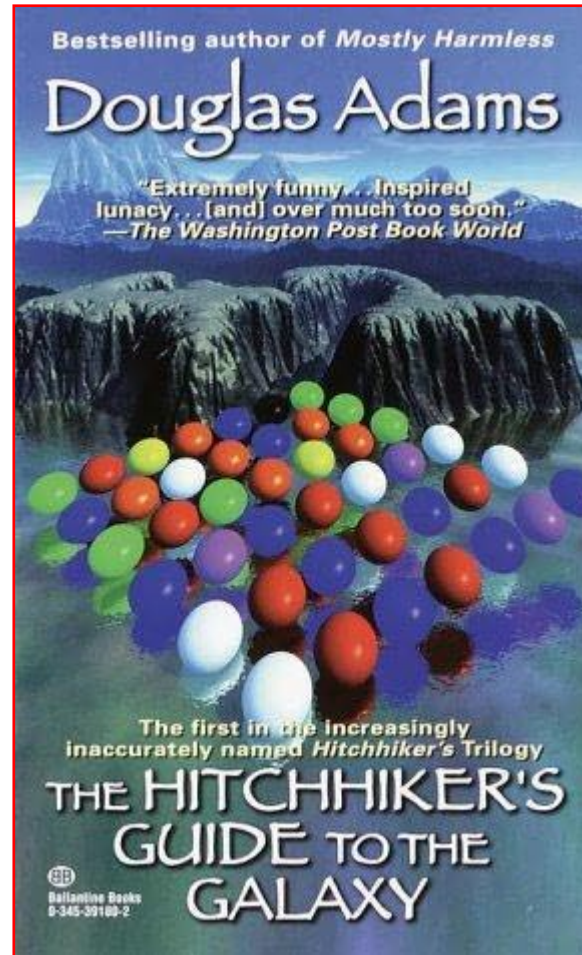


# A Stochastic Approach to the Prediction of Adjunct Costs: Monte Carlo Simulation

Donald A. McCrimmon  
VP – Academic Affairs  
Cazenovia College

# -- An Administrator's Guide -- Interpreted Through The Lens Of



# How to Calculate Adjunct Costs Reliably and Accurately?

- Dynamic Institutional Environment
  - Changes in enrollment
  - Changes in full-time faculty numbers and loads
  - Changes in adjunct compensation
  - Frequent modifications of programmatic and general education curricula
- Administrative Accounting Abhorrence
  - Division Chairs intimidated in trying to forecast adjunct costs many months in advance.
  - Experienced, senior administrators are challenged to rigorously review adjunct projections among dissimilar academic divisions

# The Old Way at Cazenovia College

- Deans and Division Chairs reluctantly made predictions that depended on a limited number of input variables (e.g., faculty and student load, enrollment, average class size, etc.) and experience-based “judgment” to forecast adjunct costs.
- The issue: how accurate are the predictions?



"I refuse to answer that question on the grounds that I don't know the answer." - Douglas Adams

# An Alternative Way

- Computer simulations make predictions in complex and variable situations.
- To replicate uncertainty, simulations inject variation into the equations and then repeatedly calculate the effects of this variation on multiple sequences of outputs.
- These “iterations” take advantage of Chance.

"That's right!" shouted Vroomfondel, "we demand rigidly defined areas of doubt and uncertainty!"

*The Hitchhiker's Guide to the Galaxy*



# Monte Carlo Simulation

- Applies randomness to input variables to iteratively assess the effects on output variables.
- Can be thought of as simulated individual samples from a larger population.
- The ultimate goal of the Monte Carlo simulation is to produce enough samples, which when statistically analyzed closely match data already in hand from an unwieldy environment.
- The number of iterations (samples) can be very large thanks to computer processing

# Fundamental Model

- Calculations on an academic year basis.
- Start with a simple verbal model: the Needed Number of Adjuncts ( $A$ ) is dependent on the difference between the Expected Number of Sections ( $S$ ) and the Capacity of Full Time Faculty ( $C$ ) to teach them.
- Mathematically:

$$A = S - C$$

# Some Modest Expansions

- *Number of sections,  $S$* , depends on the Number of Students ( $N_S$ ), their Expected Loads ( $S_L$ ) and Average Class Size ( $C_S$ )

$$S = (N_S * S_L) / C_S$$

- Faculty Capacity,  $C$ , depends on Number of Faculty ( $N_F$ ) and their Average Loads ( $F_L$ )

$$C = N_F * F_L$$

# So, the Full Model Is

$$A = S - C$$
$$= [(N_S * S_L) / C_S] - [N_F * F_L]$$

- Furthermore: Adjunct Costs,  $A\$, = A * \$2,300$ , where \$2,300 is the average adjunct compensation per section

# Now, I Add the Uncertainty

- To produce the uncertainty in  $N_S$ ,  $C_S$ ,  $N_F$  and  $F_L$ , use the Excel function RAND ()  
$$= \text{min} + \text{RAND}() * (\text{max} - \text{min})$$

	Number of Students ( $N_S$ )	Number of Faculty ( $N_F$ )	Average Class Size ( $C_S$ )	Faculty Load ( $F_L$ )
<i>Min</i>	734	45	12.87	3
<i>Max</i>	938	53	14.73	9

# 4,999 iterations for the model

Adjunct Costs Analyses 061008 [Compatibility Mode] - Microsoft Excel

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	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
	Total Section	Year Faculty	Load		No Adjuncts	Adjunct Budget		No Students	Avg Class Size	NoSections (2)	No Adjuncts (2)	Adjunct Budget (2)			
3	566.7856259	48.40165737	4.6142908		343.4463019	789,926		889.6802194	14.15323561	597.175255	347.6674159	\$	799,635		
4	553.4175308	49.33848598	7.0936173		203.4291943	467,887		827.0001934	13.49001914	582.3936762	216.1369659	\$	497,115		
5	568.1671391	45.14691817	7.5890565		225.5446276	518,753		813.0215284	13.74679102	561.8550908	203.8862989	\$	468,938		
6	593.7181732	45.43975383	8.1345388		224.0867313	515,399		824.700694	13.97968923	560.4313848	177.4439469	\$	408,121		
7	566.6294282	45.36851969	7.82775		211.4959977	486,441		738.8304938	14.3838538	487.9700385	123.5380454	\$	284,138		
8	562.3161716	46.77489768	6.9653133		236.5143553	543,383		896.6076981	14.18689495	600.3972796	255.3737808	\$	587,360		
9	605.3703357	46.9480873	8.7142065		196.2550058	451,387		882.0578599	13.22885502	633.4297004	208.6123646	\$	479,808		
10	602.1071845	52.23545989	4.0446348		390.8338247	898,918		856.5134563	13.87633517	586.3852186	348.8540287	\$	802,364		
11	572.0016484	47.69523503	7.3870523		219.6744543	505,251		892.4288728	14.54212441	583.0010837	214.5267173	\$	493,411		
12	557.4253578	49.00321442	5.9939826		263.7009436	606,512		846.5100778	14.047064	572.4929949	259.25478	\$	596,286		
13	586.3881398	48.26632497	6.0317219		295.2590925	679,096		923.4030236	13.39337677	654.9751326	338.3768593	\$	778,267		
14	599.1969561	50.91806741	7.9954618		192.0834937	441,792		742.3639375	14.56843925	484.0914861	7158956204	\$	164,656		
15	582.8909017	51.00550514	4.1554002		370.9426154	853,168		808.8304193	14.33591752	535.9886434	301.3575321	\$	693,122		
16	601.9290419	49.93230276	6.6374872		270.5040204	622,159		909.849827	13.6675612	637.1142283	284.2909624	\$	653,869		
17	569.0015533	52.21751653	3.8901103		365.8696556	841,500		880.3106012	13.89097703	602.0419367	370.9863362	\$	853,269		
18	541.8417954	45.2722848	3.1277906		400.2395695	920,551		734.9464849	13.76074551	507.3846908	340.1776923	\$	782,409		
19	597.1708437	47.06578076	6.0691237		311.5227984	716,502		919.8616704	13.5627587	644.3147787	333.560062	\$	767,188		
20	542.437654	46.21998657	6.9122096		222.9554186	512,797		820.2828348	13.97285346	557.7019007	221.5442887	\$	509,552		
21	563.9451778	48.60285134	4.3120414		354.3676692	815,046		872.6276745	13.35353509	620.8066145	382.4430685	\$	879,619		
22	548.1315586	46.38329246	8.6863788		145.2287114	334,026		863.4859948	13.39704706	612.3078404	194.7466437	\$	447,917		
23	584.5051937	48.47836542	7.61010543		216.0185842	496,843		807.5625402	14.62967205	524.4030152	145.0022573	\$	333,505		
24	549.369655	45.90770474	3.1031513		406.9110103	935,896		814.3700811	13.84791432	558.677328	387.0834601	\$	890,292		
25	549.5093891	46.9901411	5.0131293		315.9469891	726,678		795.6823031	14.42216569	524.1225237	270.220914	\$	621,508		
26	585.4438726	46.28767685	3.5034059		423.2793539	973,543		828.9708401	13.49374324	583.6203371	391.9539112	\$	901,494		
27	579.429951	45.47852802	4.337403		382.1712486	878,994		758.8281086	13.68547056	526.7533186	306.4299391	\$	704,789		
28	590.5519816	49.05884758	8.1060329		192.8793494	443,623		863.1081401	14.27994964	574.1986169	164.1691657	\$	377,589		
29	577.9946226	48.14202827	4.8041826		346.7115266	797,437		792.3801132	14.28583748	526.9282311	274.9499757	\$	632,385		
30	594.9821837	46.66686269	3.8357031		415.9819542	956,758		916.0591051	14.72157087	591.1435388	383.2932777	\$	881,575		
31	602.9788384	48.63444764	7.0565893		259.7855177	597,507		906.6241434	14.11333439	610.2689217	248.3803089	\$	571,275		
32	547.2725353	52.45698869	5.6467881		251.0590365	577,436		806.1038869	13.17844084	581.0996173	264.9440902	\$	609,371		
33	560.6149776	49.1050525	4.73482		328.1113781	754,656		885.3737071	13.13211113	640.4948988	379.4319083	\$	872,693		
34	559.3579774	45.32774092	3.0921882		419.1960716	964,151		843.4982964	13.18999647	607.5235753	434.6463526	\$	999,687		
35	564.6061341	47.41557459	5.9346798		283.2098814	651,383		862.491564	14.24557882	575.1727882	273.2121781	\$	628,888		
36	572.1836592	46.7888989	6.3270921		276.1459882	635,136		869.8973562	14.07302972	587.2242899	270.8035555	\$	622,848		
37	551.7667548	46.30564811	8.9313904		138.192932	317,844		756.2749864	13.2122113	543.7857607	1210971022	\$	278,523		
38	562.047815	45.24416432	4.5502119		356.1772784	819,208		846.6407815	14.36486791	559.9137752	329.2602118	\$	757,298		
39	564.4099629	48.94714078	3.1972951		407.9115089	938,196		851.2983272	13.73633154	588.755017	401.9986036	\$	924,597		
40	597.1141086	47.01065375	5.3730618		344.5229589	792,403		820.3019401	13.41087094	581.0859312	305.5001468	\$	702,650		
41	592.1569702	48.39386028	3.7760899		409.4174053	941,660		892.0317743	13.46981041	629.1329721	415.1458687	\$	954,835		
42	596.5756351	52.20774414	7.1118925		225.2797712	518,143		794.9586478	13.71749072	550.5458184	166.704577	\$	383,416		
43	567.9403099	50.65443375	6.1311426		257.3707552	591,945		830.3500029	13.25892027	594.9442222	264.4684408	\$	608,277		
44	579.0000000	50.0000000	0.0000000		0.0000000	0.0000000		0.0000000	0.0000000	0.0000000	0.0000000	\$	0.0000000		

# Results

Average $N_s$	Average $C_s$	Average $S$	Average $A$	Average $A\text{\$}$
836	14	576	281	\$645,747

- Univariate Regressions to **predict** Number of Adjunct Costs,  $\hat{A}\text{\$}$  from  $N_s$ :

$$\hat{A}\text{\$} = m * N_s + b, \text{ where}$$

$$m = 1587.532 \text{ and}$$

$$b = -676923$$

Year	Students (2-term average)	Estimated Adjunct Costs ( $\hat{A}\text{\$}$ )	Actual Adjunct Costs ( $A\text{\$}$ )	Error
05-06	772	\$548,652	\$481,663	-12%
06-07	788	\$574,052	\$593,014	+3%
07-08	897	\$747,093	\$741,701	-1%
08-09	931	\$801,069	\$730,300*	-9%

# Conclusions

- Once the simulation and regression analysis are done, calculation of adjunct costs needs only to take into consideration one variable, ***the projected average number of students to be enrolled in upcoming years.***
- On average, these simulations overestimated adjunct costs with less than 5% error.
- The variation around that average can be readily explained:
  - The 12% overestimation in 05-06 results from post-hoc budget rescissions that reduced adjunct costs.
  - and the 9% overestimation for 08-09 results from hiring of 5 new full-time faculty, further reducing the need for adjunct instruction.

# Conclusions

- Simulation models are sometimes criticized for being either abstract, or at least hard to understand.
- A frequent question is how we know that our model is correct?
- The answer is that, at least initially, it doesn't matter. The real issue is whether the model, as a tool for prediction, works or not.

# Conclusions

- As Douglas Adams wrote *“The universe is a lot more complicated than you might think even if you start from a position of thinking that its pretty damn complicated to begin with.”*
- Monte Carlo simulation resolves a lot of uncertainty in adjunct budget forecasting by relying on well-understood laws of probability.
- And that’s the pragmatic “bottom line”: IT WORKS (and it will work even better with some tinkering of the input parameters)

To sum up using Adams: *“I may not have gone where I intended to go, but I think I have ended up where I needed to be.”*

*Using Monte Carlo Analysis for adjunct budgeting can help us take the best advice of the Hitchhiker’s Guide....*



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