

Dealing with an Auction

The art dealer's optimal auction: English versus Vickrey

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Kas Buunk (361766)

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Supervisor:
Dr. J.J.A. Kamphorst

ABSTRACT

Given that the art dealer seeks to extend his regular business as owner of a gallery by organizing an auction, this thesis attempts to find the optimal auction mechanism by comparing the traditional oral ascending English auction with the second-price sealed-bid Vickrey auction. The thesis starts by defining the art market, after which the art dealer's strategy is compared with the auction house's strategy. The main findings are that (1) theoretical and empirical arguments support both the English and Vickrey auction in terms of revenue; (2) the Vickrey auction suits the art dealer's strategy, whereas the English auction opposes it; and (3) existing collusive models encourage free-rider behavior. This thesis proposes a compensation scheme that redistributes ring earnings fairly, discouraging free-rider behavior at the cost of not being incentive-compatible. In conclusion, the art dealer prefers the Vickrey over the English auction.

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I - Introduction

The value of art can seem mysterious. It cannot be explained by costs of production, but it is based on associations; comparable pieces with certain prices form a web around the work of art, creating a vague image of its value. That abstract image is clarified by means of associations. Knowledge on that web of associations is needed for valuation. Every thread in the web connects two works of art that are comparable in some way. The associations imply similarities, also in value, and the differences cause deviation between them.

As every work can have lots of associations with others, few people possess the knowledge needed to make a good estimate of value. Intuition goes hand-in-hand with reason, built on experience. Understanding relationships between works of art, drawing the right conclusions by comparison and intuitively adjusting the estimate, make a good valuer.

Before an art dealer buys, he estimates the potential payoff of the piece of art. In determining that estimate, he is sometimes mistaken, resulting in a *sticker*, i.e. a painting that is difficult to sell. He is stuck with something he does not want in his gallery. Furthermore, a rigid stock of paintings brings opportunity costs. A solution is to auction some paintings. If he brings them to an auctioneer, he typically pays 12-30% premium. To conduct an English auction in his own gallery, on the other hand, could well frustrate his regular business as each works best in a particular atmosphere.

In the English auction, the auctioneer incrementally increases the asked bid until but one bidder accepts. That bidder then wins the auction and pays his bid. It is considered the standard or traditional art auction, because in the art market no other mechanism exists so far. In theory, though, another auction type may better fit the image the dealer wants, the second-price sealed bid auction, named after its designer, William Vickrey. All bidders bid once, without observing each other's bid. The highest bidder wins the good and pays the price of the second-highest bid.

This Vickrey auction has theoretical and practical differences compared to the English auction, one of which is the *auction fever*. This is a psychological phenomenon that drives up the price in dynamic auctions. It may create higher expected revenue, but conflicts with the desired atmosphere at a gallery, as will be explained later.

The *Revenue Equivalence Theorem* (RET) states that both auction mechanisms generate the same revenue, under certain assumptions. This thesis will assess how the two auction mechanisms differ and how the results are relevant for an art dealer. Note that a dealer and an auctioneer differ in their business model. Whatever auction mechanism is most appropriate thus depends on the preferences of the party that considers one. This leads to the following thesis:

When an art dealer assesses an optimal auction mechanism, he prefers Vickrey to English.

This thesis starts with an analysis of the art market, to point out the relevant external factors. Furthermore, the auctioneer and art dealer will be compared and their differences assessed. Then, the auction mechanisms are compared in theory and practice. Moreover, extra attention is given to collusive behaviour when buying at auctions. With these results, a conclusion can be drawn for the optimal auction for the art dealer.

II - The market and its agents

In order to discuss the appropriate auction for an art dealer, one should first consider the environment he is working in. This section examines the art dealer's strategy, including his transaction habits, how it relates to an auction house and what his general environment is, i.e. the market for art.

The market for art

The market for art is a curious one. If one seeks to define a market, the SSNIP-test provides a useful tool. If a small but significant non-transitory increase in price would be profitable for a hypothetical monopolist, the market is well defined. If the increase in price is not profitable, there are other substitutes in the market and the market definition has to be broadened accordingly (Motta, 2004).

Art can be regarded as a *consumer good*, e.g. a decorative item for a household. If the price of certain paintings is raised, it is intuitive that consumers switch to one of a huge amount of other subgroups of art, except for niche collectors that have high demand for specifically those paintings that have risen in price. These other subgroups within art put a competitive constraint on the paintings that have risen in price. Another function of buying art may be investment. Then, all other products that can be invested in, put a competitive constraint on art if the return on investment in art becomes lower due to a higher price.

In the market for the noted works of noted but deceased artists, the elasticity of supply is absolutely zero. An inventory of a particular share is made up of a large number of homogenous securities, all perfect substitutes for one another. Widely known paintings are unique, and even two works of the same theme by a given artist are imperfect substitutes. A given share is held by many individuals who are potentially independent traders on the near perfectly competitive stock market. The owner of a unique painting holds what may be interpreted as a monopoly on that work of art. That may make it too simplified to speak of a demand for art in general (Baumol, 1986). To some extent, all works of art are imperfect substitutes. In general, art is found to underperform significantly, compared to the stock market (Mei & Moses, 2002). If prediction as applied to stock prices is a losing game, it is certainly unlikely to be a winner in the market for works of art. This does not imply that consumers of art are irrational. They may very well derive a high rate of return in the form of aesthetic pleasure (Baumol, 1986).

In art, the utility of buying a piece of art may depend on the price of the art itself. This makes it very different from purchases of other consumer goods, as this purchase can be seen as value for money. It may create a psychological effect that the utility gained by a purchase depends positively on the product's price. It is intuitive that object is worth more, if it can be sold for a higher price after the purchase. If now all prices go up, the value and utility rise with it. This has complex consequences for the interpretation of the SSNIP-test, as the assumption of constant demand no longer applies. If price goes up, value and thus utility of consumption goes up. Then, if the price of all products in the market is raised, quantity sold may be lower, higher or unaffected. This implies that raising the price of all products in the market probably increases profits on the products in stock, but also raises the price that dealers need to pay from thereon in order to refill the stock. That makes the effect on profitability ambiguous in the long run to raise prices.

When defining the market, both the product and geographical dimension need attention. The product dimension is now generally covered. It is clear and intuitive that to some extent all pieces of art form a competitive constraint if the price of a subgroup within art rises. However, the general valuation may rise with the price, which mitigates the substitutability. As for the geographical dimension, it is intuitive that there are some differences in consumer tastes per country. To illustrate this, Dutch consumers may have a preference for Dutch art, Russians for Russian and Dutch art, while French art may be of more global interest, because Paris has long been the art capital of the world. It is assumed for art to be moderately separated per country in the way that a small but significant increase in price would be profitable for a hypothetical monopolist, because national consumer preferences cut in the substitutability by foreign art.

As for the supply-side substitution, a price rise will probably induce some entry. It will increase the value of the stock of owners of art. As a consequence, more private parties offer their art for sale.

To summarize the market definition, one could say that any piece of art can put a competitive constraint on another to some extent, as well as any share in a firm or other investment option. The question is then if the return on an investment in art is affected if an increase in price only creates a positive shock in value, but no further expected increase. It can be expected to be profitable for the present stock to raise prices, but the relative margin on art bought after the price rise will be unaffected. So, according to the SSNIP-test, the market definition is (too) soon accepted, because it is profitable to raise prices if consumers' valuation and so demand rises with it. In conclusion, the SSNIP-test may not offer a good market definition, as a price rise brings about complex consequences for the profitability (Buunk & Verbeek, 2014).

Dealer versus auctioneer

The agents that operate in the market are: consumers, dealers, auctioneers, brokers, museums and, of course, the artists themselves. Only the dealer and the auctioneer will be discussed in this thesis. In this part, the differences between the dealer's and auctioneer's relations and focus are evaluated. How these differ, may just illustrate the disputability of the English auction as appropriate for a dealer. Note that these differences do not always apply; they should be interpreted in a general sense.

Shubik (2003) describes art dealers and their role in the market in his *Handbook of Cultural Economics*. An art dealer can vary from a souvenir shop to a business of annual hundred million euros in revenue. In this thesis, the art dealer is assumed to be an entrepreneur who is trusted for his keen eye for authenticity and value, which allows him to have grown to a "considerably" successful company. This excludes an everyday wallpaper salesman. An auctioneer is assumed to be of the caliber of Sotheby's and Christie's, the world's most renowned auction houses.

Expertise

The first and foremost aspect where the auctioneer and the dealer differ is expertise on the object. An expert knows the object's authenticity, quality and value. This is mostly due to the valuer's talent and experience. Auctioneers typically have broader supply, whereas dealers are more specialized in a few movements or a century of a certain nationality. Dealers buy mostly at auctions, where they select the undervalued art for their own collection and sell for true value. One does not become and survive to be a dealer if he is no expert of both authenticity and value. Overpriced purchases and underpriced sales will wipe him out, sooner or later. According to anecdotal estimates, more than 50 per cent of the dealers do not survive the first five years (Velthuis, 2011). Thus, only experts become a dealer. Given that someone is an expert, the incentive to become a dealer is both monetary and entrepreneurial. He is able to roam the market for auctions of art that is underpriced to sell it for the true value, which can bring high profits. For an auctioneer, however, the revenue is equal to the buyer's premium on the hammer price of the objects he auctions, which varies from 12-30%, depending on the price (Christie's, 2014) (Sotheby's, 2014), plus a seller's commission. The seller receives the revenue equal to the hammer price minus the seller's commission. The buyer pays the hammer price plus the premium. The auctioneer then wants to attract art both high in numbers and in value, whereas the dealer earns by distinguishing art by value. Of course, for an auction to have a good valuer is important. For a dealer, though, it is the central aspect of his business model. As for experience, the auctioneer is focused on the art that is sold by him, whereas a dealer attempts to

room all of the supply in his market. His eye needs to be more trained and experienced, which plays a central role in expertise. Note that, as mentioned earlier, a dealer's market may differ from the auctioneer's market, due to focus on particular painters, movements or periods.

Reputation

Furthermore, to be fit for a dealer, some entrepreneurial instinct is important. Economic motivation generally is an important force among dealers (Shubik, 2003). His business model is different from that of an auctioneer; a dealer takes more risk, should be a good merchant and needs to have a discriminating taste (Velthuis, 2011). This less risk-averse property is because of the fact that a dealer becomes the owner of the art he buys, where the auctioneer is an intermediary. Both a dealer and auctioneer have to keep a reputation of honest pricing and having authentic paintings. A forgery that is not recognised is not unheard of, though it is quite rare for a dealer. Reputation therefore is important for both parties, but mostly a dealer has risk of sticking with a bad purchase. If a falsification is bought at an auction and recognized and proven within the (short) term, the auctioneer returns the money to the buyer. The auctioneer pays the seller earlier and can only claim back this money if a clause is included in the conditions. Auction houses generally have these (Christie's, 2014) (Sotheby's, 2014).

Quality

Moreover, the level of quality and price is roughly higher at a dealer than an auction. As for quality, the selection procedures of a piece of art to be exhibited are more thorough for a dealer. A certain standard has to be held high. Even though dealers focus on buying underpriced art, poor quality brings negative externalities for the rest of his collection. An auctioneer cannot permit himself to be as selective, because revenue is his main focus. If the good that is offered is not appreciated, the auctioneer demands a lower limit. In addition, some services that are added by a dealer add directly to the quality, like the restoration. Price differences have more complex causes.

Price

Data on dealer prices are difficult to obtain, because it is part of the dealer strategy to keep information about his actual transactions secret. A study of dealer and auction prices of living artist has shown, however, that the aggregate price level at a dealer tends to be higher than in auction markets for works by the same artists. It compares price levels in dealer and auction markets between 1970 and 2004. The price level time series show that price levels in the dealer market were, on average, about twice as high as corresponding auction market price levels (Hutter, Knebel, Pietzner, & Schafer, 2007). Apparently, customers are willing to pay a higher price. This has a number

of reasons. Firstly, the greater expertise of a dealer is accompanied by greater trust in the authenticity of the art. This trust can also be translated by the guarantees that are provided. For example, a typical auctioneer has a few weeks or months guarantee of authenticity, whereas a typical dealer gives lifetime guarantee. Secondly, the dealer has more patience to sell his art, whereas the auctioneer organizes an event when everything needs to be sold at once. Here, the dealer is able to wait to reach that one customer that is willing to pay a higher price. Thirdly, as stated above, a dealer can offer higher service. Hence, this results in a higher willingness-to-pay. Lastly, a piece of art bought at a renowned dealer is branded. It can add value, because it has come through the intense selection procedures. Like other branded goods, it can become a status symbol to have bought at an esteemed dealer. Of course, a renowned auction house can have the same effect, although it has not gone through that selection procedure.

Service

What's more, the services they provide differ significantly. One example is the service of satisfaction guarantee, where a dealer can guarantee this by offering the customer a right to trade his purchase for something else in the collection within an agreed period of time. This guarantee is, of course, only possible when one is the owner of the art, which makes auctioneers unable to offer this service. Another example is the fact that auctioneers are quite strict in their conditions, whereas a dealer can be more flexible. Auctioneers rarely give their goods before they have received their money. It makes sense, because they function as an intermediary party and would not easily risk someone else's property. A dealer, however, is not subject to such strict conditions and can afford to perceive the situation and the customer's credibility. Additionally, a few dealers also have their own restoration department. So, after a purchase, every piece of art gets restored, cleaned and a new frame if necessary. Some other services can also greatly add value, like delivering at a preferred time and a lifetime service of restoration. Lastly, a dealer can even offer a service to drive by the customer's home to show how the painting would fit.

Ambience

In fact, the complete experience when buying at a dealer is more personal. Typically, a dealer attempts to create a domestic and discrete atmosphere, where he takes time to talk with his customer, designs a charming interior with music, gives him coffee or wine and generally tries to convince him of the idea that art would suit in his home. An auctioneer's relation with his buyers is more distant, one of the reasons being he is an intermediary, but mostly because it is not profitable to take such time for every visitor. It seems, however, to be an upcoming trend for auctioneers to organize events for their customers, like readings, lunches and drinks.

Perhaps the most important difference between the dealer and auctioneer is their attitude towards customers and the environment they need to perform transactions. The dealer wants a comfortable, trusted and sophisticated atmosphere to put the customer at ease. The auctioneer wants a spectacle, something that brings the so-called auction fever, which will be elaborated on below.

Valuation

If one compares a dealer with an auctioneer or consumer in terms of valuation, expertise plays the biggest role. Firstly, expertise on the pieces of art makes that dealers are more certain about the “value” of objects. That value can be regarded the price for which the art is expected to be sold within a couple of years by one of many interested parties. A dealer generally attracts more visitors per object than an auctioneer before it is sold, because it can afford to let his paintings even hang for several years, which increases the likelihood of reaching that interested party that has a high willingness to pay. Less expertise puts consumers at risk since they could value a piece of art “incorrectly” or end up with a forgery. That explains why, in general, dealers value the works that are interesting higher than consumers, because consumers are less capable of enduring risk. Secondly, an art dealer, as a firm compared to consumers, generally has more to spend, can borrow money more easily and spread the risk of buying something. More liquid assets and the ability to spread risk provide a significant difference.

The auctioneer’s valuation, i.e. the “estimate” in the catalogue, may be quite different from that of the art dealer. A factor of influence here is the reservation price. It is no surprise that most sellers want a reservation price, a *limit*, which is the minimum price the seller allows. Auctioneers typically desire a low limit, or none at all. The lower the limit, the better, if the auctioneer only cares for short-term revenue. However, an auctioneer pursues a reputation of high prices to attract sellers. He may therefore rather have an item unsold at a reasonable limit than risk to sell it for next to nothing. As for the estimate, a low one can be good for the seller and the auctioneer, because more interested parties are attracted. The auctioneer tends to underestimate the goods to lure more bidders. The auctioneer may therefore set the estimate close above the limit. He also has an incentive to estimate his items higher, because (1) the low estimate may convey information about a low true value and thereby lower bidders’ valuations; and (2) if the estimate is an indicator of the limit, it becomes more interesting for collusion among bidders, because the difference between the lowest possible price and their valuation, i.e. their profits, is larger. To have an estimate below the limit misleads buyers that expect to buy at a low price. This seldom occurs at renowned auctions, though. In short, the auctioneer has an incentive to persuade the seller to set a relatively low limit and set its estimation

close above or on the limit if bidders have private valuations and the threat of collusion is low (Ashenfelter, 1989).

III - The auction mechanisms

There are four basic auction mechanisms from which most others are deduced. In the *first-price sealed-bid* auction, bidders do their bid within a certain period of time and do not know each other's bid. The highest bidder wins the auction and pays his bid. The *second-price sealed-bid* auction is the same in every way, except that the winner pays a price equal to the bid of the second-highest bidder. This auction is throughout called the *Vickrey* auction, named after the one who first described the mechanism (Vickrey, 1961). The most seasoned and well-known auction is the *English* or *oral ascending* auction, where the auctioneer starts with an opening bid and then accepts increasingly higher bids from the floor, until but one bidder remains. Lastly, the *Dutch* auction is a mechanism where the auctioneer opens with a high asking price and lowers until one bidder accepts it. The English and Vickrey auctions are called *second-price* auctions, because the winner pays a price equal to the bid of the second-highest bidder. In *first-price* auctions, the winner pays his own bid, which depends on his valuation minus some speculation on the others' actions. In this thesis, the attention goes to a comparison of the Vickrey and the English auction. The other two will not be discussed.

Uncertainty

At any auction, the existence of uncertainty and asymmetric information is inevitable in practice. The seller and bidders do not know each other's valuation of the good. If they did, the seller would be able to absorb the entire surplus by only accepting a price equal to the valuation of the highest bidder. In the literature, private value and common value are often mentioned. In a private value model, everyone knows his own valuation of the good. The valuation of his competitors is unknown, but it is assumed that everyone's valuation is drawn from the same distribution. This model is therefore a symmetric game and is known as the *individual-private-values* (IPV) model (McAfee & McMillan, 1987). As for common value, there is one true value of the good, which nobody knows. Every bidder uses own information to form an idea about the value. Every piece of public information is derived from the same distribution. In practice, common value can be determined by the future valuations of interested parties. In the latter model, the winner's curse can occur, where the highest bidder will overpay, because the winning bid is likely to exceed the value of the auctioned good, due to a signal from the distribution.

Value

As stated above, art often underperforms as a "pure" financial instrument (Baumol, 1986). Mandel explains that agents are willing to accept this low financial return, however, since there is an augmenting utility benefit to holding art when prices are high. Financial returns are low since they

tell only part of the story: the price of art reflects not only the desire to smooth consumption over time as for any investment vehicle, but also the utility derived from its conspicuous consumption. Art investors are non-monetarily compensated less in financial terms for the risks they are incurring (Mandel, 2009). In other words, purchasing art can have the purpose of both pleasure and investment.

In this thesis, the IPV model will be assumed. The enjoyment of looking at, owning and boasting about the art is incorporated in pleasure. The fact that it can be sold again in the market and may have an expected in- or decrease in value falls under investment. If this definition of value is accepted, one can consider the common-value-part to be incorporated in the private value through the investment-part.

Optimal strategies

In this part, the optimal strategies per auction will be determined. In practice, few auctions meet these assumptions below. Later on, some of these assumptions will be relaxed. Note that the English auction in practice is a little different; the auctioneer asks a certain bid, which can be accepted by the bidder that acts first. Then, the auctioneer typically asks a bid that is five to ten per cent higher than the previous one. In theory, the price increases *continuously* until all but one bidder have exited the auction (McAfee & McMillan, Auctions and Bidding, 1987).

Assumptions

- 1) Every bidder, i , knows his own unchanging private valuation, v_i , the number of bidders and distribution from which the valuations are drawn.
- 2) Price is solely dependent on the bid, implying no royalties.
- 3) Valuations of the good are uncorrelated.
- 4) Bidders act non-cooperatively.

Box 1: English auction

As for the English auction, the strategy is quite straightforward. If player i loses the auction, his payoff (π_i) is zero and if he wins, payoff can be defined as the utility he gains from acquiring the good minus the cost to acquire it. This is simply his valuation (v_i) minus his bid (b_i):

$$\pi_i = v_i - b_i$$

Because i maximizes his payoff, his optimal strategy is to bid whenever his payoff is positive, i.e. when his valuation exceeds the asked bid. As soon as the asked bid equals v_i , i is indifferent between bidding and exiting. Once the asked bid exceeds v_i , which results in a negative payoff when bidding and winning, it is optimal for i to exit the auction, because losing the auction means a payoff of zero. That applies to every player, so at a given moment, there are two players left that have the highest valuations. Assuming their valuations differ, then, both players keep bidding the asked bid until the asked bid is equal to one of the two players' valuations. As soon as the bid exceeds one of the players' valuations, he exits and the other wins the auction. Notice that the winning bid is actually the valuation of the other player.

All losers get a payoff of zero. Only the winner gets a positive payoff equal to his valuation minus his bid. The final bid of the winner is equal to the asked bid at which the last other player exits, being the other player's valuation, v_{-i} . That means that the winner ultimately gets a payoff equal to the difference between his valuation and the second highest valuation:

$$\pi_i = v_i - v_{-i} > 0$$

Box 2: Vickrey auction

As for the Vickrey auction, it will be shown that the equilibrium is where all players bid their private valuation (Vickrey, 1961).

An arbitrary player, i , chooses a strategy s_i . Now, there are two options to consider: make a bid higher ($s_i > v_i$) or lower ($s_i < v_i$) than player's valuation. For both options, the outcome is now described.

When making a bid *lower* than player i 's valuation, $s_i < v_i$, there are two options:

- 1) i wins, so $s_i > p(s_{-i})$ and $\pi_i(s_i, s_{-i}) = v_i - p(s_{-i})$. If i deviates to $s'_i = v_i > s_i$, he still wins and pays the same price. So, i is indifferent between bidding s_i and deviating to bid higher, equal to his valuation.
- 2) i loses, so $s_i < p(s_{-i})$ and $\pi_i(s_i, s_{-i}) = 0$. If i deviates to $s'_i = v_i > s_i$, he either still loses or wins:
 - a. $s_i < v_i < p(s_{-i})$: i deviates to bid and loses, so payoff: $\pi_i(s_i, s_{-i}) = 0$; or
 - b. $s_i < p(s_{-i}) < v_i$: i deviates to bid $s'_i = v_i$ and wins, so payoff: $\pi_i(s_i, s_{-i}) = v_i - p(s_{-i})$.
- 3) Thus, bidding $s_i = v_i$ weakly dominates $s_i < v_i$.

When making a bid *higher* than player i 's valuation, $s_i > v_i$, there are two options:

- 1) i wins:
 - a. He makes a profit: $s_i > v_i > p(s_{-i})$ and $\pi_i(s_i, s_{-i}) = v_i - p(s_{-i}) > 0$. If i deviates to $s_i = v_i > s_{-i}$, he still wins, makes a profit and pays the same price. So, i is indifferent between bidding s_i and deviating to a higher bid, equal to his valuation.
 - b. He makes a loss: $s_i > p(s_{-i}) > v_i$ and $\pi_i(s_i, s_{-i}) = v_i - p(s_{-i}) < 0$. If i would deviate and bid $s_i = v_i$, then $\pi_i(s_i, s_{-i}) = 0$, so s'_i strictly dominates s_i .
- 2) i loses, so $s_i < p(s_{-i})$ and $\pi_i(s_i, s_{-i}) = 0$. If i deviates to $s'_i = v_i < s_i$, he also loses. So, i is indifferent to deviate to bid $s'_i = v_i$.
- 3) Thus, bidding $s_i = v_i$ weakly dominates $s_i > v_i$.

To put it in other words, for i to bid $s_i = v_i$ will either make no difference or make him better off. Every strategy where i does not bid his own valuation is dominated by bidding his valuation.

Therefore, the Nash equilibrium is for both players to make a bid equal to their private valuation, because players have no incentive to deviate. The payoff of the winner is:

Revenue Equivalence Theorem

Although the strategies differ due to the different auction structures, the payoff will be the same. In both auctions, the winner is the player with the highest valuation. The winner gets a positive payoff equal to the difference between his valuation and the second-highest valuation. The seller also has the same expected revenue for both auctions, which is the valuation of the player that had the second highest valuation.

Assuming that every risk-neutral bidder has his own signal that is drawn from a common, distribution with full support, the *Revenue Equivalence Theorem* (RET) states that every auction mechanism where the good is always won by the player with the highest signal and the expected surplus of the bidder with the lowest signal is zero, will result in the same expected payoff for the seller (Klemperer, 1999). The signal is in this case the player's private valuation. The RET explains that the English and the Vickrey auction have identical expected revenue, as well as the two first-price auctions. Apparently, under these assumptions, in terms of revenue it does not matter what mechanism one uses. An experiment has validated the RET (Coppinger, Smith, & Titus, 1980).

Furthermore, it is intuitive that as the number of bidders approaches infinity, the auction reaches the highest price possible and the seller absorbs the entire surplus. Revenue is equal to the second-highest valuation. As more bidders increase the expected second-highest valuation, *ceteris paribus*, the expected revenue increases with the amount of bidders (Klemperer, 1999).

Relaxing the assumptions

As for the assumption on risk-neutrality, the optimal strategy in the English and Vickrey auction is independent of the players' attitude towards risk. For English, players keep on bidding until the price has risen to their private valuation and for Vickrey, players still bid their valuation (Klemperer, 1999). Note that no particular risk attitude has been assumed for determining the optimal strategy of bidders. The validity of this assumption is therefore not interesting for this thesis.

Furthermore, positively correlated valuations can significantly impact the results. In the literature this is often referred to as *affiliation*. "Roughly, this [affiliation] means that a high value of one bidder's estimate makes high values of the others' estimates more likely." (Milgrom & Weber, 1982a). If this phenomenon occurs, an optimal auction can be constructed, i.e. one mechanism is better than the other (Myerson, 1981). In a common-value model, this can be explained in the following way. Every time that a person bids in the English auction, it is interpreted as a signal that conveys information about the actual (or common) value of the good. Without knowledge about others' valuations, this will not have such an effect. Therefore, positively correlated valuations only have an effect on dynamic auctions. The more the valuations depend on the information of the other bidders, the more the price is related to the valuation of the winner. That offers an explanation why the winning bid can be higher in the English than in the Vickrey auction (McAfee & McMillan, 1987). An alternative explanation, *auction fever*, is discussed below.

In theory, the English and Vickrey auction are very similar, except for the possibility of affiliation, which would have a positive impact on the expected revenue of an English auction. Still, aspects where these auctions may differ in practice are ignored. In the following parts, some relevant ones are highlighted. Not every one of these has a direct impact on expected revenue, but may well be interesting if the auctioneer seeks to pursue a certain reputation.

Auction fever

Auction fever can be defined as “*the emotionally charged and frantic behaviour of auction participants that can result in overbidding, i.e. bidding over a pre-selected bidding limit*” (Ku, Malhotra, & Murnighan, 2005). In other words, it explains why certain auction mechanisms can have higher expected revenue than others. This is not integrated in the model on strategic behaviour described above, although it is relevant if one is concerned about auction results in practice.

Ehrhart et al. (2008) state that dynamic auctions are more likely to elicit higher bids than static auctions, implying that the English auction will generate higher expected revenue than Vickrey. Psychological and behavioural economics-studies refer to pseudo-endowment effects as responsible for people’s tendencies to submit higher bids in dynamic auctions, potentially amplified by the source-dependent effect (Ehrhart, Ott, & Abele, 2008). In this part, these effects will be elaborated in order to explain *auction fever*.

Firstly, the *competitive arousal hypothesis* states that increasing arousal has an impact on decision-making bidders. Here, one could think about both rivalry between bidders and time pressure. Another explanation can be offered by *loss aversion*. In the English auction, there is an escalation of commitments that result from a stepwise justification of previous decisions by investing more or exiting the auction (Ku, Malhotra, & Murnighan, 2005).

Secondly, *Prospect Theory* forms a basis for an explanation (Tversky & Kahneman, 1979). The endowment effect as mentioned above states that the value of a good increases when it becomes part of a person’s endowment. If the same effect occurs, but the subject is no owner (yet), it is called a pseudo-endowment effect (Thaler, 1980). This implies that the current highest bidder may develop a psychological ownership of the good (Ariely & Simonson, 2003). The endowment effect has numerous experimental proofs that people value goods that are already theirs higher than the same goods that can be bought (Kahneman, Knetsch, & Thaler, 1990). In the dynamic English auction, a bidder may subconsciously consider the good as his property in the heat of the moment, causing an unplanned increase in valuation. An extension of Prospect Theory, the *attachment effect*, may also

serve as an explanation (Koszegi & Rabin, 2006). In their model of reference-dependent preferences, the reference point, from which gains and losses are measured, is determined by expectations about the outcome. The current highest bidder then expects to win with a higher probability and gets attached as a result, increasing his willingness-to-pay. This reference point mentioned above is based on a principle within prospect theory called *anchoring*, which is the cognitive bias that describes the common human tendency to rely too heavily on the first piece of information offered, the anchor, when making decisions (Tversky & Kahneman, 1979).

Thirdly, the source-dependent effect states that a higher valuation can occur when something is a result of performance rather than chance. It depends on the source, or the cause of the result, how it is valued. If it is “mere luck” that causes any result, it is less valued than if the agent actually performed an action to acquire it (Loewenstein & Issacharoff, 1994). As for the auction, the bidder may feel that the fact that the result (“winning” the auction) depends on his performance (bidding), increasing his valuation.

As for empirics, an experiment supports the theory that the dynamic English auction results in higher revenue than its alternative, Vickrey. This experiment only applies when bidders have uncertain valuations, not when they are certain about them (Ehrhart, Ott, & Abele, 2008). This is, however, more realistic; in reality, few people strictly value a piece of art with an exact and unchanged amount of money in their minds.

Irrationality

Not all experiments support the theory that a dynamic auction has higher expected revenue than Vickrey. In an experiment by Kagel, Harstad, & Levin (1987), a clear difference in bidding patterns between English and Vickrey was found. As for the English format, prices were quite close to the predicted dominant strategy. In 80% of the Vickrey auctions, price was significantly above the predicted one.

Previous experiments had shown that Vickrey results in lower revenue than the dominant strategy predicted (Coppinger, Smith, & Titus, 1980) (Cox, Roberson, & Smith, 1982). The key institutional feature responsible for these different outcomes, according to Kagel et al. (1987), is that those earlier experiments did not permit bidding in excess of private valuations, in contrast to this experiment.

Whatever the ultimate explanation of these differences, results show that:

1. permitting in excess of private valuations seems essential to testing the prediction whether market prices would deviate from the price predicted by the dominant strategy; and
2. when such bidding is allowed, average market prices uniformly exceed the dominant strategy price, and there is no tendency for these price differences to be eliminated over time.

Since bidding one's own private valuation is a dominant strategy, irrespective of risk attitudes, bidding in excess would have to be labelled irrational. It can be explained by the illusion that bidding in excess improves the probability of winning with no real cost to the bidder, because the second-highest bid will be the price (Kagel, Harstad, & Levin, 1987).

Minimal increments

In theory, the English auction as discussed in this thesis has a continuously increasing asked bid until the second-highest bidder exits. In practice, however, most English auctions have increasingly higher asked bids in the form of minimal increments. The auctioneer asks a bid and someone accepts it, after which the auctioneer only accepts a bid that is increased by a certain increment, mostly 5-10% of the current highest bid, rounded off in hundreds, thousands, or ten-thousands, etc. Assume that private valuations correspond to the steps that the auctioneer takes. Suppose, for instance, their valuations are rounded off to the incremental asked bids. This increment makes the expected revenue of the English auction a touch higher than that of Vickrey. Statistically, in half of the cases, the highest valuer will hit the bid equal to the valuation of the second-highest valuer, which results in a price equal to the second-highest valuation. In the other half, the second-highest valuer hits the bid equal to his valuation, after which the winner pays a price equal to his valuation plus the increment. Ignoring the fact that the valuation of the second-highest bidder may slightly deviate from the asked bid, the English auction in practice should have expected revenue that is 2.5-5% higher than the Vickrey auction.

However, if private valuations do not equal an asked bid, the difference in expected revenue is approximately zero. Suppose, that the second-highest valuation lies between two asked bids that are one step away from each other. Statistically, in half of the cases, the second-highest bidder will hit the lower of the two steps, after which the highest bidder will bid the next one and wins. In the other half of the cases, the bidder with the highest valuation will hit the lower of the two steps, after which the person with the second-highest valuation is not allowed to bid until his valuation. Recall that in the Vickrey auction, bidders are allowed to bid any amount, not subject to particular incremental steps. Then, depending on the distribution of private valuations, the two mechanisms generate approximately the same expected revenue.

Ambience

Some more practical differences need to be taken into account. The time it takes to bid, for instance, may be an advantage of the Vickrey auction. People can decide themselves when to hand in their envelope and carefully consider their bid within a certain period. For the English auction, it is a matter of seconds to make the decision to bid. This can only impact those bidders that are not definitely unchanged in their valuation. The whole auction processes are in fact so opposed, that the ambience cannot be ignored. The English auction is a spectacle that offers a stage for buyers to compete for a good without time to think twice. The Vickrey auction offers a civilized setting for buyers to carefully reflect their valuation, unaffected by a transitory deviation in valuation during the theatricals.

Furthermore, for most people, any auction implies the English manner, whereas Vickrey is a predominantly unknown mechanism. Uncertainty about the unfamiliar system may scare potentially interested parties off. On the other hand, the novelty may be interesting enough to attract and serves good foundation for quick publicity and so to reach many people. Therefore, the effect on the amount and type of bidders the Vickrey auction attracts is ambiguous.

In order to sustain a long and profitable relationship with the bidders, the auctioneer wants them to be satisfied. As stated before (see *Revenue Equivalence Theorem*), more bidders results in a higher expected revenue. Therefore, in the long run, the auctioneer wants to reach a wide range of bidders as many times as possible and wants them to return to bid in many auctions. Satisfaction plays a big role in the probability that a bidder returns. As for the Vickrey auction, it is hard for the customer to be dissatisfied, as he was able to take time to consider his bid. For the English auction, however, Auction Fever may have caused a transitory increase in valuation, which makes the bidder value the object higher during the auction, after which it decreases to its old value. Even though this resulted in higher revenue for the seller, any dissatisfaction may discourage bidders to return and in the long run may even decrease expected revenue. The net effect for sellers is ambiguous, but for customers, the Vickrey auction may even make them more satisfied.

Vickrey's shortcomings

In the literature, two causes are mentioned to account for the infrequency of Vickrey. Firstly, corruption may offer an explanation. The seller has an obvious incentive to increase the second highest bid in order to increase revenue. Secondly, participating in the Vickrey auction reveals the bidder's private valuation on the particular good. Few bidders may be willing to do this, because it may have unfavourable consequences for potential future negotiations (Rothkopf, Teisberg, & Kahn,

1990). Distrust in the seller or auctioneer's integrity will discourage participation in the auction and therefore make the design subordinate to the English auction. It is therefore essential to secure trust by assigning all information exchange through an independent third party: a renowned notary.

Budget constraints

Another difference between the two auctions may be the effect that a limited budget has on a bidder that is interested in more than one good. This situation has been studied for Vickrey auctions (Che & Gale, 2000). Borgs, Chayes, Immorlica, Mahdian, & Saberi (2005) show that the dominant strategy of bidding the private valuation breaks down when bidders have limited budgets. A bidder cannot bid more in total than his budget, because he may not be able to afford it if he wins every good. Considering the uncertainty it brings and the prices art can amount to, it will discourage bidders to bid as high as their valuation on the goods they are interested in, except for the most risk-loving bidders.

In the English auction, this uncertainty also exists, but a bidder will never go higher than his budget allows. The uncertainty decreases with every auctioned good that the bidder is interested in, because after every good, he knows what budget is left to spend on the other goods. Borgs et al. (2005) show the impossibility that, even if there are only two buyers and two goods, there is no deterministic truthful mechanism that satisfies three important properties: consumer-sovereignty (if an agent bids high enough, he wins all items), independence of irrelevant alternatives (if an agent who loses the auction leaves, the allocation to other agents does not change) and non-bundling (goods are independently auctioned).

This thesis proposes that bidders can bid conditionally, subject to priorities. The bidder submits his budget and adds unique priorities to every bid. Suppose that the sum of the second-highest bids on the goods he won exceeds his budget. Then, starting with the lowest priority, bids are declared invalid until the sum stops exceeding his budget. These invalid bids then will not play a role for the price of those goods. Now, every bidder with a budget is able to bid his valuation on every good he is interested in, in contrast to the English auction, where the uncertainty may prevent him from bidding until his valuation.

This solution has two drawbacks. Firstly, it makes the auction more complicated. As stated above, this system is new to the art market and may frighten people to join. Adding such extensions to the mechanism makes that worse. Secondly, it may bring forward a very low price (see box 3).

Box 3: Budget priorities

If one's bid is declared invalid, because the sum of the second-highest bids of the goods he wins exceeds his budget, he may be excluded from a good that is sold for a price that would have fitted in his budget.

Suppose for example, there are three players, i , j , and k and two goods A and B . Only i has submitted a budget and a priority. Players are assumed to bid their own valuation as is in accordance with the predicted dominant strategy. Player's valuation, budget and priority are in the table below.

Player	Valuation of A	Valuation of B	Budget	Priority
i	110	100	150	A
j	100	90	-	-
k	1	1	-	-

If *budget priorities* are applied, i would have won A and B for prices equal to 100 and 90, respectively, if it had not exceeded his budget of 150. He gives priority to good A , so his bid on B is declared invalid. Therefore, j remains to be the highest bidder and pays 1 for good B . However, i would have bid until 50 for good B , which cuts deeply in the resulting revenue.

A solution may be to decrease bids, starting with the lowest priority, until the sum stops exceeding his budget. That way, i 's bid is decreased to 40, increasing the price of B from 1 to 40.

So far, the bidder himself was given the choice what bids to prioritise. The auctioneer may also propose to prioritise the combination of bids that generate the highest surplus to the buyers or a combination that generate the highest revenue. Another solution may be that bidders submit their budget and the auctioneer processes the items in a particular pre-announced order. As soon as a bidder's budget is (almost) reached, his remaining bids are declared invalid or reduced to a bid that does not exceed his budget. Note that, in fact, this makes it equal to the English auction in terms of outcome.

The Vickrey auctioneer is apparently provided with multiple options, of which one generates the same outcome as the English. Hence, this may offer ground for some interesting extensions for improvement of the standard format.

Collusion

One assumption regarding bidder behavior is that bidders act non-cooperatively. Yet allegations of collusion at auctions are widespread. Bidder coalition, known as a *ring*, realizes a cut in price as soon as the ring contains the two bidders with the highest valuations of all bidders. The ring members agree that only one party bids, while the others refrain from doing so. Among the ring members, the good is auctioned to decide who is willing to pay most. The winner compensates the others (Graham & Marshall, 1987). Collaboration is illegal when there are solid agreements about structurally dividing the market (Larouche, 2011). In addition, it has been forbidden, before or after the auction, to make agreements amongst each other about their bidding behaviour and they are not allowed to receive a fee for making this public to the other dealers (Berkhout, 2012).

This part starts with factors that facilitate collusion. Furthermore, literature on collusive bidder behavior explains the procedure, compensation scheme and the auctioneer's reaction. A problem concerning the compensation scheme proposed is the occurrence of free-rider behavior, which makes the collusion instable. Moreover, to offer a solution to the free-rider problem, this thesis proposes an alteration of the compensation scheme, which may improve the redistribution of the ring earnings over its members and would be preferred by those with relatively high valuations. What's more, bidding strategies in this altered compensation scheme are suggested. The incentives to deviate from the coalition are then explained for the English and Vickrey auction, in order to compare them for their sensitivity to buyer collusion.

The first and foremost factor is trust among dealers. Art dealers are both competitors and colleagues of one another. Colleagues, because they can combine customer networks, exchange expertise, ask for input on authenticity of a piece of art and, sometimes, collude to their own benefit. Secondly, the concentration of firms facilitates collusion. There is only a handful of dealers that make a difference, due to the expertise needed to survive to be one. That makes the entry barriers to become a respected art dealer high and further secures their small world. Obviously, communication is easier when dealers are few in number and trust one another. Thirdly, cross-ownership of a certain good creates more points of contact. Dealers occasionally cooperate by (legally) buying a piece of art together. With more liquid assets to spend, spread risk and an increased customer network, dealers are willing to pay more, they communicate even more and improve their mutual trust (Buunk & Verbeek, 2014) (Motta, 2004).

Graham and Marshall (1987) have designed models on collusive bidder behavior at single-object second-price auctions. They find that (1) a member of a ring never enters a truly competitive bid against another ring member; (2) rings employ procedures that ensure that the ring will win an item more highly valued by a ring member than by any non-ring bidder; (3) an item won by a ring becomes property of the ring itself; the ultimate ownership of the item is determined in a secondary auction commonly known as a *knockout*, which is separated from the actual auction and involves only ring members; (4) the gains obtained by the coalition are shared equally by all ring members rather than accruing to only the winning bidder or some subset of ring members; and (5) auctioneers respond to the presence of coalitions by establishing higher reserve prices.

For the theoretical outcome, it does not matter which mechanism is chosen for the pre-auction. In practice, some cartels use sealed-bid auctions in the knockout, but others use oral auctions (McAfee & McMillan, 1992). For simplicity, though, assume that the pre-auction is a Vickrey mechanism. The procedure is as follows. First, each member submits a sealed bid to the ring center, who determines the highest and second-highest bid. The highest bidder is selected as the sole bidder and is allowed to bid in the actual auction. All other ring members do not bid. If the sole bidder wins the actual auction, he additionally pays the ring center the difference between the second-highest pre-auction bid and resulting price at the actual auction, provided this difference is positive. Note that this difference signals the impact of the coalition on the price. The ring center pays a *fixed non-contingent constant* to each ring member as compensation for not bidding. This constant is equal to the expected cost in lost revenue to the seller from the coalition, divided by the number of members of the ring. In other words, the loss of the seller benefits all ring members equally. The pre-auction knockout mechanism is *incentive-compatible*, which implies that for all ring members, the optimal strategy in the pre-auction is to bid *truthfully*, i.e. their private valuation (Graham & Marshall, 1987).

Graham and Marshall (1987) explain further that the English auction differs from the Vickrey auction in that the auctioneer observes the bids before taking any action. Specifically, he observes the highest bid and will use the additional information provided at an English auction to infer the probable source of the highest valuation, namely ring or non-ring, and react accordingly. The ring will be penalized if such an inference is possible, and, consequently, the ring will attempt to limit the informativeness of the highest bid. Ultimately, the auctioneer can offer a non-negotiable “take it or leave it” offer to sell the item to a single bidder at a particular reserve price if he believes the single bidder is the one that bids on behalf of the ring center. Another strategy of the auctioneer that can only be done in an English auction, which has the same result, is *lift-lining* or *bidding against the wall*: if he believes the highest bidder is one from the ring, he is likely “good for another bump” and so the

auctioneer bids himself (Graham & Marshall, 1987). McAfee & McMillan (1992) add that the auctioneer can react by keeping the reserve price secret.

An important problem concerning this incentive-compatible pre-auction mechanism is that it encourages *free-rider behavior*. Assume that the cartel has had an impact on the price, i.e. the second-highest bid in the pre-auction is higher than the price in the actual auction. The height of a ring member's compensation is independent of his valuation, because everyone gets equal payment by the ring center. In the pre-auction, the second-highest bidder would get the same compensation as a ring member who values the item at zero. This stimulates ring members with high valuations to form a ring within the existing ring. Therefore, this compensation scheme creates an instable coalition (Graham & Marshall, 1987).

It would seem fair that ring members who contribute to a lower price get proportionate compensation. Only the ring members whose absence in the actual auction have had an impact on the price should be compensated. Furthermore, the compensation should not be equal for all, but appropriately divided for their share. This thesis proposes an alternative compensation scheme. The following paragraph will describe how this works.

Assume that the auction consists of dealers and consumers and that all dealers join in a ring. Every bidder has a private valuation, v_i , drawn independently from a distribution. First, in the pre-auction, every dealer, $j \in [0, 1, 2, \dots, \infty]$, submits his bid, b_j , which for now is assumed to be equal to his valuation. The dealer with the highest bid (b_0) is allowed to bid in the actual auction. Suppose the dealer wins the actual auction for a certain price, p , which equals the highest valuation of the consumers. The impact of the ring on price, i.e. the ring earnings, is the difference between the second-highest pre-auction bid and the price at the actual auction. Dealers that contribute to a lower price receive compensation, c_j . Let L equal the amount of dealers for whom hold: $b_j > p$. All bids by dealers and the highest outside the cartel (p) are summarized as follows:

$$\vec{b} = \begin{bmatrix} b_0 \\ b_1 \\ b_2 \\ \vdots \\ p \end{bmatrix}$$

Without loss of generality, assume that $b_0 \geq b_1 \geq b_2 \geq \dots \geq b_L \geq p$. Furthermore, all compensations are summarized as follows:

$$\vec{c} = \begin{bmatrix} c_1 \\ c_2 \\ \vdots \\ c_L \end{bmatrix}$$

Then, compensation for an arbitrary dealer j with $b_{j \neq 0} > p$ is determined by the following formula:

$$c_j = \sum_{i=j}^L \frac{b_i - b_{i+1}}{i + 1}$$

See *Appendix 1* for an example that shows the compensation scheme for given bids and various resulting prices.

The bidding strategy of an arbitrary pre-auction bidder, i , will now be explained. Suppose that he considers to bid $b_i < v_i$. Now, nothing in the pre-auction differs from the actual auction. There is no incentive to bid lower, because i would lower his potential compensation and give up participation in the auction. Thus, bidding $b_i = v_i$ dominates $b_i < v_i$. Suppose that he considers to bid $b_i > v_i$. Now, i faces a trade-off. By bidding higher than his valuation, he weakly increases his compensation if he loses. However, if he wins, either (1) the second-highest bidder bid $b_{-i} < v_i < b_i$. Hence, i would have won anyway if he had bid $b = v_i$; or (2) the second-highest bidder bid $v_i < b_{-i} < b_i$. In this case, i becomes the winner and pays compensation to all dealers whose bid is higher than the price at the actual auction. The question is whether the extra potential compensation weighs up against the potential extra costs of compensating due to winning the pre-auction and actual auction by bidding higher than his valuation. However, determining the dynamic equilibrium of collusive bidder strategies in this scheme is beyond the scope of this thesis.

Even though this compensation scheme may not be incentive-compatible, it spreads the ring earnings more fairly, discouraging free-rider behaviour and improving the stability of the ring.

If the assumption of truthful bidding holds, the dealer with the highest valuation wins the pre-auction. If the actual auction is an English mechanism, the losing dealers of the pre-auction have no incentive to deviate from the cartel. The winner will surely bid until his valuation, which is the highest of all dealers. If a loser bids, he will lose from the winner and cuts in his potential compensation. If the actual auction is a Vickrey auction, the winner will submit a bid equal to his valuation. Again, the loser has nothing to gain by bidding, but potentially loses compensation. Thus,

the English and Vickrey auction are both sensitive to collusion, in the sense that ring members have no incentive to deviate from collusive strategy (Mailath & Zemsky, 1991). For the interested reader, see *Appendix 2* for an example that shows how untruthful bidding can result in a lower price than truthful bidding. If untruthful bidding occurs and the pre-auction winner refrains from bidding up until his pre-auction bid, dealers who lost the pre-auction may have an incentive to deviate from the cartel. For instance, if a dealer with a high valuation bids truthfully and becomes second-highest bidder in the pre-auction, he may believe he would win the actual auction if the highest bidder bid higher than his valuation in the pre-auction. In that case, he gains by bidding his valuation in the actual auction if he wins. This cuts in the coalition's stability and has positive impact on expected revenue. Deviating is also possible by not compensating the other after the auction, because the other dealer cannot enforce its rightful compensation without risking a fine for illegal collusion. After deviation, the dealers never collude again (punishment).

Recall that the choice of the pre-auction mechanism has no theoretical impact on the outcome. However, if it would be an English pre-auction, one dealer may observe that the other will go higher by examining his body language. In that case, there is an incentive to bid higher than his valuation, in order to increase the potential compensation. In a Vickrey auction, dealers are even able to avoid seeing each other, which makes it more difficult to anticipate the other's valuation. From the seller's perspective, the compensation scheme has little relevance, because it mostly influences the distribution of the ring earnings. It is possible, though, that the compensation scheme proposed in this thesis impacts revenue either positively or negatively.

Both mechanisms are sensitive to collusion in the sense that after the pre-auction has proceeded, bidders have no incentive to deviate from the cartel, provided that dealers bid truthfully. Whether dealers bid truthfully, depends on the compensation scheme. How untruthful bidding influences the equilibrium is ultimately irrelevant for the auctioneer's optimal auction. In conclusion, the English auction seems a touch less sensitive to collusion than Vickrey, due to the fact that the auctioneer is able to observe the highest bid as the asked bid increases.

IV - The appropriate auction

In this part, the differences between the English and Vickrey auction will be attributed to the art dealer, in order to assess what would offer the appropriate auction. This section considers three main aspects relevant criteria. First, an obvious aspect is the expected revenue. Second, depending on the art dealer, externalities of the auction ambience can impose a significant impact. Third, budget priorities of the Vickrey auction have a potential bonus.

Revenue

An important criterion to assess the quality of an auction for any seller, including an art dealer, is of course the expected revenue that an auction mechanism will generate. The RET states that every auction will generate the same expected revenue, when certain assumptions are met. In practice, these assumptions are rarely met and so leads to the existence of an optimal auction, one that would bring about the highest expected revenue.

Theoretical arguments on expected revenue seem to point in both directions. When relaxing the assumption of no positively correlated valuations, the auction dynamics of the English auction make that bidders value the good higher after they have seen other bidders' willingness to accept the increasingly higher asked bids. Furthermore, the auction dynamics can cause *auction fever*, which plausibly and most probably increases the expected revenue of only the English auction. Note that bidders can be or become aware of such psychological effects, after which it may lose its impact. In addition, English auction's incremental bidding can increase its expected revenue by approximately 2.5-5%, if bidders' valuations correspond to one of the pre-determined asked bids of the auctioneer. However, if private valuations are independent of the asked bids, minimal increments of the English auction have no effect on expected revenue.

Vickrey, on the other hand, can have higher expected revenue due to irrational bidders that believe in the illusion that they can bid higher in Vickrey than they would bid in English, because in Vickrey, they pay less than their bid. It seems unlikely, however, that such an effect would last in the long-term. This argument is weak, except for auctions that are incidental or have non-returning or non-learning bidders. Two irrational bidders with a high valuation are enough to make the price skyrocket.

As stated in section III, both the English and Vickrey auction have empirical support of having higher expected revenue. Thus, the effect on expected revenue is ambiguous.

Collusion

The compensation scheme proposed in this thesis discourages free-rider behaviour at the cost of not being incentive-compatible. Both mechanisms are sensitive to collusion, which has negative effects on revenue. An auctioneer's optimal response to a ring is to set a reserve price accordingly. Should the auctioneer indeed choose to react to a cartel with a reserve price, it would be more effective in the English auction. This is because he is able to observe the highest bid and is thereby more flexible to respond with a certain reserve price if he believes the highest bid comes from a ring.

The art dealer's auction choice therefore may tend to the English auction, if collusion is a considerable threat. The factors that facilitate collusion are explained, which indicate that only dealers would possibly collude. Furthermore, with just a handful of successful dealers that gain from mutual trust, it is unlikely that collusion would occur and have significant impact. Recall that dealers profit by working together on multiple fronts. They may not want to collude to reduce price at the cost of the colleague they cooperate with. Therefore, collusion is not considered to be a significant threat to an art dealer. Hence, the appropriate auction does not depend on the auction's sensitivity to collusion.

Ambience

Recall from section II that the art dealer's strategy is to (1) pursue his reputation of expertise on value and authenticity; (2) offer quality by selection procedures; (3) offer customer-oriented services and guarantees; (4) handle his customers in a discrete, domestic and sophisticated environment; and (5) set higher prices.

The English and Vickrey auction differ in its bidding procedure and atmosphere. The English auction dynamics can cause auction fever, resulting in a transitory increase in valuation during the theatricals. The theatrical happening, the hasty manner in which bidders are enchanted may thrill them to bid higher. In itself, this would not pose a problem; however, if an art dealer chooses an auction that operates in his name, it had better suit his strategy. The nature of this supposed increase in expected revenue is in fact so opposed to the dealer's desired ambience, that such an auction creates negative externalities for the rest of the company. Furthermore, the English auction will inevitably be associated with the existing auction houses. As argued in section II, the auctioneer typically has a reputation that is undesirable for a dealer. By holding an auction that is typical for a

standard auction house, the art dealer is associated with an auctioneer's desired atmosphere and relatively inferior reputation on expertise and authenticity and services.

The Vickrey auction, on the other hand, suits the dealer's strategy well. Interested parties can carefully reflect on their bid within a given period. By means of a renowned notary, the entire bidding procedure can follow a civilized, reliable course.

Budget priorities

As a bonus, the budget priorities may pose a platform for extensions of the Vickrey mechanism. Budget priorities, or another extension yet to be invented, may have desirable results that offer significant improvement. Still, the option remains to let the bids follow a pre-announced calculation, which lets the Vickrey auction result in the same outcome as the English would have.

V - Conclusion and recommendations

Theoretical and empirical arguments support both the English and Vickrey auction in terms of expected revenue. Auction fever and irrationality supposedly both have positive effect on expected revenue, but their actual impact is hardly generalizable to the entire market for art and all its dealers. Thus, there seems to be insufficient evidence to reject the revenue equivalence of the two mechanisms. Even if auction fever would result in higher expected revenue for the English auction, the nature of the extra revenue is incompatible with the art dealer's strategy. As for the irrational illusion that bidders can bid higher than their valuation, the option remains to inform bidders beforehand, if the dealer believes it is best for long-term revenue and relations. Furthermore, considering the dealer's strategy, the Vickrey auction fits the desired ambience, while the ambience of the English auction opposes it. Finally, the

Collusion apparently does not pose a significant threat to the art dealer. Therefore the art dealer's optimal auction is ultimately independent of the ring's collusive strategy and compensation scheme.

In conclusion, assuming the art dealer's strategy and position in the market corresponds with the one described in this thesis and his aim is to choose an optimal auction mechanism, the Vickrey auction is the preferred one.

Perhaps more research should be conducted on the effects of auction fever and irrationality on revenue in the market for art. Literature on theory and practice seems to point in both ways, signalling that the effects should be measured per case, due to specific environmental factors. Furthermore, the Dutch and first-price sealed-bid auction could be investigated for their attractiveness as an art dealer's auction. Finally, further research is recommended on the equilibrium and bidder strategies in bidder collusion with the compensation scheme proposed in this thesis.

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Appendix

Appendix 1

Assume, for simplicity, that the auction and pre-auction are Vickrey auctions. Consider dealers 1, 2, 3 and 4 with private valuations of respectively 100, 80, 60 and 15. There is one consumer whose valuation differs in the five scenarios and determines the price. All four dealers form a ring and are assumed to bid their valuation in the pre-auction. Dealer 1 wins the pre-auction and is allowed to bid in the actual auction, while the others refrain from bidding. Note that for dealers 2, 3 and 4, payoff π_i equals their compensation, c_i . The payoff of dealer 1 equals his valuation minus price minus compensation payments. Now consider the following resulting prices of the actual auction and pay attention to the amount each ring member gets as compensation.

Price	Dealer 1 wins	$\pi_2 = c_2$	$\pi_3 = c_3$	$\pi_4 = c_4$	$\pi_1 = 100 - p - (c_2 + c_3 + c_4)$
120	No	-	-	-	-
90	Yes	0	0	0	10
70	Yes	$5 = \frac{80 - 70}{2}$	0	0	25
30	Yes	$20 = \frac{80 - 60}{2} + \frac{60 - 30}{3}$	$10 = \frac{60 - 30}{3}$	0	40
11	Yes	$26 = \frac{80 - 60}{2} + \frac{60 - 15}{3} + \frac{15 - 11}{4}$	$16 = \frac{60 - 15}{3} + \frac{15 - 11}{4}$	$1 = \frac{15 - 11}{4}$	46

Appendix 2

Assume, for simplicity, that the auction and pre-auction are Vickrey auctions. Consider dealers 1 and 2 with valuations of 100 and 80, respectively. Suppose that, as compensation depends positively on his bid if he loses, dealer 2 bids well above his valuation: $b_2 = 120 > v_2$. Dealer 1 bids truthfully: $b_1 = 100 = v_1$. Furthermore, suppose that a third party bids $b_3 = 90$.

As dealer 2 bids above his valuation, he won the pre-auction and is allowed to bid in the actual auction. Here, he bids his valuation: $b_2 = 80 = v_2$. The third party wins the auction and pays 80. If the dealers had bid truthfully, dealer 2 would have won the pre-auction. Then, dealer 2 would have won the actual auction and would have paid 90.

Thus, the resulting price is 10 lower due to untruthful bidding.