implications, the authors note that it suggests [institution](#) success should be measured relative to scale. An institution that seems to underperform might in fact be overperforming for its size—not unlike a mammal, or a city.

**More information:** Ryan C. Taylor et al, Systematic shifts in scaling behavior based on organizational strategy in universities, *PLOS ONE* (2021). [DOI: 10.1371/journal.pone.0254582](https://doi.org/10.1371/journal.pone.0254582)

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