Stanford University
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CS183-Startup

Assignment 3 – Solutions

PROBLEM1: Power Law Distribution

As discussed in class, startup outcomes do not normally follow a Gaussian distribution; these outcomes are much more binary, with the distribution of outcomes exhibiting extremely "fat tails". Here, assume that the distribution of outcomes for startups is governed by the following equation:

$$f(x) = ax^k$$

In this equation, the variables are as follows:

f(x)	The eventual value of the company at exit, either M&A or IPO
x	Startup's "rank" within the set considered (and governed by the equation above)
a	scaling constant
k	exponential constant, driving the sharpness of the distribution. k<0 in this problem.

In this world of startups, "Startup A", the startup with the best outcome (ranked #1, or x=1) exits at four times the value of "Startup B", the startup eventually having the second best outcome (x=2).

A. What is the value of the exponent "k"? (Note: this value of k will be used for all subsequent questions in this problem)

   Answer: -2

B. If this equation holds for "Startup B" relative to "Startup C" (x=3), what is the ratio of exit valuations between "Startup B" and "Startup C" (i.e. value_B/value_C)? (Please submit your answer with two decimal places, i.e. "X.XX" or "XX.XX" format)

   Answer: 2.25

C. Assume you are a student graduating, and have the choice of joining "Startup A", which will eventually be the top exiting startup within the set considered, or joining "Startup F", the one ranked sixth. What is the ratio of outcomes (value_A/value_F)? (Please submit your answer with two decimal places, i.e. "X.XX" or "XX.XX" format)

   Answer: 36

You have the choice to join either "Startup A" as employee number 30, or "Startup F" as cofounder. You anticipate that at Startup A, you will probably own 0.1% of the company at the time of exit, by the time you account for a few rounds of financing and the dilution that is created through the issuance of these financing shares. At Startup F, you think you will still own a full 2% of the company by the time of exit, using identical logic and all information available to you.

Assume that all shareholders will be common in both of these startups, and payouts will be proportional to (i.e. pro rata with) the percentage of company equity held. That is, if you hold 5% of the company and it is sold for $100, you will be paid out $5.

D. Startup A eventually IPOs for $7.2B, the best exit in the valley all year. You ended up joining as employee 30, and now hold exactly the 0.1% of equity as you anticipated. What is your equity worth at IPO (i.e. how much can you liquidate your shares for)?
   Answer: $7,200,000

E. Meanwhile, Startup F (x=6) has grown significantly and is acquired in an all-cash transaction. The distribution of outcomes is as predicted by the equation at the start of this problem, and the value of k determined in part A. What is the value of Startup F at acquisition?

Answer: $200,000,000

F. You have a friend who went to startup F as a cofounder. As you predicted, the cofounders ended up with 2% of the company by the time a few financing rounds occurred (one of which was "flat"), the option pool was created and refreshed a few times, etc. What are your friend's shares worth at the time of acquisition?

Answer: $4,000,000

G. What is the ratio of financial outcomes between you and your friend, through each of your respective startups? That is, what is (payout_you_A/payout_friend_F)?

Answer: 1.8

H. True/False: if you only care about maximizing your financial outcome as driven by your company's exit, you would have done better joining Startup A as employee 30. (Please submit your answer as 0 or 1, where "0" indicates "false" and "1" "true")

Answer: 1 (True)

As it turns out, your friend's company, Startup F, agreed to aggressive terms from investors in their "flat" financing round, including liquidation preferences and a preferred class of shares. Later investors also received similar terms. Immediately prior to acquisition, the share breakdown was:

Preferred shares: 60,000,000 shares

Common shares: 40,000,000 shares outstanding (your friend holds 2,000,000 of the 40,000,000 common)

Thus, there are now 100 million shares outstanding at the acquisition. Assume the same startup acquisition price as in Question E of this problem. If you did not reach an answer for part E, assume an acquisition price of Startup F of $200,000,000.

The Startup F investors now have two options at the time of acquisition: first, they can let their shares convert to common and split the acquisition (paid in cash) of $200,000,000 equally with all shareholders; alternately, they can enact their non-participating liquidation preferences and be paid out $3 per share, after which common shareholders will split the remaining acquisition proceeds.

I. What are the total cash proceeds realized by the preferred shareholders if they choose to convert their preferred shares into common shares?

Answer: $120,000,000

J. What are the proceeds realized by the preferred shareholders if they choose to exercise their liquidation preferences and simply take a $3/share payout?

Answer: $180,000,000

K. If the investors choose to take the $3/share payout, how much are the 40,000,000 common shares paid out in total, from the remaining sales proceeds? (That is, what is the acquisition price minus the preferred shares payout?)

Answer: $20,000,000

L. If the investors choose to take the $3/share payout, how much cash does your friend, with 2,000,000 common shares, walk away with?

Answer: $1,000,000

M. Now, what is the ratio of financial payouts between you and your friend, as determined in Question D and Question L? i.e., what is (payout_Q_D/payout _Q_L)? (Please submit your answer with two decimal places, i.e. "X.XX")

Answer: 7.2

N. One more caveat: your friend now must work for the startup for 4 more years to realize the total acquisition payout, as the motivation behind the purchase of Startup F was partially a talent acquisition, and the buying company needs your friend through the post-merger integration. Your friend is talented and creative, and has an opportunity cost of $200,000/year. If your friend stays for 4 years, what is their effective gain in selling Startup F? That is, what is their realized payout from Question L, minus the total opportunity cost of staying 4 years post-merger?

Answer: $200,000

O. What is now the ratio between you and your friend's gains? (gain_Q_D/gain _Q_N)?

Answer: 36

Details		
A)	4	times the outcome
	0.5	ratio of ranks
	-2	value of k
B)	2	Startup B rank
	3	Startup C rank
	2.25	**ratio**
C)	1	Startup A rank
	6	Startup F rank
	36	**ratio**
D)	$7,200	M exit
	0.1%	equity stake
	$7.20	**M**
E)	**$200**	**M exit**
F)	2%	stake
	$4	**M**

G)	**1.80**	**ratio**
H)	**1**	**TRUE**
I)	60,000,000	preferred
	40,000,000	common
	100,000,000	total
	60%	share
	$120	**M value**
J)	$3	per share liq pref
	$180,000,000	**payout**
K)	$200,000,000	acq price
	$180,000,000	preferred payout
	$20,000,000	**common payout**
L)	2,000,000	friend
	40,000,000	common
	5%	share of common
	$1,000,000	**friend payout**
M)	$7,200,000	Payout D
	$1,000,000	Payout L
	7.2	**ratio**
N)	$200,000	opp cost
	4	years
	$800,000	total opp cost
	$1,000,000	payout
	$200,000	**net**
O)	$7,200,000	you
	$200,000	friend
	36	**ratio**

PROBLEM2: Startup Benefits

You are the founder of a small, funded, quickly growing startup, and are considering a few perks to offer your employees. You are running numbers to check that the benefits are financially justified.

You have 10 employees, all with a commute time of 45 minutes each direction, which they each drive a minimum of 5 days per week (on weekends, they sometimes work remotely). Assume there are 4.35 weeks per month. You believe that if they lived closer and the commutes were eliminated, they would put 2/3 of their time saved by not commuting back into working on the company. All employees are salaried, but you

estimate their marginal value to the company each at $46/hour.

You are considering a local living subsidy for employees who move to within 1/2 mile of the office, eliminating the 45 minutes drive times (each way) entirely.

A. How much can you justify offering per month to employees, under this subsidy program? Assume all employees will choose to move at the subsidy amount. (Round to the nearest ten dollars, and express as a whole number without a dollar sign)

   Answer: $1000

A nice gym opened up around the block, and you're also considering sponsoring employee gym memberships. Fees are normally $80/month, but you have managed to negotiate a group rate of $55/month per person, based on the fact that your company is growing and will bring more customers to the gym over time. Your employees now work 65 hours per week, and you believe that a gym membership would increase their productivity by at least 3%.

B. What is the average incremental value created per employee per month through this productivity boost? (Submit your answer as a whole number, omitting dollar sign)

   Answer: $390

C. What is the net gain per employee per month, after subtracting the gym fee? (Submit your answer as a whole number, omitting dollar sign and any commas)

   Answer: $335

D. You realize only four of your ten employees will probably go to the gym regularly, even with a free membership, but if you offer this perk you must provide it for all of them. If you still choose to do it, what is the net gain to the company, per employee, per month?

   Answer: $101

E. Of each employee' weekly exercise time, you estimate that 2 hours per month will come out of the work week, with the remainder coming out of the employees' free time. What is the net benefit to the company per employee per month, realizing that 40% of employees will be 3% more productive, you have to pay for memberships for all employees, and you will lose 2 hours of labor per employee per month, all coming from the more productive ones? (Submit answer as a whole number, omitting dollar sign)

   Answer: $6

   Note: we also give full credits for answer $63 or $64 which assumes only the 40% employees (the productive ones) lose 2 hours of labor every month when calculating the net benefit.

Detals		
A)	45	minutes each way
	0.75	hours each way
	1.5	hours per day commute
	7.5	hours per week commute
	4.35	months per week
	32.625	hours per month commute

	66.7%	ralized by company
	21.75	additional hours working
	$46	value per hour
	$1,000	**max subsidy value**
B)	$55	cost per month, gym membership
	65	hours per week
	282.75	hours per month
	$13,007	value of labor/emp/month
	3%	Productivity boost
	$390	**New value created**
C)	**$335**	**net gain to company**
D)	40%	usage rate
	$156.08	new value created
	$101	**net gain to company**
E)	2	hours lost
	$47	avg labor value
	$156	new value created
	$95	lost labor
	$55	gym fee
	$6	**net to company**