Queuing Markets (part 3)

1 Where we are

- Last week, we considered queuing –
  markets that clear by making you wait in line
- We considered a few different models,
  settled on one that had heterogeneous consumers and heterogeneous products,
  and found the equilibrium
- Today, we’ll finish up considering the implications of that model –
  in particular, what alternatives we have for improving outcomes
- We’ll also consider what factors we left out of our model,
  and what arguments we might be able to find in favor of queuing as a market-clearing device
- Finally, we’ll consider other types of rationing other than making people stand in line,
  and talk about some examples

- Any questions before we start?

- When I mentioned queuing, an economist I know at Thumbtack, who is Russian, told the following joke:
  A Soviet man is waiting in line to purchase vodka from a liquor store, but due to restrictions imposed by Gorbachev, the line is very long. The man loses his composure and screams, "I can’t take this waiting in line anymore, I HATE Gorbachev, I am going to the Kremlin right now, and I am going to kill him!" After 40 minutes the man returns and elbows his way back to his place in line. The crowd begin to ask if he has succeeded in killing Gorbachev. "No, I got to the Kremlin all right, but the line to kill Gorbachev was even longer than here!"
Recapping the Model and Equilibrium

- We have a measure 2 of consumers, with types \( x \) distributed uniformly on the interval \([0, 2]\).
- We have a measure 1 of concert seats, with quality \( \theta \) distributed uniformly on the interval \([0, 1]\).
- If a consumer with type \( x \) attends the concert and sits in seat \( \theta \), he or she gets payoff

\[
V + \beta x \theta - ct
\]

where \( t \) is the length of time he or she waited in line.
- At time \( T \), the doors open, and seats are allocated in order of the line – whoever got in line first gets the best seat \( \theta = 1 \), and so on, until all the seats are full and everyone still in line is sent home.

- Last week, we found that the following is an equilibrium:
  - Consumers with types \( x < 1 \) never get in line
  - Consumers with types \( x \geq 1 \) get in line at time \( T - \frac{1}{c} \left( V + \frac{\beta}{2} (x^2 - 1) \right) \)
- And we showed that in equilibrium, consumers with types below 1 get payoff 0, and consumers with types \( x > 1 \) get payoff

\[
U(x) = \frac{\beta}{2} (x - 1)^2
\]
3 What can we do once we have a model?

• The point of having a model isn’t just to solve a model –
  it’s to be able to predict what will happen to outcomes if we make changes to the environment,
  to see how we might be able to improve things
  
  – “comparative statics” – how equilibrium outcomes respond to change in a parameter
    (typically a price, but we’ve got lots of variables we can play with in our model)
  – “counterfactuals” – how the environment would react to a bigger change
    (a different way to clear the market instead of queuing, say)

• A couple that we discussed very quickly last week

• What happens if we make the concert better, by increasing $V$?

• Turns out this doesn’t create any value at all –
  it just increases how long everyone waits in line to get in,
  exactly offsetting the benefit

• This is actually a pretty damning commentary on how bad queuing is

• We normally assume, if the venue can, say, spent $10,000 to improve everyone’s concertgoing
  experience by $100,000,
  it’d be good for them to do that

• Presumably, they could increase ticket prices enough to recoup the cost;
  and if not, they could take the altruistic view, and at least realize they’re making people
  happy

• But here, if the venue spends $10,000 to increase $V$ enough so that aggregate surplus from
  the show goes up by $100,000,
  total wait costs go up $100,000 as well, totally wiping out the gains,
  so it’s not worth making the investment to begin with

• Similarly, the venue observes that people are waiting outside a long time to get in,
  and considers doing things to make waiting more pleasant,
  which in our model means reducing the value of $c$

• Sounds nice, but the equilibrium shifts –
  if $c$ gets cut in half, everyone just waits in line twice as long, and nobody’s better off
3.1 Giving out tickets randomly

- Last week, we also started comparing queuing to other alternatives

- One that we considered:
  what if we just gave out tickets randomly, with no line?

- Well, each consumer would have probability $\frac{1}{2}$ of getting in at all,
  and if they got in, on average they’d have seat $\theta = \frac{1}{2}$,
  so consumer $x$’s expected payoff would be

$$\frac{1}{2} \left( V + \beta x \frac{1}{2} \right) = \frac{1}{2} V + \frac{1}{4} \beta x$$

- I screwed up the algebra, but this turns out to be a Pareto improvement –
  for $x < 1$, this is obviously bigger than 0,
  but even for $x \in [1,2]$, this payoff is at least as good as the equilibrium payoff from queuing

- But like I said Thursday, this isn’t universally true –
  there’s a tradeoff between eliminating the cost of standing in line,
  but moving away from allocating seats to the “right” consumers –
  and we could also find a setting where randomly giving away tickets would not be a Pareto-improvement
3.2 Perfect pricing

- What if we priced things perfectly?
- That is, what if each seat $\theta$ had its own price, and the prices were set to perfectly clear the market?
- We can work out what the price for each seat would be – because it would be the same as the cost that’s already being paid for it in equilibrium, just paid in money, rather than wasted time
- In equilibrium, seat $\theta$ is bought by consumer $x = \theta + 1$, and we already know the waiting cost that each consumer pays is $V + \frac{\beta}{2}(x^2 - 1)$; so perfect pricing would require the price of seat $\theta$ to be

$$P(\theta) = V + \frac{\beta}{2}((\theta + 1)^2 - 1) = V + \frac{\beta}{2}(\theta^2 + 2\theta)$$

- Would this work? Consider consumer $x$, choosing from a menu of all available seats at these prices
- He would choose a seat to solve

$$\max_{\theta} \{ V + \beta x \theta - P(\theta) \} = \max_{\theta} \left\{ V + \beta x \theta - V - \frac{\beta}{2} \theta^2 - \beta \theta \right\}$$

with first-order condition

$$\beta x - \beta \theta - \beta = 0 \quad \rightarrow \quad \theta = x - 1$$

so each consumer $x \geq 1$ would buy seat $\theta = x - 1$, and the market would clear perfectly
- (For consumers $x < 1$, any seat would give negative payoff, so they’d stay home.)

- The result would be,
  consumer $x$ gets seat $\theta = x - 1$ and pays price $V + \frac{\beta}{2}((x - 1)^2 + 2(x - 1)) = V + \frac{\beta}{2}(x^2 - 1)$, which is exactly the waiting cost he was paying under queuing
- So now, every consumer would get the same payoff as under queuing, except the venue would get to collect a bunch of money, instead of it being wasted
3.3 Uniform pricing, with a line for better seats

- But that’s hard – it requires someone to figure out the ideal price for each seat

- Thursday, we’ll see how some have tried using auctions to “discover” the right price for each seat;
  but in the meantime, let’s try something simpler

- What if we just charged a single price for all seats,
  and still let people line up if they wanted better seats?

- This would work pretty well!

- In equilibrium, everyone who goes to the concert,
  pays a wait cost of at least $V$

- So what if we just charged a price $V$ for every ticket,
  and let people with tickets line up to get better seats?

- Well, the equilibrium would be exactly the same,
  except the line would start forming $\frac{V}{c}$ later

- So each consumer would get the same payoff as before,
  but now the venue gets $V$ from each consumer, rather than it going to waste!
3.4 What if we capped the wait time, so everyone arrived in line at once?

- The queue does two things in terms of the allocation –
  it makes sure the “right” people get into the show,
  and it gets them into the “right” seats

- What if we capped how early people could arrive,
  effectively stopping people from lining up for better seats,
  and only used the queue to determine who got in and who didn’t?

- (If that means a ton of people arrive at the same exact time,
  we would randomize seating somehow among those we let in)

- My first thought was, since in the uncapped equilibrium, the line fills at time \( T - \frac{V}{c} \),
  what if we just prevented people from lining up before that?

- This would actually work terribly

- Consumers with types below 1 don’t show up in the equilibrium,
  because they don’t want to wait \( \frac{V}{c} \) just to get the worst seat in the arena

- But if they could show up \( \frac{V}{c} \) before showtime and get a random seat,
  expected payoff would be
  \[
  V + \beta x \frac{1}{2} - c \frac{V}{c}
  \]
  which is above 0 for everyone –
  so everybody would want to get in

- To let the line actually clear the market to get into the show,
  we would need to let it form earlier –
  specifically, \( \frac{V + \beta/2}{c} \) before the show,
  so that the set of consumers willing to wait that long for a random seat is the same as the venue’s capacity
• What happens if we do that?

• Well, customers \( x \geq 1 \) all show up as soon as the line “opens”, and get assigned random seats, so consumer \( x \) gets expected payoff

\[
V + \frac{\beta x}{2} - c \frac{V + \frac{\beta}{2}}{c} = \frac{\beta}{2} (x - 1)
\]

• It turns out, once again, this is a Pareto-improvement over an uncapped line:
  each person \( x \) who goes to the show gets payoff \( \frac{\beta}{2} (x - 1) \),
  instead of \( \frac{\beta}{2} (x - 1)^2 \) in the old equilibrium,
  and since \( x \leq 2 \) implies \( (x - 1)^2 \leq x - 1 \),
  everyone ends up better off!

• (Actually, consumers \( x = 1 \) and \( x = 2 \) are exactly as well off as before,
  along with everyone who stays home,
  but all the other consumers who go to the show are strictly better off in expected value.)

• (But once again, we could devise a different setting,
  where the top customers get hurt too much by not being able to get the best seats,
  and this doesn’t end up being a Pareto improvement)

• In a sense, this is another pretty damning criticism of using queuing

• Queuing does a few different things:
  it determines who gets into the show,
  and it determines who gets which seat,
  and it burns up some resources to do each

• Getting the right people into the show would be easy with a single price;
  getting people into the right seats is harder

• So what we’re doing here is, we’re killing off the “useful” part of queuing,
  and only keeping the worse part,
  and yet it’s still a Pareto improvement!

3.5 What else could we try?
4 Summarizing the insights from our various models...

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<th>Homogeneous products</th>
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<td>Full rent dissipation – “market clears” all at once, exhausting surplus</td>
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<td>Some surplus for inframarginal consumers – same as with market clearing price, but that “price” is wasted</td>
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5 But what are we overlooking?

- So far, we’ve made the case that queuing is a pretty terrible way to allocate goods

- Instead of paying with money, in equilibrium, everyone pays just as much in waiting costs, but those costs are wasteful, rather than benefitting someone else

- (There’s a Japanese proverb that translates, more or less, “There is nothing more expensive than something free,” although it may be making a slightly different point; I would see the point as, if you don’t pay with money, you just pay with something else.)

- But what factors are we overlooking?
  What did we leave out of our model, that could argue in favor of queuing?
5.1 what if some eager fans are budget-constrained?

- So far, we’ve been using Pareto efficiency as our normative measure, which doesn’t depend on taking cardinal utility seriously.

- But suppose we did take it seriously, and had a utilitarian motive – wanted to maximize the sum of everyone’s utility.

- And suppose different consumers had different cardinal valuations for getting into the game, and some of the more eager fans had budget constraints.

- That is, suppose we believe there are some people who would get just an immense amount of joy out of going to the concert, and as utilitarian maximizers, we’d like them to get in; but they don’t have enough money to afford tickets at the market-clearing price.

- There’s a nice paper by Yeon-Koo Che, Ian Gale and Jinwoo Kim\(^1\) that considers this problem.

- They don’t look at queuing, but at random assignment – setting a price below market-clearing, and then allocating them at random among everyone who wants.

- They show that random assignment without resale is worse than the competitive market outcome (market-clearing price), but that random assignment with resale can sometimes outperform the competitive market outcome.

- And they show that the optimal mechanism – the best they could do – does involve some degree of random assignment, along with a cash incentive for people to not take tickets if they don’t value them highly.

\(^1\)Che, Gale and Kim (2013), “Assigning Resources to Budget-Constrained Agents,” *Review of Economic Studies* 80.1. Che was a professor here at UW for several years, and Kim was a PhD student here.
5.2 what if there’s an externality in eager fans getting in?

- In many cases, whoever is controlling admission may actually get additional benefit from the “biggest fans” getting in, separate from the revenue they might be able to earn.
- Maybe the Duke basketball team plays better when the wildest, most rabid fans are at the game, instead of a bunch of rich but sedate old alums.
- Maybe a band wants their biggest fans to get into the concert, because they’ll buy more albums, or merch.
- Since Obama’s campaign speech was televised, it wasn’t just for the Madison audience, but for people elsewhere; maybe it would look better if the people in the front row were wearing Obama shirts, cheering wildly, and hanging on his every word.

- So, sometimes there’s extra value generated by getting the “right” people into the event, beyond the enjoyment they themselves get.
- If the biggest fans might be more willing to wait in line, but not more able to pay a lot, then queuing may give you a good way to try to make sure they’re the ones who get in.
- There might be other ways to try to allocate tickets cheaply to the “biggest fans”.
- (In fact, Duke had more people wanting to set up tents on the first day than were allowed, and used some sort of Duke basketball trivia contest to help decide which groups got tent spots).
- But that is at least one defense of queuing as possibly making sense.
5.3 what if the good being “free” is good publicity?

- There are instances in which someone might care more about the optics of making an event “free” than the actual surplus being realized

- I mentioned the free kids music in the Overture Center

- When Overture was built, it was hugely controversial—it was taking over a lot of space on State Street, and there was a lot of opposition

- It’s possible they wanted the publicity of doing something good, and popular, and making it free—even if this didn’t actually lead to a better outcome than if they charged money

5.4 what if the line itself is fun?

- The very first example I showed was of Kryzewskiville, where Duke basketball fans sleep in tents

- We modeled waiting in line as a pure cost—something you don’t enjoy, but do in order to secure the good being rationed

- But if you go to Duke and camp out for basketball tickets, I suspect you end up enjoying it

- It becomes its own activity—competing to get a tent spot in the first place, sleeping in the tent with friends, meeting other basketball fans in line, and so on

- I imagine for a lot of people, it’s one of the big memories they take away from undergrad

- In addition, once you’ve camped out for the tickets, and built up the game as the payoff to this massive odyssey, I suspect the game is more fun—like you “earned” it

- So obviously in that case, our queuing model doesn’t really apply
6 Queuing doesn’t literally have to be queuing

- We’ve been talking about settings where people literally stand in line waiting for something

- But what we’re really talking about here is,
  making a resource valuable and scarce,
  but then having people compete for it in a way that’s wasteful

- We made this precise by forcing people to wait in line,
  but it could be anything

- The term “rent dissipation” goes back to work on the social costs of monopoly,
  and of regulations that encourage monopoly

- For example, consider a government-protected monopoly –
  a government has decided to privatize a major airport

- Whoever runs it will earn monopoly profits – “rents”

- This leads to “rent-seeking behavior” – firms competing to be the one who gets to collect this surplus

- The idea of rent dissipation is that much of this surplus will be burned up in the competition

- This competition could take different forms

- If the government were to sell this monopoly position, there would be no additional loss –
  whoever became the monopolist would pay “market price” for that right

- But if the monopoly provider was not being chosen by price competition,
  you can imagine firms might try to influence the outcome with lobbying,
  or by bribing the decision-makers, and so on

- The point is that under certain assumptions,
  this competition would exhaust the value of the monopoly

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• In our queuing model, instead of monopoly,
  we created an asset that was valuable –
  a ticket to a concert at a below-market price

• Customers had to compete by queuing to “win” the asset, using up a lot of its value

• There’s another nice example of this that I teach in my Law and Economics class: the Homestead Act of 1862

• In 1862, to encourage westward expansion, the U.S. government passed a law,
  basically saying that if you moved west and settled on land and began to farm it,
  you would get that land for free

• There’s a nice account of what effect this would have had in a book I use in that class:

• Friedman writes:

  “The year is 1862; the piece of land we are considering is beyond the margin of settlement, too far from railroads, feed stores, and other people to be cultivated at a profit. As time passes and settlement expands, that situation changes.

  The efficient rule would be to start farming the land the first year that doing so becomes profitable, say 1890. But if you set out to homestead the land in 1890, you will get an unpleasant surprise; someone else is already there. Homesteading land that is already profitable to farm is an attractive proposition, since you not only make money in the process, you also end up with valuable real estate. When valuable rights are being given away for free, there is no shortage of takers.

  If you want to get the land you will have to come early. By farming it at a loss for a few years you can acquire the right to farm it thereafter at a profit. How early will you have to come?

  To make things simple, assume the value of the land in 1890 is going to be $20,000, representing the present value of the profit that can be made by farming it from then on. Further assume that the loss from farming it earlier than that is $1,000 a year.

  If you try to homestead it in 1880, you again find the land already taken. Someone who homesteads in 1880 pays $10,000 dollars in losses for $20,000 in real estate not as good as getting it for free, but still an attractive deal.

  Working through the logic of the argument, we conclude that the land will be claimed about 1870, just early enough so that the losses in the early years balance the later gains.

  It follows that the effect of the Homestead Act was to wipe out, in costs of premature farming, a large part of the land value of the United States.”

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4David Friedman (2001), Law’s Order, Princeton University Press, available free online here: link
7 Next time

• Next time, we’ll talk a little about other forms of rationing besides queuing

• And we’ll look at some examples

• In particular, we’ll talk in more detail about concert tickets,
  and some efforts to use auctions to find the right prices;

• and we’ll talk about Uber,
  and the use of prices instead of waiting to clear the market for rides

• And that will wrap up queuing and rationing;
  if there’s time left Thursday, we’ll recap what we’ve done so far and catch our breath before
  moving on to a different type of market