UNIVERSITY of ROCHESTER | SIMON BUSINESS SCHOOL

MKT 440: PRICING ANALYTICS

SAMPLE FINAL EXAM

COMMON INSTRUCTIONS FOR IN-PERSON / REMOTE PARTICIPANTS

1. The real exam is a combination of conceptual and computational questions and lasts 2 hours in total. This document contains sample questions. The total length resembles the real exam, but the contents of the question may vary year to year (in some past year we had "interpret the figure" question, which isn't covered in this sample quiz, etc.). So this sample quiz is there for you to understand the exam format, and not for "I'll ask similar questions in the final" sort of things. The exam is **open book/note/computer**. Feel free to reuse your own codes from the projects.
2. You will type in your answers on blackboard answer sheet. The link will be available on the blackboard front page a few days prior to the exam. Feel free to view the answer sheet prior to the exam and have a sense of the interface. **Do not "submit" the answer sheet until you are done with the exam - once you submit, you won't have access to the answer sheet file again.** Otherwise, you can play with the answer sheet file as you wish prior to the exam.
3. When you need to use Greek letters, please either use the Greek letters available on the blackboard interface or use the following notation: β_0^{KB} = "beta0KB", θ = "theta", etc. Other Greek letters (like β_1) are analogous. You may use "/" to represent division, and "*", "X" or "x" to represent multiplication.
4. At the start of the exam, I strongly recommend reading through the exam first and consider how to allocate your time. Questions are *not* ordered according to their difficulty!
5. For computational exercises, besides the numbers you get, please try to explain the process through which you get to your result (do NOT copy-paste the code. Instead, please provide some verbal description). Without explanation of the process, we cannot give you full mark even if your numbers are right. On the other hand, even if you struggle to come up with a number, if you put down the thought process we can give you partial points.
6. Please avoid copying and pasting from lecture slides (penalty assumed for direct copy-paste), and please keep your answers concise. A good rule of thumb is 4 sentences per question for conceptual part, and 5 sentences per question for computation (no penalty for longer answers, but you probably don't want to spend too much time per question).
7. Use of cell phones and smartwatches is prohibited. So if you have any notes in your smartphone, please copy them to your laptop prior to the exam. Other larger devices (iPad and other tablets) are allowed.
8. Any activities considered as violation of academic integrity are strictly prohibited. Do not

communicate with others during the exam. Do not copy anyone else's answers and codes (including previous years' students' answers). Any violations will result in an automatic "fail" grade – no excuse accepted.

ADDITIONAL INSTRUCTIONS FOR IN-PERSON PARTICIPANTS

9. Exam time is Thursday, Mar 2nd at 6 pm (both daytime and evening participants take the exam at the same time). Last name A-H will meet at S-207, J-O will meet at S-407, and P-Z will meet at G-318. Please leave your smartphone and smartwatch away from you (place them on the front wall along with your bag). Please keep a pen with you as you'll sign on the pledge of academic integrity.
10. You will be handed a printed exam book. Please sign on the pledge of academic integrity. Your exam won't be graded without the signature. Do not proceed to the exam question page unless you are instructed to do so.
11. At the end of the exam, we will collect the exam book (with your signature). If you finish your exam early, please hand the exam book to the proctor and quietly leave the room.

ADDITIONAL INSTRUCTIONS FOR REMOTE PARTICIPANTS (THOSE WITH APPROVALS FROM THE OSE)

12. Exam time is Thursday, Mar 2nd at 6:20 pm (both daytime and evening participants take the exam at the same time). Please come to the office-hour Zoom link (same as daytime zoom link). https://rochester.zoom.us/my/mkt440.31a
13. The exam is proctored, and you are expected to keep the camera on during the exam. If you need to step away (e.g. bathroom break), please report in the chat when you leave and when you return.
14. The URL for the exam questions will be available on the Zoom chat at the start of the exam. The question file is readable only on the browser at the assigned URL (and only when you hover your mouse over the browser). No download is available. Please keep the browser open during the exam. If you accidentally close the browser, go to the URL again from the Zoom chat.

In the spirit of the Simon Credo, I promise to follow the Simon Academic Honesty Policy, and thus I promise to neither give nor receive unauthorized aid during this examination.

SIGNATURE: _____

PRINT NAME: _____

Please clearly print first name and last name

Section 1 [5 points each]: Description questions

(1) Explain why choice data is a better data structure than sales data.

Choice data allow us to observe demand structure at a finer scale. We can develop models of individual purchase decisions, as opposed to models of aggregate sales. This helps us recover causal relationship from P to Q. It also allows us to consider segmentation better.

(2) With choice data, we may select a model according to BIC, which is a metric of predictive analysis. With sales data, we may not use any metric of predictive analysis (e.g. adjusted R^2) for the purpose of model selection. Explain why this difference arises.

In the environment of choice data, we tend to have no issue in establishing causal relationship from P to Q. Hence our objective is to build a model that provides the best predictive performance. In sales-data environments, often we face contamination issues. Hence our focus is on how to recover the right causal relationship, rather than the overall model fit.

(3) Consider a market with two products (your product and your rival's) and consumer choices are characterized by a multinomial logit model without segmentation. In this environment, if your rival increases its price, your optimal prices also increases. Explain (either intuitively or analytically) why.

(Advanced level) If the price of rival product goes up, choice probability of my product goes up. Because the own-elasticity is given by $\eta = -\beta_1 P(1 - Pr(y = j|P))$, if choice probability goes up at the current price, own-elasticity of my product at the current price goes down. Lower elasticity implies that consumers are less responsive to the price, and hence I should increase my price.

(4) Pure latent segment models often outperform models with pure demographic-based segmentation. However there are cases where demographic-based segmentation models may produce a better performance. Provide one such example (do not use the examples we covered in the class).

Latent segment models do not use any of the demographic information. In some cases, demographic information provides a clear-cut demand implication. For example, just like the baby diaper example, there are products that only consumers with certain age groups will use. Consider demand for mobility aid products (e.g., wheelchairs), protein supplements or romance movies. Demand for those products are usually concentrated in a relatively narrow range of demographic groups and hence identifying the target consumer according to the demographic often provides striking performance.

Section 2 [5 points each]: True/false questions

True/false questions: Say "True" or "False" and explain why (concisely!).

(1) "Suppose that the demand follows a multinomial logit model. If your product is more popular and is priced lower than other products, your market share is always higher."

True. β_0 is higher and price is lower, implying that the ratio of exponentials is always higher than those of other products.

(2) "If we apply the K-mean clustering approach to demographic variables and cannot find any dispersion of preferences across clustered segments, that means those demographic variables cannot explain demand heterogeneity in this market."

False. K-mean clustering is based on a particular assumption that demographics will affect preference across clustered segments. If we develop models with different assumptions, such as regression-in-logit, we may still find demand segmentation based on demographics.

(3) "Consider demographic-based targeted pricing. Assume that offering targeted prices is costless. The profit from optimal targeted pricing cannot be smaller than that of optimal uniform pricing (i.e. same price for everyone)".

True. As long as consumers are heterogeneous, the optimal price for each segment differs from one another. Having to set an uniform price is a constraint – without the constraint (i.e. ability to charge different prices across segments), we can raise our profits.

Note: Imagine that all consumers are homogeneous. Then targeting won't do anything and even with targeting attempts, we end up charging the same price across everyone. This is the only case where targeted pricing and uniform pricing result in the same profitability. With a slightest difference in preferences among consumers, targeted pricing will always raise profit.

Section 3 [15 points total]: Interpreting willingness to pay measure

Suppose that you estimated a multinomial logit model with two discrete segments using K-mean clustering. With the estimated parameters, you find the following willingness to pay structure.

	Segment 1	Segment 2
KB	1.75	2.25
KR	1.25	1.08

Evaluate the following statements in this environment. To each statement, say "True" or "False" and explain why.

(1) "β_0^{KB} of segment 2 is higher than that of segment 1".

False. It is possible that β_0^{KB} is lower for segment 2 and segment 2 consumers are less price responsive (β_1 close to zero).

(2) "It is possible that β_0^{KB} of segment 1 is lower than β_0^{KR} of segment 1".

False. As WTP is the ratio between β_0 *and* β_1 , if β_0^{KB} is higher than β_0^{KR}, WTP for KB is always higher than that for KR.

(3) "It is possible that Segment 1 consumers buy KB at P^{KB}=1.8".

True. WTP only captures inherent valuation of the product for each consumer, and does not take into account any idiosyncratic factors that may impact purchase decisions at each shopping trip (ε in the discrete choice model). If ε realization is high, consumers may still buy a product at a price higher than their WTP.

Section 4 [Total 50 points]. Kiwi-Bubbles: pricing decision using market share surveys

You are a pricing analyst in a new soft drink company. Your R&D team has developed a new soft drink flavor and branded it as "Kiwi Bubbles". They told you that the unit cost is $0.70 for each bottle. Your task is to assign a price to the product. Since this is a new product, your team decides to run the product in a test market.

Unfortunately none of your partner retailers own a loyalty-card program, and hence there's no way you can get the choice data of consumers. Instead you have collected a data set on market shares of your product at different prices. You know that there are two segments of consumers in this market, and the retailer was able to separately fill in the market-share information across segments. Below is the data set you have. (Note: feel free to stop the clock here for a few minutes to type in the table below)

Table 1: Market share in the test market

Price ($)	Market share in Segment 1 (%)	Market share in Segment 2 (%)
0.8	51.5	81.9
0.9	29.0	75.6
1	17.1	68.0
1.1	8.5	50.5
1.2	7.9	47.7
1.3	5.0	46.3

You may assume that consumers within a segment are homogeneous. Hence you can interpret the market share in each segment as the probability that a consumer from each segment chooses your product.

Assume that in this market, 70% of consumers belong to Segment 1 and the remaining 30% belong to Segment 2. Also assume that this market consists of 1000 consumers in total. You may ignore competitor behavior because your product is sufficiently differentiated.

Question 1 [5 points]. Your supervisor believes that since you can only sell one product and charge one price, you only need to predict the aggregate market share (i.e. aggregate choice probability). Given the proportion of each segment provided in the previous page, calculate the aggregate market share at each price and fill in the last column of the following table.

Price ($)	Market share in Segment 1 (%)	Market share in Segment 2 (%)	Aggregate market share
0.8	51.5	81.9	60.6
0.9	29.0	75.6	43.0
1	17.1	68.0	32.4
1.1	8.5	50.5	21.1
1.2	7.9	47.7	19.8
1.3	5.0	46.3	17.4

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Question 2 [10 points]. Given that you have aggregate market share, and also you know the total market size (=1000), you know the aggregate sales in this market. Your boss suggests that you estimate a log-log demand function of total sales and price. She thinks that this will give you an approximately correct price guidance.
Regress log(aggregate sales) on log(price) and report the estimates. You may assume that the estimated coefficient is the true causal relationship (i.e. no contamination exists). What is the point elasticity of price, at the price of $1.0? What is the elasticity at $1.2?

Intercept = 5.77 (std.error 0.04)
Log(price) = -2.68 (std.error 0.24)

For all computational questions, you are expected to also describe how you got these numbers. It helps when your numbers are incorrect – if you describe the process better, we can see where you got right/wrong and you likely end up with more partial points.

Assuming log-log model, elasticity is constant and 2.68.

Question 3 [10 points]. Calculate the optimal price according to the estimate you obtained from Question 2.

Optimal price is 1.12.

Question 4 [5 points]. You handed in the results and your boss was happy. However, you do not believe that this is a satisfactory answer. You do understand that ultimately, you can only charge the same price to every consumer; but you suspect that you are missing some information by not looking at each segment separately. This time, recover the price elasticity *separately for each segment*. You may run separate log-log regression for each segment. What is the price elasticity for each segment?

Elasticity of segment 1 = 4.82
segment 2 = 1.34

Question 5 [10 points]. You now have the information to predict market shares for each segment at different prices you could charge. Find the optimal price with this new piece of information. Keep in mind that you can only set one price (i.e. the same price across both segments).

The optimal price is 2.1.

Question 6 [10 points]. Are the results similar or different between the two scenarios? If you see any difference, explain the mechanism *intuitively*, i.e. *why* your predictions differ.

- Segments have very different elasticities
- As prices go up, fewer people from Segment 1 will purchase, leading to the product being positioned closer to segment 2
- Turns out that segment 2 is inelastic enough to support a high price

  [something along these lines]