

Online Auctions and Health Care

Mosca, I.

Publication date:
2007

[Link to publication](#)

Citation for published version (APA):

Mosca, I. (2007). *Online Auctions and Health Care*. (Research Paper; No. 2007-03). Dutch Healthcare Authority.

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

Take down policy

If you believe that this document breaches copyright, please contact us providing details, and we will remove access to the work immediately and investigate your claim.

FOREWORD

The paper *Online Auctions and Healthcare* belongs to the Research Paper Series edited by the Dutch Healthcare Authority (NZa). The Research Paper Series aims at the enhancement of the knowledge and expertise in the regulation and competition in healthcare markets. All papers in this Series are written by invited authors and/or NZa staff.

The growth of information and communication technologies (ICT) has impacted the healthcare sector a great deal. The more intense use of online applications has caused the emergence of online reverse auctions that are used to procure specific medical services and goods.

The paper combines a theoretical approach and real applications of reverse auctions in the health industry. In particular, we describe what typology of online auctions are used for healthcare services and goods, and if this ultimately leads to efficiency gains. Such analysis is carried out by identifying the main effects of online auctions on public interests.

In the theoretical section we make use of contract theory to explain the possible effects of auctions on transaction costs, coordination, and motivation between the parties.

The second part of the paper deals with concrete examples that are currently taking place on the Dutch market. Online reverse auctions are now used as an instrument to allocate postpartum medical services. By means of contract theory we identify an alternative bidding mechanism to the current one that gives big incentives to providers to actively compete with each other, and allows customers to be more price sensitive in their choices.

The paper is written by Ilaria Mosca, employee at the NZa in the unit Economic Analysis and at TILEC (Tilburg Law and Economics Center) of Tilburg University.

The author would like to thank Frank Pellikaan, Misja Mikkers, and Wolf Sauter for their useful comments that led to many improvements.

Frank de Grave
Chairman of the Executive Board
Dutch Healthcare Authority

ONLINE AUCTIONS AND HEALTHCARE

English abstract: The growth of information and communication technologies (ICT) has impacted the healthcare sector. The emergence of online reverse auctions (RAs) is a new phenomenon that has come about. This paper investigates the role of online auctions in healthcare services. We give a brief overview of auction theory in the first section and we identify the main effects of online RAs on public interests. Furthermore, there is an application of contract theory (coordination, motivation, and transaction costs) on online auctions.

The second section of the paper deals with concrete examples; in particular we focus on the Dutch case of Zorgveiling.nl. By means of contract theory we identify an alternative bidding mechanism that (1) gives incentives to providers to actively compete, and (2) allows customers to be more price/cost sensitive.

Keywords: Auction Theory, Contract Theory, Public Interests, Zorgveiling.nl, Bidding System.

Nederlandse samenvatting: De groei van informatie en communicatietechnologie (ICT) heeft zijn invloed op de zorgsector. De opkomst van omgekeerde veilingen via het Internet is hierbij een nieuw fenomeen. Dit artikel onderzoekt de rol van online veilingen voor zorgdiensten. In het eerste deel van dit artikel wordt een kort overzicht gegeven van de theorie over veilingen en worden de belangrijkste effecten van omgekeerde veilingen op de publieke belangen geïdentificeerd. Daarnaast wordt de contracttheorie (coördinatie, motivatie en transactiekosten) toegepast op online veilingen.

Het tweede deel van dit artikel gaat in op een aantal concrete voorbeelden van online veilingen; hierbij wordt vooral aandacht besteed aan een Nederlandse veilingssite die zorgdiensten veilt Zorgveiling.nl. Met behulp van het raamwerk dat is ontleend uit de contracttheorie stellen wij een alternatief biedingmechanisme voor dat (1) aanbieders prikkelt om actief met elkaar te concurreren en (2) prikkels geeft aan consumenten om meer prijs/kostbewust te zijn.

Keywords: Veilingtheorie, Contract Theory, Publieke Belangen, Zorgveiling.nl, Biedingmechanisme.

1. INTRODUCTION

The emergence and growth of information and communication technologies (ICT)¹ has brought many challenges and opportunities in different spheres of life. Today, e-health represents a direct and accessible way to inform people about healthcare programs and decisions.²

A lot of goods and services are nowadays exchanged through internet auctions. One of the consequences is that the role of the intermediary has vanished, thereby allowing consumers and providers of goods and services to bargain directly. The auction mechanism is a popular device to reduce the asymmetries of information between buyers and sellers when the transparency is guaranteed.

A recent phenomenon that has come about is the emergence of online auctions in healthcare for determined services; these auctions are called in technical terms *reverse auctions* (RA) because - unlike standard auctions where there is one seller and many buyers - there is just one buyer and many sellers.³

Some advantages of the use of e-auctions are the reduction of transaction costs (costs that are normally incurred when making an economic exchange); the facilitation of coordination between different parties; and the motivation/incentives that a party enjoys because of the use of a market mechanism rather than following a top-down Government rule.

It is important to keep in mind that when the theory of auction is applied to the healthcare sector, more system requirements and prerequisites are likely to be demanded. The reason is that being healthcare a merit good, and an experience and post-experience good,⁴ the intervention of the state is still desirable in order to avoid possible market failures. Leaving space to auctions in healthcare might well be good for some kind of services where quality can be considered as *given*, but possibly harmful for other services where quality plays a bigger and more relevant role. In general, one should not forget that measuring the quality of services in healthcare is more difficult than assessing the quality of a product. The delivery of a healthcare service involves some unmeasurable aspects like the empathy between the service giver and taker, the care with which the service provision is given, etc.⁵ This is highly different than assessing if, say, a medical institution has a MRI tool or not.

The goal of this policy paper is to shed light on the role of online auctions in healthcare. In sections 2 and 3 we will present a brief overview of auction theory and the different types of auctions. In section 4 we will dwell on the features of RAs that are used in the healthcare sector. In particular, we will analyze the effects of RAs on public interests (such as accessibility, innovation, quality and safety standards, etc.). Section 5 deals with the contractual analysis of auctions (coordination, motivation, and transaction costs). A few examples of online RAs in healthcare are presented in section 6. Conclusions and policy suggestions are drawn in section 7.

SECTION I

2. AUCTION THEORY

Before beginning the discussion over health auctions, it is useful to clarify some definitions and terms that will recur throughout this policy paper.

An auction is defined as a market institution with an explicit set of rules determining resource allocation and prices on the basis of bids from market participants (Jap, 2002). Thus, it is a method for determining the value of a commodity that has an undetermined or variable price, in the absence of intermediate market makers. Auctions are modeled as bidding games of incomplete information. The bidders' (players') strategies are bid functions converting their private

¹ The term ICT describes a range of technologies for gathering, storing, retrieving, processing, analyzing and transmitting information. The major advantages of ICT are twofold: first, a progressive reduction in the costs of managing information, enabling individuals and organizations to undertake information-related tasks more efficiently; second, to introduce innovations in products, processes and organizational structures. An example of ICT in healthcare is telemedicine, which is used for medical diagnoses and patient care when the care provider and the client are physically separated.

² E-health is a relatively recent term for healthcare practice, which is supported by electronic processes and communication. The term is interchangeable with Health Informatics.

³ These auctions are also referred to as *procurement auctions*.

⁴ An experience good is a product or service where some characteristics such as quality or price are difficult to observe; therefore its characteristics can be ascertained only upon consumption (e.g. home care professionals). A post-experience good is a good for which it is difficult for consumers to ascertain the quality even after they have consumed them, such as physical therapy.

⁵ These abovementioned aspects can partly be measured through questionnaires for patients' satisfaction, and this would fall in the category of subjective quality measurement. The objective quality measurement, e.g. the real gain in the health status of a person due only to medical intervention and its implicit quality, is harder to measure.

information about the objects in sale, and previous bids observed, into a money amount that is a bid.

Game theory has been extensively used in modeling auctions, since auctions involve well-defined rules that govern how goods will be allocated. This enables the use of game concept equilibrium to evaluate different bidding strategies and determine the outcome of a particular auction. Klemperer (1999) provides a review of the literature as well as an overview on formal auction theory.

The basic auction model is the one in which all bidders are assumed to have a unique private value for the good being auctioned and where these individual values do not depend on the other's valuations (the *independent private value model*). Once each bidder estimates the value, they then have to determine how much to strategically shade their bid if they hope to capture the gains from being the successful bidder. In fact, if they bid and pay their full valuation, there will be then no gains. This of course entails developing a bidding strategy based in part on the expectations of their competitors' bidding strategies (Klemperer, 2004). In the *pure common-value* model the actual value is the same for everyone, but bidders have different private information about what that value actually is. Hence basically the most important difference between the independent private value and common value model is that the value of private information held by bidders differs. In the real world most auctions fall in between the two models, where bidders have a mix of private information about themselves (e.g. costs differences between providers of care services) but also have common value information (e.g. they can estimate the value of the infrastructure of a medical institution such as a nursing home).

Two other important assumptions characterize the basic auction model. The first one is that bidders are symmetric, that means that all of them make bids from the same probability distribution so that there is no apparent difference between bidders given the same amount of information. They would continue valuing the good in the same way. When bidders are not symmetric, they can be distinguished, for example on the basis of cost differences that can lead bidders to have different valuations. The second hypothesis that forms the bedrock of the basic auction model is that bidders are risk neutral.

The format of auctions ranges between two extremes: open- versus sealed-bid formats. In an open auction bidding is simultaneous, the notification for sale is broadcast publicly, and any buyer who receives the notice may submit a bid to buy. A sealed auction has hidden or undisclosed bid prices. One party does not know the price offered by any other party. There are a lot of differentiated auctions that do fall either in the first or in the second category format. Section 3 deals with this issue more in-depth. Open-bid formats use either a soft-close or a hard-close rule for ending the auction. In a soft-close the ending time is itself a variable, thus not set a priori. The auction ends when a particular time is reached with no bidding activity for a specified prior number of minutes. With a hard-close rule the end time is fixed.

When bidders are symmetric, risk neutral with independent private values, regardless of the format of the auctions used, these will yield on average the same revenue to the seller (Milgrom, 1987). This is the so-called *Revenue Equivalence Theorem*. The auction outcome is efficient, in the sense that the individual with the highest bid is the one obtaining the good. This also leads to efficient allocations because the person with the highest utility eventually receives the good. The revenue equivalence theorem basically states that it is irrelevant which auction format is chosen, because all auctions will perform equally when measured in terms of the seller's revenue.

However, if we weaken the symmetry assumption the theorem no longer holds. Several models have been constructed showing that there is not a way a priori to identify whether the price will be higher or lower in an English auction compared to a first price sealed-bid for example.⁶ Literature on auctions shows that - if bidders are risk averse - the first price sealed bid auction produces higher expected revenues than either an English auction or a second price auction, because individuals marginally increase their bid to augment their winning probability. McAfee and McMillan (1987) suggest that when the risk neutrality assumption is weakened and individuals are either under constant or decreasing absolute risk aversion, a first price sealed bid auction has a higher expected selling price when bidders do not know how many other bidders are present on the market.

⁶ Although somewhat dated papers see for further knowledge Vickrey (1961), Griesmar, Levitan and Shubik (1967), and Maskin and Riley (1985).

Another seminal concept in auction theory is the possibility of the *winner's curse*. If there is a common value component to the good being auctioned, then the successful bidder will be the one with the highest estimate of its value. This means that all the other bidders had a lower estimate of the value of the good. Therefore, bidders that are over-optimistic or tend to bid too aggressively will win more often, and eventually find out that they pay more than the good was worth. Winning means then losing money, hence the *winner's curse*.⁷

As a consequence, rational bidders will start taking this into account and they will reduce the amount of money they are bidding (shade their bids more, that is they will not reveal their true estimate of the good) to avoid the *winner's curse*. By so doing, the expected seller's revenue diminishes. This behavior can lead to the paradox that the more bidders there are on the market, the lower the final prices, because bidders adjust their strategies in order to take the *winner's curse* into account. It is therefore in the interest of the seller to remove any uncertainty by making as much information available as possible about the good being auctioned, so to increase the good's valuation by bidders (Klemperer, 1999). Bulow and Klemperer (2002) also suggest that it might be in the seller's interest to decrease the number of bidders so that these latter bid more aggressively, or for the seller to add more supply, or commit to rationing to increase the number of winners to offset the effect so that expected prices increase.

The goal of auctions is to stimulate a sane competition between bidders. The successful features of auctions are the same issues that any regulator would recognize as key concerns: discouraging collusive, entry-detering and predatory behavior (Klemperer, 2002).

Collusion is normally defined in economics as cooperation between rival companies for their mutual benefits. Although firms would still engage in non-cooperative behavior, their recognition of the nature of the market might be sufficient to deter them from competitive behavior. For example, a firm might realize that by initially bidding higher it will win more, temporarily raising profits as it can expand production, but ultimately other firms will respond by raising their bids so that the firm is no longer successful in obtaining more goods and profits are reduced due to the higher costs of the good. Consequently, all firms in the market will avoid to bid prices up. Such outcomes are defined as tacitly collusive.⁸ As McAfee and McMillan (1992) report, much of this kind of behavior is hard to challenge legally, because this would restrict the bidders' flexibility and generate inefficiencies, so that a possible solution to this problem is better auction designs.

Cartel members face four difficulties in effectively sustaining collusive arrangements (McAfee and McMillan, 1992):

1. They must devise a mechanism as a means to allocate the profits. Firms cannot engage in side payments if the cartel is weak. Alternative strategies are thus to submit identical bids (and then split the gains through transfers) or submit rotating bids (devising a strategy that selects which firm will submit the winning bid). For strong cartels firms can employ side payments. So the bidder who values the good most will likely get it. But this requires a mechanism to redistribute the gains.⁹ The problem with these methods is that it requires communication among cartel members, and by so doing the chance of detection becomes higher.
2. They must enforce the agreement. Research has proved that oral auctions are more susceptible to sustain collusion, since cartel members can monitor one another for deviation from the agreement. The one who deviates from the collusive agreement is likely to be punished via retaliation. In the sealed-bid context the winner is known only after the sale is rewarded, and this reduces the ability of the cartel to enforce the agreement during the auction (Wolfstetter, 1996; Milgrom, 1987).
3. They must fend off potential entrants. In fact, if the price of the goods auctioned gets very low, the chance that new outside entrants are attracted increases.
4. Those parties against whom the agreement is designed might find germane strategies to reduce the effectiveness of the agreement.

Of course it is necessary to develop some mechanisms that help preventing collusion agreements among bidders. A seller that is facing collusion can apply three strategies (McAfee and McMillan, 1992):

⁷ Of course the *winner's curse* takes place in the context of sealed-bid auctions.

⁸ Such implicit collusion is not illegal and is more difficult to detect than explicit collusion.

⁹ One such method is the so-called knock-out auction, which consists in re-auctioning the good among cartel members and the difference between the price reached in that auction and the purchase price is shared among members according to their bid.

1. Raising the reserve price.¹⁰
2. Keeping the reserve price secret.
3. Interfering with the cartel's enforcement mechanisms. To do so the seller can decide to sell the good in lots, that is by increasing the size of the sale, so that gains from cheating are bigger, or by reducing repeated interactions among bidders.

Of course another means to prevent collusive behaviors of firms is via government regulation of the pricing and the output of the firm or industry.

Hendricks and Porter (1989) empirically research how to identify a collusive bidding pattern. They suggest that there exists no general rules that could point into the direction of a collusion identification: bidder heterogeneity, market characteristics, and the institutional setting need all be taken into consideration in empirical analyses for auction market.

The theoretical approach of auction theory becomes less strong when such models are applied to real world situations. Rothkopf and Harstad (1994) demonstrate that auction participants often show little or no knowledge for formal bidding theory.

Hendricks and Porter (1988) state that bidding behavior is far more complex than that predicted by simple models by looking at auctions for offshore oil and gas leases in the US.

Experiments have also been used to isolate the effects of auctions.¹¹ Chamberlin (1948) introduced a design to create markets for artificial commodities in which the reservation prices of buyers and sellers can be controlled by the experimenter. Chamberlin's design allows to compare different forms of auctions, holding all else constant.

Smith (1962) further develops auction experiments showing that in a double oral auction (where buyers and sellers can both propose prices to the market) there is a strong tendency for prices to converge to a competitive equilibrium. Kagel (1995) and Kagel and Levin (2002) survey the large literature on auctions.

To conclude, the outcome of an auction can have significant implications for how the market will function. Competition among suppliers forms the bedrock of successful auctions. When competition exists, auctions can add a great deal of value to the sourcing process because they provide a format that motivates suppliers to offer their best prices. Hence, more suppliers should theoretically lead to better price competition in auctions.

Klemperer (2002) suggests that ensuring markets work well is more a matter of ensuring effective competition, and that the emphasis should not be on choosing the optimal auction rules or formats, but instead on crafting an effective competition policy.

3. DIFFERENT TYPES OF AUCTIONS

There exists several types of auctions. Below we give a concise description of the most used and known auctions.

3.1 English ascending-bid auction

The most common, and probably well-known, form of auction is the *forward auction (or English ascending-bid auction)*, in which buyers bid and the seller's goal is to push the price up. Ascending-bid auctions are by far the most prevalent on the internet, and they make bidder participation relatively easy. Once the bidder finds the item he is interested in, he can view the current high bid, and decide whether to raise it by filling out his own bid amount in a text box in his web browser. After submitting his bid, there is an automatic update of the auction status, which shows whether he successfully became the current highest bidder. He can then leave the site as the winning bidder, and return at any time before the close of the auction to check on its status again. This poses of course an incentive problem: if the auction closes at a fixed date, then what incentive does a bidder have to place any bids early in the auction? Indeed, many internet auction bidders have engaged in a procedure called sniping, that is the practice of waiting until the last minute before the auction ends, and trying to submit a bid which just barely beats the highest bid and gives the rival bidder no time to respond. The first of the two alternatives is to offer a short extension period to the auction. The most common extension period is five minutes long. An

¹⁰ The reserve price is the minimum price for which a seller is willing to sell an item. This amount may or may not be disclosed.

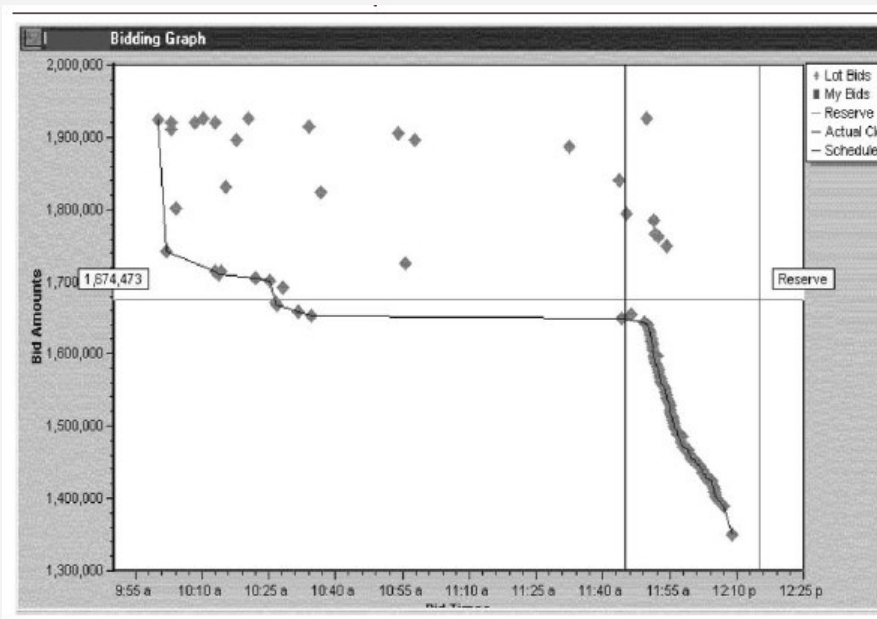
¹¹ Experimental economics is that branch of economics that analyzes certain aspects of economic behavior through the use of experimental methods. The term experimental economics is also used to define social experiments. One of the most famous social experiments was carried out in the 60's in the United States, by introducing an income negative tax for given groups of individuals. Their behavior, in terms of job supply, was analyzed for three years and compared with the behavior of a control group.

alternative solution is for the auction site to implement a proxy bidding mechanism.¹² The auction ends when no participant is willing to bid further, or when a pre-determined buy-out price is reached, at which point the highest bidder pays the price. The seller may set a reserve price (the minimum price a seller will accept to sell an item in the auction) and if the auctioneer fails to raise a bid higher than this reserve the sale may not go ahead.

3.2 Open and sealed-bid auctions

The format of online auctions ranges between two extremes: open- versus sealed-bid formats. The term sealed refers to the fact that only one supplier and the buyer have access to the details of a bid. The bid process is asynchronous in the sense that the buyer and supplier take turns viewing the bid. There are two types of this auction. The first one is called *first-price sealed-bid* and describes a situation where all bids are submitted at the very last minute, and the winning bidder pays his bid amount. In other words all bidders simultaneously submit bids in such a way that no bidder knows the bid of any other participant. The highest bidder pays the price he submitted. The second one is called *second-price sealed-bid auction* (also known as a *Vickrey auction*), where the winning bidder pays one increment over the second-highest bid received (this is identical to the sealed first-price auction, except the winning bidder pays the second highest bid rather than his own). In theory, this is mathematically equivalent to the English auction, because in both the first-place bidder receives the item at a price equal to the second-place bidder's willingness to pay. Oligopolistic competition of price setting firms under incomplete information (Bertrand competition) is an instance of a first price procurement auction.

Box 1: Graphical example of an open-bid auction format



Source: Jap (2002)

The line connects the lowest bids at any point in time. The buyer's reserve price is also plotted and represents the minimum price that the buyer will accept the auction. The graph depicts an intense bidding activity close to the scheduled closing time of the auction. At this point, bidding really becomes aggressive and the effect is reflected on the price, which falls rapidly over the next 30 minutes.

¹² A proxy bid is a mechanism to automatically submit bids, which do not go beyond the price that the individual sets as his limit (which is called *price limit*). The proxy submits an initial bid for an individual at the price necessary to outbid the current winner. It submits revised bids whenever the individual is outbid. If the proxy bid reaches its limit, one needs to submit a new bid to continue to compete.

In an open-bid event the buyer electronically posts a request for proposal (RFP) and during the designated time period suppliers bid simultaneously on the contract. In this situation, all suppliers and the buyer view the bids at the same time.

3.3 Dutch auction

A Dutch auction is a sequential bidding game where the price is gradually lowered, typically by means of an exogenous counting device (a clock, or a pointer), until a bidder stops it. The first bidder to halt the clock wins the item and pays the price where he stopped the wheel. Dutch auctions are strategically equivalent to first price sealed-bid auctions.

3.4 Double auction (or two-side auction)

These websites allow continuous updating of offers by sellers as well as bids by buyers. Traditional double auctions take place with multiple buyers and sellers trading multiple units of the same commodity.

In double or two-side auctions there are multiple sellers and multiple buyers that participate in an auction in order to trade a commodity. The general process is as follows: both sellers and bidders submit their bids, which are then ranked highest to lowest to generate demand and supply profiles. From the profiles the maximum quantity exchanged can be determined by matching selling offers with demand bids, and the transaction price is set and the market clears.

4. AUCTIONS USED IN HEALTHCARE

The goal of this section is to describe the typology of online auctions used in healthcare and to understand which healthcare services can possibly make use of this instrument for obtaining efficiency gains. Moreover, we will highlight some seminal aspects to consider when auctions are implemented in the healthcare context. These aspects relate to public interests, such as accessibility, quality and safety standards, and so on.

4.1 Reverse auctions (or procurement auctions) and multi-dimensional auctions

In a normal auction there is a single seller and many potential buyers bidding for the item being sold. For e-purchasing and e-auctions there is generally just one buyer and many sellers. This type of auction is called *reverse auction* (RA). The broad idea is that the buyer specifies what he wants to purchase and offers it to many suppliers. To make sure the winner is suitable the buyer should pre-qualify those suppliers, who are allowed to take part. The process will usually produce the lowest possible price but suppliers should be chosen on the basis of quality, cost, delivery performance, development resources, management and finances. In other words, not just price.

RAs are very similar to standard auctions. Of course, in a RA the lowest bidder wins, while in a standard auction the highest bidder is the winner. Formally the two types of auctions are equivalent, so there is no substantial difference between them. It is clear that a RA is the best tool to apply in the context of healthcare for some specific services that are easy to plan and organize and could be classified as homogeneous goods (e.g. home care professionals): there is one patient asking for a service, and there are different providers of care, who bid for the service to be delivered. Once the other characteristics of the service (e.g. quality, delivery performance, etc.) are set, the RA allows price competition.

It is important to underline the fact that an important feature of online auctions both in the healthcare sector and in others, is the robustness against collusion and its attractiveness to potential bidders. The auction design may not matter very much when there is a large number of potential bidders for whom entry to the auction is easy so that competition plays on its maximum level (Klemperer, 2001).

Consequences RAs

The main consequence of RA is a fierce competition on the price level; however, when RAs are used to allocate health goods and/or services, it is necessary to consider other aspects such as quality. Online auctions may, in fact, be inefficient for procuring services for which the focus is not only on price. In fact the online format does not allow for the expression of non-price attributes. Thus, suppliers may find it difficult to express their intangible value and to provide non-price information to best meet the buyer's needs (Jap, 2002).

At large however, buyers can accept a higher price in order to get the service from a specific supplier who meets some particular quality criteria. Clearly the certainty of working with an established and trusted supplier is worth some premium over working with an untested start-up (Paulson, 2004). A supplier might thus become the winner of the auction not by offering the lowest

price, but by successfully influencing the buyer's subjective weighting relative to competitors. Of course it is suitable that the auctioneer applies the so-called Linkage Principle, which aim is to commit all participants to the auction to reveal all information about their product/service, hence not only price.

Such shortcoming of traditional auctions has been widely discussed in the literature, especially in the case of spectrum auctions. Of course online auctions in the healthcare sector do fall in the same category. Instead of revenue-maximizing auctions some countries have applied negotiations, the so-called comparative hearings or beauty contests (Nielsen, 2004).

A beauty contest is a multi-dimensional approach as opposed to a traditional auction with minimum quality levels. It is however less transparent than a traditional auction. Negotiations also depend to a large extent on negotiation power and lobbyism. For a further discussion refer to Genty (1999).

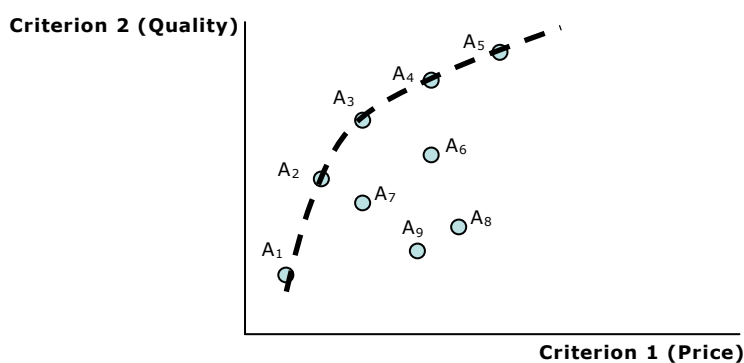
Multi-attribute auctions

Auction mechanisms that support bids characterized by several criteria/attributes and thus not only by price seem to be one of the last frontiers to the generalization of auctions. Such mechanisms are usually referred to as multi-attribute, multiple issue, multi-dimensional auctions. The literature on multi-dimensional auctions is rather sparse. The works of Che (1993) and their extension by Branco (1997) were among the first considering multi-dimensional auctions.

Che (1993) wrote a central paper showing how the existing theory on auctions can be generalized to multi-dimensional auctions. He considers the allocation of a procurement contract that compensate the winner with a payment p . The principal's score function values a one-dimensional quality parameter q and the payment p . Che shows that the equivalence theorem can be applied to the multi-dimensional score auctions. The score function provides a one-dimensional valuation that transforms the problem to the traditional private value single dimensional case.

Healthcare auctions that restrict the competition only to the price may be hazardous in the sense that all the other (varying) attributes, such as quality, are hidden from the auction process. This fact can give perverse incentives to cut on quality. To overcome this difficulty a most well known multi-dimensional auction is used. This is the so-called *score auction*, where the auctioneer aggregates bids by using a pre-specified scoring rule. This auction uses a score function to map multi-dimensional bids (non-price vectors and prices), into one-dimensional scores. The score represents the principal's utility or the welfare function and is used to allocate an item or task and determine the price. The score auction takes the principal's utility or the welfare function as given. In practice the determination of such score is a difficult matter because a same value of this aggregated score may hide bids of which the nature is very different. Figure 1 depicts this problem.

Figure 1: Graphical representation of the score auction



Source: De Smet (2003)

In this example there are two criteria: Price and quality. The assumption here is that for a specific price, quality should be maximized. The dashed line represents the set of dominant bids. Therefore bid A_3 is preferred to bid A_7 because for the same price bid A_3 offers higher quality. Figure 1 shows a situation where two bidding categories coexist in the same bidding space. The nature of the traded items is such that potentially two multi-dimensional auctions could have been conducted independently; one for each typical set of the item's attributes. Of course the most problematic aspect of multi-dimensional auctions remains the management of incomparability between bids.

4.2 Which healthcare services can be auctioned? The market for auctions

Healthcare is a good of a complex nature and is considered as a merit good by the society.¹³ The free market principle is hence not applicable because it alone cannot perform all economic and social functions. For this reason the government steps in and corrects such market failures, which represents all those situations where markets do not efficiently organize production or allocate goods and services to consumers (Mosca, 2005).

The introduction of online auctions in healthcare certainly stimulates a higher level of competition in a field that is normally characterized by regulated prices and, sometimes, quantities.

The characteristic of the health sector nowadays is not only to cure the patient and improve their health. There is also the aspect of *care* that is involved, which entails not only cure but also showing concern and understanding for the patient and comprises long-term services such as handicap centers, nursing homes, and so on.

Not all healthcare services can be auctioned. In general one could think of auctioning health services that are easy to plan and therefore simple to organize. It is thus clear that all emergency services or all those treatments relating to serious illnesses should not be auctioned online. Moreover, in order to be auctioned, the service needs to be delivered by multiple providers of care and not only by one.¹⁴ In general, all healthcare services that do not vary considerably in time can be auctioned. Some examples are home care professionals, postpartum services, and supply of medical tools (e.g. haemostatic devices).

4.3 Effects on public interests caused by online health auctions

The main goals of using auctions are the following:

- To stimulate competition between providers of care;
- To determine the value of a commodity or service that has an undetermined or variable price;
- To enhance the transparency of the procurement process;
- To stimulate product and process innovation;
- To check on the behavior of real or possible competitors, and;
- To adapt the own strategies to market conditions.

Auctions thus render the market very much flexible and more open to changes. Auctions for assigning healthcare services also impact on public interests. For example an online RA is likely to offer advantages for consumers, such as low prices, convenience, easy of use and personalized services. In this sense one can talk of a patient empowerment move that has come about.

Price

The use of online auctions in healthcare can be described either as a B2B (Business-to-Business) operation, which concerns commercial transactions between companies, for example between a health insurer and a healthcare provider, or as a B2C (Business-to-Consumer) operation, which comprises all transactions involving a product/service supplier and the final customer.

The main element of these transactions is to let competition play its role. A state regulation or a particular set of rules that would fall on online health auctions would be desirable only if market failures arise. Given the fact that online auctions are pursued between parties, protection measures from the state are not needed.

Quality

As already highlighted in this paper, an important element of healthcare is its quality of goods and services. The issue of how qualitatively good health services are is a well-known question that does not relate specifically to online auctions. Whether a healthcare system is capable of offering services of good quality is independent from the use of online auctions.

Through the use of multi-dimensional auctions, that is auctions that consider not only price but also the quality level of health services, a consumer has a broad spectrum of choice. At the end he might be willing to spend a little bit more for having a superior quality.

It is a reality that quality measurements are very difficult to apply in the healthcare sector. The most common framework for analyzing quality of care is that of Donabedian (1980), who conceptualized three quality of care dimensions: structural quality (the attributes of settings where

¹³ The positive externalities of a merit good are not internalized by consumers. To increase efficiency the State can decide to encourage greater production or consumption.

¹⁴ A service can be delivered by one provider when it is a highly specialized service or when scale economies are present.

care is delivered); process quality (whether or not good medical practices are followed); and outcome quality (impact of the care on health status). As it is readily understandable, it is relatively easy to measure the first two aspects of quality, while it is more problematic to measure health outcomes. When services are auctioned online the structural quality aspect automatically disappears. Providers of care should be selected on the basis of quality assessments, for example through ISO- and/or HKZ-certification that measures process quality.¹⁵ Only through this certification there is a sound basis that the parties involved in the auction keep high quality standards. Moreover, there is also the need to develop some outcome indicators, which measure the impact of care provided to a patient. Outcome indicators are important tools because they allow consumers to compare providers more easily. It is important to certify quality *ex-ante* through a certification mechanism, but also *ex-post* (for example through patients' surveys).

Accessibility

Online auctions enhance the accessibility to healthcare. In fact there are lower entry barriers for suppliers and customers. Anybody can easily access internet and take part to an auction. The transparency of the offerings is also higher and faster, and is often coupled with extensive product descriptions and more opportunities for providing price information. Theoretically the web enables a high number of customers to be reached.

Innovation

The health market certainly becomes more dynamic with the introduction of online auctions. This is due to the greater competition that is introduced into this sector and the new challenges faced by the different parties involved.

It is likely that the effect of e-auctions on innovation go in two opposite directions. On the one hand, in order to remain competitive on the market and build a solid reputation, a supplier of care is propelled to invest in process innovation and R&D. Therefore online auctions would positively affect this aspect. On the other hand, by having a downward strong competition on prices, providers of care face harder financial constraints and would thus become less interested in investing in product innovation and quality.

5. COORDINATION, MOTIVATION AND TRANSACTION COSTS OF AUCTIONS

The utilization of online auctions in healthcare brings positive aspects with itself. These advantages can be analyzed from the viewpoint of contract theory, which considers three aspects: coordination, motivation, and transaction costs (Bogetoft and Olesen, 2004).

Coordination

Coordination should be viewed in this context as the ability of all the different providers of care to deliver good services at the right time and at the right place at the possible lowest cost. This involves that all parties should coordinate their provision of services and efficiently steer patients to other infrastructures if so is needed. The basic elements behind coordination are the need of information and of reduced risk.

Auctions can be used as a coordination mechanism that results in an equilibrium price. They involve the acquisition and allocation of goods and services in the short term. A good coordination between providers of care ensue an efficient allocation of all those auctioned goods and services. In this manner financial savings are realized and there is a gain in the process efficiency.

One has to be aware of the fact that parties can decide to collude. If collusion takes place the outcome of the auction will be distorted and efficiency will thus not be reached.

Motivation

Motivation is required in order to align the interests of the independent decision-makers, that is give each decision-maker a private interest in making decisions that will maximize the integrated profit (Bogetoft and Olesen, 2004). In other words it must be profitable to undertake activities.

In auction terms the bidder with the highest valuation will be the one receiving the good/service. Auctions facilitate a higher and faster transparency of the offerings with extensive product/service description and allow for more opportunities for providing price/bid information. The auction design motivates individuals to participate into the auction and bid their true valuation.

¹⁵ ISO develops international standards specifying the quality requirements for products, services, processes, and materials. HKZ is a Dutch foundation that sets quality criteria in the healthcare sector.

Motivation should also give the incentive to keep being innovative by investing in the quality of products/services. Of course such motivation emerges if multidimensional auctions are conducted, so that price is not the only decisive factor. As analyzed in the previous chapter, innovation in auctions can go in two opposite directions (process or product innovation).

Transaction costs

Transaction costs are the costs of planning, monitoring, and motivating the parties. By definition transaction costs must be minimized. Online auctions effectively allow reducing these costs. As Pinker (2003) puts forth the use of ICT has diminished the costs of auctions. If in the past only those goods which value was unknown was auctioned, nowadays auctions are also done for those goods and services that have more or less a set value. This proves that the transaction costs for online auctions are low both for buyers and sellers.

The costs for setting-up and running auctions are lower; consequently lower transactions fees and commissions can be charged. Moreover, costs for the logistics of the trade object are also lower given the separation existing between trading process and physical logistics. This latter advantage is obviously only valid for goods and not for services.

Jap (2002) underlines the ability of online auctions to provide immediate costs savings in the short run. However, he also stresses that these cost savings diminish over time. This can finally lead to two different situations: 1) online reverse auctions will ultimately disappear, once costs have been squeezed from the sourcing process;¹⁶ 2) online reverse auctions will continue to exist and to provide sourcing efficiencies in terms of process efficiencies, introduction of new suppliers on the market, and so on.

Auctions ultimately create cost savings in terms of time. A high number of suppliers and buyers has access to internet so that an online auction can be open to an infinite high number of actors.

In table 1 the contractual analysis of auctions is briefly recapped.

Table 1: Contractual analysis of auctions

Focus	Concern
COORDINATION	<ol style="list-style-type: none"> 1. Establish an equilibrium price 2. Acquisition and allocation of goods/services in the short term 3. Financial savings 4. Collusion
MOTIVATION	<ol style="list-style-type: none"> 1. Must be profitable to undertake activities 2. The bidder with the highest valuation will receive the good 3. Higher and faster transparency 4. Opportunities for providing price/bid information
TRANSACTION COSTS	<ol style="list-style-type: none"> 1. Lower setting-up costs 2. Lower transaction fees and commissions 3. Cost savings in time 4. Gain in the process efficiency

SECTION II

6. EXAMPLES OF ONLINE AUCTIONS IN HEALTH

The use of online auctions in the healthcare sector seems to be a relatively new phenomenon. The following examples briefly describe where and how this instrument is used.

6.1 Wales

The Welsh Health Supplies (WHS) negotiates contracts on behalf of the National Health Service (NHS) in Wales. WHS auctioned online the contract for the supply of blood-collection bottles. The July 2003 e-auction was the first for medical products conducted within the NHS in England and Wales, and proved the point: over more than US\$1 million was saved over three years.

¹⁶ The situation we are referring to here is when the market has reached such a level of competition that it is not necessary anymore to intervene with online auctions. The level of competitiveness has reached such a high degree that the market is thus able to regulate itself and adjust easily.

The use of auctions came as a post-tender negotiating tool. First, the quality of the parties involved in the e-auction is assured, so that the competition is set on the level of prices during the auction. Note that the patient choice is not a variable of interest in this case, nor is it quality.

6.2 United States

Rice and Katz (2000) report that a health website (www.medicineonline.com) offers an auction service for elective, non-emergency surgery. The service allows consumers to post their requests for a desired surgical procedure and those physicians registered with the service have the chance to bid for a period of 72 hours. On the basis of the bids received, the patient can subsequently decide if to accept or not.

6.3 The Netherlands¹⁷

Since 2005 online RAs on postpartum services¹⁸ are taking place via an internet website (www.zorgveiling.nl) in the Netherlands. This is a B2B (Business To Business) auction taking place between healthcare insurers and providers of care. Two healthcare insurers auction postpartum services for their clients.

The auction works as follows: The request for postpartum services is placed on internet and subsequently care providers have seven days at disposal to auction off. If the request for care is located in the working area of a provider, this one has to make a bid in order to not to incur in a fine.

Zorgveiling.nl guarantees the freedom of choice of customers. These latter specify their characteristics and preferences on the web and receive the health service accordingly.

The first selection is based on whether the customer has expressed a choice for a particular provider of care. If this is the case, and the provider happens to bid in the auction, then this preferred provider will get the mandate, no matter how high its bid is.¹⁹ The mandate is thus always assigned to the provider of care for which a client has expressed her preference.

If the client gives two preferences, then it is the best bid that determines the winner and hence who is going to provide the service.

Should the concept of choice/preference not be enough for selecting a healthcare provider or be absent (that is the consumer has not specified any preferred provider), then the winner of the auction is based on price. The provider that offers the highest discount on the tariff, and that is therefore able to provide postpartum services for the lowest amount of money, wins the auction.

The utilization of an online auction for health services has raised many questions and concerns, also due to the fact that there are not comparable services in use at the moment.

In table 2 we present the score sheet of Zorgveiling.nl following the criteria set up in table 1 regarding the contract analysis of auctions.

¹⁷ For further knowledge refer to the Dutch Healthcare Authority report (2006) on auctions in postpartum services.

¹⁸ In the Netherlands pregnant women can ask for postpartum services (*kraamzorg*). These latter consist of different activities, the most important being the assistance during and after the childbirth (most childbirths take place at home). The goal of this service is to give useful information and help a newly mother to take good care of her child and support her in her housework.

¹⁹ Bids of healthcare providers correspond to discounts they intend to offer on the regulated hourly tariff for postpartum services, which is currently set at € 34.60

Table 2: Score sheet

Focus	Concern	Score
COORDINATION	1. Establish an equilibrium price	+
	2. Acquisition and allocation of goods/services in the short term	+
	3. Financial savings	+
	4. Collusion	+/-
MOTIVATION	1. Must be profitable to undertake activities	+
	2. The bidder with the highest valuation will receive the good	-
	3. Higher and faster transparency in the market for providers	-
	4. Higher and faster transparency in the market for insurers	+
	5. Transparency of the auction mechanism	-
	6. Opportunities for providing price/bid information	+
TRANSACTION COSTS	1. Lower setting-up costs (short vs. long term)	-/+
	2. Lower transaction fees and commissions	?
	3. Cost savings in time	+
	4. Gain in the process efficiency	+

Score sheet: Coordination

The use of auctions allows to set a price for postpartum services, which are subsequently allocated to the customers in a short period of time. In the long-term it is expected that auctioning these services will allow to have financial savings. In fact, being auctions a mechanism in which the role of the intermediary completely disappears, these costs will not be represented anymore.²⁰ The process itself will be more efficient, because customers receive care according to their expressed preferences.

At the moment it is not clear whether collusion is actually taking place. Given the fact that the number of providers can be relatively small in some areas of the country, it is likely that some care providers can adopt collusive strategies.

Score sheet: Motivation

At the moment auctions are not a price-based process on Zorgveiling.nl. In fact if the customer expresses a preference then it does not matter what providers bid; the preferred provider will eventually get the mandate.

In the future customers will be able to express their preferences via a self-reported patients' satisfaction system (star system), that will allow to make a choice on the basis of other characteristics (e.g. quality, satisfaction with the service). Therefore it is not true that only those providers who offer a high discount on the regulated tariff will eventually get the mandate.

With respect to the transparency concept it is useful to subdivide it in two parts: on the one hand, the transparency related to the capacity existing in the market improves via the website. The market gets an incentive to be more transparent to all requests of postpartum services. On the other hand, the transparency of the auction mechanism itself should be improved. For example it would be interesting to assess the system, by ascertaining the regularity of the auction at its end by means of an accountant. This is translated into the possibility of having continuous information on the development of the auctions and its conclusion. It would also be of interest to understand if the auction was won on the basis of price or quality, so that in future auctions providers can qualitatively adjust their bids accordingly. At the moment this is not happening with Zorgveiling.nl.

Score sheet: Transaction costs

With respect to transaction costs we have to make a distinction between the short and long term. The setting-up costs are likely to have been initially high for the healthcare insurers, due to the fact that they both needed to deal with a higher number of providers than what they normally had

²⁰ These costs included for example the brokerage fees.

to deal with in the past.²¹ In this sense the use of online RAs is more labor intensive and this has increased costs. The establishment of the website is of course an investment that, as a consequence, has had an impact on the setting-up costs. However, this will probably change in the long-run. In fact the investments done both by the health insurers and the website can be considered as a one-shot investment. The efficiency gains of real competition will likely compensate these added costs. Furthermore, the fact that providers of care make their bids online allows to have cost savings in terms of time. There is indeed no need to establish a contact with all possible providers of postpartum services.

Concerning transaction fees and commission we do not have information on whether these costs have lowered with Zorgveiling.nl.

7. CONCLUSIONS AND PROPOSALS

Clear rules

In many industries suppliers may have little or no experience with auctions as is now the case with healthcare.

It is of paramount importance that the rules of the auction are clear. This means for example having the knowledge of whether the auction format will be a sealed bid or full-price visibility; whether the auction will use a soft or hard close; what the minimum bid increment will be; and when the winners will be announced.

Suppliers also need to know the basis on which award will be made, whether it is on a first-or second-price basis and whether the buyer holds the final determination. Without this information, suppliers may have difficulty producing quality bids, and the outcomes of the auction could be harmed (Jap, 2002).

Auctions are good mechanisms when there is a sufficient and sane competition between healthcare providers. In this manner each provider will have the incentive to bid what he thinks is the right amount. If there is no competition the risks of collusion and opportunistic behavior by players clearly hinder the advantages of the auction mechanism.

Multi-attribute auctions

Given the fact that healthcare is a good with many attributes, it is important that multi-dimensional auctions are used. In particular the aspect of quality may give rise to subjectivity in the choice of the final winner. Because of the fact that at the moment there are no clear-cut quality indicators measuring the performances and outcomes of care, the selection procedure should be as much transparent as possible. Transparency can be guaranteed by establishing an auditing system at the end of the auction.

Transparency

Transparency is the Achilles heel of zorgveiling.nl. The actual system does not inform yet about quality and on how the choice of provider is made (which weight the quality has had in the selection procedure). Moreover, the problem is that if the customer gives a preference over a provider, she will receive post-partum services from the specified provider. If on the one hand the choice of a customer is respected in this manner, on the other hand competition between parties is stifled. Competition might be in fact harmed if providers of care know ex ante that a customer has given a preference for them. They can start behaving opportunistically and strategically.

Regulation

As described above there are at least three prerequisites for a successful auction system that could require standards set out by means of regulation. These are summarised here as:

1. Setting pre-qualification criteria for participating to the auction (e.g. ensuring minimum quality standards, innovation);
2. Ensuring pre-auction transparency: the rules of how the auction is going to be run must be known by parties beforehand;
3. Ensuring post-auction transparency via an auditing system (public or private) of the auction.

Such standards could be set out in a public or private code of conduct.

²¹ Before joining the initiative of www.zorgveiling.nl the two healthcare insurers were assigning postpartum services through brokers. All requests were basically dealt by the broker and the healthcare insurer did not have any insight either in the selection procedure or who the healthcare providers were.

Evidently there has to be a legal basis allowing auctions (or at least not prohibiting them) in the first place. In the case of the Netherlands, it is thought that auctions as an allocation mechanism are at least not prohibited, and a further legal basis for their use - and regulation thereof - may be found in articles 45 and/or 48 of the Healthcare Market Act (Wmg).

Depending on the subject of the auction process, the funding regime (e.g. public or private funds) and the parties involved (B2B or B2C) the case for public regulation may be weaker or stronger. However, it goes beyond the scope of this paper to discuss this issue in detail.

Alternative bidding system

To solve this last problem connected with the choice expressed by customers we suggest an alternative bidding system that can be summed up in the following three points:

1. There is a request for post-partum services, which is placed on internet. Suppliers of care make their bids. Out of all bids the consumer chooses three preferred providers, without ranking them.
2. When the auction is over there are three possible outcomes:
 - a. The cheapest preferred provider wins, or;
 - b. The cheapest provider wins and the client receives a bonus if she opts for this provider. The bonus consists in the difference between the preferred provider's bid and the cheapest provider, and can be translated in, for example, extra hours of postpartum services;
 - c. Another provider wins and the client, if she still wants to receive services from a preferred supplier, pays the difference (out-of-pocket) between the provider's bid and the cheapest preferred provider's bid.

Note that in this manner the consumer choice is still central in the determination of the final supplier of services and is still guaranteed. The client ultimately has the right to choose between a preferred and a non-preferred provider.

In order to make this alternative bidding system as efficient and effective as possible it is necessary that quality is transparent so that it can be taken into account in the bidding process. If quality aspects are missing and/or unclear the auction is basically run on prices.

Consequences of the new bidding system

The consequences of the new bidding system are the following:

- Providers of care are incentivized to compete;
- Customers are incentivized to be more price/cost sensitive.

Consumer choice is guaranteed, actually improved, because the client always has the possibility to choose between a preferred and a non-preferred provider of service, but at the same time the auction selects the best bid. The overall bidding mechanism stimulates more efficiency.

Moreover, with such a mechanism it is likely that in the long run the maximum tariff on postpartum services can be levied.

The focal point remains the development and identification of good quality indicators that allow to consider non-price attributes in a score auction. As already underlined the rating procedure – in this case price versus quality – is not clear-cut and further investigation is needed to correctly address this issue.

REFERENCES

Bogetoft, P. and Olesen, H.B. (2004), Design of Production Contracts: Lessons from Theory and Agriculture, Copenhagen: Copenhagen Business School Press.

Branco, F. (1997), The Design of Multi-Dimensional Auctions, *RAND Journal of Economics* 28(1): 63-81.

Bulow, J. and Klemperer, P. (2002), Prices and the Winner's Curse, *RAND Journal of Economics* 33(1): 1-21.

Chamberlin, E.H. (1948), An Experimental Imperfect Market, *Journal of Political Economy* 56(2): 95-108.

Che, Y.K. (1993), Design competition through multidimensional auctions, *RAND Journal of Economics* 24(4): 668-680.

- De Smet, Y. (2003), Multi-criteria auctions: a few basics, Technical Report TR/SMG/2003-08, SMG, Brussels: Université Libre de Bruxelles.
- Donabedian, A. (1980), Explorations in Quality Assessment and Monitoring, Volumes I-III, Ann Arbor, Michigan: Health Administration Press.
- Dutch Healthcare Authority (2006), Rapport Zorgveiling: Een onderzoek naar het veilen van kraamzorg, Utrecht: Dutch Healthcare Authority. (www.nza.nl)
- Genty, L. (1999), Auctions and comparative hearings: Two ways to attribute spectrum licences, *Communications & Strategies* 35(3): 11-43.
- Griesmer, J., Levitan, R. and Shubik, M. (1967), Towards a Study of Bidding Processes, Part Four: Games with Unknown Costs, *Naval Research Logistics Quarterly* 14(4): 415-433.
- Hendricks, K. and Porter, R. (1988), An Empirical Study of an Auction with Asymmetric Information, *American Economic Review* 78(5): 865-883.
- Jap, S.D. (2002), Online Reverse Auctions: Issues, Themes, and Prospects for the Future, *Journal of the Academy of Marketing Science* 30(4): 506-525.
- Kagel, J.H. (1995), Auctions: A survey of experimental research, in: Kagel, J.H. and A.E. Roth (eds), *Handbook of Experimental Economics*, New Jersey: Princeton University Press.
- Kagel, J.H. and Levin, D. (2002), *Common Value Auctions and the Winner's Curse*, New Jersey: Princeton University Press.
- Klemperer, P. (2004), *Auctions: Theory and Practice*, Princeton, New Jersey: Princeton University Press.
- Klemperer, P. (2002), What Really Matters in Auction Design, *Journal of Economic Perspectives* 16(1): 169-189.
- Klemperer, P. (1999), Auction Theory: A Guide to the Literature, *Journal of Economic Surveys* 13(3): 227-286.
- Maskin, E. and Riley, J. (1985), Auction Theory with Private Values, *American Economic Review* 75(2): 150-155.
- McAfee, R.P. and McMillan, J. (1987), Auctions and Bidding, *Journal of Economic Literature* 25(2):699-738.
- McAfee, R.P. and McMillan, J. (1992), Bidding Rings, *American Economic Review* 82(3):579-599.
- Milgrom, P.R. (1987), Auction theory, in: T. Bewley (ed.), *Advances in Economic Theory: Fifth World Congress*, Cambridge: Cambridge University Press.
- Mosca, I. (2005), Healthcare Expenditure and Decentralization: A National and International Empirical Analysis For OECD Countries, Doctoral Thesis, University of Lugano, Switzerland.
- Nielsen, K. (2004), Designing Benchmarking and Auction Mechanisms, *Auction Theory: An Introduction With Particular Emphasis On Multidimensional Auctions* (Chapter 6), Doctoral Thesis, Copenhagen: The Royal Veterinary and Agricultural University (KVL).
- Paulson, G.D. (2004), Online Reverse Auctions: Power Tools and Fair Perceptions?, Engineering Management Conference, IEEE/UT, 63-69.
- Pinker, E.J., Seidmann, A., and Vakrat, Y. (2003), Managing Online Auctions: Current Business and Research Issues, *Management Science* 49(11): 1457-1484.
- Rice, R.E., and Katz, J.E. (2001), *The Internet and Health Communication: Experience and Expectations*, Thousand Oaks, CA: Sage.
- Rothkopf, M. and Harstad, R.M. (1994), Modeling Competitive Bidding: A Critical Essay, *Management Science* 40(3): 364-384.
- Smith, V. (1962), An Experimental Study of Competitive Market Behavior, *Journal of Political Economy* 70(2): 111-137.

Vickrey, W. (1961), Counterspeculations, Auctions, and Competitive Sealed Tenders, *Journal of Finance* 16(1): 8-37.

Wolfstetter, E. (1996), Auctions: An Introduction, *Journal of Economic Surveys* 10(4): 367-420.