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.