Ticket resale, bots, and the fair price ticketing curse

Pascal Courty[1]

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Abstract: The fair price ticketing curse occurs when an event organizer sells tickets at fair prices, that do not correspond to underlying demand conditions, and does not want resellers to profit from resale opportunities. The curse has been exacerbated with the advent of online ticketing. The challenge is to facilitate genuine ticket exchanges while eliminating resale for profit. None of the public or private solutions tried solve the problem. We propose a simple mechanism, identify a key set of necessary conditions for it to work, and discuss recent technological innovations that facilitate its implementation.

1 Introduction

The emergence of large online marketplaces has given a new legitimacy to ticket resale, which has grown to a $7-$8 billion industry. With Stubhub operating in 48 countries, it is a global trend that is largely endorsed by the sports industry, ticket distribution firms (e.g. Ticketmaster), and many fans. Those who cannot attend an event can easily recover their expense. Those looking for a ticket have access to large ticket inventories with little to worry about fraud and counterfeit. Obsolete resale laws have been repealed or are not enforced anymore (Moore 2009). There is no question that modern ticket resale is here to stay.

Despite many great successes, the move to online ticketing has brought new problems (Waterson 2016, Schneiderman 2016). Paradoxically, it has been a curse for the events that are meant to be free (public lecture, Papal audience), sold at cost (temporary art exhibition or non-profit event), or at prices that are significantly below those prevailing in secondary markets (an exceptionally successful musical or performer, e.g., Hamilton, Ed Sheeran...). We use the label fair price ticketing to describe these situations.[2] Fair price ticketing is cursed because the cost of capturing profit opportunities has greatly decreased with online ticketing: scalpers can write or buy computer programs called bots that flood reservation systems, gobble the best tickets and subsequently resale these tickets on Stubhub or Viagogo. In some instances, tickets are sold out within minutes of the initial release date and appear right after on secondary websites.

Massive sums of money are diverted away from the public. The extent of underpricing is gauged by the markups in the secondary markets and the fraction of resold tickets. As early as 2010, a single large scale brokers, Wisequys Tickets, was prosecuted for earning more than $25 millions in profits. At the peak of the Hamilton show, between 10 to 45 % of tickets were resold for profit. A New York Times analysis suggested that resellers were making $60 million

[1]This paper makes many references to press coverage of recent events. For the sake of exposition, I do not refer to a specific source when the relevant facts have been widely covered in the media, and can be found using google searches. When useful, the exact sources are reported in colored hyperlinks. I would like to thank Ken Lawson and Michael Waterson for useful discussions.

[2]This problem has not been addressed in past studies of resale (Courty 2003a,b, Cui et al. 2014). See also Christian Hassold's Ticket Economist.

per year on this show alone. Similarly, Ed Sheeran has left millions to brokers in the past few years.[3]

FanFair Alliance has launched a campaign to stop the industrial-scale reselling caused by the bot epidemic. Many countries (Ireland, Canada, England, Singapour, Australia) are reviewing their legislation. Proposed bills aim to criminalize bots, put a price cap on resale, or prohibit resale for profit. We review all public and private solutions that have been attempted to solve the fair price ticketing problem and argue that none is successful. Many economists are highly skeptical of resale bans and for good reasons (Happel and Jennings 1995). But at the same time, there are valid arguments against a plain free-market approach for fair price ticketing. To start, resale is costly. An exchange on Stubhub, for example, costs about 25 percent of the agreed transaction price. Moreover, many have argued, including some economists, that resale for profit imposes negative externalities when applied to fair price ticketing (Kahneman et al. 1986, Roth 2007, Sandel 2012) and we offer suggestive evidence of these externalities. Once one take into account transaction costs and resale externalities, competitive resale can be dominated by a resale ban. Most importantly, a one size fit all law, as has been considered in most countries, fails to address the fact that resale is typically beneficial when there are no massive profits to be earned (e.g. sports) and isn't when there are (fair price ticketing).

We propose a solution to the fair price ticketing curse that dominates both competitive resale and a resale ban. We identify a set of minimum features such that genuine exchanges due to schedule conflicts are possible but resale for profit is eliminated. Our solution combines some of the measures that have already been used (secondary identification check, block chain ledger of ticket ownership, re-allocation of returned tickets) but we argue that only when implemented together can these measures achieve the desired outcome. We discuss recent ticketing innovations, and changes in resale regulations, that contribute to this solution.

2 Recent transformations in ticket markets

Technology has dramatically changed the way tickets are sold in primary markets and resold in secondary ones. Till the mid 90's, people would buy physical tickets using phone reservation systems or going to a box office or dedicated retail outlets. Excess demand would result in queues. Ticket resale was time consuming, rarely legitimate, often regulated and plagued by fears of counterfeit and fraud. With the advent of the Internet, ticketing has become paperless and moved online with significantly less hassle and major cost savings. This is not only the case for large events. Many small or non-profit events now use online reservation systems.

Large online resale marketplaces (e.g. Stubhub) allow buyers to browse through wide ranges of ticket inventories. While there are thousands independent buyers and sellers, a few online resale marketplaces dominate the industry. Moreover, the boundaries between the primary and secondary market are blurred after Ticketmaster acquired TicketsNow (Drayer 2011b). There

[3] In one instance, he canceled 10K tickets that were selling eight time above face value. He returned these tickets to fan. At the face value of €86, this corresponds to a €6 million transfer that went back and forth from scalpers to fans. This is the tip of the iceberg. Since 2015, he has sold 2.7 million tickets and in all countries visited there were huge problems with resale for profits.

has been much innovation to connect buyers and seller, gather all inventory in centralized platforms, display ticket inventory on user-friendly seat maps, and offer convenient price setting options for sellers. Tickets aggregators (e.g. SeatGeek, TicketIQ) offer price updates and a place to browse for tickets from a wide variety of sources. Escrow accounts and seller reputation ratings have largely eliminated fraud and counterfeit. Together with scale and matching economies, these innovations have fueled a massive growth in resale transactions. It has been argued that about 20 percent of ticket appear on secondary sites (Bhave and Budish 2014) although this figure varies from event to event (Schneiderman 2016).

After being frowned-upon for decades, ticket resale is now widely accepted. The sports industry has endorsed resale for profit. Most teams in the top four North American leagues have formed alliances with Stubhub and Ticketmaster, to create sponsored resale marketplaces, that certify ticket ownership and completely eliminate any fear of fraud (Courty, forthcoming). The world's busiest music venue, the O_2 Arena, has a partnership agreement with Stubhub for ticket resale. Sponsored resale marketplaces generate revenues, help teams optimize prices for future games, boost data analytics, and improve sponsor negotiations. Many teams have moved away from the traditional single release date model with fixed prices. Instead, dynamic pricing adjusts prices in part in response to what happens in secondary markets.

Ticket resale has been explicitly or implicitly deregulated. Largely obsolete resale regulations have been repealed or are not enforced anymore (Happel and Jennings 1995, Elfenbein 2006, Moore 2009, Drayer 2011a). New York was the first U.S. state to regulate 'gross profiteering' in 1922. It decriminalized ticket resale with a sweeping legal change in 2007. Minnesota repealed its scalping law from 1963, making all ticket reselling legal in 2006. Ontario has deregulated resale in 2015. The emergence of online resale marketplaces has not been without problems. There is continued debate around the practices of acquiring tickets through bots and reselling at high markups.[4]

3 The fair price ticketing curse

Under fair price ticketing, the event organizer sells tickets at fair prices, that do not correspond to underlying demand conditions, and does not want resellers to profit from resale opportunities. This occurs for highly popular events with large demand and limited supply. When prices are set far below secondary market prices, scalpers operate computer software programs called (ro)bots to scrape a large number of tickets and resell them at ridiculous markups. Fans are confused, frustrated, disappointed and angry. Although this happens for a small fraction of events, the cash grab by greedy resellers is widely reported in the media and the blame is put on the resellers who bought tickets with the sole intention to profit.

Some events are meant to be free. Others are sold at cost, or at a fair price. Tickets are issued to coordinate large crowds, avoid unnecessary lines and spare visitors from disappointment and

[4]Other problems about ticketing are discussed in recent policy reports (Waterson 2016, Schneiderman 2016): (a) Deceptive websites that mimic the official event organizer and charge inflated prices. (b) Lack of transparency in primary markets, with use of pre-sales and holds, and manipulation of prices and supply. We revisit this latter point in the conclusion.

upset. Several situations fit this description. About 80,000 free tickets for the Pope's East Coast visit were distributed through lotteries. Many of these tickets were resold on Craigslist and eBay (NBC news). When Harvard Professor Michael Sandel gave a free public lecture at the University of Tokyo, tickets were assigned by lottery in advance and were resold online for up to $500 (The Japan Times). When former U.S. President Barack Obama offered a speech at the Montreal Chamber of Commerce, tickets were resold on StubHub for up to four times the face value (CBC news). There was much outrage when tickets for Ariana Grande's One Love Manchester benefit concert were touted. Resale also happens for museum or temporary exhibitions that offer pre-booking.

Under-pricing is not restricted to non-profit events. For-profit event organizers also under-price tickets. For example, 'crown jewel' events in sports (e.g. Super Bowl) and popular music (e.g. Tragically Hips final tour), typically sell out in the primary market. Some performers (e.g. Pearl Jam, Kid Rock, Ed Sheeran, Adele...) care about fairness, affordability, or want 'true fans' to attend.

Finally, pricing below market price is common for the best seats in a venue, also know as the golden circle. Charging the market price for these tickets, which could be five, ten times, or more, than for regular seats, is frowned upon. Many event organizers do not want to go there. A related problem occurs when an event organizer uses coarse ticket classes as is typically the norm for popular music (Courty and Pagliero 2013). The best seats in each section end up being under-priced (Leslie and Sorensen 2013).

Pricing below market price has fueled academic controversies (Bhave and Budish 2014, Sandel 2012, Roth 2007), but this is not the issue here. The take away for this work is that underpricing is a reality and that it will continue to occur. The event organizer deliberately leaves money on the table and would like the public to be the sole, or at least main, beneficiary. This is rarely what happens. Instead, many tickets are bought by professional resellers using bots. There is no question that bots deprive fans from tickets. Investing in technology to get around security systems, bots get ahead of regular fans and obtain a large fraction of the tickets or cream-skim the best seats in each section.[5] Paradoxically, the problem has been exacerbated with online ticketing. It has proved difficult for primary sellers to screen bots. In fact, fans had a better chance in physical queues than they do against electronic programs using high speed connections and sending thousands of requests.[6]

The press demonizes the cash grab and blames resellers for the lack of availability.[7] FanFair Alliance is a lobby that brings stakeholder together and lobbies governments to take action against resale for profits, points out to abuse (it accused Viagogo of moral repugnance for selling tickets for a charity concert), and helps fans get refunds. Several governments (e.g

[5]The Schneiderman report (2016), which has investigated many events taking place in New York, documents how brokers use bots (see Section A.2).

[6]The music industry is releasing most tickets on a single day with congestion and virtual queues. While paper tickets sold in box office generate a random allocation, brokers can now acquire a massive number of quality tickets.

[7]Obviously, the argument is flawed because resellers do not reduce the number of seats. Resellers take surplus away from fans, channel the tickets to the fans with the highest willingness to pay, and also add transaction cost frictions.

UK, Australia, Ireland, Ontario, Alberta) have recently opened public inquiries. Clearly, the public is hurt when affordable tickets are resold at inflated prices. But the problem is not with the transfer of tickets. No-one takes issue with resale at face value. The problem occurs when resale is for profits. It is a source of discontent because it is unfair (Kahneman et al. 1986), repugnant (Roth 2007), immoral (Sandel 2012), generates unnecessary transaction costs, impose enforcement costs (see Section 3.2), or because it distorts supply (discourages artists from performing or from using large venues). Whatever the reason, bots' cash grab imposes negative externalities.

An obvious solution to the fair price ticketing problem would be to use only gate admission with no advance-release of tickets. This, however, is impractical for large venues.[8] Moreover, many fans need to know early in advance whether they will get access. At the same time, the event organizer wants to allow genuine ticket exchange in order to accommodate the patrons who cannot attend. When tickets are released a few months prior to the event date, it is expected that some fans will have to cancel due to unfortunate circumstances, schedule or traveling conflict, work or personal imperatives or because they made impulsive purchases.[9] In fact, much of resale activity is fan-to-fan. For example, Leslie and Sorensen (2013) document in the context of popular music concert, that about half of resale is not done by professional resellers. Similarly, Sweeting (2012) reports that in baseball many reseller sell a single ticket. He concludes that 'many sellers are season ticket holders who do not want to attend all 81 home games.' Genuine ticket exchange also reduces the number of empty seats. High occupancy rates generate revenues from on-premise sales and positive publicity (the large blocks of empty seats at the 2012 Olympics was embarrassing for the events organizers (The Economist, 2012)).

3.1 Public solution: Resale market or resale ban?

We propose a simple framework to analyze two solutions that have been widely debated: secondary markets and resale bans. There are N fans who value attending the event V.[10] The venue capacity is $K < N$. The event organizer sets the price of a ticket at $p_0 < V$. The event organizer could earn higher profits with $p_0 = V$ but deliberately chooses not to do so.[11] There are B bots who can acquire tickets before consumers. Although B is exogenous, the model could accommodate broker entry, and the discussion acknowledges that B increases with underpricing. There is excess demand in the primary market. Tickets are allocated to consumers according to a rule that is not important with identical consumers: $K - B$ consumers are lucky and receive a ticket. The remaining $N - K + B$ don't. After the initial sale, each consumer

[8] A notorious exception is the Wimbledon queue.

[9] Even when a concert or sporting event is sold out, the President of Stubhub, Chris Tsakalakis, reports that about 5-10 percent of the people don't show up, leaving some seats empty.

[10] The argument generalizes to heterogenous valuations. It is widely acknowledged that excess demand in the primary market results in allocative inefficiencies that disappear with resale. But the gains are small as long as the valuation support, $V_{max} - V_{min}$, is small relative to the average valuation, $\overline{V}$. In equation 1, all terms are normalized by V and the allocative efficiency gains are negligible compared to the other terms when $\frac{V_{max}-V_{min}}{\overline{V}}$ is small.

[11] As mentioned above, event organizers sometimes underprice to manipulate the perception of scarcity and generate a sense of value (Brock 1968, Mullainathan and Shafir 2013). We focus here on the plain vanilla case of 'sincere' under-prices. We discuss strategic motives in the conclusion.

finds out whether she can attend which happens with probability α. Schedule conflict events are independent across consumers. We assume that $\alpha > \frac{K}{N}$: the venue capacity is still too small for the consumers who can attend.

Under a resale ban (RB), patrons cannot transfer their tickets. Bots do not buy tickets because resale is not possible. Only fraction α of ticket holders attend the event. Total welfare is $W_{RB} = \alpha VK$. With a resale market (RM), consumers and bots can exchange tickets. There is a transaction cost t per ticket exchanged. It is not relevant here whether t is paid by the buyer or seller. Resale for profit also imposes greed externalities. When blaming resale markets, artists, fans and the popular press often fixate on the large premium charged above face value. Here, we assume that greed externalities are proportional to the surplus that is diverted away from the consumers who attend, $X = x(p_r - p_0)q_r$, where x is a constant that measures social harm, p_r is the equilibrium price in the resale market and q_r is the number of tickets resold. Although this choice of loss function is somewhat arbitrary, the analysis follows even without greed externalities ($x = 0$). When resale is allowed, B bots and $(1-\alpha)(K-B)$ ticket holders who cannot attend offer their tickets for sale. Demand is $\alpha(N - K + B)$. The latter is greater than the former under the assumption that $\alpha > \frac{K}{N}$. The resale price gross of the transaction cost is $p_r = V$ and $q_r = B + (1-\alpha)(K-B)$ tickets are exchanged. Total welfare with a resale market is $W_{RM} = VK - tq_r - X$ or

$$W_{RM} = VK - (t + x(V - p_0))\left(B + (1-\alpha)(K-B)\right).$$

Welfare decreases with the number of tickets scooped up by bots. Brokers do not contribute to welfare in this model. In practice, broker resale contributes to welfare by, for example, adding liquidity and helping with the price discovery process and the argument could be extended.

Additional notations help clarify the exposition. Denote by $\beta = \frac{B}{K}$ the share of bots, $\tau = \frac{t}{p_r}$ the transaction cost as a fraction of the final price and $\mu = \frac{p_r - p_0}{p_r}$ the relative price markup in the secondary market. The resale market option dominates the resale ban if and only if

$$1 - \alpha \geq (\tau + x\mu)\left(1 - \alpha(1-\beta)\right) \tag{1}$$

The LHS term measures the welfare loss of empty seats under a resale ban. The RHS measures the transaction and externality costs under resale markets. RM is more likely to dominate RB when α, β, μ, τ and x are low.

Case 1: There are no bots ($\beta = 0$). Inequality 1 becomes $(1-\alpha)(1-\tau-x\mu) > 0$. RM dominate when transaction cost and externality greed are low $\tau + x\mu \leq 1$. There are inefficiencies associated with RM. But the opportunity cost of empty seats is greater than these frictions.

Case 2: Consumers can always attend ($\alpha = 1$). Inequality 1 becomes $(\tau + x\mu)\beta < 0$ which never holds. RB dominates RM. There are no gains from resale because consumers have no schedule conflict. Bots generate unnecessary transaction costs.

Case 3: There are no greed externalities ($x = 0$ or $p_r \simeq p_0$). These assumptions hold for sports where prices are set close to market value, and where there is little stigma associated with resale for profits.

Proposition 1. *There are no greed externalities. RM dominate RB if and only if* $\frac{1-\alpha}{\alpha} > \frac{\beta\tau}{1-\tau}$.

In the absence of greed externalities, the choice between RM and RB trades off the gains from transferability and the loss due to transaction costs. A sufficient condition for RM to always dominate is $1-\alpha > \tau$; the probability to cancel is greater than the transaction cost. Assume that the transaction costs is around 25 percent, which matches Stubhub's fee policies, and that fans have a schedule conflict with probability 5.4% which matches the estimate from Leslie and Sorensen (2013).[12] RM dominates if and only if bots capture at most 52.5% of tickets. When schedule conflict happens 8 % of the time, the threshold for β decreases to 25%. This demonstrates that for plausible cancellation probabilities, and even without externality greed, RB can dominate RM. Moreover, the choice between the two options will likely vary event by event if (α, β) are not uniform across events.

Case 4: General case ($\beta > 0$, $\alpha < 1$, $x > 0$). RM dominates RB when equation (1) holds. Welfare under RM is low when the event organizer grossly under-prices the event. A large μ imposes a direct externality cost. But two factors outside the model tend to make things worse. To start, a large μ is likely to increase β (because reselling is more profitable). To add to the problem, the event organizer typically increases τ to deter bot activity but this is often ineffective. The perfect storm scenario happens when (μ, τ, β) are large because there will be large transaction costs and greed externalities.

Baning bots (a reduction in β) unambiguously improves welfare. In fact, several countries have introduced uncontroversial laws that criminalize bots and impose penalties for violators.[13] Fighting bots, however, is complex because it involves internet commerce, often over multiple jurisdictions, involving various legislations, and with no individual victim to file complaints.[14] Event organizers do not suffer direct monetary losses from bots and fans are free to purchase tickets in secondary markets.

Beyond banning bots, the legal status of resale varies enormously across countries and jurisdictions with no clear pattern in favor of RM, RB, or a price cap (as currently considered in Ontario, Ireland, Australia) for that matter. This is consistent with the model's prediction that there is no solution to the problem that applies to all events. A one size fit all solution harms the events where resale is beneficial (e.g. sports) or those where it isn't (e.g. highly popular and grossly underpriced show) and the harm is higher when there is much variability across events in μ. The fact that proposals in favor or RM or RB, or price caps, are controversial

[12] Leslie and Sorensen (2013) observe resale on eBay and Stubub, which is 5% of all tickets, and they claim that this probably represents half of all resale. We deduct that the fraction of tickets resold is 10%. They also report that half of resale is done by brokers which gives $\beta = 5\%$. Plugging $\alpha = \beta = 5\%$ and $\tau = 25\%$ in Proposition 1, we conclude RM dominates RB for the average event in their sample.

[13] In the United States, the Better Online Ticket Sales (BOTS) Act of 2016 makes it illegal for bots to purchase tickets or to resale tickets that were bought by bots.England has passed The Digital Economy Act 2017.

[14] One rare exception is NY's $7.1 million fines settlement with brokers following a massive inquiry (Schneiderman 2016).

and difficult to pass, is also consistent with the analysis. One problem is that resale laws are difficult to enforce and often ineffective (Elfenbein 2006, Moore 2009, Drayer 2011a). Even ignoring such limitations, the analysis suggests that resale laws are fundamentally problematic. After banning bots, for example, the New York State legislature has reached stalemate, and has not managed to passed any follow-up bill. This is because ticketing involves many stakeholders with conflicting and sometimes changing interests.

Both RM and RB do poorly when (α, μ) are high. RB does poorly because transferability is beneficial. RM does poorly because transferability for profits generates large greed externalities. What is needed is transferability not for profit. Before we propose a mechanism that achieves this goal, we review some private solutions.

3.2 Private solutions to the fair price ticketing curse

Several policies have attempted to limit brokers' access to primary markets. This corresponds to a reduction in β. This can be done directly by holding inventory away from brokers or indirectly by increasing τ to deter broker entry:

1. *Real-time screening.* Screen out bots using CAPTCHA[15], tests and checks on IP address, email, or credit card holder identity, or limiting on the number of tickets that can be bought per transaction. This is a whack a mole game because brokers invest massive resources to pass through security systems (Schneiderman 2016). Screening is costly and not always effective. Instead, some artists release only physical tickets, release the ticket bar code only close to the event date, or require fans to pick tickets up at the box office. This increases the transcation cost both for genuine resale and resale for profit.
2. *Pre-sale registration.* Adele has teamed up with Songkick to block scalper and claimed to have saved fans \$6 millions. Brokers can be screened out using fan scoring methods that use social media postings or attendance to prior events by the same artist. Ticketmaster offers a service called Verified Fan, which has been used by Bruce Springsteen and Ed Sheeran among others. The system reduces resale for profit but it is not perfect (between 2-5% of the tickets for the Springsteen show were available on the secondary market).
3. *Post-sale audit.* Another solution is to conduct ex-post forensic audits of ticket sales, checking buyers characteristics and searching for tickets posted on secondary markets soon after primary market release. Eric Church uses a proprietary program and has dedicated employees who scrutinize buying and selling. In 2017, he canceled 25K tickets to buyers who conspicuously fit broker patterns. Ed Sheeran has monitored sales transactions with the National Trading Standards Cyber Crime team. This approach is costly and must be done with caution to not cancel the wrong tickets.
4. *Fan-to-fan exchange platforms.* Fans can exchange tickets at face value or less. For example, Ed Sheeran has supported Twickets. Loyal fans can recover some of their cost while letting others enjoy the event. Fans, however, must be willing to forgo significant profits. Moreover, this solution does not address resale for profits by brokers.

[15] Completely Automated Public Turing test to tell Computers and Humans Apart

5. *Non-tranferability restrictions.* These are enforced by, for example, matching at admission the credit card used to purchase the ticket, checking identification against buyer's name, associating the ticket to a unique mobile phone, using face recognition or other methods... Miley Cyrus, Metallica, Radiohead and others have used Ticketmaster's paperless system, requiring fans to show identification to be admitted. Non-transferability, however, is highly controversial and fought over. The Fan Freedom Project, initially funded by eBay and StubHub, is devoted to making the practice illegal. New York and Connecticut have essentially outlawed non-transferable e-tickets.
6. *Increase supply.* Garth Brooks adds concerts till demand is exhausted. Ed Sheeran selects large venues and adds dates. Doing so partially displaces the problem because the first and most prominent shows are more desirable.

Policies 1-3 increase welfare to the extent that they reduce the number of tickets that are allocated to bots. But brokers can still acquire tickets the old-fashioned way, by using real people to fool pre-sale registration systems, as they were doing prior to the Internet, when they were paying 'diggers' to wait in line at the box office. Policy 5 prevents resale but increases the chance of having empty seats.

3.3 Centralized exchange

A successful mechanism should exclude brokers from the primary market and allow genuine resale. It must deter exchange when it is for profits but facilitate it when it isn't. We introduce a mechanism, which we call centralized exchange (CE), that achieves these goals. Under CE, the un-served fans are kept in a virtual line. Served fans receive refund p_0 when they return their ticket. Returned tickets are randomly allocated to someone in the virtual line. Admission requires identify verification. Assuming that the costs of administering CE are minimal, total welfare is $W_{CE} = VK$ because all seats are used and there is no transaction or externality costs.[16] CE dominates both RM and RB when the following features are implemented (see the Online Appendix for a formal analysis):

1. Ticket owners are (partially) refunded when they return their tickets. For free events, ticket recipients would be charged a small deposit that would be refunded when they return the ticket or attend the event.
2. Update a virtual queue of unserved fans with no schedule conflict and randomly allocate returned tickets to the queue. Random allocation is required to prevent transfer for profits.
3. Maintain a ledger of the block-chain of ticket owners. At any point in time a ticket has only one legitimate owner who is entitled to access the venue.
4. Identification is required for admission. A ticket that is acquired outside CE is worthless to anyone but its last owner as reported on the ledger.

[16]Stubhub charge 25% per ticket exchange while the fan-to-fan Twickets platform charges 10%. Part of this difference is because a sponsored fan-to-fan exchange can be integrated with the primary market with fewer disputes or fraud cases.

Only when these conditions are met will transferability not-for-profit be successful. CE is different from a fan-to-fan ticket exchange. This is because tickets exchanges that take place outside the CE are invalid.

Under CE, the event organizer keeps track of the current owner of each ticket and of the pool of unserved fans who are available for the event, and checks at the gate that the person who redeems the ticket matches the identity of the last owner. Some of these measures have been implemented separately but never together with one exception. As mentioned above, some artists have used multiple technologies to match identity at admission (feature 4), Twickets reallocates returned tickets (feature 2), and some startups (Blocktix, BitTicket) offer block chain technologies for ticket exchange that allow to track-and-trace the ownership chain (fetaure 3). However, we show in the Online Appendix that these measures alone do not solve the problems of no-shows and resale for profit. Ed Sheeran has come closest to a CE for his 2018 tour. A shortcoming of his scheme is that each buyer can purchase up to four tickets and only the identify of the buyer is checked at admission. Scalpers arrange to enter the venue with those who purchase their extra tickets. But the take away is that the basic building block necessary to implement a CE are available and have been used. Achieving the desired outcome is just a matter of implementing the different building blocks together.

4 Concluding remarks

Governments have made little progress toward finding a solution to the fixed price ticketing curse. Beyond banning bots, we have shown that a one size fit all rule is not the appropriate way to address the problem. This is not to say that there is no role for governments. The challenge is to accommodate event organizers' needs to have some control over what buyers can do with tickets, while putting restrictions to prevent abuses. Enforcing blind non-transferability restrictions, as currently done in the airline industry for example, would not be desirable. Fans should be able to exchange or return tickets. Beyond that, the event organizer should decide whether resale can be for profit or not.

Progress is being made thanks to technological innovations. Bots had an early start due to the incentive imbalance between the parties that create the harm and those who suffer. One answer to the bot epidemics has been to increase prices—or supply when possible. Many sports teams took that path (Courty, forthcoming). Even Hamilton creator's Lin-Manuel Miranda has done so after years of frustration with scalpers.[17] But now that the pain is widely recognized, some of the artists who have much at stake have started to experiment with other solutions. Bruce Springsteen, Adele and others have asked fans to pre-register to improve bot screening. After experimenting with various approaches to fight bots, Ed Sheeran eventually settled on very strict rules (for his 2018 tour) that come close to our proposed mechanism. New technologies are being developed and tested (face value resale platforms, track and trace a ticket's ownership chain, smooth identity check at the gate, virtual queue management). This is a slow process

[17] As a gesture to its public, he offers about 50 premium seats for $10 on a lottery basis, which when valued at $1000 per seat, amounts to a $50K gift per show.

because large events involve tens of thousands of people and non-trivial operational issues. A recent U2 concert in British Columbia that introduced identity verification, for example, had hours-long line ups, entry delays and frustrated fans.

But there are other reasons for the slow progress toward a solution. For some events, bots are not the sole culprit for the lack of tickets in the primary market. Some promoters do not sell all tickets at face value. Instead, they generate scarcity by holding back tickets that are subsequently resold in secondary markets above face value (Schneiderman 2016). Promoters have been prosecuted in some rare instances. Governments in Ontario and elsewhere are looking at rules that increase transparency in the primary market. We argue that solving the fair price ticketing curse will also tackle price and supply manipulations in the primary market. Successful CE adoption by some event organizers will teach the public that ticket exchange at face value is possible. This will force others to be more transparent about how they manage their ticket inventory, or face the risk of being exposed. Blaming unscrupulous scalpers for one's own resale profiteering will not be an option once the public understands that fair price ticketing does not have to be cursed.

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5 Appendix: Analysis of CE

The CE mechanism has four features (see Table 1, Column 1): (RfR) refund for return, (RA) random reallocation of returned tickets, (BCL) block chain ledger of current legitimate owner, and (ID) check at admission that identification of ticket holder matches name on ledger. We compare the CE with a situation where all these features are not implemented jointly. When a feature is not implemented, we assume that the default feature presented in Column 2 applies. For example, fans are not refunded anything instead of RfR (line 1), two default features could be used instead of RA (line 2), and so on... Clearly, other default options than those presented in Column 2 could be considered. Since the point is to demonstrate the importance of the four design features of a CE, we consider here the implicit defaults used in practice. Some events have also implemented one CE feature alone (see Section 3.2) and we are aware of only one event that has implemented a scheme that comes close to all four CE features.

To sum up, the event organizer chooses up to four design features (RfR, RA, BCL, ID). The features chosen by the organizer are implemented together with RM or RB. Here, we present the argument assuming RM, keeping in mind that a ticket bought in RM does not entitle admission when BCL and ID apply. Still, considering RM is important because brokers may buy and resale tickets for strategic reasons as described below. Finally, we assume that $p_0(1+\alpha(N-K+b)) > V$ and $\alpha V > p_0$. These assumptions are reasonable in the context of the fair price ticketing curse since excess demand, $N-K$, is large, α is close to one, and $V \gg p_0$.

Table 1: Design Features of Centralized Exchange (CE) and Default Features

Centralized Exchange	*Default Features*
(RfR) Refund for return	Zero refund
(RA) Random reallocation of returned tickets to fans who can attend	(1) Returned tickets are unused (2) Returned tickets are allocated to a queue
(BCL) Block chain ledger of current legitimate owner	The name on the ticket remains to the buyer in the primary market
(ID) Check at admission that identification of ticket holder matches name on ledger	Anyone in possession of the ticket is admitted

The timing of events goes as follows: (1) The event organizer announces which of the four design features are implemented. A default feature applies when a design feature is not selected. (2) b brokers purchase tickets (with $b \leq B < K$). (3) $K-b$ remaining tickets are randomly distributed to fans. (4) Fans find out whether they are available for the event: Fraction $\alpha\frac{K-b}{N}$ of fans own a ticket and can attend, $(1-\alpha)\frac{K-b}{N}$ of fans own a ticket and cannot attend, $\alpha\left(1-\frac{K-b}{N}\right)$ do not have a ticket and can attend. (5) Brokers post price $p_r > p_0$. (6) Fans may buy tickets from brokers, sell tickets in RM, or return tickets if this option is available.

Proposition 2. *Welfare is maximized if and only if* (RfR, RA, BCL, ID) *are implemented.*

The maximum possible welfare is VK. We first show that $W_{CE} = VK$. Assume $b > 0$. A fan who buys a ticket from a broker at p_r can return the ticket (or require that the broker does so). Doing so increases the number of tickets that are randomly re-allocated. Assume that X tickets have been returned by brokers and consider a fan who purchases x tickets. Her utility is

$$U = \pi(V - p_0) - xp_r$$

where $\pi = \frac{(1-\alpha)(K-b)+X+x}{\alpha(N-K-b)}$ is the probability to receive a ticket. We have $\frac{\partial U}{\partial x} < \frac{V-p_0}{\alpha(N-K-b)} - p_r < 0$ under the assumption $p_0(1+\alpha(N-K+b)) > V$. Thus, fans never buy tickets in the secondary markets. We conclude that $b = 0$ and welfare is VK.

Next, we show that welfare is reduced if all four components of a CE are not present together. We consider here eliminating a single feature at a time, keeping in mind that the argument generalizes when multiple features are eliminated jointly: (a) When RfR is not implemented, fans do not return tickets and welfare is αVK;[18] (b) When RA is not implemented, there are two possibilities. If returned tickets are unused we have again that welfare is equal to αVK. If tickets are sequentially allocated to a queue, the fan with rank just past $(1-\alpha)(K-b)$ in the queue is willing to pay a broker to make sure that an additional ticket is returned. $b = 0$ is not an equilibrium anymore because brokers can ask for side payments to return tickets; (c) When BCL is not implemented but ID is, reallocated tickets cannot be redeemed. Welfare is αKV; (d) When ID is not implemented, we are back to the RM outcome. This concludes the proof.

We have outlined key necessary design features to address the fair price ticketing curse, keeping in mind that a CE can tackle some problems but not all. For example, a CE can deal with groups as long as each group member is registered. As a shortcoming, a CE would have difficulties managing ticket transfers to family and friends. Allowing such transfers would be costly to manage because it would require human verification that each transfer is genuine. A cost effective system has to minimize human verification.

To conclude, we consider a fan-to-fan face value exchange (FtF) because it has been used in practice. Doing so also clarifies the role of random reallocation. FtF has the RfR feature but the difference is that a ticket owner can choose the recipient of her ticket. Implemented alone, FtF does not deter brokers from reselling tickets in RM. To make the argument more interesting, assume that FtF is implemented along with BCL and ID. This does not achieve the first best outcome because brokers can benefit by selling at face value on FtF (in order to make sure that the buyer is the new legitimate owner on the ledger) conditional on receiving a side payment from the buyer. Such side payments would be difficult to detect and punish. It is now clear why random reallocation of returned tickets is necessary to prevent side payments by marginal fans in the queue.

[18] We assume that fans weakly prefer to keep a ticket than to get a zero refund. The argument generalizes to non-zero refunds.