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How to Win Twice at an Auction.
On the Incidence of Commissions in Auction Markets

Summary

We analyze the welfare consequences of an increase in the commissions charged by the organizer of an auction. Commissions are similar to taxes imposed on buyers and sellers and the economic problem that results looks similar to the question of tax incidence in consumer economics. We argue, however, that auction markets deserve a separate treatment. Indeed we show that an increase in commissions makes sellers worse off, but some (or all) buyers may gain. The results are therefore strikingly different from the standard result that all consumers lose after a tax or a commission increase. We apply our results to comment on the class action against Christie's and Sotheby's and argue that the method used to distribute compensations was misguided.

Keywords: Auction, Intermediation, Commissions, Welfare

JEL Classification: D44, D80

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1 Introduction

The development of new technologies led to the emergence of digital market places and auction portals targeted to consumers (such as e-Bay) or to industries and part-suppliers (most industry-exchange portals). In the non-digital world, auction houses such as Christie's and Sotheby's also serve as go-betweens. Since intermediaries make profits by charging commissions to buyers and sellers, it is important to analyze the welfare consequences of an increase in their commissions. The question is important for competition policy authorities evaluating the welfare losses resulting from an abuse of dominant position or a collusive agreement in the market for intermediation.["] The question is also important from a policy point of view since taxation of profits of intermediaries is likely to result in higher commissions charged to participants.

Since commissions are taxes imposed on sellers and buyers, the economic problem that results is similar to the question of tax incidence in consumer economics for which we know the answer: Taxes make consumers and sellers worse o! since the tax decreases e!ective demand or e!ective supply; demand and supply elasticities a!ect the relative losses of buyers and sellers. There would be no need for a separate treatment of auction markets if the e!ects of larger commissions or taxes paralleled those in markets without intermediation. This may explain why tax incidence in markets with intermediaries has not received much attention in the literature.[2]

We argue that auction markets deserve a separate treatment, and show that an increase in commissions makes sellers worse o!, but some (or all) buyers may gain. Moreover, the

["]As was the case for Christie's and Sotheby's from "993 to 2000.

[2]In a di!erent model, Baye and Morgan (200") consider the access prices charged by a monopolist intermediary in a "standard" market with Bertrand competition. Each seller is a monopolist on his local market but may have to compete with the other seller on the intermediary market. Since sellers will be willing to pay positive access fees only if they expect not to face head-to-head competition with probability one, access fees make sellers indi!erent between participating or not in the intermediary market. The welfare comparisons in their model are ambiguous. This is partly due to the existence of multiple equilibria. A key assumption in their model is the monopoly power of the sellers in their local market: Sellers would prefer that the intermediary market not to exist. We consider instead situations in which intermediation has value for the sellers.

expected welfare of participants in the market may be larger after the increase. The results are therefore strikingly di!erent from the standard result that *all* consumers lose after a tax or a commission increase.

The di!erence in results from two specificities of auction markets. First, there is a basic externality in auctions that is absent in other markets. In an auction, buyers and sellers worry about the degree of competition; the willingness to pay of a buyer and the willingness to sell of a seller depend on the degree of competition. Second, the "good" that bidders want to purchase is risky since they face a lottery consisting of a probability of getting the object and the expected price of the object conditional on winning. When the degree of competition (that is the number of bidders) changes, this a!ects both the probability of winning and the expected price, often in opposite directions; this makes welfare comparisons based on price changes only rather suspect.

To assess the welfare e!ects on participants, it is necessary to take into account the joint variation of both variables. This also suggests that the welfare consequence of a change in commissions may be di!erent when assessed ex-ante (before the winner is known) or ex-post (after he is known).

The model of intermediation in auctions that we use is standard. There is a large set of potential bidders and sellers. Sellers o!er the same type of object and have the same valuation. Bidders are ex-ante symmetric but learn their valuation after having decided to participate, which they do when their expected utility is larger than a positive cost of participation.

There is a go-between who sets and announces commissions paid by buyers and sellers. We show first that the equilibrium payo!s depend on an "aggregate commission" that is a non linear function of the buyer and seller commissions. An increase in commissions refers to an increase in this aggregate.

Sellers adjust their reserve price as a function of the commission. A higher commission leads to an increase in reserve prices and therefore to a decrease in the expected utility of bidders. It follows that a higher commission induces a lower number of bidders participating in the auction, as well as the possibility of a higher price paid by the winner. There is therefore the possibility that bidders will be worse o!.

Our main results are the following.

- From an ex-ante perspective, as long as the cost of participation is the same for all agents, the ex-ante average welfare of bidders is the same in the high- and the low-commission auctions.

- Participants who are likely to win (*effective bidders*) must have a valuation larger than the reserve price of the seller. The average welfare of these e!ective bidders in the high-commission auction is strictly larger than the average welfare that they would have had in the low-commission auction.

- Among the winners of the high-commission auction, those paying a price strictly larger than the reserve price are strictly better o! than if they had been winners in the low-commission auction. Winners paying the reserve price are weakly worse o!.

- In the ex-post stage, the question of compensating winners in the high-commission auction is complicated by the fact that while we observe the price they pay, we do not observe the probability they had of winning the object. Following established practice in consumer economics for compensating consumers for price variations, we make the thought experiment of finding the monetary transfer that would make the winner indi!erent between paying the current price or facing more competition but a lower commission (compensating variation). More competition would imply that he wins the object less often, but potentially at a lower price. For valuations that are uniformly distributed, we show that the winner would, on average, not be willing to pay to face more competition and a low commission, that is to be faced with a situation similar to the low-commission auction. Compensating winners in a high-commission auction would therefore make them win twice.

These results suggest that in auction markets, sellers are the main losers and that there can be reasons not to compensate buyers. While there may be a welfare loss, it may essentially be due to bidders who are excluded, either at the ex-ante stage or at the interim stage, because their valuation was lower than the reserve price of the seller in the high-commission auction. These phantom participants may deserve compensation but they are obviously impossible to identify.

In the next section, we show that in an auction, potential buyers take into account an increase in their commission rate by shading their bid and are therefore not directly a!ected. This shading decreases the price, thus a!ecting the seller who can react by strategically increasing his reserve price. To the extent that the reserve price a!ects the outcome of the auction (by increasing the price or by a failure to sell), buyers can be indirectly hurt. Section 3 introduces a model of an auction house as an intermediary who charges commissions on both sellers and buyers. It takes into account all the decisions on buyers and sellers (participation decision, setting of the reserve price, bidding) as a function of the commissions rates. In Sections 4 and 5, we show that while the ex ante total welfare decreases that e!ective bidders and buyers may be better o! with higher commissions.

2 A first look at the impact of commissions in auctions

As noted by Ashenfelter and Graddy (2003), the theory of private value auctions implies that buyers are indi!erent to the level of the commission. Since ascending price auctions often used by salesrooms are strategically equivalent to second-price auctions, a bidder has a dominant strategy to bid his valuation. The price paid by the winner corresponds thus to the valuation of the second highest bidder. When the buyer's commission is raised, buyers reduce their bids by the same amount, and this results in a reduction of the hammer price. For concreteness, suppose that the buyer's commission c_B is raised from 0 to 20%. A buyer with a valuation of v would bid up to v in the first case and up to $(1 - c_B)\, v$ in the second one. Thus, the entire burden of the commission ends up being borne by the seller since buyers fully endogenize the commission in their bidding.

However, the seller is not totally passive. Economic theory has investigated how a seller can increase his expected revenue by setting strategically a reserve price under which he refuses to sell the object. Let us analyze how this changes our previous conclusion.

Suppose there is one seller with valuation v_s and n buyers with valuations v_i distributed on $[0, 1]$ according to a cumulative density function $F(\cdot)$. The commission rates are c_S and c_B for sellers and buyers, respectively. Hence if p is the hammer price, the buyer pays $p(1 + c_B)$, the seller receives $p(1 - c_S)$, and the intermediary (the auction house) collects $p(c_S + c_B)$. The following ratio, denoted by α, will play an important role:

$$\alpha = \frac{c_S + c_B}{1 + c_B}.$$

Note that α is increasing in c_S and c_B. It takes its smallest value when $c_S = c_B = 0$.

In the appendix 7.", we show that the optimal reserve price for the seller is

$$r - \frac{1 - F(r)}{f(r)} = \frac{v_s}{1 - \alpha}, \tag{"}$$

while the ex-ante surplus of a buyer in this auction is

$$B(n, c_S, c_B) = \int_r^1 \left(\int_r^v F(x)^{n-1} dx f(v) \right) dv. \tag{2}$$

The optimal reserve price of the seller increases with the commission rates (see (")), while the surplus of the buyers decreases with r (see (2)). If, after the increase in commissions, the winning bidder pays the reserve price, he may lose. However, if he pays more than the reserve price, he does not lose. It is therefore easy to tell whether buyers should or should not be compensated, but it is clear that not all of them should be.

So far we have only analyzed how commissions influence the bidding decision of buyers and sellers (a reserve price can be interpreted as a bid). But since the welfare of buyers and sellers may decrease with an increase in commissions, their decisions to participate in the auction market may also change, and this will change the simple welfare considerations made above. This is analyzed in the following three sections.

3 The auction house as an intermediary

3.1 The model

Consider the following two-sided market. On one side, there is a mass N of potential buyers, each with a participation cost t, with distribution $G(\cdot)$. Assume that each buyer wants to purchase one unit of the good, and can participate in one auction only. Participating buyers have valuations v, that are identically and independently distributed according to $F(\cdot)$. On the other side of the market, there is a mass M of potential sellers with valuation v_s and an ex-ante participation cost t, with distribution $H(\cdot)$.

There is a unique auction house which acts as an intermediary between buyers and sellers. It organizes auctions for the objects that sellers are willing to sell and sets commission rates (c_S, c_B), each a fixed proportion of the hammer price.

Buyers are distributed uniformly among auctions. Let n denote the ratio of participating buyers over participating sellers. This ratio represents the degree of competition among buyers in the market. If every buyer and seller participates in an auction, then $n = N/M$.

The auction format used is the second price (Vickrey) auction that is strategically equivalent to the English auction used by most salesrooms.[3] Sellers decide on a reserve price r,[4] and buyers make their bids.

3.2 Participation decisions

Since commissions decrease the revenue of sellers, these are likely to change their behavior and may decide not to participate or to participate but modify their optimal reserve price. This has a feed-back e!ect on the surplus of buyers and hence on their own participation. Therefore, a change in commissions modifies the number of participants and therefore the ratio of buyers over sellers.

[3] We focus on second price auctions. Our results would not change if we used any other usual auction format, since the revenue equivalence principle can be applied in our framework.

[4] The fact that the reserve price is often secret, coincides with reality, but does not matter here.

Sellers' participation

A potential seller takes $c = (c_S, c_B)$ as given, anticipates n and sets his reserve price r (which, given (") depends only on c) to maximize $\Pi(c, r, n) = (1 - c_s)p(c, r, n) + F^n(r)v_s$, where $p(c, r, n)$ is the expected hammer price in the auction, $F^n(r)$ represents the probability that the object goes unsold and, is kept by the seller who values it at v_s. He participates if $\Pi(c, r, n) - t \geq v_s$. The mass of participating sellers is $H(\Pi(c, r, n) - v_s) \cdot M$.

Buyers' participation

A potential buyer takes $c = (c_S, c_B)$ as given, anticipates n and r. He participates if his cost of participating, t is smaller than his expected surplus $B(c, r, n)$. The mass of participating buyers is $G(B(c, r, n)) \cdot N$.

Equilibrium

Rational expectations require that n, the ratio of active buyers on active sellers solves:

$$n = \frac{G(B(c, r, n) \cdot N}{H(\Pi(c, r, n) - v_s) \cdot M}.$$

4 Equilibrium

4.1 Solving the model

To solve for equilibrium, we need the expressions of the optimal reserve price r, the hammer price p, the surplus of sellers, $\Pi(.)$ and of buyers, $B(.)$.

Let $b_{(1)}$ and $b_{(2)}$ be the highest and second highest bids among the n bidders. With a reserve price r, the object is sold to the highest bidder only if $b_{(1)} \geq r$ at a hammer price equal to $\max\left\{r, b_{(2)}\right\}$. Let $F_{(1,n)}$ be the distribution of the first order statistic when there are n bidders and let $F_{(2,n)}(x|y)$ be the distribution of the second order statistic when the first order statistic is equal to y.

In this case, it is immediate to see that the dominant strategy of a bidder with valuation v is to bid $b = v/(1 + c_B)$. Hence, if there are n bidders, the i-th order bid is $b_{(i)} = v_{(i)}/(1 + c_B)$, where $v_{(i)}$ is the i-th order valuation among the n bidders.

The expected hammer price is then

$$
\begin{aligned}
p &= \int_{r(1+c_B)}^{1} \int_0^x \max\{r, \frac{v}{1+c_B}\} dF_{(2,n)}(v|x)\, dF_{(1,n)}(x) \\
&= \int_{r(1+c_B)}^{1} \left(\int_0^{r(1+c_B)} r dF_{(2,n)}(v|x) + \int_{r(1+c_B)}^{x} \frac{v}{1+c_B} dF_{(2,n)}(v|x) \right) dF_{(1,n)}(x)
\end{aligned}
$$

Making the change of variable,

$$\rho \equiv r(1 + c_B),$$

we can write the hammer price as,

$$p = \frac{1}{1+c_B} I(\rho, n),$$

where

$$I(\rho, n) \equiv \int_{\rho}^{1} \left(\int_0^{\rho} \rho dF_{(2,n)}(v|x) + \int_{\rho}^{x} v dF_{(2,n)}(v|x) \right) dF_{(1,n)}(x).$$

The seller's profit

The expected profit of the seller is now

$$
\begin{aligned}
\Pi &= \frac{1-c_S}{1+c_B} I(\rho, n) + F^n(\rho)\, v_s \\
&= (1-\alpha)\, I(\rho, n) + F^n(\rho)\, v_s \qquad (3)
\end{aligned}
$$

and a strategic seller chooses ρ to maximize Π.[5]

[5] We assume that the seller chooses an optimal reserve price, but our qualitative results would still obtain if we simply assumed that ρ is increasing in α. That would be so if the seller sets $\rho = v_S/(1 - c_S)$ in order to guarantee a price net of commission larger than his valuation v_S.

The buyer's surplus

Standard arguments imply that the marginal surplus of a buyer is the expected probability of winning. If the reserve price is r (a function of α), all buyers with valuation $v < \rho = r(1 + c_B)$ have a zero probability of winning. Hence, the expected surplus of a buyer with valuation v is

$$B_v(v, c, r, n) = \int_{r(1+c_b)}^{v} F^{n-1}(x)\,dx = \int_{\rho}^{v} F^{n-1}(x)\,dx.$$

Ex-ante, the surplus of a buyer is

$$\begin{aligned} B(c, r, n) &= \int_{r(1+c_b)}^{1} B_v(v, c, r, n) f(v) dv \\ &= \int_{\rho}^{1} B_v(v, c, \rho/(1 + c_B), n) f(v) dv. \end{aligned} \tag{4}$$

This surplus is clearly decreasing in n (for fixed ρ) and decreasing in ρ (for fixed n).

The auctioneer's profit

The auction house sets the commission rates in order to maximize its profits. Its revenue in each auction is $(c_S + c_B)p(c, r, n) = (c_S + c_B)I(\rho, n)/(1 + c_B) = \alpha I(\rho, n)$. Thus, its total profit equals $R = \alpha I(\rho, n) H(\Pi(c, r, n) - v_s) \cdot M$. The trade-o! is between the number of transactions and the revenue that commissions generate on each transaction.

4.2 A neutrality result

We now show that the outcome of the auction depends on the commissions only to the extent that these modify $\alpha = (c_B + c_S)/(1 + c_B)$. Any change in the commission structure that leaves α unchanged, leaves una!ected the payo!s of sellers, buyers and salesroom. Indeed, by inspection of (3), we see that the seller's profit and thus his choice of ρ depends only on α. His optimal reserve price is equal to $r = \rho/(1 + c_B)$. The reserve price thus depends on the commission structure, but since buyers shade their bids by the same factor ($b = v/(1 + c_B)$), the marginal type of buyer who is excluded from the auction has a valuation $v = \rho$, which depends on α only.

For buyers, (4) shows that the surplus is equal to

$$\int_{\rho}^{1}\int_{\rho}^{v}F^{n-1}(x)dxf(v)dv,$$

and depends on ρ, and thus on α only. Since participation decisions depend directly on the surplus, the equilibrium ratio of buyers to sellers n also depends only on α.

It is then clear that the auctioneer's profit depends on α only, and that he faces a one variable optimization problem which we can write with some abuse of notation:[6]

$$\max_{\alpha\in[0,1]} R(\alpha) = \alpha p(n(\alpha)) H(\alpha p(n(\alpha))) \cdot M.$$

Proposition 1 (Neutrality of the structure of commission rates).

All commission rates (c_S, c_B) keeping $\alpha = (c_S + c_B)/(1 + c_B)$ constant generate identical surpluses and profits for all agents in the model (buyers, sellers and auction house).

5 Welfare

The result of Proposition " allows us to restrict attention to an increase in the commissions from α to $\hat{\alpha}$. In traditional markets, the increase of a tax shifts the supply and demand curves, which results in a higher net price for buyers and a lower net price for sellers. The welfare consequences are simple: All buyers and sellers are worse o!.

In our model, the welfare consequences are more di#cult to evaluate. The increase in commission leads to higher reserve prices and a lower participation of buyers. The original auction market is characterized by a low commission α, low reserve prices ρ and a ratio of buyers to sellers equal to n. In the new market, the commission to $\hat{\alpha} > \alpha$, leads to higher reserve prices $\hat{\rho}$ and to a new ratio $\hat{n}$. The welfare considerations depend mainly on the ratio of buyers to sellers, which represents the competitiveness of the auction markets and has a direct influence on the welfare of buyers since it determines their probability of winning and the expected price if they win.

[6] The bounds on α follow the bounds on c_S and c_B. Note that as $c_B \geq 0$, $\alpha \leq 1 - c_S$; since $c_S \geq 0$, $\alpha \leq 1$.

5.1 Ex ante welfare

At the ex-ante stage, buyers and sellers are necessarily worse o!.

Proposition 2

Suppose that $v_s > 0$ and that sellers set their reserve price strategically. If $\hat{\alpha} > \alpha$, then the ratio of buyers to sellers decreases ($n > \hat{n}$). Thus the ex-ante welfare of buyers and sellers decreases.

Proof Suppose by way of contradiction that $B(\hat{\alpha}, \hat{r}, \hat{n}) > B(\alpha, r, n)$. Since ρ increases when α increases, and since $B(\alpha, r, n)$ is decreasing in r and n, it must be that $\hat{n} < n$. But if the ex-ante surplus of buyers increases, the number of buyers who participate is also larger. To have $\hat{n} < n$, it is then necessary that more sellers participate as well, but this is not possible since the ex-ante profit of sellers decreases with α and n. So $B(\hat{\alpha}, \hat{r}, \hat{n}) \leq B(\alpha, r, n)$. □

Part of the ex-ante welfare loss is due to the lower participation of potential bidders. The elasticity of participation of buyers and sellers (due to the distribution of participation costs) is one of the important factors that explains the impact of an increase in commissions. If buyers' participation is very elastic (for instance if all buyers have the same positive cost of participation), the buyer's ex-ante surplus is left unchanged by the increase in commissions. The participation decision decreases competition in the market to the point that it compensates exactly the direct decrease in welfare due to higher commissions and reserve prices.

However, the welfare comparisons made in the practice are for the *effective* buyers and sellers; ex-ante welfare is not the right measure on which the compensation of e!ective buyers should be based since it includes the welfare of buyers who will never win in the new auction. In auction markets, the definition of an e!ective buyer is not as clear as in traditional markets. We can distinguish between e!ective bidders and e!ective buyers: the former are those whose bid is greater than the reserve price and who therefore have a chance – at the interim stage – to win the object; the later are the e!ective bidders who actually won the object, that is the observed winners. We consider first of e!ective bidders.[7]

Proposition 3

When the participation decision of buyers is elastic, then e!ective bidders are ex-ante better o! in the market with high commissions.

Proof When the participation decision is very elastic (identical cost of participation t for every buyer), the ex-ante welfare does not change with commissions: We have $B(a, r, n) = t = B(\hat{\alpha}, \hat{r}, \hat{n})$. The e!ective bidders are those with a valuation larger than the reserve price $\hat{\rho}$. Their ex-ante welfare in the new auction is $\int_{\hat{\rho}}^{1} B_v(v, \hat{\alpha}, \hat{r}, \hat{n}) f(v) dv = \int_{\rho}^{1} B_v(v, \hat{\alpha}, \hat{r}, \hat{n}) f(v) dv$ since buyers with type in $[\rho, \hat{\rho}]$ have no chance to win the auction. But now we have that

$$\begin{aligned} \int_{\hat{\rho}}^{1} B_v(v, \hat{\alpha}, \hat{r}, \hat{n}) f(v) dv &= \int_{\rho}^{1} B_v(v, \hat{\alpha}, \hat{r}, \hat{n}) f(v) dv \\ &= \int_{\rho}^{1} B_v(v, \alpha, r, n) f(v) dv \\ &> \int_{\hat{\rho}}^{1} B_v(v, \alpha, r, n) f(v) dv. \end{aligned}$$

The last inequality comes from the fact that in the original market, buyers with type in $[\rho, \hat{\rho}]$ have a positive expected surplus. As long as the participation is elastic, and thus that $B(\hat{\alpha}, \hat{r}, \hat{n})$ is not much smaller than $B(a, r, n)$, the previous argument would still hold.□

The change of average *ex-post* welfare of e!ective buyers and sellers is usually what economists have in mind when they analyze the e!ect of an increase in commissions in order to compensate losers from such an increase. If, ex ante, buyers are worse-o!, it is not clear whether this will also be so ex post. Since sellers change their reserve prices and since higher reserve prices decrease ex-ante welfare of buyers and thus their participation,

[7] Our definition of e!ective bidders broadly corresponds to the observed bidders in an English (ascending) auction, used in most salesrooms.

ex-post, buyers face less competition. Buyers who actually win can end up paying less than they would have otherwise. Thus compensating the winning buyers might not be the best idea. We elaborate on this point in the next section.

We summarize this discussion in Figure ", which shows the timing of the model and the various welfare definitions.

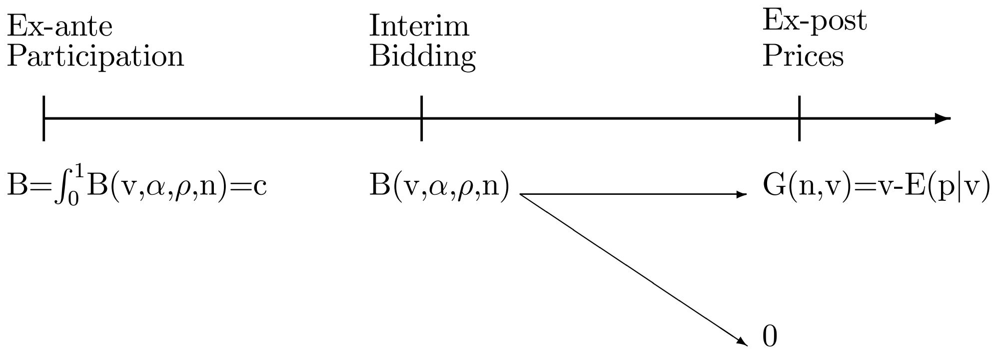

Figure " : Welfare Considerations

Table " summarizes the e!ects of increased commissions on the various welfare measures that we analyze.

Sellers	Buyers (ex ante)	E!ective bidders (interim $v > \hat{\rho}$)	Winners (ex post)
Worse o!	Weakly worse o!	Better o! if participation not too elastic	Uniform: Better o! on average High types: Better o! Low types: Worse o! Better o! if reserve price not binding

Table "

5.2 Ex-post welfare: Winning twice

The welfare of a participant in an auction is a function of the probability of winning and the expected price conditional on winning. To assess the welfare changes of participants, it is therefore necessary to take into account the joint variation of these two variables. This suggests that the welfare consequences of a change in commissions is di!erent when assessed ex-ante (before the winner is known) and ex-post (after he is known).

The winner of an auction who has a valuation $v \geq \rho$ has on average a surplus of

$$W(v,c,r,n) = \int_{\rho}^{v} \left(v - \max\left(\rho, v_{(2)}\right)\right) dF_{(2,n)}\left(v_{(2)} \middle| v; n\right).$$

He pays the second highest bid if the second highest bid is larger than the reserve price, or pays the reserve price if there is no other larger bid. Indeed, if $v_{(2)} \geq \rho$ the hammer price is $v_{(2)}/(1+c_B)$; otherwise, the hammer price is r.

When $v \geq \rho$, we can rewrite $W(v,c,r,n)$ as

$$\begin{aligned}
&\int_{0}^{\rho} (v-\rho)(n-1)f(z)\frac{F(z)^{n-2}}{F(v)^{n-1}}dz + \int_{\rho}^{v} (v-z)(n-1)f(z)\frac{F(z)^{n-2}}{F(v)^{n-1}}dz,\\
= \quad & (v-\rho)\left(\frac{F(r(1+c_B))}{F(v)}\right)^{n-1} + \int_{\rho}^{v} (v-z)(n-1)f(z)\frac{F(z)^{n-2}}{F(v)^{n-1}}dz,\\
= \quad & v - \rho\left(\frac{F(\rho)}{F(v)}\right)^{n-1} - \int_{\rho}^{v} (n-1)zf(z)\frac{F(z)^{n-2}}{F(v)^{n-1}}dz.
\end{aligned}$$

Suppose that α increases to $\hat{\alpha}$, that is suppose that the reserve price increases from ρ to $\hat{\rho}$ and let n and $\hat{n}$ be the corresponding equilibrium values of number of bidders per auction. We want to compare the expected surplus of winners when the commissions are $\hat{\alpha}$ to what they would have been with α. More competition implies that the winner wins the object less often, but potentially at a lower price.

The first dimension to look at is the price. Had he won in the other auction, a successful buyer would have paid a price determined in an environment with a lower reserve price but more competition. The second dimension is the probability of winning. By definition, an observed winner has a probability of winning equal to one in the auction under consideration. In the market with lower commissions, he would have faced more competition. To make a meaningful comparison, we consider the following thought experiment. We fix the valuations of all the bidders present in the new auction, and add new bidders ($n - \hat{n}$, to be precise) drawing valuations for them. This decreases the probability of winning from 1 to $F^{(n-\hat{n})}(v)$ for an observed winner with a valuation of v.

For valuations that are uniformly distributed, we show that in fact the winner would, on average, not be willing to pay to face more competition and a low commission, that is to be faced with a situation similar to the low-commission auction. Compensating winners in a high-commission auction would therefore make them win twice.

5.3 The uniform distribution case

We first show that if type v wins in the $(\hat{\rho}, \hat{n})$ auction, then the expected surpluses $W(v, \hat{\rho}, \hat{n})$ and $W(v, \rho, n)$ satisfy a single crossing property. (All results not appearing in the text are in the Appendix)

Proposition 4

Consider $\hat{\rho} > \rho$ and $\hat{n} < n$.

(i) For $v \in (\rho, \hat{\rho}]$, $W(v, \hat{\rho}, \hat{n}) - W(v, \rho, n) < 0$,

(ii) If $n/\hat{n} \leq (1-\rho^n)/(1-\hat{\rho}^{\hat{n}})$, then $W(v, \hat{\rho}, \hat{n}) - W(v, \rho, n) < 0$ for all v,

(iii) If $n/\hat{n} > (1-\rho^n)/(1-\hat{\rho}^{\hat{n}})$, then there is single crossing: There exists a unique v_0 such that $W(v_0, \hat{\rho}, \hat{n}) - W(v_0, n, \rho, n) = 0$ and $(v - v_0)(W(v, \hat{\rho}, \hat{n}) - W(v, \rho, n)) > 0$ for all $v \neq v_0$.

Ex-post, we can divide buyers into two groups, the winners and the losers. Highest types are better o! with higher commissions since they benefit from the reduced competition and rarely su!er from the increased reserve price while lowest types are worse o! since there is a high probability that the reserve price is binding when they win.

We now consider an example which shows that, on average, winners are better o! in the auction with high commissions.

Example 1: *An example in which buyers are better off*

Assume that (a) all sellers have a valuation $v_s = \frac{1}{4}$, (b) sellers have no cost of participating, (c) buyers have valuations uniformly distributed on $[0, 1]$, (d) all buyers have the same participation cost $t = 0.025$,[8] and (e) the commission ratio α goes from 0 to 50%[9]

The optimal reserve price is

$$r(\alpha) = \frac{1}{2} + \frac{1}{8(1-\alpha)}$$

$$B_v(v, \alpha, r, n) = \int_r^v (x)^{n-1} dx = \frac{(v)^n - (r)^n}{n}.$$

Thus the ex-ante surplus B of a buyer who expects n buyers in each auction:

$$\begin{aligned} B(\alpha, r, n) &= \int_r^1 B_v(\alpha, r, n, v)\, dv \\ &= \int_r^1 \frac{(v)^n - (r)^n}{n} dv \\ &= \frac{1}{n(n+1)} - \frac{r^n}{n} + \frac{r^{n+1}}{n+1}. \end{aligned}$$

For $\alpha = 0$, $r(0) = 5/8$, and $B(0, 5/8, n) = (1 - (5/8)^n(1 + 3n/8))/n(n+1)$, and for $\hat{\alpha} = 0.5$, $r(0.5) = 3/4$, and $B(0.5, 3/4, n) = (1 - (3/4)^n(1 + n/4))/n(n+1)$.

In Figure 2, we represent the welfare locus for both levels of the commission rate (reserve prices). The upper (lower) curve is the one for the low (high) commission rate. The equilibrium ratio is determined when the ex-ante welfare curve crosses the (thick) straight line that represents the (constant) participation cost. The graph illustrates the fact that a constant participation cost leads to the highest possible decrease in the degree of competition.

[8] Since we want to make the case that successful buyers can be better o! on average, we make the assumption that all buyers have the same participation cost. This makes buyers' particpation very elastic, and leads to the largest possible decrease in participation and the lowest possible degree of competition.

[9] We suppose for clarity if exposition that the commission is on sellers only. (this is without loss of generality, as a result of proposition ").

The increase from no commission to commissions of 50% is very large indeed. This extreme increase illustrates that even with such steep increase, successful buyers are better o!. Of course, since the degree of competition decreases continuously with α, our results would obtain with a smaller increase in commission.

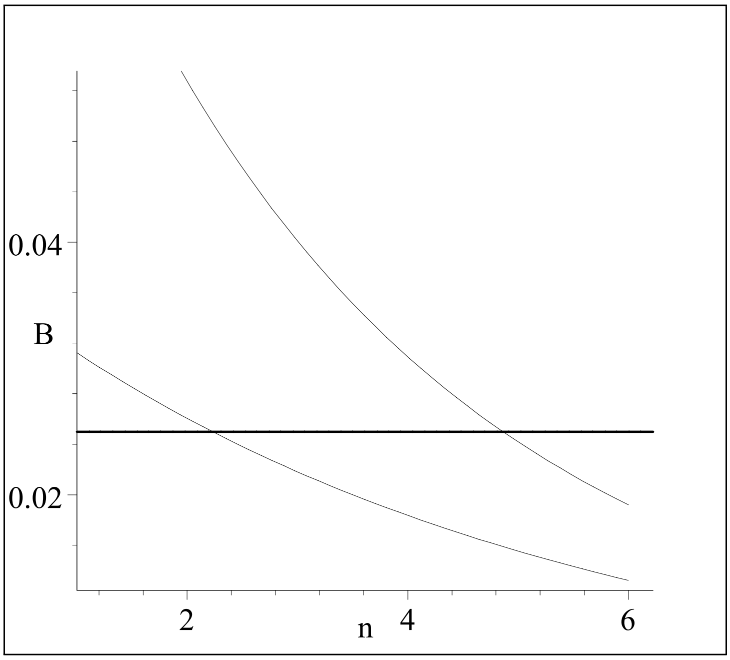

Figure 2: Ex-ante Welfare and Participation

The equilibrium number of participants is obtained when $B(.,.)$ is equal to the participation cost $t = 0.025$. This leads to $n = 4.8631$ for $\alpha = 0$ and $\hat{n} = 2.2277$ for $\hat{\alpha} = 0.50$.

The increase in the commission rate leads has two main e!ects on the price paid. First, the second order bid decreases, since the increase in commission leads to a decrease in the degree of competition: $\hat{n} < n$; this will decrease the hammer price. Second, the reserve price increases, so that the price paid by the winner is more likely to be equal to the reserve price. Whether or not the (higher) reserve price is actually larger than the (lower) second order bid in the initial auction depends on how fast n decreases when r increases. The expected price paid by the winner of the auction if his valuation $v = 1$ is:

$$\begin{aligned} E(p|1) &= rF(r)^{n-1} + \int_r^1 n-1)xf(x)F(x)^{n-2}\,dx \\ &= r^n + \frac{n-1}{n}(1-r^n). \end{aligned}$$

We can then compute the expected price paid by the highest type in both situations. These are: $p(\alpha = 0) = 0.7876$, and $p(\hat{\alpha} = 0.50) = 0.81528$. The expected price paid by the highest type is lower when commissions are high. He is better o! with high commissions. We now compute the expected price paid by a winner who has a valuation v :

$$\begin{aligned} E[p|v] &= rF(r)^{n-1} + \int_r^1 (n-1)xf(x)\frac{F(x)^{n-2}}{F(v)^{n-1}}dx \\ &= \frac{1}{v^{n-1}}\left(r^n + \frac{n-1}{n}(v^n - r^n)\right). \end{aligned}$$

Figure 3 displays the expected price of a winner of type v in both auctions. We see the single-crossing property at work. High types ($v < 0.939\,85$) would pay a lower price in the auction with no commission. The downward e!ect on the price due to lower competition more than compensates the upwards pressure due to a higher reserve price. The e!ects are reversed for the low types.

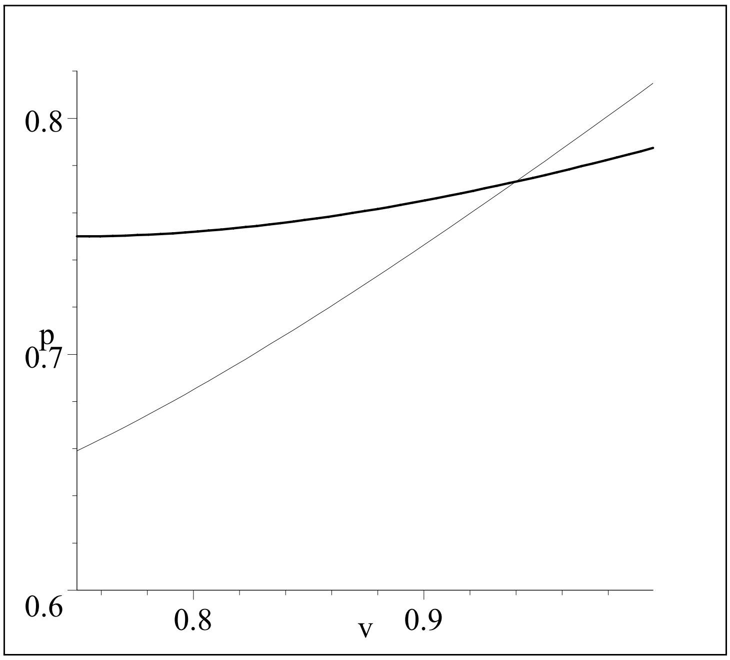

Figure 3: Expected price paid by the winner

Comparing prices is only comparing markets along one dimension. The second dimension is the probability of winning. And on that dimension, observed winners have clearly benefited from the increase in commissions that has led to lower participation and lower competition. As suggested earlier, we make the thought experiment of finding the monetary transfer that would make the winner indi!erent between paying the current price or face more competition but a lower commission (compensating variation).

On average, the welfare of a successful winner of type v is :

$$(v - E[p|v,\hat{n}]) = v - \frac{1}{v^{\hat{n}-1}}\hat{r}^{\hat{n}} + \frac{\hat{n}-1}{\hat{n}}\left(v\hat{n} - r^{\hat{n}}\right).$$

We want to compare this to the welfare he would have had in the auction with low commissions, discounted with the probability that one of the additional bidders would have had a higher valuation, that is

$$(v - E[p|v,n])\, F^{n-\hat{n}}(v).$$

Returning to our numerical example, we graph these two functions in Figure 4.

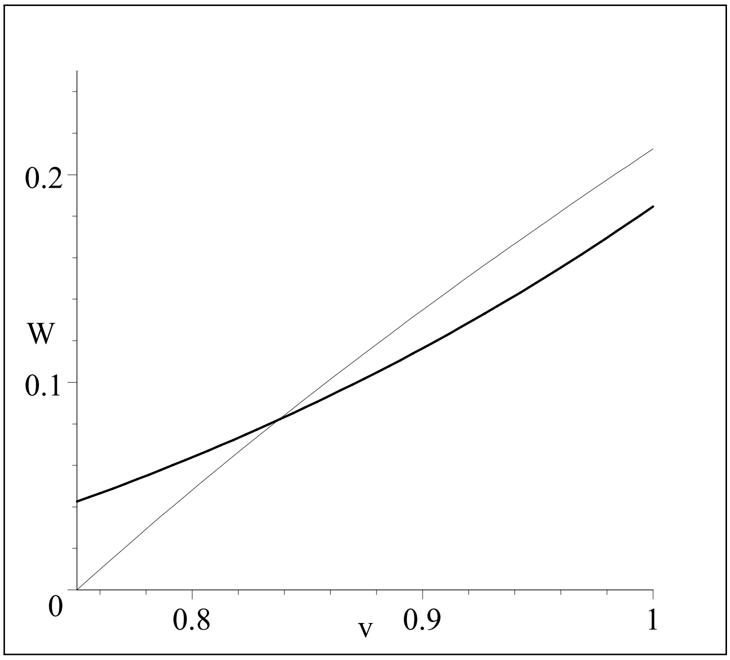

Figure 4 : Comparison of ex-post welfares

We now have to average these values with the density of winners to recover a meaningful comparison between

$$\hat{W} \;=\; \int_{\hat{r}}^{1} (v - E[p|v,\hat{n}])\, dF^{(1,n)}(v))$$

$$
\begin{aligned}
&= \int_{\hat r}^{1}\left(v-\frac{1}{v^{\hat n-1}}\hat r^{\hat n}+\frac{\hat n-1}{\hat n}\left(v\hat n-r^{\hat n}\right)\right)(nx^{n-1})dv. \\
&= \frac{1-nr^{n}-r^{n}+r^{n+1}n}{n+1},
\end{aligned}
$$

and

$$
\begin{aligned}
W &= \int_{\hat r}^{1}\left(v-E\left[p|v,n\right]\right)F^{n-\hat n}\left(v\right)dF^{(1,n)}\left(v\right)) \\
&= \int_{\hat r}^{1}\left(v-\frac{1}{v^{n-1}}\left(r^{n}+\frac{n-1}{n}\left(v^{n}-r^{n}\right)\right)\right)v^{n-\hat n}(\hat n v^{\hat n-1})dv \\
&= \hat n\frac{1-nr^{n}-r^{n}-\hat r^{n+1}+\hat r r^{n}n+\hat r r^{n}}{n\left(n+1\right)}.
\end{aligned}
$$

Numerical calculations yield $\hat W = 0.0056 > W = 0.0052$. The winners are better o! in the high commission market and would be ready to pay not to be in a market with lower commissions.

5.4 Welfare and reserve prices

The previous analysis shows that observed winners may have gained when the intermediary increases its commission but that they may have lost if the reserve price binds. One way to simplify the welfare analysis is therefore to verify whether the reserve price set by the seller was binding. An increase in commissions leads to a higher price only if the price paid is equal to the reserve price, otherwise the decrease in the degree of competition n would have driven the price down. Successful buyers who did not pay more than the reserve price are better o! in a regime of high commissions and low competition than in a regime of low commission and high competition.

6 Conclusion

The welfare analysis of taxes is well understood in traditional markets and leads to the simple conclusion that buyers and sellers are worse o!. In this paper, we argue that a separate analysis is needed in auction markets with intermediaries. The welfare consequences of increased commissions is more ambiguous and e!ective buyers can be better o! with higher commissions since the impact of commissions is compensated by lower participation and a lower degree of competition.

Our model is relevant to evaluate previous competition policy decisions. For instance, in 200", Christie's and Sotheby's who had colluded between "993 and 2000 to set (and increase their previous) commission rates were convicted to pay $5"2 millions to compensate their clients for their welfare loss. Buyers received the largest share of this settlement. This was obviously based on poor understanding of how auctions work. With this decision, compensated bidders may have won twice, while sellers may not have been compensated as they should.

7 Appendix

7.1 Optimal Reserve Prices

The expected payment of a buyer with valuation $v \geq r$ can be written:

$$p(v,r) = rF^{n-1}(r) + \int_r^x y(n-1)f(y)F^{n-2}(y)\,dy.$$

The ex-ante expected payment of a bidder is:

$$\begin{aligned} E[p(x,r)] &= \int_r^1 p(v,r)f(x)\,dx \\ &= \int_r^1 \left(rF^{n-1}(r) + \int_r^x y(n-1)f(y)F^{n-2}(y)\,dy\right) f(x)\,dx \\ &= r(1-F(r))F^{n-1}(r) + \int_r^1 y(1-F(y))(n-1)f(y)F^{n-2}(y)\,dy. \end{aligned}$$

The expected revenue of the seller is thus $\Pi = (1-\alpha)nE[p(x,r)] + F^n(r)v_s$. Di!erentiating with respect to r, we obtain:

$$\begin{aligned} \frac{\partial \Pi}{\partial r} &= (1-\alpha)n(1-F(r)-rf(r))F^{n-1}(r) + nF^{n-1}(r)f(r)v_s \\ &= (1-\alpha)n\left(1-\left(r-\frac{v_s}{1-\alpha}\right)h(r)\right)(1-F(r))F^{n-1}(r), \end{aligned}$$

where $h(x) = f(x)/(1-F(x))$ is the hazard rate associated with distribution F.

Since $\partial\Pi/\partial r > 0$ at $r = v_s$, it is always optimal to choose a reserve price larger than the seller's valuation.

The optimal reserve price has to satisfy $\partial\Pi/\partial r = 0$. This will be true if

$$1 - (r - \frac{v_s}{1-\alpha})h(r) = 0,$$

so that

$$r - \frac{1-F(r)}{f(r)} = \frac{v_s}{1-\alpha}.$$

7.2 Proof of Proposition 4

We have,

$$\begin{aligned}\Delta(b) &\equiv W(b;\hat{\rho},\hat{n}) - W(b;\rho,n) \\ &= \frac{b}{n\hat{n}}\left[n\left(1-\left(\frac{\hat{\rho}}{b}\right)^{\hat{n}}\right) - \hat{n}\left(1-\left(\frac{\rho}{b}\right)^{n}\right)\right].\end{aligned}$$

Note that $\Delta(1) = \left[n\left(1-\hat{\rho}^{\hat{n}}\right) - \hat{n}\left(1-\rho^{n}\right)\right]/n\hat{n}$; this is negative only if $n/\hat{n} < (1-\rho^n)/(1-\hat{\rho}^{\hat{n}})$.

The sign of $\Delta(b)$ is equal to the sign of the term in brackets. The derivative of the term in brackets with respect to b is

$$\frac{d}{db}\left(\hat{n}\left(\frac{\rho}{b}\right)^{n} - n\left(\frac{\hat{\rho}}{b}\right)^{\hat{n}}\right) = \frac{n\hat{n}}{b^{n+1}}\left(\hat{\rho}^{\hat{n}}b^{n-\hat{n}} - \rho^{n}\right).$$

Since $n-\hat{n} > 0$, the expression is increasing in b. As $b \leq \hat{\rho}$, $W(b;\hat{\rho},\hat{n}) = 0 < W(b;\rho,n)$ and $\Delta(b) < 0$, which proves (i). The issue is whether there exist values of b for which $\Delta(b) > 0$.

Suppose that there exists b_0 such that $\Delta(b_0) = 0$; this requires that

$$\begin{aligned}\frac{n}{\hat{n}} &= \frac{1-\left(\frac{\rho}{b_0}\right)^{n}}{1-\left(\frac{\hat{\rho}}{b_0}\right)^{\hat{n}}} \\ &\Leftrightarrow\ b_0^{n-\hat{n}}\hat{\rho}^{\hat{n}} - \rho^{n} = \frac{n-\hat{n}}{\hat{n}}b_0^{n}\left(1-\left(\frac{\hat{\rho}}{b_0}\right)^{\hat{n}}\right) \\ &\Rightarrow\ b_0^{n-\hat{n}}\hat{\rho}^{\hat{n}} - \rho^{n} > 0\end{aligned}$$

where the last implication follows $b_0 \geq \hat{\rho}$. Hence, for $b > b_0$, $\Delta(b) > 0$ and for $b < b_0$, $\Delta(b) < 0$. The existence of such a b_0 therefore requires that $\Delta(1) \geq 0$, in which case we have the single crossing property (iii) . When $\Delta(1) < 0$, we must have $\Delta(b) < 0$ for all values of b, which proves (ii).

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(lix) This paper was presented at the ENGIME Workshop on "Mapping Diversity", Leuven, May 16-17, 2002
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(lxviii) This paper was presented at the ENGIME Workshop on "Governance and Policies in Multicultural Cities", Rome, June 5-6, 2003
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