

Ticket resale, bots, and the fair price ticketing curse¹

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Abstract: The fair price ticketing curse occurs when an event organizer sells tickets at 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 exchange while eliminating resale for profit. None of the attempted public or private solutions 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 ticket 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 in terms of 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 Obsolete resale laws have been repealed or are not enforced anymore (Moore 2009).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 that have been the object of recent policy reviews of resale markets (Waterson 2016, Schneiderman 2016, US Government Accountability Office 2018). 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 event, e.g., Hamilton, Ed Sheeran...). Underpricing tickets is cursed because it is difficult to deter resale for profits with online ticketing: scalpers can write or buy computer programs called bots that flood reservation systems, gobble the best tickets and subsequently resell these tickets for profits. The next section defines the fair price ticketing curse (FPTC), recognizes that it is predicated on the assumption that some producers have motives other than profit maximization, and gives examples of events to which it applies. We acknowledge that the FPTC is restricted to a small set of distinct events that are nevertheless important to study because these events generate much controversies about the nature and economic roles of resale markets.²

A wide range of solutions have been proposed to deal with the FPTC. 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 supporting a *laissez-faire* free-market approach as a solution to the FPTC. Brokers waste resources in zero-sum ticket acquisition games (Leslie and

¹I would like to thank Daniel Rondeau and seminar participants at the University of Victoria for useful comments.

²This problem has not been addressed in past studies of resale (Courty 2003a,b, Cui et al. 2014). See also Christian Hassold's Ticket Economist (<http://ticketeconomist.com/scholarly/>).

Sorensen 2014), and then pay fees to resell these tickets in secondary markets to fans who could have bought the same tickets, had brokers stayed out of the way. Several countries (Ireland, Canada, England, Singapore, Australia) are reviewing their resale statutes. Proposed bills aim to criminalize bots, put a price cap on resale, prohibit resale for profit, among other options... We review all public and private solutions that have been attempted to solve the FPTC and argue that none is successful.

Section 3 proposes a simple framework similar to Leslie and Sorensen (2014) to compare social welfare with a resale market and a resale ban. Our main contribution is to consider a newly proposed solution that allows fans to exchange tickets within a centralized exchange as long as it is not for profit. This solution combines some of the measures that have already been used (secondary identification check, ledger of ticket ownership, re-allocation of returned tickets), but we demonstrate that only when implemented together can these measures achieve the desired outcome that genuine exchanges due to schedule conflicts are possible while resale for profit is eliminated. We show that the centralized exchange dominates both a resale market and a resale ban when rent-seeking ticket acquisition costs are high, reallocation efficiencies low, and under-pricing significant.

Section 4 discusses recent ticketing innovations, and changes in resale regulations, that contribute to implementing a centralized exchange. An important conclusion of our analysis is that a one-size-fits-all regulation, as has been considered by most jurisdictions, fails to address the fact that resale is typically beneficial when there are no massive profits to be earned (e.g. North American sport leagues) and isn't when there are (e.g. FPTC events).

2 Recent transformations in ticket markets and the FPTC

Technological innovations have dramatically changed the way tickets are sold in primary markets and resold in secondary ones. Until the mid 90's, people would buy physical tickets using phone reservation systems or going to a box office or dedicated outlets. Excess demand would result in queues. Ticket resale was time consuming, rarely legitimate, often regulated and plagued by fear of counterfeit, fraud or seat misrepresentation. With the advent of the Internet, ticketing has become paperless and moved online with significantly less hassle and major cost savings. Most events, including many small or non-profit ones, now use online reservation systems (US Government Accountability Office 2018).

Large online resale marketplaces (e.g. Stubhub) allow buyers to browse through wide ranges of ticket inventories. While there are thousands of independent buyers and sellers, a few online resale marketplaces dominate the industry. There has been much innovation to connect buyers and sellers, gather all available seats 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 scores have largely eliminated fraud, misrepresentation of a seat's location within a venue, and counterfeit. Together with scale and matching economies, these innovations have fueled a massive growth in resale. It has been

argued that about 20 percent of tickets appear on secondary sites (Bhave and Budish 2017) 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. Most of the teams belonging to the top four North American leagues have formed alliances with Stubhub and Ticketmaster, to create sponsored resale marketplaces, that certify ticket ownership and seat location within a venue, and completely eliminate any fear of fraud (Courty 2019). Sponsored resale marketplaces generate revenues, help teams optimize prices for future games, boost data analytic, and improve sponsor negotiations.

Ticket resale has been explicitly or implicitly deregulated. Largely obsolete resale regulations have been repealed or are not enforced (Happel and Jennings 1995, Elfenbein 2006, Moore 2009, Drayer 2011). 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.

2.1 The Fair Price Ticketing Curse

While resale markets have been hugely successful, there is a small class of distinct events where resale for profit is a curse. We define the fair price ticketing curse (FPTC) and present supporting evidence that a small class of events has been harmed by the recent changes in the way tickets are acquired in primary markets and subsequently resold.³ Let p_0 denote the price set by the event organizer, p_m the monopoly price, q_0 and q_m the corresponding demands, and K the venue capacity.

Definition 1. *The FPTC happens when: (1) tickets are under-priced $p_0 \ll p_m$; (2) there is excess demand in the primary market $q_0 \gg K$; (3) tickets are meant to be randomly distributed to fans; (4) brokers use bots to acquire tickets prior to fans.*

There is no excess-demand under monopoly pricing ($q_m \leq K$). The FPTC occurs when the event organizer sells tickets at prices that do not correspond to underlying demand conditions and cannot prevent resellers from using bots to preempt fans. Fair price ticketing is cursed because it is not possible to distribute under-priced tickets to fans through a fair lottery. The FPTC is distinct from situations where under-pricing happens because of idiosyncratic mistakes, obvious strategic reasons, or because the seller acts like a lazy or incompetent monopolist. We focus here on situations where under-pricing is meant as a deliberate gift to the public, and we use the terminology ‘fair price ticketing’ to distinguish these instances.

³Other problems with primary and secondary markets that have been discussed in recent policy reports (Waterson 2016, Schneiderman 2016, US Government Accountability Office 2018) include: (a) Lack of transparency in primary markets, with use of pre-sales and holds, and manipulation of prices and supply by the event organizer or ticketing agent. We revisit this issue in the conclusion and argue that these practices would diminish with our solution to the FPTC. (b) Deceptive websites that mimic the official vendor and charge inflated prices.

2.1.1 Deliberate Under-Pricing

Under-pricing applies to many non-profit events that are meant to be free, sold at cost, or at a fair price. Tickets are issued to coordinate large crowds, avoid unnecessary lines and spare visitors from being denied access. The following events offer clear illustrations of the FPTC: (a) About 80,000 free tickets for the Pope’s East Coast visit were meant to be distributed through lotteries. Many of these tickets were resold on Craigslist and eBay (NBC news). (b) When Harvard Professor Michael Sandel gave a free public lecture at the University of Tokyo, tickets were meant to be assigned by lottery in advance but some were resold for up to \$500 (The Japan Times). (c) 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). (d) There was much outrage when tickets for Ariana Grande’s One Love Manchester benefit concert were touted. (e) Resale happens for popular temporary exhibitions and cultural events that offer pre-booking.

Under-pricing is not restricted to non-profit events. For example, ‘crown jewel’ or ‘marquee’ 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 be able to attend irrespective of their income. In its thorough review of ticket resale, the US Government Accountability Office (2018) acknowledges that “for some high-demand events, tickets might be ‘under-priced’, that is, knowingly set below the market clearing price that would provide the greatest revenues” and argues that some event organizers care about ‘affordability’ and ‘audience mix’. It is also true that some artists care about their image and reputation. They fear that ‘price gouging’ in the primary market sometimes triggers backlash and consumer retaliation.⁴

Finally, pricing below market price is common for the best seats in a venue, also known 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 charge such prices. 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 2014).

Pricing below market price has fueled academic controversies with some arguing that sellers sometimes have ulterior profit-maximizing interests, which certainly happens, and others appealing to higher motives (Bhave and Budish 2017, Sandel 2012, Roth 2007). Drawing the line between profit motives and sincere and deliberate gifts to the public is not the issue here. The take away of this Section is that deliberate under-pricing is a reality for some events and that it will continue to occur.

2.1.2 Bots acquire tickets before fans

When prices are set far below resale values, scalpers operate computer software programs called (ro)bots to scrape large numbers of tickets and resell them at ridiculous markups. There is

⁴<https://www.npr.org/sections/money/2018/11/28/671580422/episode-468-kid-rock-vs-the-scalpers>

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 now against electronic programs using high speed connections and sending thousands of requests. It is easier to grab a large fraction of tickets online, while maintaining anonymity and reducing the chances of being detected and investigated, than with physical lines and rationing by waiting.

There is much evidence that bots have reduced ticket availability for some under-priced events. The press demonizes the cash grab and blames resellers for the lack of availability.⁶ FanFair Alliance is a lobby that aims to stop industrial-scale reselling, bring stakeholder together, lobby governments to take action against resale for profits and reveal abuses (e.g when Viagogo resells tickets for charity events). Several governments (e.g UK, Australia, Ireland, Ontario, Alberta, British Columbia) have recently opened public inquiries.

Massive sums of money are diverted away from the public. The extent of under-pricing is gauged by the markups in the secondary markets and the fraction of resold tickets. As early as 2010, a single large scale broker, Wiseguys Tickets, was prosecuted for earning more than \$25 millions in profits. At the peak of the Hamilton show, between 10 and 45% of tickets were resold for profit. A New York Times analysis suggested that resellers were making \$60 million per year on this show alone. Similarly, Ed Sheeran has left millions to brokers in the past few years.⁷

2.1.3 Challenges

An obvious solution to the FPTC would be to use 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 find out after having bought a ticket that they cannot attend. When tickets are released a few months before 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 (2014) document in the context of popular music concert, that about half of resale is not done by professional resellers, and Sweeting (2012) reports that much of resale in baseball is done by fans. Genuine

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

⁶Obviously, the argument is flawed because resellers do not reduce the number of seats available for fans.

⁷In one instance, he canceled 10K tickets that were selling eight time above face value. He returned these tickets to fans. 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. There were problems with resale in most countries he visited.

⁸A notorious exception is the Wimbledon queue (https://www.wimbledon.com/en_GB/atoz/queueing.html).

⁹Even 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 (<http://www.huffingtonpost.com/chris-tsakalakis/why-reselling-tickets-is-b.643219.html>).

ticket exchange also reduces the number of empty seats, increases revenues from on-premise sales and television rights.

To sum up, the challenge with the FPTC is to implement a fair distribution of tickets in the primary market, subsequently allow genuine ticket exchange due to plan changes, while deterring resale for profits. We propose next a simple framework to analyze two solutions to the FPTC that have been debated for decades, secondary markets and resale bans, and a newly implementable solution proposed by industry insiders (centralized exchange).

3 Three solutions to the FPTC

There are N fans willing to pay $v \in [0, \bar{v}]$ to attend the event. $F(\cdot)$ denotes the CDF of willingness to pay among fans. A fan requests a ticket if her valuation is greater than the price. Demand is $N(1 - F(p))$ when the price is p .¹⁰ The venue capacity is K . The event organizer sets the price of a ticket at p_0 such that there is excess demand: $q_0 = N(1 - F(p_0)) > K$. Tickets are randomly distributed among fans with $v \geq p_0$. We denote by $\bar{V} = E(v|v \geq p_0)$ the average valuation among served fans.

Assumption 1. $E(v|v \geq x) - x$ is decreasing for $x \geq p_0$.

This condition holds, for example, for uniform distributions or when there is little valuation heterogeneity across fans. After the initial sale, each consumer finds out whether she can attend the event, which happens with probability α . Schedule conflict events are independently distributed across fans.

Under a perfectly enforced resale ban (RB), tickets are non-transferable. One way to enforce a resale ban, for example, is to issue nominative tickets and check identification at admission. Brokers do not buy tickets because resold tickets have no value to anyone but the original purchaser. Only fraction α of ticket holders attend the event. Total welfare is $W_{RB} = \alpha \bar{V} K$.

In the other two mechanisms, tickets can be transferred. There are costs of acquiring and reselling tickets. Fans have no acquisition cost and pay \tilde{t} to resell a ticket in the event of schedule conflict.¹¹ Brokers use bots to acquire tickets before consumers in the primary market. The cost of acquiring and reselling a ticket is the same for all brokers and it increases with the fraction of tickets acquired by brokers. Broker entry increases all brokers' costs because acquisition is a zero sum game with negative cost externalities. For example, Leslie and Sorensen (2014) model ticket acquisition as an 'arrival game' with costly investments.

Assumption 2. Let $t(\beta)$ for $\beta \in [0, 1]$, with $t(\beta) \geq \tilde{t}$ and $t'(\beta) \geq 0$, denote the broker cost of turning around a ticket (acquisition and transaction cost) when fraction β of tickets are captured by brokers.

¹⁰Although unusual, the assumption that fans do not anticipate future prices, resale opportunities and cancellation possibility, is not entirely unrealistic in the context of our application. It is consistent with the puzzle that fans rarely resell tickets for profits (Krueger 2001) and with evidence from the airline industry that few travelers are forward looking (Li et al. 2014).

¹¹This is a rough attempt at capturing the distinction between fans and brokers. Some fans spend time and often fail to acquire a ticket because bots have an advantage. This welfare cost, which is not taken into account here, would further reinforce the conclusion that resale markets are not always optimal.

An alternative way to model broker cost would be to assume that there an upward slopping supply of brokers and no cost externalities (the cost of each broker does not depend on the level of broker entry). We contrast our results with this alternative approach after Proposition 2.

3.1 Resale market

Consumers and brokers can exchange tickets in the resale market. We first solve for the equilibrium price in the secondary market for a given β . Brokers acquire βK tickets and the remaining $K(1 - \beta)$ tickets are randomly allocated to fans. We assume that ticket holders without schedule conflict never resell their tickets which is consistent with casual observation (Krueger 2001). When resale is allowed, βK brokers and $(1 - \alpha)(1 - \beta)K$ ticket holders who cannot attend offer their tickets for sale. The supply of tickets is $K(1 - \alpha(1 - \beta))$. Denote by p_r the equilibrium resale price. Market clearing requires $\alpha(N - K(1 - \beta))(1 - F(p_r)) = K(1 - \alpha(1 - \beta))$ and we obtain

$$p_r = F^{-1} \left(\frac{\alpha N - K}{\alpha(N - K(1 - \beta))} \right).$$

Total welfare with a resale market is $W_{RM} = K[\alpha(1 - \beta)E(v|v \geq p_0) + (1 - \beta)(1 - \alpha)(E(v|v \geq p_r) - \tilde{t}) + \beta(E(v|v \geq p_r) - t(\beta))]$. Denote by $\tilde{\tau} = \frac{\tilde{t}}{\bar{V}}$ and $\tau(\beta) = \frac{t(\beta)}{\bar{V}}$ the normalized transaction costs, and $\delta_v = \frac{1}{\bar{V}}(E(v|v \geq p_r) - E(v|v \geq p_0))$ the normalized difference in willingness to pay between a fan (with no schedule conflict) who bought her ticket in the secondary versus primary market. We obtain

$$W_{RM} = \bar{V}K [1 + \beta(\delta_v - \tau(\beta)) + (1 - \alpha)(1 - \beta)(\delta_v - \tilde{\tau})].$$

W_{RM} measures welfare for a given level of broker entry. The term $\beta(\delta_v - \tau(\beta))$ measures the marginal social impact of brokers and the term $(1 - \alpha)(1 - \beta)(\delta_v - \tilde{\tau})$ the impact of allowing ticket owners with conflict to resale.¹² In a free entry equilibrium, the marginal broker must earn zero profit. We obtain that β brokers enter such that $p_r - p_0 = t(\beta)$ and the value of β is fed into the welfare equation to obtain the equilibrium welfare under a RM.

Proposition 1. *Assumption 1 holds. Welfare decreases with broker entry, that is, $\frac{d}{d\beta}W_{RM} < 0$.*

Under RM, it is socially optimal to have no broker in the market ($\beta = 0$). The issue with RM is not that there is anything wrong with resale. In fact, resale by fans increases welfare. The issue is that broker entry results in rent seeking wastes. Much of the gift $p_r - p_0$ intended by the event organizer for fans is wasted by brokers in acquisition costs that do not benefit anyone.

3.2 Centralized exchange

Under CE, tickets are randomly allocated in the primary market and the un-served fans are kept in a virtual line. Served fans receive refund p_0 when they return their ticket. The event organizer

¹²Brokers contribute to welfare by allocating tickets to high valuation consumers. Other arguments in support of brokers, not modeled here, are that they add liquidity and help with the price discovery process.

keeps track of the un-served fans who can attend and randomly allocates returned tickets to these fans. At any point in time a ticket has a single legitimate owner who is entitled access. Admission requires identity verification. A ticket that is acquired outside CE is worthless to anyone but its last owner as reported on the ledger. We show in the Appendix that all seats are used and no broker purchase tickets when the following conditions hold:

1. Ticket owners are (partially) refunded when they return their tickets.¹³
2. Returned tickets are randomly allocated to un-served fans who can attend.
3. A ledger records the last legitimate ticket owner.
4. Identification is required for admission.

Under CE, the event organizer keeps track of the current owner of each ticket and of the pool of un-served fans who are available for the event, and checks at the gate that the person who redeems each ticket matches the identity of its last owner. Doing so deters exchange when it is for profits but facilitates it when it isn't. CE eliminates acquisition costs because the best fans can do is register to the lottery and those who do not mean to attend stay out of the lottery. Assuming that it costs \tilde{t} to process each ticket exchange,¹⁴ total welfare under a CE is

$$W_{CE} = \bar{V}K(1 - \tilde{\tau}(1 - \alpha)).$$

CE dominates RB since $\tilde{\tau} < 1$. We have to compare RM with CE and RB.

3.3 Comparing RM, CE and RB

Table 1 summarizes how the three options perform along two dimensions of efficiency. The second column in Table 1 measures allocation and cancellation efficiency. The ideal or first best mechanism allocates tickets to fans who can attend (no empty seats), and within this group to those with highest valuations, and do so with least transaction cost possible. This mechanism is represented on the first line. Allocation and cancellation efficiency decreases as one moves further down column 2. Under a RM, only tickets resold in the secondary market, by brokers or fans who cancel, are allocated to high valuation consumers, and this represents fraction $1 - \alpha(1 - \beta)$ of the tickets. The last column shows that acquisition and transaction costs are highest under RM and decrease as one moved down column 3. A resale ban generates no transaction or acquisition costs but performs poorly on the ground of cancellation and allocation efficiency.

To simplify notation, let $\beta_{CE, RM}$ denote threshold fraction of brokers such that $W_{CE} = W_{RM}$ and similarly for $\beta_{RM, RB}$. We have $\beta_{CE, RM} = \frac{(1-\alpha)\delta_v}{\alpha(\tau(\beta)-\delta_v)+(1-\alpha)(\tau(\beta)-\tilde{\tau})}$ and $\beta_{RM, RB} = \frac{(1-\alpha)(\delta_v+1-\tilde{\tau})}{\alpha(\tau(\beta)-\delta_v)+(1-\alpha)(\tau(\beta)-\tilde{\tau})}$. These coefficients are relevant when condition (Ext) in the following Proposition holds in which case we have $0 \leq \beta_{CE, RM} < \min(\beta_{RM, RB}, 1)$.

¹³For free events, ticket holders would be charged a small deposit that would be refunded when they return the ticket or attend the event.

¹⁴Stubhub charge 25% per ticket exchange while the fan-to-fan Twickets platform charges 10%. Part of this difference is because integrating the sponsored fan-to-fan exchange with the primary market eliminates disputes, misrepresentation and fraud.

Table 1: Three Policy Options (welfare value normalized by $\bar{V}K$)

	Allocation and Cancellation Efficiency	Acquisition and Transaction Cost
First Best	$1 + \delta_v$	0
Resale Market	$1 + (1 - \alpha(1 - \beta))\delta_v$	$\tau(\beta)\beta + \tilde{\tau}(1 - \alpha)(1 - \beta)$
Centralized Exchange	1	$(1 - \alpha)\tilde{\tau}$
Resale Ban	α	0

Proposition 2. *Assumption 1 holds. The three mechanisms are ordered according to:*

1. $W_{RM} > W_{CE} > W_{RB}$ if: (1a) (Eff) $\delta_v - \tau(\beta) > -(1 - \alpha)\tilde{\tau}$; or (1b) (Ext) $\delta_v - \tau(\beta) < -(1 - \alpha)\tilde{\tau}$ and (L) $\beta \in [0, \beta_{CE, RM}]$.
2. $W_{CE} > W_{RM} > W_{RB}$ if: (Ext) and (M) $\beta \in [\beta_{CE, RM}, \beta_{RM, RB}]$.
3. $W_{CE} > W_{RB} > W_{RM}$ if: (Ext) and (H) $\beta \in [\beta_{RM, RB}, 1]$.

Proposition 2 contains two sets of conditions. Condition (Eff) is an efficiency condition that says that the incremental allocation efficiency net of cost, $\delta_v - \tau(\beta)$, dominates the cost required under CE to take care of cancellation efficiencies alone $-(1 - \alpha)\tilde{\tau}$. Condition (Ext) says the opposite. The second set of conditions, which are relevant only when (Ext) holds, imposes restrictions on the level of broker entry. RM is preferred for low levels of broker entry (L). It is dominated by CE for intermediate levels of entry (M) and by both CE and RB for high levels of entry (H). Four benchmark cases are of special interest:

1. When all fans have the same valuation ($\delta_v = 0$) or with no fan cancellation ($\alpha = 1$), condition (Ext) holds and $\beta_{CE, RM} = 0$. Case 2 in Proposition 2 applies: CE dominates RM for any level of broker entry.
2. With no broker entry ($\beta = 0$) condition (Eff) holds and Case 1 in the Proposition applies: RM is preferred to CE. Stated differently, a RM with no broker dominates any other mechanism.
3. With no under-pricing in the primary market, $p_0 \approx p_r$, there is no broker entry and $W_{CE} = W_{RM}$.
4. With no consumer transaction cost ($\tilde{\tau} = 0$) condition (Ext) holds and the preference over RM and RE depends on the level of broker entry.

The model predicts that RM is preferred when there is no under-pricing in the primary market. This prediction is standard. With under-pricing, however, the preference for RM depends on the model's parameter values. This prediction is at odd with received wisdom. In fact, many economists would argue that RM corrects the allocative inefficiencies associated with under-pricing. The reason this prediction does not necessarily hold in our model is because of acquisition cost externalities. To show this formally, consider the case without cost externalities. The function $\tau(\beta)$ is interpreted as a standard upward slopping supply curve. In contrast

with the model with costly rent-seeking externalities, the cost of the marginal broker ($\tau(\beta)$) is now different from the average broker cost ($\beta^{-1} \int_0^\beta \tau(\beta') d\beta'$). Thus, the zero profit free-entry condition remains the same, $\tau(\beta) = p_r - p_0$, but the efficiency condition (Eff) should be rewritten with the average broker cost as follows $\delta_v - \beta^{-1} \int_0^\beta \tau(\beta') d\beta' > -(1 - \alpha)\tilde{\tau}$. Under free entry, Proposition 1 stating that there is excess entry continues to hold, condition $\delta_v > \tau(\beta)$ still fails for the marginal broker, but possibly not for the average broker. When the average broker cost is not too high, we have $\delta_v > \beta^{-1} \int_0^\beta \tau(\beta') d\beta'$, Condition (Eff) is satisfied, and Case 1 in Proposition 2 holds. This captures the economic argument in favor of brokers: significant misallocation under random lotteries (high δ_v) and low average acquisition and transaction costs, which is plausible in the absence of acquisition cost externalities. Many economists would argue that these conditions make the case in support of resale markets with broker entry and leave the argument at that. Although this conclusion is correct when the average broker cost is low, it fails with acquisition cost externalities.

In fact, condition (Eff) will typically fail when Assumption 1 holds and when $\tilde{\tau}$ is not too large. Free entry implies $\delta_v - \tau(\beta) = (E(v|v \geq p_0) - p_0) - (E(v|v \geq p_r) - p_r)$ which is negative under Assumption 1. Brokers waste more resources acquiring tickets than they increase allocative efficiency. This is because $\frac{d}{dx}(E(v|v \geq x) - x)$, which is loosely speaking the marginal broker's net allocative welfare impact, is negative under Assumption 1. As a result, the efficiency condition fails when $E(v|v \geq x) - x$ decreases between p_0 and p_r by more than the transaction cost $-(1 - \alpha)\tilde{\tau}$ required under CE to take care of cancellation efficiency.

When condition (Ext) applies, (CE) dominates when $\beta_{CE, RM}$ is low and cases (2-3) in Proposition 2 apply. This will be the case when allocation inefficiencies are low (δ_v low), acquisition costs are high ($\tau(\beta)$ large) and when under-pricing is significant ($p_r - p_0$ and β large). To illustrate, assume that acquisition and transaction costs are around $\tau(\beta) = 40\%$ (Stubhub's fee alone is 25%), fans have a schedule conflict with probability $\alpha = 5\%$, the allocation efficiency gain is $\delta_v = 30\%$, and the fee in CE is $\tilde{\tau} = 10\%$.¹⁵ Condition (Ext) holds with these values and we obtain $\beta_{CE, RM} = 14\%$. We conclude that CE dominates RM if bots capture at least 14% of tickets. This demonstrates that CE can dominate RM for plausible parameter values. Moreover, the choice between the two options will likely vary event by event because α and δ_v change across events.

3.4 Discussion: Other Reasons to Support CE over RM

Our argument against RM in the context of the FPTC rests on the premises that the increase in consumer surplus is dominated by the acquisition and transaction costs borne by brokers and this holds under Assumptions 1 and 2. Brokers end up wasting much of the under-pricing gift intended for fans in acquisition cost externalities. The point is particularly obvious and valid when fans have similar valuations (δ_v small). We have $E(v|v \geq p_r) \approx E(v|v \geq p_0)$ and brokers waste resources in acquisition costs (which can be significant if $p_r \gg p_0$) without increasing

¹⁵There is scant evidence on resale. The evidence in Leslie and Sorensen (2014) suggests that about 5% of resale is due to plan change. Schneiderman (2016) reports that brokers can purchase up to "90% of the most desirable tickets."

welfare above what can be achieved under a CE. It is important to note that a small δ_v is not inconsistent with high prices in the resale market. For the sake of completeness, we discuss here three arguments against resale for profit and in favor of a CE that do not rely on the Assumptions 1 and 2.

One argument starts from the observation that willingness to pay (WTP) and willingness to accept (WTA) are typically not the same for tickets (Krueger 2001). WTP is the maximum dollar amount a ticketless fan is willing to pay for a ticket and WTA is the minimum dollar amount at which a fan is willing to sell her ticket. Assume there much more variations among fans in WTP than in WTA due, for example, to income differences (Tunçel and Hammitt 2014). The mark-up in the resale market, $p_r - p_0$, is high when there is much heterogeneity in WTP. But differences in WTA across fans, which determine the potential welfare gains, may be small. Brokers reallocate tickets to high WTP fans but generate transaction costs. The net social welfare impact of RM is negative when rent seeking costs are high and allocative efficiency gains low. This argument against broker resale does not rely on assumptions 1 and 2.

Another argument popular outside economics says that resale for profit imposes negative externalities on the public at large. The problem is not with the transfer of tickets as no-one takes issue with resale at face value. Resale for profit, however, is a source of discontent when it is unfair (Kahneman et al. 1986), repugnant (Roth 2007), immoral (Sandel 2012), or when it deals with incommensurable goods. The public is hurt when affordable tickets are resold at inflated prices. Waterson (2018) refers to the trade-off between efficiency and equity. Incorporating these considerations in the analysis would further tilt the balance away from resale markets.

A final argument is based on the notion of paternalistic gift. An event organizer makes a gift to customers when it chooses to under-price. The problem with resale for profits is that it enables brokers to undo this gift and by doing so it obliterates the gift motive. According to that argument, resale for profit is responsible for the under-supply of under-priced events and for distortions in the choice of venues and in the type of show offered.

Interestingly, the proposed CE mechanism dominates RM in all three cases. In the second case, the CE may even implement the first best outcome to the extent that it is socially optimal to randomly allocate tickets. An important contribution of Proposition 2, however, is to demonstrate that even when these non-classical arguments for banning resales are absent, a CE may still be preferred to resale markets.

4 Public and private solutions

Banning bots, or any reduction in β that holds $\tau(\beta)$ constant, unambiguously improves welfare. In fact, several countries have introduced uncontroversial laws that criminalize bots and impose penalties for violators.¹⁶ Fighting bots, however, is complex because it involves Internet commerce, often across multiple jurisdictions, involving various legislation, and with no individual

¹⁶In the United States, the Better online Ticket Sales (BOTS) Act of 2016 makes it illegal for bots to purchase tickets or to resell tickets that were bought by bots. England has amended the Consumer Right Act in 2015 and introduced the Digital Economy Act in 2017.

victim to file a complaint.¹⁷

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). This is consistent with the model's prediction that there is no solution to the problem that applies to all events. A one-size-fits-all solution will either harm the events where resale is widely accepted (e.g. many sports) or those where it isn't (e.g. highly popular and grossly under-priced shows). Proposals in favor of RM or RB, or price caps, are controversial and difficult to pass. After banning bots, for example, the New York State legislature has reached stalemate, and has not managed to pass a follow-up bill. One problem is that resale laws are difficult to enforce and often ineffective (Elfenbein 2006, Moore 2009, Drayer 2011). Even ignoring such limitations, our analysis suggests that resale laws are fundamentally problematic because ticketing involves many stakeholders with conflicting interests and a fast evolving technology.

Private solutions attempt 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 the function $\tau()$ to deter broker entry:

1. *Real-time screening.* Screen out bots using CAPTCHA, check on IP address, email, or credit card holder identity, or limit 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.
2. *Pre-sale registration.* Adele has teamed up with Songkick to block scalpers and claimed to have saved fans \$6 million. 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).¹⁸
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.¹⁹ 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. *Non-transferability restrictions.* This is equivalent to a RB and can be enforced by, for example, matching at admission the credit card used to purchase the ticket, checking

¹⁷One rare exception is NY's \$7.1 million fines settlement with brokers following the Schneiderman inquiry.

¹⁸ [http : //www.huffingtonpost.com/entry/despite - 1000 - secondary - market - prices - springsteen_us_59a9d86de4b0c50640cd5f5b](http://www.huffingtonpost.com/entry/despite-1000-secondary-market-prices-springsteen-us_59a9d86de4b0c50640cd5f5b)

¹⁹[https : //www.ericchurch.com/news/438669/eric - church - cancels - 25k - secondary - market - ticket - or](https://www.ericchurch.com/news/438669/eric-church-cancels-25k-secondary-market-ticket-or)

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.

5. *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. The main distinction between CE and a fan-to-fan exchange, however, is that the latter does not deter brokers from selling tickets outside the fan-to-fan platform.
6. *Increase supply.* Garth Brooks adds concerts till demand is exhausted. Ed Sheeran selects large venues and adds dates.

Policies 1-3 increase welfare to the extent that they reduce the number of tickets that are allocated to bots without increasing acquisition costs. 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 4 is equivalent to a resale ban. It prevents resale but increases the chance of having empty seats.

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 2019). Even Hamilton creator’s Lin-Manuel Miranda has done so after years of frustration with scalpers.²⁰ 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 owner using block chain technology, smooth identity check at the gate, virtual queue management). This is a slow process because large events involve tens of thousands of people and non-trivial operational issues.

5 Concluding remarks

Governments have made little progress toward finding a solution to the FPTC. Beyond banning bots, we have shown that a one-size-fits-all regulation of ticket markets is not the appropriate way to address the problem. This is not to say that there is no role for the government. The challenge is to accommodate some event organizers’ needs to have some control over what buyers

²⁰ 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.

can do with tickets, while putting restrictions to prevent abuses. For example, enforcing blind non-transferability restrictions, as has been supported by some industry interests, 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.

The CE mechanism we propose is simple. We have shown that it improves welfare in situations where resale markets fail to serve the public. We have outlined key necessary design features the CE must have to address the FPTC, keeping in mind that a CE can tackle some problems but not all.²¹

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. Sometimes, not all tickets are sold in the primary market at face value. Withheld tickets end up being sold in secondary markets above face value (Schneiderman 2016). Promoters have been prosecuted in some rare instances for manipulating ticket availability and prices.²² In one instance, a ticketing agency was revealed to support bots' tickets acquisition in the primary market.²³ Event organizers are often complacent because they benefit directly or through the publicity associated with rapid sell-outs. Several jurisdictions are looking at rules that increase transparency in the primary market. We argue that solving the FPTC will also tackle the problems of 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. Other event organizers will have 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 believable once the public understands that fair price ticketing does not have to be cursed.

²¹For example, a CE can deal with groups by assigning a probability to be served that decreases with the size of the group. 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.

²²<https://www.iq-mag.net/2017/08/top-promoters-and-ticketers-face-prosecution/#.WbQH99GQxEY>

²³<https://www.cbc.ca/news/business/ticketmaster-resellers-las-vegas-1.4828535>

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6 Appendix

Proof of Proposition 1: We have $\frac{d}{d\beta}W_{RM} = \bar{V}K(\delta_v - \tau(\beta) - (1 - \alpha)(\delta_v - \tilde{\tau}) + \beta\tau'(\beta))$. $\frac{d}{d\beta}W_{RM} < 0$ is equivalent to $\tau(\beta) - \delta_v > -\beta\tau'(\beta) + (1 - \alpha)(\tilde{\tau} - \delta_v)$. To demonstrate that this inequality holds, observe that: i) $\tau(\beta) - \delta_v > 0$ under free entry and Assumption 1; ii) the first term on the right hand side, $-\beta\tau'(\beta)$, is negative; and iii) to deal with the second term consider two possibilities. If $\delta_v \geq \tilde{\tau}$, this term is negative and the inequality holds. If $\tilde{\tau} \geq \delta_v$, the inequality is a consequence of $\tau(\beta) \geq \tilde{\tau}$. QED

Proof of Proposition 2: RM dominates CE if and only if

$$\bar{V}K(1 + (1 - \alpha(1 - \beta))\delta_v - \tau(\beta)\beta - \tilde{\tau}(1 - \alpha)(1 - \beta)) > \bar{V}K(1 - \tilde{\tau}(1 - \alpha))$$

which simplifies to

$$\beta((1 - \alpha)(\tau(\beta) - \tilde{\tau}) - \alpha(\delta_v - \tau(\beta))) < (1 - \alpha)\delta_v$$

This inequality always hold when $\delta_v - \tau(\beta) \geq \frac{1-\alpha}{\alpha}(\tau(\beta) - \tilde{\tau})$. When this is not the case, that is $\delta_v - \tau(\beta) < \frac{1-\alpha}{\alpha}(\tau(\beta) - \tilde{\tau})$, RM dominates CE for any value of β if $\beta_{CE, RM} > 1$ which is equivalent to $\delta_v - \tau(\beta) > -(1 - \alpha)\tilde{\tau}$. Since $\frac{1-\alpha}{\alpha}(\tau(\beta) - \tilde{\tau}) > -(1 - \alpha)\tilde{\tau}$, we conclude that RM dominates CE for any value of β when $\delta_v - \tau(\beta) > -(1 - \alpha)\tilde{\tau}$. This establishes claim (1a) in Proposition 2.

When $\delta_v - \tau(\beta) < -(1 - \alpha)\tilde{\tau}$, RM dominates CE when $\beta < \beta_{CE, RM}$ and CE dominates RM otherwise. This, together with the definition of $\beta_{RM, RB}$ establishes claims (1b), (2) and (3) in Proposition 2. QED

Analysis of CE: The *CE* mechanism has four features (see Table 2, Column 1): (RfR) refund for return, (RA) random reallocation of returned tickets, (L) ledger of current legitimate owner, and (ID) check at admission that identification of ticket holder matches the 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), returned tickets are unused 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 select defaults used in practice.

Some of these measures have been implemented separately but never together with one exception. As mentioned in Section 4, 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 (feature 3). However, we argue that these measures alone do not solve the problems of no-shows and resale for profit.

Table 2: Design Features of Centralized Exchange (CE) and Default Features

<i>Centralized Exchange</i>	<i>Default Features</i>
(RfR) Refund for return	Zero refund
(RA) Random reallocation of returned tickets to fans who can attend	No option to return tickets
(L) Ledger of current legitimate owner	Ticket is assigned to original buyer
(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) Fraction β of tickets are bought by brokers. (3) Fraction $1 - \beta$ of remaining tickets are randomly distributed to fans. (4) Fans find out whether they can attend the event: Fraction $\alpha(1 - \beta)\frac{K}{N}$ of fans own a ticket and can attend, $(1 - \alpha)(1 - \beta)\frac{K}{N}$ own a ticket and cannot attend, $\alpha(1 - (1 - \beta)\frac{K}{N})$ 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. The cost of reallocating a ticket within CE is $\tilde{\tau}$. (6) Tickets are redeemed. A ticket bought in RM does not entitle admission when L and ID apply.

Proposition 3. $W_{RM} = \bar{V}K(1 - \tilde{\tau}(1 - \alpha))$ if and only if (RfR, RA, L, ID) are implemented.

When (RfR, RA, L, ID) are implemented no broker enter: i) $\beta = 0$, ii) fraction $1 - \alpha$ of tickets are resold, iii) all tickets are used, and iv) the average valuation amongst users is \bar{V} . We have $W_{RM} = K\bar{V}(1 - \tilde{\tau}(1 - \alpha))$.

Next, we show that welfare changes 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 $\alpha K\bar{V}$; (b) When *RA* is not implemented, returned tickets are unused and we have again that welfare is equal to $\alpha K\bar{V}$; (c) When L is not implemented but ID is, reallocated tickets cannot be redeemed. Welfare is $\alpha K\bar{V}$; (d) When ID is not implemented, we are back to the RM outcome. This concludes the proof.

Ed Sheeran has come closest to a CE for his 2018 tour.²⁴ 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.²⁵ Scalpers have arranged 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.

To conclude, we consider a fan-to-fan face exchange (FtF) because it has been used in practice. Doing so also clarifies the role of random reallocation in CE. FtF has the RfR feature but the difference is that the other features do not apply. 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 L and ID. This does not achieve the first best outcome because brokers are not deterred. 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 (recall that L and ID apply) 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 (RA) is necessary to deter broker entry.

²⁴<http://www.edsheeran.com/news/got-question-about-eds-european-tour-2018-38036>

²⁵<http://www.independent.ie/entertainment/music/music-news/even-ed-sheeran-cant-stop-the-touts-tickets-for-singers-2018-irish-dates-already-on-reselling-sites-for-1200-35910408.html>