

# Research at the Auction Block: Problems for the Fair Benefits Approach to International Research

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These are somewhat paradoxical times for the ethics of cross-national medical research. On the one hand, there is widespread recognition that research funded by high-income countries (HICs) and carried out in low and middle-income countries (LMICs) raises important issues of fairness and justice. On the other hand, the lack of consensus about which conception of justice or fairness should regulate cross-national social relations has created an almost principled aversion to directly addressing such issues when evaluating international research initiatives.

Increasingly procedural approaches to normative questions have been advocated as a tonic for those seeking to reconcile theoretical agnosticism with meaningful regulatory guidance.<sup>1</sup> It should come as no surprise, therefore, one of the most prominent approaches to regulating the conduct of cross-national research, the “fair benefits” approach (Participants, 2004), adopts just such a procedural strategy.<sup>2</sup>

As a process, the fair benefits approach is supposed to respect the autonomy of host communities, facilitate free and informed decision making and empower host communities to advance their own interests. It is also supposed to bring about outcomes that are fair in several concrete respects, ensuring that host communities are not exploited, all without taking a controversial stand on divisive questions of social and distributive justice.

Despite its allure, we argue that the fair benefits approach suffers from fundamental ambiguities at both a conceptual and an operational level. In many ways, this makes it something of a moving target, as key features of this approach have not been described in operationally useful detail. In order to fill this gap, we propose an economic model that captures the most intuitive and straightforward ways of implementing this approach. This analysis reveals that the

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1 For a scathing criticism of the proliferation of procedural approaches to controversial questions in bioethics see Ashcroft (2008).

2 In a recent paper Weijer and LeBlanc (2006) have also argued that what benefits members of host communities receive in return for participating in a clinical trial should be determined by a process of “moral negotiation” and cite with approval some of the recommendations of the fair benefits approach. The analysis provided here would therefore apply also to their process of “moral negotiation.”

outcomes most likely to result from its application in practice are inconsistent with the features of fairness that proponents of this view claim that it will produce. As a result, we are concerned that what appears to be an appealing flexibility of the fair benefits approach is at best simply a lack of operational clarity and at worst a lack of internal consistency.

In the end, our analysis is significant for several reasons. First, it illustrates the importance of demonstrating how a procedural approach will manage or mitigate conflicts between the values in its domain and not simply obscure them from view. Second, it illustrates how the idea that procedures are in some sense neutral between competing conceptions of justice or fairness may represent a romantic, pre-economic view of procedures. One lesson that we draw from the now well-developed literature on procedures in economics – so called *mechanism design* – is that somewhat similar procedures can result in radically different outcomes. The process of designing and selecting relevant procedures is often highly influenced by substantive values, including judgments about the appropriateness of their outcomes. Stakeholders should therefore be wary of the idea that procedures can avoid recapitulating substantive debates about the nature of fairness while retaining sufficient operational clarity and content to be action-guiding.

## 1 The “Fair Benefits” Approach

Over the past decade the amount of research sponsored by entities from HICs and carried out in LMICs has increased substantially (Department of Health and Humans Services, 2001; Thiers et al., 2007). This, in turn, has spurred a vociferous, and now voluminous, debate about the ethical standards that should be used to regulate such research (Angell, 1997; Laurie and Wolf, 1997; Crouch and Arras, 1998; Glantz et al., 1998; Annas and Grodin, 1998; Benatar, 1998; Attaran, 1999; Benatar and Singer, 2000; Macklin, 2001; Resnik, 2001; Benatar et al., 2003; Flory and Kitcher, 2004; London, 2005).

This debate has been complicated by the fact that research in HICs is carried out within a very different social, economic, and scientific context than research in LMICs. LMIC populations often experience higher burdens of communicable and preventable disease because they lack a widespread and robust system of public health. As a result, there can be a significant divergence between the health priorities of LMIC communities and the HIC communities that sponsor and carry out research. Similarly, a substantial portion of the disease burden in LMICs represents the effects of poverty, social and economic deprivation. In many cases, the central problem is a lack of robust access to existing medical and public health interventions, rather than a lack of knowledge or know-how that requires scientific investigation to overcome or address. Finally, most LMICs lack a substantial social investment in scientific research. As a result, the research agenda is frequently set by foreign sponsors. Similarly, key elements of the research infrastructure may be underdeveloped or missing altogether. Some of these elements pertain to regulation and oversight. Others represent components in the complex division of social and economic labor necessary to ensure that the fruits of scientific inquiry are translated into interventions, policies, or procedures, that physicians, nurses, clinics, or the public health service

can use to better address the community's health needs.

These differences create the prospect that research carried out in LMICs will not be relevant to the health priorities of host communities. HICs may export the risks and burdens of research to populations already burdened by deprivation and disease and import knowledge that is of substantial social value only to the HIC health systems. Even when individual trial participants stand to benefit from participating in such research, there are questions about the fairness of carrying out research in LMICs if the science is not relevant to the priority health problems of the larger community. Although there is widespread agreement that these are important questions, there is substantial disagreement over the requirements necessary to ensure that research in this context is just, fair, and otherwise ethically acceptable.

A driving force behind the fair benefits approach is its critique of the "reasonable availability" approach. On this latter approach, the main ethical problem in cross-national research is that host communities and research participants will bear research risks without benefiting from its fruits. Many commentators have argued that in such cases researchers and their sponsors exploit participants and host communities (Annas and Grodin, 1998). In order to rectify or avoid this, it is argued that agreements must be made in advance to make the fruits of successful research reasonably available to the host community.<sup>3</sup>

Proponents of the fair benefits approach have been staunch critics of this view. They agree that the central problem to be avoided in this context is exploitation. But they claim that exploitation is a very specific moral wrong that has largely been misunderstood. To clarify the terms of the debate, they adopt Wertheimer's account of exploitation (2008). On this view, exploitation is a property of micro-level interactions between individual parties to some discrete agreement or cooperative endeavor. Party A exploits party B if party A receives "an unfair level of benefits as a result of B's interactions with A" (Participants, 2004, 19).

They argue that the reasonable availability view does not avoid the problem of exploitation. In early-phase research or unsuccessful late-stage research there is no intervention to make available to communities. In such cases host communities bear the costs of participation without receiving any offsetting benefits.

Similarly, they argue that it is overly paternalistic to require host communities to accept, and perhaps even to pay for, the fruits of a particular research study when there may be different benefits that those communities would prefer (Participants, 2004, 21).<sup>4</sup>

A proper understanding of exploitation is supposed to reveal two insights that are fundamental to the fair benefits approach. First, the key to avoiding exploitation is ensuring that the people who bear the risks and burdens of research receive fair benefits through the conduct and/or

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3 CIOMS Guideline 15 from 1993 reads "As a general rule, the sponsoring agency should agree in advance of the research that any product developed through such research will be made reasonably available to the inhabitants of the host community or country at the completion of successful testing. Exceptions to this general requirement should be justified and agreed to by all concerned parties before the research begins" (Council for International Organizations of Medical Science (CIOMS), 1993).

4 Weijer and LeBlanc (2006) emphasize this point as well.

results of research. Second, all types of benefits that might flow from research, not just access to the investigational agent, must be considered in determining whether the benefits are fair (Emanuel, 2008, 719-728 at 724-5).

In this view, the issue is not “what” benefits host communities receive but the fairness of the “level” or amount of benefit (Participants, 2004, 20). As a result, the fair benefits approach would allow host communities to bargain with researchers for a fairly wide range of benefits. Instead of access to the study intervention, for instance, they might want help in cleaning their water supply, constructing a road, or vaccinating their children.

One profound implication of this approach is that if the host community is not interested in the information or the interventions that the study is designed to generate, and if it is not obligatory to provide post trial access to the study intervention, then it is difficult to justify requiring cross-national studies to be aligned with or to focus on the urgent health needs or priorities of the host community. The fair benefits approach is so attractive because it supplants a cumbersome mix of requirements enshrined in international documents and replaces them with a single, seemingly manageable process. What isn’t to like?

Because the central issue on this approach is avoiding exploitation and because this requires ensuring that host community members receive a fair level of benefits, the ethical question at the heart of the fair benefits approach is: How is the fairness of a division of benefits to be assessed?

It will be useful to keep track of several important claims that proponents of the fair benefits approach make about fairness. For instance, we are told that a fair distribution should have certain properties.

**(Benefits must increase with burdens.)** “As the burdens on the participants and the community increase, so the benefits must increase.” (Emanuel 2008, 725; see also Gbadegesin and Wendler 2006, 251 and Participants 2004, 22.)

**(Benefit must increase with benefits to others.)** “Similarly, as the benefits to the sponsors, researchers, and others outside the population increase, the benefits to the host population should also increase.” (Emanuel 2008, 725; see also Gbadegesin and Wendler 2006, 251 and Participants 2004, 23.)

**(Benefits must track relative contributions.)** “The level of benefits that a community should receive to ensure a fair deal depends on the community’s contribution relative to the contributions of all other parties that are involved in the research project, including sponsors, investigators, subjects, and other communities.” (Gbadegesin and Wendler, 2006, 251)

These properties of fairness are so important that they are used as grounds for rejecting the reasonable availability approach: “Reasonable availability fails to ensure a fair share of benefits; for instance, it may provide for too little benefit when risks are high or benefits to the sponsors great” (Participants, 2002, 2133).

On the other hand, the proponents of this approach lament that:

- (a) “Currently, there is no shared international standard of fairness; reasonable people disagree” (Participants, 2004, 23).

Additionally, different individuals and different communities may have different valuations of the diverse benefits that might be on the table at any time. As a result they go on to assert,

- (b) “Most importantly, only the host population can determine the value of the benefits for itself” (Participants, 2004, 23). Therefore
- (c) “Ultimately, the determination of whether the benefits are fair and worth the risks cannot be entrusted to people outside the population, no matter how well intentioned” (Participants 2002, 2134, see also Participants 2004, 22).

The claims in (a), (b), and (c) are quite strong and they provide the justification for the claim that “the population being asked to enroll determines whether a particular array of benefits is sufficient and fair” (Participants, 2004, 22).

At the core of the fair benefits approach are two additional principles that are supposed to put members of the host community in a position to determine whether a particular division of benefits is fair. The first is called “collaborative partnership.” At the level of concrete action, researchers and host community members are to engage in a process of bargaining or negotiation in which host communities and researchers negotiate a specific package of benefits to be exchanged. The second is a principle of transparency that is supposed to regulate this process. In order to understand their account of fairness, therefore, we need to understand the way that these principles are supposed to structure the process of bargaining or negotiation.

Unfortunately, although we are told that the parties should engage in a process of “collaborative partnership,” we are not given specifics about how that process should be designed and conducted. As a result, a number of important questions remain unanswered. For example, given the strong claims in (a), (b), and (c), what is the relationship between this process and the claims that in a fair division benefits must increase with burdens, with benefits to others, and track relative contributions? Is the bargaining process supposed to be shaped so that the resulting bargains satisfy those criteria? Is it to be shaped in a way that makes it more likely that these conditions will be met? Given that the host community is the ultimate arbiter of whether a division of benefits is fair, does it follow that agreements that do not satisfy these conditions still count as fair as long as the host community freely accepts them?

How significant of an ambiguity is this? One can easily imagine that some stakeholders are attracted to the fair benefits approach because this view will ensure that benefits to host communities will increase with burdens, with benefits to others, and track relative contributions. In particular, they may like the idea that when LMIC communities host research that has the

potential to generate hundreds of millions, if not billions, of dollars in revenue that host communities will be guaranteed to receive fairly substantial benefits in return for hosting the research. Moreover, the prospect that host communities may reap a significant economic benefit may mitigate or render unproblematic the prospect that such research may focus primarily on HIC health needs or be designed to vindicate interventions that are unlikely to be used on a widespread basis in LMICs. Some might embrace fair benefits, and reject principles like the requirement that research be responsive to host community health needs, because fair benefits looks like a more effective way of helping LMIC communities.

In contrast, other stakeholders may like this approach because it makes host community decisions the final arbiter of fairness. On their view, a division of benefits that does not increase with burdens, with benefits to others, or track relative contributions would not necessarily be unfair as long as the host community freely accepts it. So they may be attracted to the idea that HIC research could be exported to LMIC communities, allowing sponsors to incur a significant cost savings, while being free to use their significant bargaining power to ensure that they capture almost all of the benefits from the transaction. These people may embrace fair benefits and also reject principles like the responsiveness requirement, but out of a desire to be free to more effectively advance their own interests.

Similar ambiguity surrounds how the “Principle of Transparency”, the second principle, is supposed to ensure that the outcomes of collaborative partnerships are fair. The Principle of Transparency involves the creation of a publicly accessible database of all benefits agreements between various research sponsors and host communities. This repository is supposed to be maintained by an independent party, such as the World Health Organization, with the expectation that various groups, such as researchers and sponsors, governments and potential host communities will have access to the data. In fact, their view requires that the database should be advertised to potential host communities so that they can be familiarized with the various packages of benefits that have been exchanged in the context of other research projects.

How is this database supposed to ensure that agreements are fair? First, it eliminates informational asymmetries between the host country and the researcher. This is required because,

- (d) “[A] fair distribution of benefits at the micro-level is based on the level of benefits that would occur in a market transaction devoid of fraud, deception, or force, in which the parties have full information” (Participants, 2004, 20).
- (e) “A population in a developing country is likely to be at a distinct disadvantage relative to the sponsors from the developed country in determining whether a proposed level of benefits is fair” (Participants, 2004, 23).

The database is supposed to reduce the likelihood of fraud or deception by giving potential host communities access to a wide range of information about the range of costs and benefits associated with a research project. Seeing what other communities received in the past also

enables them to factor the competitiveness of a proposed division of benefits into their determination of whether it is worth accepting, and therefore, fair.

But the proponents of the fair benefits approach also claim that the principle of transparency is supposed to advance a regulative as well as an information goal. In particular, their approach has been criticized on a number of grounds, one of which is that it does not recognize the extent to which inequalities in bargaining power will allow researchers and sponsors to exact hugely disproportionate benefits from the agreements reached in this process (London, 2005). In response, proponents of the fair benefits approach have argued that:

- (f) “The criticisms seem to miss the fact that the fairness of agreements is not determined just by bargaining. The purpose of the transparency principle is to provide an external check that independently assesses the fairness of agreements” (Emanuel, 2008, 719-728 at 726).
- (g) “Such information will facilitate the development of “case law” standards of fairness that evolve out of a number of agreements” (Participants, 2004, 24).

It is this regulative goal that is referred to in (f) and (g) and it is this function as an external check on fairness that makes it more difficult to reconcile (f) and (g) with (a), (b), and (c).

How serious of a problem is this? Well, it is difficult to say and, as a general point, that is itself part of the problem. We know so little about how the process of bargaining is supposed to be carried out that it is difficult to know how the database will influence that process. It is therefore unclear exactly what kind of “check” it is supposed to provide.

As a result, some stakeholders may be attracted to the claim that the principle of transparency will function as an effective external check on the fairness of agreements. Perhaps it will do this by ensuring that benefits to host communities increase with burdens, with benefits to others, and track relative contributions. Perhaps it will also function as an external check on the differences in bargaining power that separate host communities and international sponsors.

In contrast, other stakeholders might like the idea that the principle of transparency will only create a more transparent and informed negotiation process and that it will not override or constrain the decisions of host community members. As such, it would not function to offset the considerable bargaining power of research sponsors.

Whose assessment is correct? In order to answer this question, we would need to know much more about how this process would be implemented in practice.

## 2 “Collaborative Partnership” is really an auction

How might the fair benefits approach be carried out in practice? We start from the idea that the ultimately, the focus of negotiations concerns how to divide the surplus value generated by the research. We assume that every study has an expected surplus (the expected profits minus the cost of conducting the research), and that some of this surplus can be transferred to the LMIC

host community. We also assume that there are some costs associated with hosting the research, and no community will agree to host research where its share of the surplus is less than its expected costs.

## 2.1 Simultaneous, iterated bidding

Consider first the situation in which researchers are free to negotiate simultaneously with as many interested parties as they like. In this case, researchers inform potential host communities about the various costs, risks, and potential benefits associated with a particular research initiative. After consulting their constituent members, each community proposes a basket of benefits that it would be willing to accept in return for hosting the initiative. Assume further that researchers are then free to inform each community of what the others are asking. This would allow each community to compare a given level of benefit to what they perceive as their cost for hosting the research. At some point one community will be willing to accept a level of benefit that is less than what it would cost another community to host the initiative. At that point the latter community will withdraw from the negotiations. Other communities will consider whether the current bid is above their cost and, if it is, they will lower their bid. At some point negotiations will reach a level at which only two communities have a cost that is below the current offer. Negotiations will continue until the bid reaches the cost of the second place community. That community will not lower its offer and the community with the lowest cost will reduce its bid accordingly. After this point there will be no more offers. The community with the lowest cost thus pays a fraction more than the cost of the second place bidder. The division of benefits that results from this process will be such that the eventual winner gains the difference between its own cost and the cost to the second cheapest host community.

The process just described has the structure of a first price, open cry auction – those familiar to most of us from live and internet auctions. Instead of bidding larger amounts of money to purchase a commodity, potential host communities try to make themselves more attractive venues for research by lowering the share of the surplus value generated by the research that they are willing to accept in return for hosting a research initiative. Negotiating this way allows researchers to choose the venue with the lowest costs, in effect, maximizing the surplus that they can expect to receive from the bargaining process.

It might be objected that this is not the kind of negotiation process that proponents of the fair benefits approach had in mind. However, we can find nothing in the fair benefits approach that would prohibit this form of negotiation. In fact, this form of negotiating is consistent with the few features of the approach that proponents of this view do stipulate. That is, in this scenario researchers are negotiating directly with individual host communities. It closely approximates the full information requirement for ideal market transactions by giving each community the chance to adjust their bid in light of the current bid of other communities. Each community determines which offers they are willing to accept and benefits accrue directly to the eventual host



community.

If the fair benefits approach wants to rule out using this kind of negotiating procedure, then it needs to be much clearer about either the way that procedure should be conducted, or about the properties that it should satisfy and how those properties rule out this kind of approach. Nevertheless, it is true that the proponents of the fair benefits approach do not describe a process of repeated negotiation between communities and although they stipulate that all parties must have access to the database of previous agreements they do not state that each community must be aware of what other contemporaneous communities are willing to accept.

## 2.2 One-shot bidding

So we might imagine instead a process of negotiation in which researchers engage in a deliberative process with each community and then each has one opportunity to inform researchers of the amount they regard as a fair return. This eliminates the repeated process of negotiation or bidding and, in turn, eliminates the condition of perfect information that each community had in the previous scenario about the cost structure of other communities.

Unfortunately, as long as each community knows that there are others that are interested in hosting the research, and each community knows that they have only one chance to submit an offer, then, on average, the outcome will be the same as the first price, open cry auction. That is because negotiations of this type also have the structure of an auction; in this case it is a first price, sealed bid auction. Variants of this kind eliminate the situation of perfect information, but not the incentive to make educated guesses about the cost structure of other bidders. Bidders simply have to base their negotiation strategies on those guesses. Sometimes they miscalculate and get less than they would in an open cry auction, other times they get lucky and get more; on average, however, the outcomes will be the same.

There are many ways in which these two processes of negotiation may differ. But the irrelevance of these differences is established by a powerful and elegant formal result, now well known as the “revenue equivalence theorem.” What this theorem proves is that, given a particular set of constraints, the average amount paid in an auction (here interpreted as the amount of the surplus kept by the researcher) is the same (Myerson, 1981; Riley and Samuelson, 1981). On average the researcher will keep all of the surplus minus the average value of the second lowest cost.

In appendix A we state the assumptions required for the revenue equivalence theorem to hold and we defend their relevance to the present case. Briefly, these assumptions require very little from the structure of the interaction. There must be an imbalance between supply and demand (modeled as multiple sites vying to host a single research initiative). Individuals who are bidding cannot enjoy taking risk for its own sake (although they may be willing to take risks). The structure of the process by which research is awarded must be such that the person who bids the lowest receives the research, even if they pay an amount different from their bid. If a community

has the highest possible cost for hosting research, they must expect not to get any surplus. There are some restrictions on what communities believe about each other's costs, and all of this must be known by all parties.

Notice that many of the features we commonly associate with auctions are not required for the outcome to be equivalent to the outcome of an auction. The high bidder need not pay her bid, or even the bid of the second highest bidder. Bids can be made simultaneously or sequentially or any combination of the two. The result holds for an astonishing variety of ways of permuting the process of negotiation so that it differs from both of the examples we sketched above.

### 2.3 Modified one-shot bidding

For instance, in an effort to remove some of the strategic element to the competitive bidding process, each community might be informed that there will be one chance to submit a bid and that although the lowest bidder will still win, that bidder will receive an amount of the surplus that is equivalent to the bid of the second lowest bidder. This is known as a second price, sealed bid auction. The strategic element to the bidding is removed but the result remains the same. The researcher expects to receive the same amount of the surplus as in the other cases: almost all of it.

### 2.4 Commitment with the chance of relocating in the future

In fact, a negotiation process where there is not simultaneous competitive bidding can still function like an auction over time. Perhaps, for instance, host communities are first chosen on the basis of factors such as existing relationships, convenience, and ease of conducting the research. These factors are similar to those that proponents of the fair benefits approach describe in their account of the Havrix study that was conducted in Thailand. Assume, however, that at the completion of the study researchers have the option of locating subsequent studies elsewhere. As long as there are multiple potential host communities for each proposed research initiative then communities with a lower cost structure have an incentive to approach researchers, or their sponsors, in an effort to host a subsequent research study. As long as there is a realistic possibility that researchers will relocate, then the threat of being underbid in the future puts pressure on host communities to reduce their costs and, with this, the amount of benefit that they seek in return.<sup>5</sup>

### 2.5 The result of an auction

Auction-like structures do an excellent job of realizing in practice the features of ideal markets in

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<sup>5</sup> For a brief overview of repeated auctions see (Klemperer, 2004, section 1.10.3).

(d) above that are central to the fair benefits approach. What do these outcomes look like in practice?

Suppose that the anticipated benefits of a research project can be assigned a monetary value and that a particular project is expected to generate \$10m in surplus. To model the results of this bargaining process, we assign each host community a cost for hosting this initiative by randomly drawing a number between \$100,000 and \$1m. If we randomly assign costs in this range to two host communities and carry out the auction process over and over, the average split will be \$700,000 for the host community and \$9.3m for the researcher. The average cost for the winning host community is \$400,000 so the average profit is \$300,000. If there are three communities, the average profit drops to \$225,000 (a \$550,000-\$9,450,000 split). If there are nine, the profits are a meager \$90,000 (a \$280,000-\$9,720,000 split).

What if we retain all of the assumptions above, but we assume that instead of ten million dollars in surplus that the study is expected to generate ten billion dollars? In this case, the payouts to the host community remain the same. The additional profits are absorbed entirely by the sponsor.

What if research does not impose such steep costs on host communities? If we assume, as in the previous example, that the expected profit is \$10m, but the costs to host communities are in the range of [\$0,\$100,000] then with two bidders the expected profit for the host community is \$33,333 (a split of \$66,666-\$9,933,334). For three bidders the expected profit drops to \$25,000 (a split of \$50,000-\$9,950,000), and if there are nine potential hosts the expected profit drops to \$10,000 (a split of \$20,000-\$9,980,000).

Notice now one respect in which this approach can have some counterintuitive consequences. Suppose that the costs for host communities are as described in our first example, somewhere in the range of \$100,000 and \$1m. Now suppose that an altruistically motivated researcher wants to help defray the costs that host communities might incur from hosting a research project. So he lobbies the research sponsor to use more of their own personnel, defraying personnel costs, or to bring in a mobile laboratory, defraying infrastructure costs. This altruistically motivated act would in fact work against the interests of host communities and would capture a potentially sizable increase in profit for the research sponsor. This is because defraying costs to host communities reduces the range of potential hosting costs, thereby decreasing the distance between the cost of the winner and the cost of the second highest bidder. If costs could be reduced to the range of our second example, between [\$0,\$100,000], then the benefits to host communities would decrease to those listed in the second example. In other words, with three bidders the host community's expected profit drops from \$225,000 to \$25,000 and with nine bidders it drops from \$90,000 to a paltry \$10,000.

## 2.6 Some Implications of this Model

This very brief modeling exercise allows us to answer some important questions that we raised

above. For example, would the outcomes of this process satisfy the principles that benefits to host communities must increase with burdens, with benefits to others, and track relative contributions? Under auction-like structures it is unlikely that any of these desiderata will be satisfied.

The first principle requires that the benefits to the host community must increase as the burdens to participants and the larger community increase. Under auction-like structures, however, the benefits that the host community receives (its profit) are not a function of the burdens that the research imposes on participants or the larger community. Sure, as costs for potential host communities rise, the size of the split that the host community receives will have to be larger in order to offset those costs. But “benefits” here are modeled as the share of the surplus that host communities receive that is over and above their costs. This is determined by the difference between the costs of hosting the research in the winning community and the costs of the community with the second lowest costs, and by the number of communities that are party to the negotiations.

Another way of putting this point is to say that trials that are more expensive cost more to conduct. But it does not follow from this that host communities will receive more benefit from this higher cost. Low risk or less burdensome studies for rare conditions may reward host communities with sizable profits while high risk or more burdensome studies for conditions that are quite common may produce minuscule profits for host communities. Our point is that under auction-like structures, the burdens that research subjects or host communities bear do not directly influence the share of the benefits that they receive from hosting a trial. If outcomes of this process satisfy this condition, it will be as a result of happy coincidence and *not as a result of the structure of the negotiation process itself*.

The second principle states that the share of the benefits that host communities enjoy should increase as the benefits for other stakeholders, such as sponsors, researchers, and others outside the population increase. Under auction like structures, however, the degree to which others profit from a community’s participation is basically irrelevant to determining how the surplus is divided. In particular, if we hold fixed the costs of hosting a trial and the number of bidders, then it doesn’t matter if the projected profit is two million dollars or twenty billion dollars – the expected profit of the host community does not change. If the host community can expect to receive twenty thousand dollars of benefit in the first case, that is what it can expect to receive in the latter. It is therefore important to recognize that auction-like structures function in a way that makes it unlikely that outcomes will ever satisfy this condition.

The third principle says that the benefits to host communities ought to be proportional to the community’s contribution relative to other stakeholders. Unfortunately, the proponents of the fair benefits approach have not given us a clear account of what they mean by a “contribution” here. It should be clear from the above analysis, however, that under auction-like structures, it is difficult to see how we could understand the contribution of the host community relative to those of researchers, sponsors, and others in a way that would make it relevant to determining the share

of the benefits that host communities receive. Even if there are only two communities in the world that could host a particular trial, the magnitude of the benefits that the eventual winner receives will be a function of the difference between its cost and the cost of the other community. If the trial can be conducted with few costs, and the costs of the two communities are fairly close to one another, then the host community could expect to receive fairly meager benefits.

The upshot of this analysis is that there is little reason to believe that the process at the heart of the fair benefits approach will produce outcomes that satisfy the minimal conditions of fairness that the proponents of this view themselves endorse and certainly use as grounds for rejecting other views.

This brief modeling exercise also demonstrates the potential for the fair benefits approach to result in a race to the bottom when implemented in practice. And, just so the point is clear, the process of negotiation does not have to be structured as a first-price open cry auction in order for this result to obtain. The structural features that create the incentive for host communities to lower their bids are present even in the sequential case where researchers locate their study in a particular community but have the option of relocating for subsequent studies. In fact, we argue in Appendix B that even some fairly restrictive and unrealistic requirements aimed at equalizing the bargaining power of researchers and host communities would be unlikely to prevent a race to the bottom.

Several additional factors increase the likelihood of a race to the bottom. First, there is anecdotal evidence that international research is becoming increasingly mobile and that host communities have become aware of the fact that they need to restrain their requests for benefits or risk having researchers relocate (Petryna, 2007). This is because the outsourcing of clinical trials has effectively created a market for companies whose purpose is to match research initiatives with potential host communities (McManus and Saywell, 2001; Petryna, 2007). These contract research organizations (CROs) seek profits by reducing research costs and more efficiently matching research with host communities. These companies therefore have a powerful incentive to increase the size of their “portfolio” of potential communities that might host various research initiatives. This, in turn, makes the prospect of relocation very real for host communities. It also creates a market environment where host communities are more clearly competing with one another to secure access to research.

The operation of CROs is thus making the marketplace for hosting research more competitive. Even if host communities are not bidding against one another each time they host a trial, the fact that the CRO can find a community that might be willing to host a similar study for less provides an incentive to reduce the size of the surplus that host communities seek to retain for themselves now.

What about the principle of transparency? It might come as a surprise to some to learn that it will do nothing to hinder the race to the bottom. This is largely because the race to the bottom is actually facilitated by the full information requirement of ideal theory that this principle is supposed to approximate.

More importantly, perhaps, the suggestion that the data from this repository should be advertised to LMIC communities that might be eligible to host research initiatives (Participants, 2004, 23), would serve to increase the number of potential host communities by bringing new “buyers” into the market. That is, potential host communities could see what others have received in the past and enter the market armed with the information that they need to make extremely competitive bids. After all, if I know that researchers located an ongoing study in one place for some cost  $X$ , and I know that my community could host that research for considerably less cost than  $X$ , then I have an incentive to approach the researchers, their sponsor, or their CRO in an effort to host their next initiative. Even if the proponents of this approach do not intend the database to be used as a marketing tool to bring new host communities into the market, CROs have a powerful incentive to use it this way.

Rather than averting a race to the bottom, or setting a floor for the benefits that host communities receive, the principle of transparency may actually place a ceiling on benefits as communities are forced by competition to seek less in return for hosting studies.

### 3 An independent check on fairness

One might object that the above characterization of the fair benefits approach is overly pessimistic because we have left out the regulative aspect detailed in (f) and (g). In this interpretation, the role of regulators might be to prevent a race to the bottom or to ensure that outcomes satisfy the principles that benefits to host communities must increase with burdens, with benefits to others, and track relative contributions.

This objection dramatizes deep ambiguities within the fair benefits approach because it calls into question exactly what kind of procedural approach it is supposed to be. At some points, it sounds like it is supposed to be a *pure procedural approach*. Under a pure procedural approach, an outcome or a state of affairs is regarded as fair if and only if it is the result of a particular procedure. That is, the fairness of an outcome consists in the fact that it was arrived at or produced by a particular procedure. But, if the race to the bottom is prevented by a regulator imposing some constraints on which *outcomes* are acceptable, the fair benefit approach is not a pure procedural approach. How do we determine which restrictions should be imposed by the regulator? It cannot be from this *procedure*, since the regulator must now impose on the parties outcomes that differ from those that were arrived at by the relevant procedure.

At other points, the fair benefits approach seems like it is supposed to be an *imperfect procedural approach*. In an imperfect procedural approach, the special value of the procedure lies in its ability to produce, imperfectly, but more or less reliably, outcomes that are fair. On this view, though, the fairness of the outcome is constituted by something other than its relationship to a particular process. The value of the process lies in its ability to produce outcomes that are fair according to some independent standard or criterion of fairness.

But this interpretation raises a host of new questions. In particular, what is the independent

criterion for determining the fairness of outcomes? The previous discussion illustrates how proponents of this approach sometimes appeal to at least two potentially inconsistent criteria. One criterion requires that outcomes meet the conditions that benefits to host communities increase with burdens, with benefits to others, and track relative contributions. Moreover, the claim that, “Reasonable availability fails to ensure a fair share of benefits; for instance, it may provide for too little benefit when risks are high or benefits to the sponsors great” (Participants 2002, 2133) seems to imply that satisfying at least the first two conditions is a necessary requirement for avoiding exploitation.

Alternatively, another possible criterion follows (d) in defining fair outcomes as whatever “would occur in a market transaction devoid of fraud, deception, or force, in which the parties have full information” (Participants, 2004, 20). The proponents of the fair benefits approach seem to think that they can consistently endorse both of these criteria. In light of our analysis, this now seems dubious.

So, there are two possibilities. One is to argue that fair outcomes should at least approximate the principles that benefits to host communities must increase with burdens, with benefits to others, and track relative contributions. In that case, we now need a detailed account of the procedures that will be used to enable researchers and host communities to negotiate in such a way that they are likely to arrive at outcomes that approximate these conditions. We have argued that on a number of plausible ways of making operational the conditions outlined in (d), these outcomes are unlikely to hold. If the job of ensuring that these principles are met is supposed to fall to regulators, then this would require a significant diminution of the expansive role of host community autonomy expressed in (c). On this new proposal, regulators, not host countries, would decide if a bargain is ultimately fair. Moreover, their decision would be based on a substantive view of fairness, not on a procedure. While this is a tenable position, it is very different from the original presentation of the fair benefits approach and would require a defense on substantive, rather than procedural grounds.

A second alternative would be to stick with the market norms outlined in (d) and to jettison a commitment to the principles that benefits to host communities must increase with burdens, with benefits to others, and track relative contributions. Now, the role of external regulators would be to make sure that actual agreements approximate those that would have been reached in the ideal market. In this case, we need a more precise specification of what constitutes the idealized market. For instance, is the ratio of buyers to sellers in the idealized market the same as in the actual one? If it is the same, then we are back to the discussion of section 2. That is, not only will the principles that benefits to host communities must increase with burdens, with benefits to others, and track relative contributions not hold, but regulators will not provide an external check on the bargaining process, other than ensuring that there was no deception, fraud or concealment.

Interestingly, if the ratio of buyers to sellers in the ideal market is not the same as the actual one, then regulators might play the role of adjusting bargains to reflect this ideal ratio. Although this is also an interesting proposal, it would require additional, substantive arguments to (a)

specify the ideal ratio and (b) justify using *this* feature to determine a fair distribution of benefits as opposed to some other view of fairness.

#### 4 Pure procedural justice revisited

Perhaps we have underestimated the appeal of the fair benefits approach as a pure procedural approach to issues of fairness in this context. After all, “collaborative partnership” is compelling ideal. What is there not to like about the idea that researchers and host communities should engage each other as “partners,” “collaborating” to advance shared ends, in a way that is respectful of the autonomy of the host community and its distinctive values and ends? The relationship of moral equality implied by “collaborative partnership” also strikes a welcome contrast to ethical imperialism or the inequalities of the “white man’s burden.” Since these values are the bioethics equivalent of mom and apple pie, perhaps we should follow them wherever they lead and simply call those outcomes “fair.”

This sounds good. The problem is that endorsing these values does not entail that everyone who endorses them conceives of them in the same way. Nor does it entail that one has a set of procedures that are faithful to these values in practice. Both of these problems afflict the fair benefits approach.

The view contains within it several competing conceptions of the sense in which sponsors and host community members should be treated as equals in their “partnership.” One ideal is grounded in the norms of the market. All parties should be equally free to make binding contracts in light of full information, free from fraud, coercion, and deception. Within those constraints, there is nothing unfair about participants using inequalities in urgent needs, endowments, and the like to their strategic advantage.

In contrast, different ideals of equality and partnership undergird the principles that benefits to host communities must increase with burdens, with benefits to others, and track relative contributions. Here, ideals of equal respect for welfare, partnership, and agency are conceived of in ways that differ from ideal market norms because they constrain the way that collaborators can use inequalities in endowments or urgency of needs to their strategic advantage.

The problem is not simply that these different ideals lead to incompatible outcomes, it is that the incompatibility of these outcomes reflects substantive differences in ideals of respect for others as moral equals.

Before we can know whether we should follow the procedures of the fair benefits approach wherever they lead us, therefore, its proponents need to (a) specify a consistent set of ideals that these procedures are supposed to track or embody, (b) justify the claim that these are the relevant ideals and (c) demonstrate that their procedures for realizing these values in practice are faithful to those ideals, properly understood. Our claim is not that this can’t be done—it is that there appear to be several, potentially incompatible, ways of doing this and each represents a significant departure from the original ambitions of the approach.



For example, sticking with their claim in (d) that “a fair distribution of benefits at the micro-level is based on the level of benefits that would occur in a market transaction devoid of fraud, deception, or force, in which the parties have full information” (Participants, 2004, 20) proponents might simply embrace the claim that auction-like structures represent the best way to ensure that real-world negotiations satisfy these conditions. If this process results in highly disproportionate divisions of benefits and if LMIC communities wind up receiving a lower level of benefits than they would have received under reasonable availability, then this simply shows that such outcomes are not exploitative, not that the fair benefits approach is somehow faulty.

If proponents want to move in this direction then they should drop the misleading language of “collaborative partnership.” After all, there is a sense in which online auction sites like Ebay respect the autonomy of participants and treat them as morally equal. But nobody is confused into believing that whether they get the item at the end of that process depends on the reasons that they offer to their “partners” in some collaborative, deliberative interaction. This is because there is a more important sense in which auctions, and markets in general, are designed to harness the power of *competition*, not collaboration. More importantly, they would then need to provide substantive arguments to justify what would at least now be explicit claims about the status of research as a commodity and market norms as the relevant criteria of fairness.

## 5 Moving Forward

At various points in our analysis critics might object that we have relied on questionable empirical assumptions. For instance, we note that even if researchers are committed to conducting research in a particular community, others that could host future research projects at a lower cost have an incentive to recruit researchers away. But it might be objected that hosting a trial may give that community an advantage over other communities and make it more likely that they could retain future research initiatives while still increasing the benefits that they receive. So things might not turn out as badly as our model predicts. And perhaps this is the case with other features of our model as well.

Several responses to are in order. First, our analysis is intended to illustrate the importance of providing stakeholders with some framework for assessing the normative claims that one makes on behalf of a proposed procedural approach. This framework should clarify for stakeholders how the proposed procedures are likely to behave, given realistic assumptions, and it should help stakeholders understand the variables that will determine how the approach performs in actual practice. Proponents of the fair benefits approach have not done this. We have tried to fill this gap. If proponents of the fair benefits approach have a different model to propose, they are welcome to elaborate it. But it is not a vindication of the fair benefits approach, as it has been articulated to date, to leave our model and its general conclusions unchallenged and simply to hope that something will happen in actual practice that will avert its predictions from coming to pass.

Second, one advantage of articulating a model of the form that we provide is that it makes such questions more tractable by bringing into focus the set of factors or variables that are relevant to the model's predictions. In this case, for example, whether researchers are likely to relocate may in no small part depend on the extent to which the relevant stakeholders view research as just another form of economic exchange. Research sponsors, after all, are under constant pressure to cut costs and to make their basket of resources stretch farther. We suspect that, if anything, the fair benefits approach contributes to the view that research is an economic opportunity that is rightly governed by market norms. As such, the widespread endorsement of this view may reduce the inhibitions of various stakeholders to relocate research when doing so can be justified on economic grounds.

Third, in all cases, the probability that researchers will relocate in the future hinges on whether other communities can make themselves more attractive hosts. It would be a mistake to understand this claim as somehow imputing crude or insensitive motives to researchers. One of the points of our analysis is that the motives of various parties may matter much less than structural features of the system in which those parties are constrained to act. Researchers may have deep commitments to host communities, but they may not be able to live up to those commitments if they are under pressure from sponsors or others to relocate in order to cut costs. In fact, we have shown that the way that a particular system is structured can have such far reaching consequences that it can create situations in which altruistically motivated acts have unintended, deleterious consequences.

Nothing in our analysis presupposes that stakeholders have unsavory motivations. Nevertheless, it is important to recognize that there are armies of well-paid professionals who make their living analyzing systems and figuring out how to maximize the returns of their firms. "Gaming the system" may be frowned upon in some forms of "collaborative partnership," but in the market, the ability to work the system to one's advantage is regarded as a virtue, rather than a vice. Since market norms play such a pervasive role in the fair benefits approach, these concerns are centrally relevant.

One implication of the analysis presented here is that the fair benefits approach could easily wind up functioning in practice as a kind of ethical Trojan horse. Ambiguities and inconsistencies at the conceptual level may make it attractive to a broad range of stakeholders, each of whom has a different view of how to understand and reconcile its core commitments. But when it is carried out in practice, this view may simply entail that LMICs are free to "collaborate" in research that advances the health interests of HIC populations while HIC sponsors are free to use their considerable bargaining power to capture almost all of the benefits generated by such collaborations.

We have also argued that in order to clarify the normative content of their position, proponents of this approach cannot avoid engaging substantive issues of fairness and justice. In this regard, both proponents and critics of the fair benefits approach need to pay greater attention to a move that the fair benefits approach uses to shape the terms of the debate, but for which we

can find no explicit argumentation. Recall that Wertheimer treats exploitation as a micro-level concern. It is a property of discrete interactions between individual actors and it is supposed to be independent of broader background concerns about rights and justice. As we mentioned above, the key issue on this view is not which benefits are received, but how much. This in turn motivates the view that whether a particular research project is aligned with and focused on the health needs of the host community is less relevant (if it is relevant at all) than the question of whether they receive a sufficient level of benefits in return for hosting the study. And this leads to a view that effectively treats research as a commodity.

But even if one were to agree, for the sake of argument, that Wertheimer's view of exploitation is the correct view of that concept, this does not establish (1) that the most fundamental or important ethical issues in the context of international research are those that occur at the micro-level, (2) that researchers (as opposed to other stakeholders such as governments, NGOs, or funding agencies) should be seen as the primary duty bearers in this context, or (3) that to the extent that researchers do have duties in this context that they should be treated essentially as private parties with no prior obligations that are relevant to the exchange.

Moreover, we regard questions about the funding, regulation, and conduct of international research as issues of institutional design. But concerns about the fairness of *institutional systems* cannot be accommodated within Wertheimer's account of exploitation since his view applies only to the discrete interactions of individuals and not to the operation of institutions.

All sides of this debate need to be careful that in sharpening or refining the concept of "exploitation" they do not beg the question against those who view clinical and public health research as unique social goods, who think that we in HICs have a duty to unlock the power of science to advance the health interests of LMIC populations, and who ground such duties in larger norms of social, distributive, or rectificatory justice.

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# Supplimentary material for “Research at the Auction Block: Problems for the Fair Benefits Approach to International Research”

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## Appendix A Underlying Assumptions

How plausible are the assumptions that are required in order for the revenue equivalence theorem to hold? First, let the various costs to host communities from hosting a research initiative be represented as  $c_i$ , where  $i$  represents each potential host community. From the point of view of the other communities this value is a random variable independently drawn for each country from some distribution with a cumulative distribution  $p(\cdot)$ . Let  $v$  represent the surplus value generated by the study for the researcher. We then assume:

- **Supply and Demand Imbalance:** At any time, the number of potential host communities is greater than the number of potential research studies by at least one.
- **No Risk Seeking:** Parties to a bargain do not seek risk for its own sake.
- **Highest bidder:** Whatever the price paid, researchers will choose the community that represents the lowest cost to them.
- **Last place:** If a community has the highest possible cost, it expects to get zero surplus from the negotiation process.
- **Smooth distribution:**  $p(\cdot)$  is strictly increasing and atomless over some range  $[c_{min}, c_{max}]$

- **Common knowledge:** The value of the research, the distribution of costs,  $p(\cdot)$ , the structure of the bidding process, and the number of potential bidders is all common knowledge.

These assumptions appear to present a fair representation of the situation of most LMIC communities. The supply and demand imbalance represents the fact that for most diseases there are more communities that could host a research project that targets a given disease than there are studies targeting that condition. This does not require that there be more communities than research projects in total since a single community can host multiple studies. In fact, all that is required is that there are at least two potential host communities for each study.

The no risk seeking assumption is very weak. It merely requires that no party to one of these bargains has a positive utility for risk, as such. This does not mean that the various communities will not differ in their tolerance for risk. It means that they are not like mountain climbers or sky-divers, where they seek out this activity precisely because it is risky. This assumption does not prohibit risk aversion, but we do not assume it. If we did, then the expected profit for the researcher would actually increase since a community with a low cost would be willing to bid more to ensure it was able to host the research and thus get something rather than nothing.

The highest bidder assumption simply entails that researchers choose to locate their research in communities that have the lowest apparent costs (where apparent means the cost to the researcher not the actual cost of hosting the research borne by the host community). It is important to emphasize that this assumption does not entail or imply that researchers are themselves selfish, purely profit driven, or acquisitive. It implies only that they are motivated to choose host communities that reduce their costs. It may be, for instance, that researchers would like to be as generous as possible but they are under pressure from sponsors to minimize research costs. This is a plausible scenario since sponsors want to maximize the number of research studies that can be funded from a fixed research budget. In fact, this has lead some research sponsors, such as the U.S. National Institutes of Health, to limit the use of research funds to costs that are directly associated with the conduct of the research in question.

The last place assumption also appears to be fairly uncontroversial. It holds that if a community has the highest conceivable cost (i.e.,  $c_{max}$ ) then they expect either not to host the research, because someone will have out

bid them, or to give all the surplus minus their cost to the researcher, since otherwise the researcher could have done better.

The smooth distribution assumption requires that there is some range of costs such that there are no values that are impossible. It would be strange, for instance, for a community to think that another's costs might be  $x$  or  $y$  but nothing in between.

The common knowledge assumption is perhaps the strongest since it requires both that all parties be aware of many things and also that they know what others know. Recall, however, that the proponents of the fair benefits approach suggest that eliminating informational asymmetries is a primary aim of the centralized database. The common knowledge assumption represents a sort of extreme success of this project, since the only private information is known by the individual communities. While these assumptions are required for the proof of the revenue equivalence theorem, it should not be presumed that if this constraint were relaxed more equal distributions would thus be possible. As is the case with all of these assumptions, they are sufficient, but not necessary for the proscribed outcomes.

Given these assumptions, the revenue equivalence theorem entails that regardless of the auction mechanism, the expected outcome for the researcher is the same – namely to keep all of the value minus the expected second lowest cost.



## Appendix B Formal model of constrained bargaining

In this appendix we consider a non-auction mechanism which we regard as implausibly restrictive. We present it primarily as an illustration to show how even very restrictive bargaining mechanisms can produce very skewed distributions in favor of the researcher.

What if proponents of the fair benefits approach wanted to prohibit both simultaneous and sequential negotiations with multiple host communities in an attempt to equalize the relative bargaining power of the parties? Could they require, for each research project, that researchers must first choose a host community with which to partner and only then conduct negotiations about the division of benefits?

The first problem with this proposal is that it would require an implausibly strong restriction on research. In order to distinguish this from the various auction-like mechanisms, it would have to be the case that if negotiations fail the researcher is not allowed to conduct this research anywhere. Otherwise, we would have a case of multiple, sequential negotiations, and the result from auctions would apply.

Perhaps more importantly, however, even this more restrained process can still result in a race to the bottom. In one sense, this process fares better than the previous proposals, since once researchers chose a community they are committed to finding an acceptable bargain with that community and simultaneous competitive bids have been prohibited. As a result, this setup includes more equitable divisions of the surplus as possible outcomes. However, even this setup does not entirely equalize the bargaining power of the parties. The inequality persists because there will always be future studies and communities with lower costs have an incentive to lure researchers to their venues.<sup>1</sup> Further work is needed, therefore, in order to ascertain how plausible it is that more equitable outcomes will result from adopting this structure for negotiations.

In what follows we develop a formal model and show that in it there are a litany of potential agreements (Nash equilibria) that range from the host community getting almost the entire surplus to outcomes where the host

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<sup>1</sup>(Petryna 2007) provides an example where a host community engages in ethically questionable behavior for fear that future research by that firm would be conducted elsewhere if they adhered to more strict standards.

community expects very little surplus. If we use a more restrictive predictive tool from cooperative game theory known as the Core, we find that only a few outcomes are possible, all of which involve the host community receiving very little surplus. Informally, an outcome is in the Core if it is immune from the possibility of a coalition of players banding together to switch strategies. While there are valid criticisms of the Core we argue that there are features of this circumstance which make it a plausible predictive tool.

Informally our argument regarding the Core works like this. Suppose a bargain is struck between a researcher and host community that results in a close to equal division of resources. Since there are Nash equilibria with this result, it is a possible outcome of this setup. Now suppose, thanks to the public repository of past agreements, that another community sees the terms on which the present bargain was struck and finds that it could host a similar research project for less, allowing the researcher to keep more of the surplus. The coalition between the researcher and this new host community is better for both parties, and does not require the cooperation of anyone else. As a result, the equilibria with an equal division is not in the Core, and so we expect would not be a stable result of this process. In fact, since this possibility exists and can be predicted by others, we expect that initial bargains may be very biased as host countries attempt to prevent underbidding on future projects.

This shows, again, how this more rigid structure acts much like an auction when implemented. The only agreements that are in the Core are divisions where the host community agrees to keep very little of the surplus, if it can afford to. The amount it offers to keep must be so small, that it would not pay to switch to another community since they would only rarely be able to afford a bargain that is better for the researcher. This represents a standard race to the bottom where each community tries to eek out some profit by underbidding the previous winner. We expect that the fact that researchers engage in several different projects over time will lead to the only equilibrium that is immune from this process – one where the host community expects very little surplus.

It is this informal dynamic process that we think would be encouraged by the presence of the database. The publicly accessible record of previous negotiations actually enhances the ability of lower-cost communities to realize that they may be able to secure a benefit by underbidding current host communities. In this sense, if the database does anything, it works to the detriment of the host community.

## B.1 Formal discussion

This model utilizes some of the assumptions used for the revenue equivalence theorem. We drop the Highest Bidder and Last place assumptions, and strengthen the assumption about risk to require that all parties are risk neutral. Some results will change if some of the parties are risk averse (willing to pay to avoid risk), but we do not expect this will radically alter the results. We do preserve the assumption that the researcher wishes to locate the research in the community which has the lowest cost to them.

Suppose there is a set of players  $\{E, 1, \dots, n\}$  (where  $E$  represents the researcher, and each number a community).  $E$ 's strategy is a community,  $i \in \{1, \dots, n\}$  and a bottom line  $b_E$ .  $b_E$  represents the point at which  $E$  will refuse to conduct the research rather than accept a split of the value less than that. Each individual community,  $i$ , chooses a bottom line as well  $b_i$ .

Like the auction case we will assume that there is cost for the research for each individual community  $c_i$  which is drawn from some common distribution. We assume the community, but not the researcher, is aware of the actual  $c_i$ , but the distribution is common knowledge.

Let  $f_i(x)$  represent the outcome of the bargaining process when the bottom lines differ by  $x$ . This represents the amount of the surplus value is allocated to the researcher when the bottom lines are compatible. As an example, suppose that the value of the research is 10. Suppose the researcher chooses community  $x$  and a bottom line of 3. Suppose community  $x$  chooses a bottom line of 5. We know that they will reach an agreement, since they have compatible bottom lines.  $f_x(2)$  represents how much of the extra 2 units is kept by the researcher. So in total, the researcher receives  $3 + f_x(2)$  and the community receives  $5 + (2 - f_x(2)) - c_x$  (their bottom line, plus their part of the surplus, minus the cost they have to expend to support the research).

Let  $E$ 's strategy be  $\langle i, b_e \rangle$  and community  $i$ 's strategy be  $b_i$ . The players utility functions are:

$$\pi_E = \begin{cases} b_e + f_i(v - b_e - b_i) & \text{If } b_e + b_i \leq v \\ 0 & \text{Otherwise} \end{cases} \quad (1)$$

$$\pi_i = \begin{cases} b_i + (v - f_i(v - b_e - b_i)) - c_i & \text{If } b_e + b_i \leq v \\ 0 & \text{Otherwise} \end{cases} \quad (2)$$

$$\pi_j = 0 \text{ For all } j \neq i \quad (3)$$

Suppose that the  $f_i(\cdot)$  functions are unknown to any players, but drawn

from a commonly known distribution. Let  $\mathcal{E}_f(x)$  be the expected value of  $f_i(x)$  given the common distribution for  $f$ . Let  $\mathcal{E}_c$  be the expected value of  $c$  given the common distribution. Then the expected utilities of the given players is given by the following equations:

$$u_E = \begin{cases} b_e + \mathcal{E}_f(v - b_e - b_i) & \text{If } b_e + b_i \leq v \\ 0 & \text{Otherwise} \end{cases} \quad (4)$$

$$u_i = \begin{cases} b_i + (v - \mathcal{E}_f(v - b_e - b_i)) - c_i & \text{If } b_e + b_i \leq v \\ 0 & \text{Otherwise} \end{cases} \quad (5)$$

$$u_j = 0 \text{ For all } j \neq i \quad (6)$$

**Proposition 1 (Negotiation irrelevance)** *Suppose a Bayes Nash equilibrium where  $E$ 's strategy is  $\langle i, b_e^* \rangle$  and  $i$ 's strategy is  $b_i^*$  and  $b_e^* + b_i^* \leq v$ , then  $b_e^* + b_i^* = v$ .*

*Proof* We will show that there cannot be a Bayes Nash equilibrium where  $b_e^* + b_i^* < v$ . Suppose a strategy for  $E$ ,  $\langle i, b_e \rangle$  and a strategy for  $i$ ,  $b_i$  such that  $b_e + b_i < v$ . Suppose that  $\mathcal{E}_f(v - b'_e - b_i) = 0$  and choose a  $b'_e$  such that  $b_i > b'_e > b_e$ . The  $b'_e$  performs strictly better. A symmetric argument can be made for  $i$  when  $\mathcal{E}_f > 0$ .  $\square$

This proposition shows that, in equilibrium, the process of negotiation is irrelevant. One player or another expects to lose something in the negotiation and so has an incentive to increase their bottom line so as to not be taken advantage of in the process of negotiation. This allows us to ignore the negotiation process in considering equilibria.

Given this, we can easily see that no community will adopt a bottom line lower than their cost, since they are sure to receive a negative payoff. However, there are many different equilibria.

**Proposition 2 (Any division)** *Let  $x = \max_e p(v-e)e$ , let  $y$  be any number such that  $0 \leq y \leq x$ , there is a Bayes Nash equilibrium where  $E$ 's strategy is  $\langle i, y \rangle$  and  $i$  proposes  $v - y$  if  $v - y \geq c_i$ .*

*Proof* Suppose  $y$  as above. We will construct Bayes Nash equilibrium where  $E$  proposes  $y$ . Let  $E$ 's strategy be  $\langle i, y \rangle$ ,  $i$ 's strategy be  $v - y$  if  $v - y \geq c_i$  and  $c_i$  otherwise. For all  $j \neq i$  let  $b_j = v$ . Since  $i$  never proposes less than  $c_i$  her payoff cannot be less than zero. Larger values of  $b_i$  result in

zero payoff regardless of  $c_i$ , so  $i$ 's strategy represents a best response for  $i$ . No alternative strategies for  $j \neq i$  will increase their payoff.

Now consider the researcher. If  $c_i \leq v - y$  then the researcher receives  $y$ , otherwise 0. The probability that  $c_i \leq v - y$  is  $p(v - y)$  and the expected utility for the researcher is  $p(v - y)y$ . Bidding more will result in an expected payoff of 0, and so cannot be superior. Consider  $z < y$ . This has expected payoff  $p(v - z)z$ . But the function  $f(a) = p(v - a)a$  is strictly decreasing as  $a$  moves away from  $x$ . So,  $p(v - z)z$  is strictly lower than  $p(v - y)y$ .  $\square$

Essentially  $x$  in the proof represents the optimal amount to ask for when the community bids to keep  $c_i$ . When  $y = x$  this is the favored equilibrium for the researcher and the most disfavored equilibrium for the community. This proposition shows that there is an improvement in this model over the previous auction model. Here there are equilibria where there are equitable divisions between researcher and host community. But this is far from the result desired. While equitable divisions are equilibria, so too are inequitable ones. So equitable outcomes are far from guaranteed. Even worse, inequitable equilibria have features which make us expect them more often than equitable ones as well – unfair equilibria are the only equilibria in the Core.

The Core represents a type of equilibria which is resilient to coalition formation. If an equilibria is in the Core, players cannot form coalitions of two or more players to move to another outcome. In this game, the only equilibria that are in the Core are those that result in the researcher keeping significant amounts of the value of the research for himself and the sponsor.

**Proposition 3** *Let  $y < \max_e p(v - e)e$ , let  $E$ 's strategy be  $\langle i, y \rangle$  and  $i$ 's strategy be  $v - y$  if  $v - y \geq c_i$ . Suppose all other communities strategies are such that this constitutes a Nash equilibrium. This strategy is not in the Core.*

*Proof*  $E$ 's expected utility from this strategy is  $p(v - y)y$  The payoff to all communities  $j \neq i$  is 0. Consider the strategy set where  $E$  plays  $\langle j, z \rangle$  for some  $z > y$  and  $z < \max_e p(v - e)e$ , and  $j$  plays  $v - z$  if  $v - z \geq c_j$ .  $E$ 's expected utility from this strategy is higher since it is closer to his preferred equilibrium (the maximum of  $p(v - e)e$ ) and this function is strictly increasing as one approaches the maximum. This equilibrium is also better for  $j$  – his expected utility is non-zero since  $z < \max_e p(v - e)e$ . As a result  $E$  and  $j$  form a collation which strictly prefers this strategy set to the other.  $\square$

It should be easy to see that the only strategy sets which are in the Core are those where the host community receives very low expected utility (the favored equilibria of the researcher). This result does depend on a slightly odd structure for the choice of strategy. Here the community is promising to choose a contingent strategy which is better for the researcher than the status quo strategy. However, this contingent strategy presumes that the community was unaware of its cost when making that promise. If we were to suppose that the communities were aware of their costs when offering to form the coalition with the researcher, than the results would be identical to the auction.

While the Core is occasionally criticized as an inappropriate predictive tool, we believe it is appropriate in this case. First, the non-Core equilibria are destabilized by a very small coalition. It does not require significant coordination. Second, the repeated process introduced by multiple projects over time makes the possibility of renegotiation very real. In fact, the presence of the database is likely to speed up this race to the bottom (in this case the Core), since a potential “outbidder” can use the database to determine what offer to make.