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FACULTY WORKING PAPER NO. 1341

Designing an Auction to Demonstrate and Evaluate Competitive Bidding as Method for Pricing Clinical Laboratory Services

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March 1987

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Abstract

This paper illustrates the practice of operations research. The problem: design the experimental competitive bidding mechanism to be used in a multi-million dollar demonstration and evaluation of competitive bidding as a method for pricing clinical laboratory services provided to Medicare patients. If the demonstration proceeds as initially conceived, this competitive mechanism will price about 250 million dollars worth of services.

Our model of this problem, and the proposed solution developed in stages. This paper presents and discusses the objectives and constraints of the model. We also recap the main stages through which the final solution developed. An example illustrates the final proposal.

Introduction:

The practice of operations research consists of two steps. First, one models the problem that needs attention. Then, one develops a solution to the problem as modelled. Of course, when examined in the context of the actual problem, the solution to the model may suggest changes that need to be made to the model. So, the practice of operations research typically turns into an iterated process of model building and model solving. But ultimately, one ends up with a model, and with a solution to the model.

This paper illustrates the practice of operations research. Given the problem of designing the competitive pricing mechanism to be used in a multi-million dollar demonstration and evaluation of competitive bidding as a method for pricing clinical laboratory services, we started by defining the goals, objectives, political realities, and constraints as we saw them. Then we searched for a solution. An examination of the solution often suggested changes to how we viewed the problem, and another round of modelling and solving ensued. In the end, we had a model of the problem, and a solution that seems to have evolved in several stages; subsequent sections of this paper present the final model, the multi-stage development of the final solution, and the final solution itself.

Note that this paper illustrates the process of operations research rather than the application of any specific optimization techniques. Indeed, our problem appears much harder to pin down and define than typical textbook examples. And, the resulting model fell outside of any neat class of models for which tidy solution techniques already exist. Instead, we wallowed through an iterative process of combining many individuals' different understandings of the client's goals, of the health care industry and the practice of medicine, and of the theory of auctions and competitive bidding to come up with a practical, but not necessarily optimal, solution to a problem that we still only imperfectly understand.

Operations reseearch cannot be practiced in a vacuum. Someone must first recognize that a problem exists. The problem must be considered to be of enough practical importance to warrant attention. And, there must be some hope that giving attention to the problem will improve matters. Our problem satisified all three of these prerequisites.

In particular, the annual cost of the Medicare and Medicaid programs now exceeds 89 billion dollars (U.S. Department of Commerce, 1986, p. 100). For example, Medicare annually pays over two billion dollars for clinical laboratory services alone (Health Care Financing Administration, 1984). And, the costs of health care continue to grow at an alarming rate, a rate well in excess of general inflation. The Health Care Financing Administration (HCFA)--the organization that administers the Medicare and Medicaid programs--has an obvious problem: what can it do about the spiralling cost of health care?

HCFA currently pays for services on the basis of a fee schedule which is based upon amounts previously billed for the same services. This fee schedule approach has an obvious inflationary incentive: a lab can increase its future payment rate by billing the government at prices which exceed the current fee schedule. In designing the Medicare program, Congress wanted Medicare to pay prevailing market prices for health care services. This was an unrealistic approach because Medicare was such a large program that it inevitably created a vast increase in demand and a consequent rise in health care prices. However, the commitment to pay prevailing prices is the reason for the existence of the fee schedule methodology. In recognition of the actual inflationary incentives, Congress has periodically stepped in and made ad hoc adjustments to the fee schedule methodology to slow down the inflationary process. As a consequence, the fee schedule is now calculated by a rather complicated formula (it is now set at 60 percent of the 75 percentile of all bills submitted for a particular test) which is subject to frequent political adjustment. Competitive bidding is supposed to help break the inflationary spiral by giving providers an incentive to bid lower prices (in order to win) rather than higher prices (in order to raise the fee schedule), and thereby result in prices indicative of actual costs.

In an auction--for example, in a sealed bid auction of a contract--the competition among bidders counteracts any commonality of interests in establishing a high price. True, a bidder may bid more than his actual expected cost of performing the contract conditional on winning; indeed he must do so if he expects to make a profit. However, each bidder must now tradeoff increases in his expected profit conditional on winning against decreases in his probability of winning; the lower he bids, the better a bidder's chances of winning a contract. This competition among those who hold the cost information limits the amount by which the winner's bid exceeds his expected costs of performing the contract. And, the bid-taker doesn't need to know anything about the bidders' actual costs.

These characteristics of competitive bidding recommend it as a method for pricing clinical laboratory services. Indeed, many Health Maintenance Organizations (HMOs) already use competitive bidding to price the clinical laboratory services that they purchase. These HMOs perceive a substantial financial savings, and the prices negotiated by these organizations appear to be much less than Medicare's (Anderson, 1986). Others' experiences and experiments with competitive bidding (Paris (1976), Mennemeyer (1984), and Scherer (1964)) also suggest that HCFA should consider competitive bidding to price the services that it purchases.

In an attempt to gain experience with competitive bidding, HCFA in 1983 awarded a contract to the Center for Health Policy Studies (CHPS) to design a system of competitive bidding for clinical laboratory services. CHPS developed a model which allowed for exclusive multiple winning bidders. This meant that several bidders would be selected as winners and all other bidders would be excluded from doing further work for Medicare during the period (one to two years) until the next bidding opportunity. One strength of this approach was that it solved a thorny problem of how HCFA could assure that the winning bids would not be so low that they might encourage a deterioration in the quality of laboratory tests. This was viewed as an important consideration because the Air Force had experienced serious quality problems a few years earlier when it had awarded an exclusive contract for pap smear testing to a single laboratory. Under the CHPS design, physicians would be free to shift their business among several laboratories. This meant that the system would be self policing in the sense that each laboratory would have to continually satisfy its physician-customers that their patients were receiving accurate tests. No additional regulatory machinery would have to be created to monitor quality beyond a licensure and periodic inspection program that was already in place.

The CHPS design, however, set off an uproar in the laboratory industry because it meant that losing bidders would be excluded from being able to do business with Medicare. This was viewed as a calamity because Medicare represented about 30 percent of a typical lab's business. Even more important was the perception that physicians wanted to deal with one laboratory to perform all of their work; it was widely believed that a physician would not split his business between a laboratory eligible for Medicare work and one that was ineligible. Exclusion from being able to serve Medicare was viewed as a death sentence to losing laboratories. This perception was heightened by the fact that the CHPS design called for bids on everyone of some 2,000 tests for which Medicare reimbursed. The industry perceived this bidding format as favoring large commercial laboratories which are capable of performing such a wide range of tests. In practice, most small to medium size laboratories confine their testing to 60 to 100 of the most common tests and they send out the remaining relatively rare tests to either the large laboratories or to small highly specialized laboratories. The CHPS design actually allowed smaller laboratories to arrange for referral work, but this fact was overlooked by much of the industry. It was also widely believed by the industry that the CHPS design would encourage predatory pricing by the larger laboratories. That is, the laboratories would submit artificially low bids and subsequently come to enjoy a near monopoly after the demise of their smaller competitors.

The industry's perceptions were viewed by HCFA and by CHPS as bordering on the hysterical. They expected that a two tiered market would develop. Winning laboratories would charge physicians a premium price (for non-Medicare tests) and offer the convenience of testing for both Medicare and other business; losing laboratories would counter with a lower price to induce the physician to send some of his business to the losing laboratory. In any case, CHPS and HCFA believed that the only way to induce bidders to offer a price approaching their actual cost was to confront (high) bidders with the alternative of losing Medicare's business entirely.

HCFA and CHPS were also skeptical of the predatory pricing argument because entry costs into the industry are not particularly high; they felt it would be very difficult for a predato to maintain a hold on the market unless it kept its profits at a level near that of perfect competition.

In 1985 HCFA awarded a second contract to Abt Associates to review the CHPS design, revise it as necessary, and then conduct and evaluate a demonstration of competitive bidding in five sites using the revised model. The model which was developed under the Abt contract is described in this paper. Its major innovations were that it allowed losing bidders to continue to be reimbursed by Medicare (on a discounted price basis) and it restricted the number of tests which would be subject to bidding. These features were viewed by the industry as being much less threatening to the business survival of losing bidders.

In spite of these changes, the industry conducted a massive lobbying campaign to get Congress to stop HCFA from conducting such a demonstration. Our interpretation of these efforts is that the new model preserved the basic incentive of any auction; namely that of delivering the goods at a price near the level of perfect competition. Delays, first of six months and then again of another year, were eventually attached to Congressional budget resolutions. However, these efforts at delay plus the development of the "nonexclusive" model described in this paper have both helped to shift the burden of proof from HCFA to the industry to show why grave harm (to anything other than some laboratory's profits) might result from the revised model. At this writing, the industry is under a requirement to present a reasonable counter plan.

The Model:

The model presented in this section evolved through an iterative process. In particular, given any particular model, we tried to develop a solution to the model as currently stated. Then, sorting through this solution's good and bad characteristics, and trying to discover what about the model allowed or forced these characteristics, suggested aspects of the model that needed modifying, and aspects of the model that should be retained if possible. For example, starting with the simplistic goal of reducing HCFA's costs as much as possible, taken quite literally, resulted in the obviously unacceptable "solution" of eliminating the Medicare programs, laboratory benefits entirely, and ultimately led to constraints of maintaining the current quality and scope of service, and of not simply shifting the costs to others. Simply put, the objective became to establish the lowest cost at which the clinical laboratory services currently paid for by Medicare could be obtained.

Notice that we say "the lowest cost at which" rather than "the lowest cost to HCFA at which;" reducing HCFA's costs by simply pushing the costs onto someone else would be a false economy. For example, HCFA's costs would be reduced dramatically if the Government passed a law stating that in order for a laboratory to retain its certification and be allowed to provide clinical laboratory services, the laboratory must provide at least as much service for free to Medicare patients as it performs for a fee for non-Medicare patients. This wouldn't reduce the cost of the services, but simply reassigns the costs. Although the example may be extreme (and perhaps a denial of Constitutional due process), it does illustrate the phenomenon of simply shifting the costs to some other party, something that we wish to avoid.

Note also the phrase "services currently paid for;" reducing the cost of Medicare services by reducing the quality or scope of services would also be a false economy. For example, saving HCFA money by lessening the accuracy of tests would be unacceptable. This gave rise to the constraint that the package of services provided under the experimental pricing mechanism be as good or better than that currently provided.

This constraint of maintaining the current level of service proved much harder to pin down than that, for instance, of not shifting costs. For example, imagine a laboratory somehow managing to be paid for thousands of dollars worth of tests that it did not perform, and then distributing some of the ill-gotten gains to the doctors who send their laboratory work to this laboratory. If this extra income permits a doctor to take a more relaxing vacation than otherwise, and then treat Medicare patients slightly more effectively when on duty, should HCFA want to continue to pay the laboratory for the bogus work? Our answer: "Only if there were no other, less expensive way to make an offsetting improvement in a Medicare patient's services." Clearly, whatever the ultimate cost of the program, a patient should receive the best medical care possible at that cost--this brings us to the issue of efficiency.

Conceivably, the same quality of services--maybe even exactly the same services--can be obtained at a lower cost. This might result from HCFA's prices encouraging a more efficient system. For example, imagine a situation in which the fee schedule currently specifies vastly different unit prices--say $2 and $20--for two different types of laboratory services--say "A" and "B"--that are in fact roughly equally expensive to provide; the vast variation in the fee schedule prices for the same service in different states (Gurney and Clopton, forthcoming) hardly argues against such a scenario! Imagine also that Medicare patients, as a whole, require roughly equal amount of these two types of services. Now, Always Helpful Hospital (AHH) can perform either type of service at a unit cost of $10, and has a policy of providing as much of these services as may be requested of it. Note that if the requests for each type of service by AHH have roughly the same proportion as required by Medicare patients as a whole, AHH still makes a profit; the profits on type B services slightly more than offsets the losses on type A services. In contrast, Joe Businessman, Inc., (JBI) can perform either service at a unit cost of $15, but somehow manages to provide significantly more type B services than type A, and therefore, although JBI (the less cost efficient provider) makes a profit, AHH (the more efficient provider) nets a loss. HCFA could risk the bankruptcy of AHH or it could let the entire fee schedule inflate some more, or it could try to align the fee schedule prices more closely with the actual relative costs. Ideally, the proposed pricing mechanism will tend to align prices with costs and thereby save HCFA from needing to ferret out relative cost information on its own.

An additional constraint on our design came from the fact that the Medicare program serves a heterogeneous population and is consequently committed to offering as much freedom of choice and to beneficiaries as possible. This means that beneficiaries, or more precisely the physicians who order tests on their behalf, should be free to choose a laboratory which offers "convenient" service provided that it meets standards of basic quality. In contrast, a HMO may decide to limit the choices which it offers its enrollees (they may only use certain hospitals, certain physicians, or certain laboratories) in order to secure for them a more economical service. Thus, HCFA's preference is to offer physicians as many choices of laboratories as possible, provided that service costs do not rise "too much" as choices expand.

This problem is illustrated by Figure 1 where the bids of various labs are arrayed in rank order. In Case 1, the bid prices rise very sharply beyond the third ranked bidder while in Case 2, there is a very mild price rise between the third and seveth ranked bidders. We wanted to design the competitive bidding system so that the number of winning bidders, beyond the number required to assure some minimum level of convenience, would be a function of the rate at which marginal costs rose. That is, in Case 1 we wanted to stop selecting winners after the third lab, while in Case 2 we were willing to select the first six laboratories. One problem in implementing this design was that we had no empirical information on what the actual distribution of costs looked like (hence the need for the demonstration!) and we had no precise quantification of how much Medicare was willing to pay in order to increase the number of winning labs.

In developing our competitive bidding mechanism, we also had to consider how much we wanted to change program rules. One major constraint here was that we could not substantially alter (without compensation to beneficiaries) the benefits of the Medicare program. Another constraint was that we had to limit the number of program changes so that it would be possible to evaluate their effects. Since the demonstration was designed to involve only six sites, we obviously had very few degrees of freedom to work with.

One important consideration was whether we wanted to alter the financial incentives faced by Medicare beneficiaries as distinguished from their physicians. Under Medicare rules in effect after January of 1987, beneficiaries have no out-of-pocket financial obligations associated with laboratory tests. (They do have partial payment obligations for other Medicare services.) While we might have altered program rules to give beneficiaries an incentive to scrutinize laboratory test costs, we chose to leave the rules unaltered so that we could focus the evaluation on measuring the effects of competitive bidding on commercial laboratory prices.

Another issue was whether we wished to alter the methods by which HCFA certifies and inspects laboratories. At present, HCFA has a program of routine and periodic inspection for commercial laboratories but it has no inspection program for tests performed by doctors in their own office. Both the rigor of the laboratory inspection process and the absence of any inspection of physicians' offices have been criticized. While our mission was obviously not to review the whole issue of how and when to inspect laboratories, we had to consider how competitive bidding might lower a laboratory's reimbursement and encourage it to skimp on test quality. At the same time, we did not want to increase the costs of inspection to the point where they might offset the savings from competitive bidding. Our solution was to adopt the multiple winning bidder concept originally proposed by CHPS. That is, we left the current laboratory inspection system unaltered and we designed the competitive bidding process so that physicians would have a wide choice of laboratories and thus be able to quickly switch their business away from any laboratory which appeared to be reducing its quality.

Even with multiple winners, the most straightforward auction would pay non-winning laboratories nothing for any Medicare services that they provided. This effectively bars a non-winning laboratory from providing services even if the laboratory just barely missed being a winner, and therefore runs counter to our philosophy of having competitive bidding set the price while having as little effect as possible on who may provide the services. So we wanted to design an auction in which a laboratory, if it just barely missed being a winner, could still provide Medicare services so long as it was willing to provide them at a slightly lower price than a winner would be paid. More precisely, we wanted that the closer a winner and a loser bid, the smaller the difference between the rates at which HCFA would pay for any services that they provided, and that this difference would shrink to zero if the winning and losing bids were as close together as they could be. Thus, a laboratory could not in effect be completely barred from providing Medicare services simply because it made a very small error in how it bid.

Finally, the competitive mechanism should be as simple as possible given all the other constraints and objectives as simple as possible in at least two ways. First, the mechanism should be simple enough so that it may be clearly defined and easily understood; this limits the demands that the experiment places on providers' resources, and minimizes the chances of errors. Second, the mechanism should be simple in the sense of making it possible for providers to bid very nearly optimally from the start; no matter how simple the rules of an auction may be, bidders may require many iterations of the auction to converge to nearly optimal bids if how each should bid--in other words, the tradeoffs between the probability of winning and the size of the profit conditional on winning--depends heavily and subtly on how others bid. In short, the experiment should give some hope of demonstrating how the mechanism might work in the longer term, and should so demonstrate without imposing an undue burden on the participants in the experiment.

Of course, any cost reductions or service improvements must come from somewhere. In the longer term, these benefits may come from increased productivity in providing clinical laboratory services; indeed we expect the proposed mechanism to result in prices that would encourage increased productivity. However, in the short term, we have a pie of fixed size, and any cost savings in Medicare programs must come at someone's expense. While we might view some changes--for example, JBI providing equal amounts, possibly zero, of both types of service in our previous example--as changes for the better, others may disagree--for example, JBI would probably prefer things as they are in the example. Thus, at least in the short term, we cannot hope to satisfy everyone touched by the experimental competitive bidding mechanism. However, by having stated our model as clearly as possible, HCFA can ask those who disagree with one or more aspects of the model to be precise in how they disagree and why; HCFA can then weigh both sides of the issues when deciding what changes it will consider as being for the better, and which changes it too would like to avoid.

Solving the Model:

The solution evolved in stages as the model developed and as we incorporated features to address issues that had been set aside previously. In fact, many variations on the final solution emerged, each with its own properties, and each satisfying the previously stated goals and constraints in varying degrees. Here we recap the main stages in the development of the competitive bidding actually proposed to HCFA--Mennemeyer et al. (1986) describes a number of the variations considered.

The process started with a simple auction of a single object. In particular, imagine that the object will be sold to one of a fixed number of risk neutral bidders. The bidder who offers to pay the most, or in the case of a contract, asks to be paid the least, for the object wins it.

The price of the object may be set in many ways; we consider two possibilities explicitly. The price might be defined as equal to the winner's bid, just as it would be in a typical sealed bid auction. Alternatively, the price might be defined as the most competitive looser's bid; this "second price" approximates the outcome of common oral auctions, auctions in which the price stops rising the instant it exceeds the second most competitive bidder's willingness to pay.

One might think that the "first price" scheme of having the winner pay the amount of his bid would generate a more favorable price for the bid-taker than the second price scheme. Not necessarily so. For example, consider the case of privately known values--the expected value of the object to each bidder conditional on whatever he knows about the object and conditional on winning is independent of whatever any other bidder knows about the object; or more roughly speaking, each bidder knows his own private value for the object precisely. Then, in a second price auction, each bidder can do no better than bidding equal to his expected value for the object. In fact, the winner's bid has no effect on the price he pays. The size of his bid does determine when he wins. To maximize his expected profit, a bidder should bid so as to win if and only if his expected value for the object exceeds the price he must pay if he wins. Bidding equal to one's actual expected value accomplishes this, and does so regardless of the bidding strategies employed by others.

On the other hand, in first price auctions (more generally than just in the case of privately known values), a bidder must shade his bid away from his expected value for the object if he wants a positive expected profit from the auction. Furthermore, the optimal amount of shading depends on how others, and on how many others, bid. At equilibrium--that is, when no one bidder can improve his bidding strategy given how his competitors are bidding--in the case of private values, the theory (Vickrey, 1961) predicts that the expected shading by the winner in a first price auction exactly equals the expected difference between the winner's bid and price in an otherwise identical second price auction.

Myerson (1981) takes this revenue equivalence theory one step further. Again for the case of privately known values, at equilibrium in <u>any</u> auction that guarantees a bidder an expected profit of exactly zero when the bidder has the lowest possible value for the object, the expected revenue from the auction depends only on how who wins depends on the bidders' values. For example, the same expected revenue results so long as the bidder with the highest value--or lowest cost--always wins if the winner has a value of at least some reservation value r (and otherwise the bid-taker keeps the object for his own use).

Thus, for a sufficiently regular auction of a single object, the problem of obtaining the best price for the bid-taker becomes on of optimally setting the reservation price. For a fixed number of bidders, the optimal reservation price may be quite substantial (Myerson 1981). However, if the number of bidders may vary--perhaps, the more profitable the auction to the bidders, the more individuals will bid--then Engelbrecht-Wiggans (1987a, 1987b) argues that in the case of an oral auction with private values, the reservation price should be insignificant enough so that just as many bidders bid as would have had the bid-taker set the reservation price equal to his own value (or cost) for the object.

So far, one might recommend using a second price auction (with reservation prices equal to the current Medicare fee schedule) to select a single provider of clinical laboratory services for Medicare patients. Bidders would have a much easier time determining how to optimally bid in such an auction than, for example, in a first price auction; this reduction in bidding costs may result in an improvement in the winning price that more than offsets any changes in the expected price from using some other form of auction. However, having only a single provider violates one of our goals.

So, consider the simultaneous auctioning of k identical objects with the k highest bidders each winning one object. Again, compare the first price auction in which each winner pays the amount of his bid, to the second price auction in which each winner pays an amount equal to the most competitive losing bid. Vickrey (1962) provides that, under similar conditions as before, the second price auction generates the same expected price as the first price auction. In the second price auction, bidders still have just as simple an optimal bidding strategy as before. Furthermore, while the first price auction typically results in a different price for each winner, the second price results in the same price for all winners; in the case of auctioning k contracts for clinical laboratory services, this single price could be interpreted as the fair market price for the particular clinical laboratory.

On the other hand, paying each winner at a rate equal to what the winner bids creates an incentive for lower bidding winners to subcontract to have their work performed (or, at least billed to HCFA) by a higher bidding winner. Such an arrangement would most likely benefit the higher bidding winner--presumably the higher cost bidder--at the expense of the lower bidding winner. In addition, such subcontracting would tend to drive the average price paid by HCFA up toward the amount bid by the highest bidding winner.

In short, the theory of auctions and competitive bidding as well as the effects of subcontracting suggest that HCFA would not necessarily pay more if it set all the winners' prices equal to the last winning bid or first losing bid, than if it paid each winner at the price it actually bid. Furthermore, the uniform price auction may be simpler for inexperienced bidders to bid in, and the uniform price auction eliminates the subcontracting benefit that higher cost winners may reap if laboratories were paid the price that they bid. Thus, at this point, we pretty much settled on using a second price auction in the demonstration. However, so far, we still only have a limited number of winners--that is, a limited number of providers from which a doctor can choose.

Now is the time to remember that the auction should focus on setting the price to be paid for clinical laboratory services, but should try to avoid setting who provides the services. Therefore, consider the following "everyone (almost) wins" auction. Each potential provider of clinical laboratory services bids on the unit cost of providing a particular type of service. The k lowest bidders win in the sense that, although they must provide any amount of services requested of them, they will be paid at a rate equal to the k+1 st (the most competitive other) bid. On the other hand, any other bidders may provide services if they wish (if they can find the demand), but will only be paid some lower price--for example the k th bid discounted by the percentage by which their bid exceeded the k th bid). We would still expect for bidders to find it relatively easy to decide how to bid in such an auction. However, now a doctor can elect to obtain services from a provider other than one of the k lowest bidding providers IF that provider is willing to take the payment offered by this mechanism--an amount less than he bid, and less than that paid to the lowest bidding providers--as full payment for the service. (As is currently the case, the Medicare beneficiary pays nothing.) Therefore, this mechanism, or some slight variation thereof, meets our basic goals.

However, this mechanism leaves two issues unresolved. For one, how do we set k? We could set k based on an examination of typical providers' capacities to provide services and them simply make sure that the capacity of those providers who must provide any amount of services requested of them exceeds the maximum likely amount of Medicare services to be required. Indeed, such a method might be feasible even though HCFA may in general have certain difficulties in obtaining accurate information about individual providers; the necessary capacity estimates would be much easier to obtain--and their accuracy would be less critical--then the actual cost data required under the current fee schedule approach. In addition, it would allow HCFA to set a ceiling--say 150 percent of the anticipated service volume divided by k--on the maximum amount of services that anyone of the k lowest bidders need provide.

Alternatively, we could have providers bid on both price and on the ceiling for the maximum amount of a service that they could be required to provide. An appropriately designed mechansim would encourage reasonable capacity bids. For example, each of the k lowest bidders could be paid a premium for each unit of capacity availability they promised--this is similar to a utility company charging you for the maximum rate at which you may consume their service (for example, 200 amps, or the amount of water that will enter your house through a one inch supply pipe) in addition to a unit charge for each unit of service actually provided. Aside from the premium, we could even have all providers paid at the same unit rate, the kth lowest price bid, where we set k to be the smallest number so that the combined capacity bid by the k lowest bidders exceeds the anticipated volume or services required. As a slight variation, the premium could be paid only on that fraction of bid capacity that is actually used in providing services. However, either version would be harder to bid and harder to administer than if bidders did not bid on quantity in addition to price.

Thus, we returned to exogenously setting the number of providers that would be paid at the most favorable rate, but with a significant twist. Rather than exogenously setting k, we set a rule for setting k. In particular, set k as the number of bidders who bid less than 105 percent of the 45 th percentile bid; if these k providers do not appear to have enough capacity to meet anticipated demand, increase k as necessary. In fact, this mechanism specifically addresses one of our goals, the goal of making reasonable tradeoffs between the cost of the service and the number of providers to be paid at the most favorable rates (providers which much provide any amount of service requested of them). Specifically, such a mechanism has the effect of increasing a doctor's range of alternatives whenever a number of providers bid very close to what might have otherwise been the cutoff.

Finally, we needed to address the issue of simultaneously pricing many different types of services. One approach would be to price them independently of each other. This solves the problem of how to price them, but raises the possibility that a doctor could not find any one provider that would provide the full range of services at the rates to be paid to that provider for services to Medicare patients.

Alternatively, the mechanism could rank bidders based on some weighted average of their bids for individual services. Then, the same k providers would be required to provide all services at the established rate. However, such a mechanism opens up the possibility of bid unbalancing as described for the construction industry by Stark

(1974). Specifically, if a provider knows that he will provide a higher proportion of service type A, and a lower proportion of service type B, than given by the weights used to calculate his composite bid, then the provider can increase the expected price that he would be paid without changing his composite bid; he need simply reduce his bid for type B services, while increasing his bid on type A services just enough to leave the composite bid unchanged. The proposed mechanism, described in the next section, uses composite bids, but attempts to limit for any incentives to unbalance bids.

The Proposed Solution

The example of this section essentially defines the competitive bidding mechanism proposed for the demonstration. Specifically, imagine that seven labs (A, B, C, etc.) bid on four different types of tests. Table 1 shows the Bid Specifications consisting of the relative weight for each test and the target volumes anticipated by HCFA. The relative weights are used to determine the weighted average price of each lab. (For simplicity, we use weights that are proportional to target volumes but this is not essential.)

The target test volumes are used to check the initial selection of winners to see if their capabilities are sufficient to service the market with adequate provision for backup capacity and choice of laboratory.

Table 2 shows the prices and volume capabilities of the laboratories. For example Lab A bids a price of $2.00 for Test 1 and states it is capable of supplying Medicare with up to 300 tests. The weights from Table 1 are used to compute the value of the basket of tests submitted by each laboratory. The rank order of the market baskets is also shown. for example, Lab A is the lowest bidder (Rank = 1) with a market basket of $5.25. Laboratories are initially selected as winners if their market basket average price falls within 105 percent of the 45th percentile. (This assumes that the market basket also falls below the market basket which would be computed from the existing maximum Medicare payment rates. One restriction on the bidding is that it must yield overall a better set of prices to the government than would the current method of reimbursement.) Under this criterion Labs A, B, D, and F are winners. Note that each of these bidders falls below $6.72 which is the initial cutoff point at 105 percent of the 45th percentile.

The next step in the analysis of the bids is for HCFA to determine if the initial winners have sufficient apparent capacity to meet the target volume levels. This determination will involve examination of each laboratory's declared capability followed with verification inspections to any lab that makes capability declarations that are well above its historical volume of Medicare tests. Table 3 shows the cumulative volumes of the winning laboratories. The cumulation begins with the lowest bidder (Lab A), and proceeds in ascending rank order of the bids.

Note that in our example HCFA's target volume for Test 4 is satisfied as soon as Lab B has been selected. However, since the selection of winners is based upon 105 percent of the 45th percentile, more than enough capability is obtained for this test. For Tests 1, 2, and 3, the target is not met until all four winning laboratories have been selected. In our example, it is not necessary to select any laboratories beyond 105 percent of the 45th percentile of prices in order to meet the target volume. If further selection had been necessary, Lab C with a market basket price of $6.95 would have been the first selected.

The reward basket is defined as the average of the highest winning basket received and the first losing basket. In this example, the highest winning basket is $6.50; the first losing basket is $6.95; the reward basket is $6.73 = (($6.50 + $6.95)/2).

Table 4 shows the steps which are involved in computing the prices which are to be paid to both the winning and losing laboratories. Step 1 inflates the prices of each bidder in proportion to the ratio of that bidder's market basket to a "reward" market basket. This step assures that all winners will be paid the same amount in terms of an overall market basket price. For example, Lab A is the lowest bidder. Each of the prices that it bid are inflated by the ratio of the reward basket to its basket ($6.73/$5.25). This process brings its prices up so that it will be paid on average as much as the highest winning bidder. We also want to discourage inappropriate subcontracting among laboratories. To do this, all of the winning prices computed in Step 1 are then averaged for each test. This is shown in Step 2. Note that this averaging process inevitably means that some of the higher successful bidders at this point are going to be paid LESS THAN WHAT THEY BID even though on average across all tests they are getting at least as much as they asked for. For example, Lab D bid $5.00 for Test 1. Since D is the highest bidder, its price is averaged down to $4.82.

Another reason for averaging the price in Step 2 is that this makes it more difficult for bidders to engage in unbalanced bidding because they cannot be sure that the prices which they bid will be exactly what they are paid. Of course, if the market basket weights are not believed to be a correct representation of future sales proportions, and if most bidders have similar ideas about future sales proportions and unbalance their bids to take advantage of this situation, the averaging process will be thwarted by the combined strategies of the bidders.

In Step 3, the prices for losing bidders are computed. Here we use the formula where prices are adjusted downward by the percentage by which the loser's own basket exceeds the reward basket. For example, Lab C bid $4.00 for Test 1. While this price is actually lower than the prices bid for Test 1 by winning Labs D and F, Lab C's overall basket of prices ($6.95) was higher than the highest winning bidder, namely Lab D ($6.50). All of C's prices are adjusted downward by [1-($6.95 - $6.73)/$6.73) = .97] so that the winning price of $4.82 on Test 1 is reduced to a payment of $4.66 [= $4.82 * .97].

Note also that Lab C's discount is milder than that for the other losing labs. Lab G, for example, is paid only half of the winning price because it was almost twice as high as the cuttoff market basket. This approach means that "near losers" are discounted much less severely than are losing bidders with comparatively much higher prices. The purpose of this approach is to create a progressively stronger incentive for bidders to offer Medicare their most favorable price. However, to protect inexperienced bidders from strategic errors in bidding, the discount is limited to being 50 percent of the winning prices.

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Table 1

Bid Specifications

	Weight	Target Volume
Test 1	0.20	2000
Test 2	0.30	3000
Test 3	0.35	3500
Test 4	0.15	1500

Table 2

Prices and Volume Capabilities of the Labs

Lab	Lab A	Lab B	Lab C	Lab D price volume	Lab E	Lab F	Lab G
Test 1	2.00	3.00	4.00	5.00	6.00	8.00	7.00
	300	700	1000	600	200	600	200
Test 2	4.00	2.00	6.00	4.00	7.00	4.00	9.00
	400	700	2000	1000	300	1000	100
Test 3	10.00	14.00	12.00	11.00	13.00	9.00	23.00
	400	900	3000	1300	350	1000	100
Test 4	1.00	2.00	1.00	3.00	2.00	3.00	5.00
	600	900	800	400	150	800	200
Basket Total	5.25	6.40	6.95	6.50	8.15	6.40	12.90
Rank	1	2.5	5	4	6	2.5	7
Status	Win	Win	Lose	Win	Lose	Win	Lose

45th percentile plus 5% = 6.72

Highest Winning Basket = 6.50
First Losing Basket = 6.95
Reward Basket = 6.73 = (6.50 + 6.95)/2

Table 3

Cumulative Volume Capabilities Offered by Winners

	Lab A	Lab B	Lab F	Lab D	Target
Test 1	300	1000	1600	2200	2000
Test 2	400	1100	2100	3100	3000
Test 3	400	1300	2300	3600	3500
Test 4	600	1500	2300	2700	1500
Rank	1	2	3	4	

Table 4

Computation of Prices Paid to Bidders

Step 1 Adjust Winners by Market Basket Ratio

	Lab A	Lab B	Lab C	Lab D	Lab E	Lab F	Lab G
Test 1	2.56	3.15	NA	5.17	NA	8.41	NA
Test 2	5.12	2.10	NA	4.14	NA	4.20	NA
Test 3	12.81	14.71	NA	11.38	NA	9.46	NA
Test 4	1.28	2.10	NA	3.10	NA	3.15	NA
Basket	6.73	6.73	NA	6.73	NA	6.73	NA

Step 2 Average the Adjusted Winning Prices

	Lab A	Lab B	Lab C	Lab D	Lab E	Lab F	Lab G
Test 1	4.82	4.82	NA	4.82	NA	4.82	NA
Test 2	3.89	3.89	NA	3.89	NA	3.89	NA
Test 3	12.09	12.09	NA	12.09	NA	12.09	NA
Test 4	2.41	2.41	NA	2.41	NA	2.41	NA
Basket	6.73	6.73	NA	6.73	NA	6.73	NA

Step 3 Compute Discount Payments to Losing Bidders

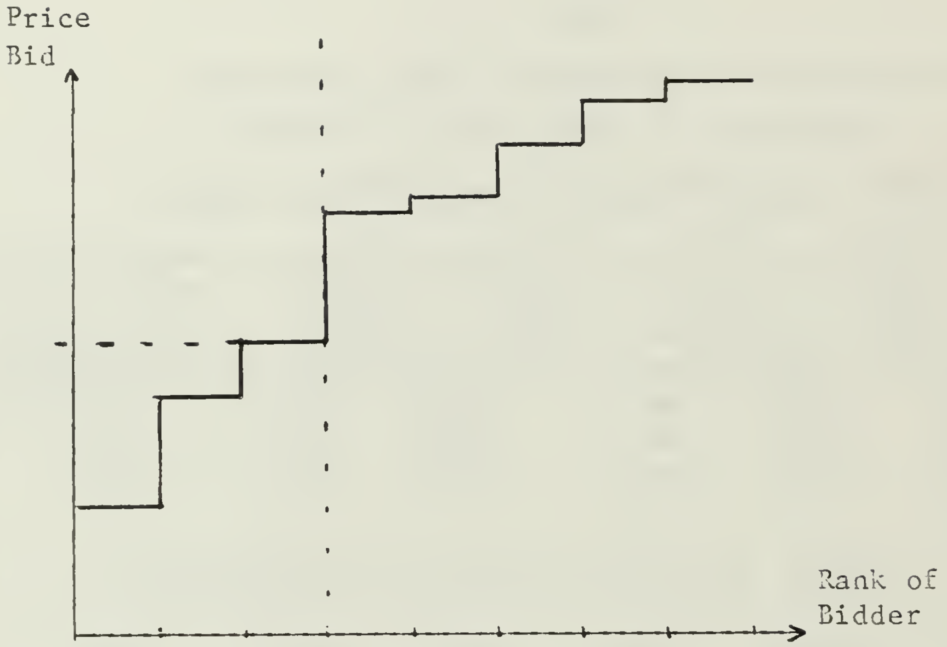
	Lab A	Lab B	Lab C	Lab D	Lab E	Lab F	Lab G
Test 1	NA	NA	4.66	NA	3.80	NA	2.41
Test 2	NA	NA	3.76	NA	3.07	NA	1.95
Test 3	NA	NA	11.69	NA	9.53	NA	6.04
Test 4	NA	NA	2.33	NA	1.90	NA	1.20
Basket	NA	NA	6.50	NA	5.30	NA	3.36

Summary Payments to all Parties

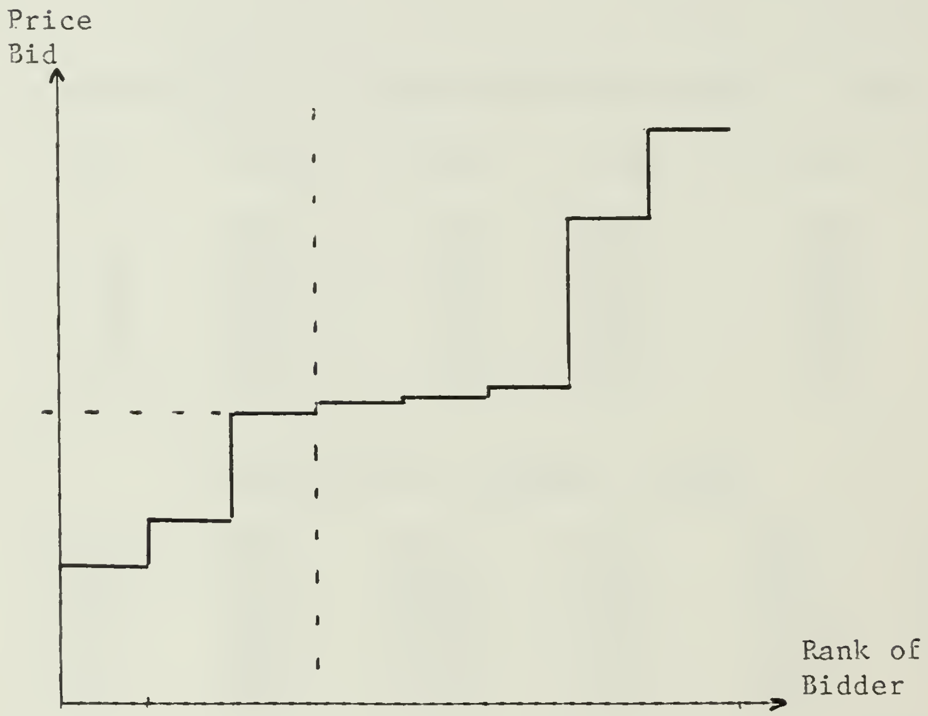
Test 1	4.82	4.82	4.66	4.82	3.80	4.82	2.41
Test 2	3.89	3.89	3.76	3.89	3.07	3.89	1.95
Test 3	12.09	12.09	11.69	12.09	9.53	12.09	6.04
Test 4	2.41	2.41	2.33	2.41	1.90	2.41	1.20
Basket	6.73	6.73	6.50	6.73	5.30	6.73	3.36

NA = Not Applicable

Figure 1.



Case 1



Case 2