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Sequential Bargaining, Land Assembly, and the Holdout Problem

by

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Abstract: Although the holdout problem is a well-established part of legal and economic lore, the exact source of the problem is not well understood. The problem is usually attributed to high transaction costs or excessive bargaining power on the part of sellers once they recognize the scope of the project. In an effort to isolate the essential features of the problem, this paper considers the simplest possible setting in which a buyer bargains sequentially with a series of sellers, each of whose land is necessary to realize the gain from a large-scale project. Using ordinary Nash bargaining and assuming complete information, we identify a minimum set of factors that give rise to a holdout problem, which highlight the importance of commitment and the inefficiency of partial assembly.

Key words: Bargaining, holdout problem, land assembly
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1. Introduction

The need to assemble land is common in urban settings, whether it be for construction of a highway, an urban renewal project, or a large scale private development. Generally, however, assembly is viewed as a potential impediment to the successful completion of such projects due to the holdout problem. In response, local and state governments often resort to eminent domain for those projects that meet the requirements of the Fifth Amendment Takings Clause, while private developers commonly employ secret buying agents or other strategies to disguise the scope of their projects for as long as possible (Kelly, 2006).

Although the holdout problem is a well-established part of legal and economic lore, the exact source of the problem is not well understood. The problem is often vaguely linked to such factors as high transaction costs, imperfect information, excessive bargaining power on the part of sellers once they recognize the scope of the project, the need for contiguous parcels to complete a given project, or strategic behavior by sellers. In an effort to isolate the essential features of the problem, this paper considers the simplest possible setting in which a buyer bargains sequentially with a series of sellers, each of whose land is necessary to realize the gain from a large-scale development project. Using ordinary Nash bargaining and assuming complete information, we identify a minimum set of factors that give rise to a holdout problem. These factors are: (i) sequential bargaining between a buyer and multiple landowners, (ii) commitment during the bargaining process (i.e., all sales are final), and (iii) the reservation price of current landowners exceeds the value of individual parcels to the buyer (so that partial assembly is inefficient). We show that the combination of these factors leads to a holdout problem that may result in the buyer's failure to undertake an otherwise beneficial project. Although other studies have shown that a holdout problem can also arise in models with more complex bargaining or information structures, our objective is to show that a much simpler set of circumstances is sufficient to impede the efficient assembly of land.

The remainder of the paper is organized as follows. Section 2 provides a brief review of the previous literature on the holdout problem. Section 3 then develops the model and proves our main results, first for the simple case of two parcels, and then for the general case. Section 4 highlights the importance of commitment by examining purchase agreements in which the buyer has the right to cancel previously negotiated sales at any time during the assembly process, and the use of option contracts to acquire the needed land. We show that both approaches eliminate the holdout problem. Section 5 presents an extension of the model in which the buyer can make a non-salvageable investment in preparation for the project and shows that a second inefficiency emerges, attributable to the "holdup" problem. Finally, Section 6 concludes.

2. Previous Characterizations of the Holdout Problem

As a prelude to our analysis, and as an illustration of the lack of a consensus in the literature, it will be instructive to describe some of the previous theories of the holdout problem. Munch (1976, p. 474), in a paper on the use of eminent domain to overcome holdouts, offers a typically equivocal description:

> Consolidation of many contiguous but separately owned parcels of land under one owner supposedly creates a holdout problem, with each seller having an incentive to hold out to be the last to settle and capture any rent accruing to the assembly. Because of either

> monopoly prices of sellers or high transaction costs or both, … the free market results in a suboptimal amount of assembly being undertaken.

Posner (2003, p. 55) similarly attributes the holdout problem to a combination of monopoly power by landowners in the path of an advancing highway or railroad line, and high transaction costs of land acquisition. In this same vein, Cooter (2000, p. 289) emphasizes the advantage of being the last seller, which "gives each owner an incentive to delay the sale, thus increasing the project's transaction costs."

Goldberg (1985) and Heller (1998, 2008) focus on a different problem associated with assembly: namely, the number of sellers who have to reach an agreement before a project can go forward. Goldberg characterizes the problem as one of rent-seeking by sellers, while Heller sees it as a variant of the anti-commons problem "in which multiple owners hold effective rights of exclusion in a scarce resource" (Heller, 1998, p. 668). Either way, the result is a "one-way ratchet" in land transactions that makes it easier to disassemble land than to assemble it (Heller, 2008, p. 111).[1]

Various efforts have been made to examine the land assembly problem more formally using game theory. For example, in the urban economics literature, Eckart (1985) uses cooperative game theory in a context of imperfect information to examine how collusion among landowners will affect acquisition prices. Asami (1988) also uses cooperative game theory and coalition formation, but his emphasis is on the distribution of rents from a project that requires assembly of contiguous parcels. O'Flaherty (1994) focuses instead on externalities that arise from assembly projects and shows that, because profit-maximizing developers ignore the

[1] Interestingly, Parisi (2002) likens this asymmetry to the Second Law of Thermodynamics in physics, which says that the extent of entropy, or disorder, in a closed system will increase over time.

spillover effects of their projects on neighboring landowners, the scale of assembly will be inefficiently small.

Strange (1995) and Shavell (2010) emphasize the buyer's lack of information about individual seller reservation prices as the principal source of the inefficiency from holdouts. Shavell (2010, p. 4), however, characterizes sellers is this case as "honest holdouts" (as distinct from "strategic holdouts") because they are not seeking prices in excess of their true valuations. Still, the problem of inefficient assembly remains because the failure of any one owner to sell (for whatever reason) potentially scuttles the whole project.

Menezes and Pitchford (2004) and Miceli and Segerson (2007) examine holdouts in a simple bargaining context, but in contrast to the current paper, they couple it with a non-cooperative "entry game" wherein sellers decide when to bargain with the buyer. Both papers assume that all mutually beneficial transactions are eventually completed, so the inefficiency is solely due to a cost of delay in completing the project. Cai (2000, 2003) similarly focuses on delay in a context where landowners strategically choose their bargaining order, but he uses the Rubinstein (1982) bargaining model rather than Nash bargaining. His basic conclusions, however, are similar—namely, that delay in the completion of the project (including infinite delay) is a possible outcome of the assembly game. Moreover, the threat of delay increases with the number of sellers with whom the buyer must bargain.

In terms of the existing literature, our modeling approach is closest to Asami and Teraki (1991), who also use a sequential Nash bargaining model of assembly with complete information and commitment. However, in their model the buyer expects a non-negative profit from the assembly project, no matter how many parcels it requires (though the buyer's share of the profit may be small), implying that partial assembly is not inefficient. As a result, their model does not give rise to a holdout problem.

In contrast to the previous literature, our model identifies a set of assumptions about the bargaining context and the characteristics of the project that we show are critical to generating the holdout problem. In so doing, we abstract from—and hence show that the holdout problem does not necessarily hinge on—factors such as high transaction costs, imperfect information, contiguous parcels, or strategic behavior (e.g., endogenous ordering).

3. The Model

Consider a buyer who wishes to assemble a large number ($n \geq 2$) of individually owned parcels of land for purposes of undertaking a large development project.[2] Let the gross value to the buyer of the completed project be V, which is known to all parties. For simplicity, we assume that each of the individually-owned parcels is identical and is worth R to its current owner, reflecting the lowest price that he or she would accept in a consensual sale. Further, the buyer is assumed to know R.

We assume that

$$V > nR, \qquad (1)$$

which implies that completion of the project is efficient. We will also need to assume something about the value of "partial" assembly to the buyer. This depends on how the buyer's valuation function varies with the number of parcels assembled. The natural assumption in an assembly

[2] We do not distinguish between public and private projects as the essential features of the problem do not depend on the identity of the buyer or the particular nature of the project.

context is that this function is convex, reflecting economies of scale in parcel size.[3] It follows that an individual parcel is worth less than its average value once all n parcels are assembled, or

$$v < V/n, \tag{2}$$

where $v \geq 0$ is the (fixed) value of an individual parcel to the buyer. In the extreme case where the project cannot commence until all parcels are acquired, individual parcels are worth zero to the buyer until all are assembled.

Also important is the relationship between v and R. (Note that conditions (1) and (2) do not establish a necessary relationship between these two values.) We will assume that

$$v \leq R, \tag{3}$$

or that sellers value their parcels at least as much as the buyer. Thus, we focus on the case where the buyer's only reason for acquiring individual parcels is for purposes of the assembly. A case of particular interest will be $v<R$; that is, where sellers value their individual parcels strictly more than does the buyer. That is, partial assembly is inefficient in the sense that it is best that the land remain with the original owners unless all n parcels can be acquired.

We model the process by which the buyer assembles the land as a sequential bargaining game where the buyer negotiates with each seller in turn until he has acquired all n parcels. The order of bargaining is exogenous, and prices are determined by simple Nash bargaining at each stage. Also, once the buyer and seller agree to a price, the sale is final and neither the buyer nor the seller can back out, even if the project falls through. (We relax this assumption in Section 4 below.) We illustrate the outcome of this bargaining game by first considering the simple case of $n=2$.

3.1. The Two-parcel Case

[3] See Colwell and Munneke (1999) for some empirical evidence on the relationship between land value and parcel size in an urban setting.

As usual, we derive the outcome in reverse sequence of time. Thus, suppose that the buyer has successfully acquired the first parcel for a price equal to P_1. The buyer's threat point in his bargaining with the second seller is therefore v, and his net surplus from a successful purchase is $V-v-P_2$. (Note that P_1 does not enter this expression because it is a sunk cost.) The seller's threat point, on the other hand, is R and her net surplus from a sale is P_2-R. Nash bargaining thus produces a price equal to

$$P_2 = \frac{V+R-v}{2}, \tag{4}$$

which, given equal bargaining strengths, divides the net surplus, $V-v-R$, evenly.

Now consider bargaining between the buyer and the first seller. In this case, the buyer's threat point is zero, but if he successfully acquires the first parcel, his surplus will be $V-P_2-P_1$, given that he rationally anticipates that he will buy the second parcel for P_2. The seller's surplus is the same as above and is equal to P_1-R. The resulting price is given by

$$P_1 = \frac{V+R-P_2}{2},$$

or, after substituting from (4),

$$P_1 = \frac{V+R+v}{4}. \tag{5}$$

It is apparent that the prices are not generally the same. In fact, we can show that $P_2>P_1$. To see this, form the difference

$$P_2 - P_1 = \frac{V+R-3v}{4}, \tag{6}$$

which is positive by (1) and (3). This result reflects the conventional wisdom that it is better (more profitable) for sellers to sell later—that is, "holding out" is profitable.

We can also examine the impact of sequential bargaining on efficiency by noting that the buyer will only initiate the above process if he expects to make a profit from the assembled parcels, or if $V-P_1-P_2\geq 0$. Using (4) and (5), this condition is equivalent to

$$V \geq 2R + (R - v). \tag{7}$$

If $v=R$ this is equivalent to (1), and the project will go forward if and only if it is efficient. In other words, bargaining does not impede the efficient completion of the project. Alternatively, suppose $R>v$. Now condition (1) is necessary but not sufficient for (7) to hold. Thus, some efficient projects will be foregone. This conclusion reveals that the source of the inefficiency usually attributed to the holdout problem is the fact that $R>v$, or that a single parcel is worth less to the developer than it is to its current owner. Intuitively, once the buyer acquires the first parcel, he has essentially committed himself to complete the project or he will suffer a loss. Knowing this, the second seller acquires a bargaining advantage that allows her to extract a higher price than she would have been able to obtain if $v=R$.

3.2. The n-parcel Case

This section generalizes the basic results from the previous section to any $n \geq 2$. The process by which the parcels are acquired is the same as above, beginning with seller n and working backwards in time to seller one. The general formula for the price at any stage in this process is given by

$$P_s = v + \frac{V + R - (n+1)v}{2^{n-s+1}}, \qquad s = 1, \ldots, n. \tag{8}$$

Note that this expression is strictly positive by (1) and (3). Further, we can prove

Proposition 1: P_s is increasing in s.

Proof: The result follows immediately from (8). ■

This result generalizes the above conclusion that later sellers enjoy a bargaining advantage relative to early sellers. More specifically, it shows that the price rises gradually with successive bargains, reaching a maximum for the nth seller.

It is instructive to derive the expression for (8) for the case where $v=R$:

$$P_s = R + \frac{1}{2^{n-s+1}}(V - nR). \quad (9)$$

In this case, individual parcels are equally valuable to the buyer and sellers. Assembly of all *n* parcels, however, yields a surplus of $V - nR$. Sellers know this and are therefore able to extract a share of the surplus that is increasing over time. In fact, (9) reveals the manner by which this surplus is divided among the *n* sellers: the *n*th seller ($s=n$) obtains half of the surplus, while the share obtained by each of the previous sellers "decays" by a factor of one-half. Based on this observation, we can prove

Proposition 2: When $v=R$, the buyer expects to receive a strictly positive surplus from the project for a finite *n*.

Proof: Note that $\lim_{n\to\infty} \sum_{s=1}^{n} \frac{1}{2^{n-s+1}} = 1$. Thus, the sum of the sellers' shares of the surplus from the project is strictly less than one for a finite *n*. ■

This generalizes the above result that when $v=R$, sequential bargaining does not impede efficient assembly. That is, prior to commencing with land purchases, the buyer expects to receive a positive surplus from the assembly project if and only if (1) holds.

Finally, consider the case where $v<R$. Using (8), we can compute the sum of the prices for all sellers to be

$$\sum_{s=1}^{n} P_s = \frac{(2^n-1)(V+R)+[n-(2^n-1)]v}{2^n}. \quad (10)$$

Based on this expression, we can prove

Proposition 3: Assume $v<R$. Then, given (1) and (2), the gross value of the project, *V*, may or may not exceed the sum of the prices in (10).

Proof: Using (10), we can show that the $V - \sum_{s=1}^{n} P_s$ is non-negative if and only if

$$V \geq nR + [(2^n - 1) - n](R - v). \quad (11)$$

Since $(2^n-1)-n>0$ for $n\geq 2$ and $R-v>0$, the second term on the right-hand side is strictly positive. Thus, (1) is necessary but not sufficient for (11) to hold. ■

This result shows that when $v<R$, the sum of the sale prices may exceed the buyer's gross value of the project, even though that value is assumed to exceed the sum of the sellers' reservation prices. As a result, some efficient projects will be foregone. This result generalizes the above conclusion that $v<R$ is the true source of the inefficiency associated with the holdout problem when there is sequential bargaining and commitment.

4. The Right of Cancellation and Option Contracts

In the previous sections we showed that, given sequential bargaining and commitment, the inefficiency of partial assembly alone generates the holdout problem. In this section, we show the critical role that commitment plays in this result. Toward this end, we consider two alternative approaches to the land acquisition process. In the first, the buyer retains the right to cancel any previously negotiated sales without penalty at any point in the assembly process (Asami and Teraki, 1990), and in the second, the buyer acquires an option from sellers to purchase their property over some time period at a pre-specified price (Cooter, 1985). We show that both approaches overcome the above inefficiency associated with holdouts.

Consider first the cancellation approach. As above, we first illustrate the outcome for the case of n=2. Using backwards induction, we suppose that the buyer has succeeded in acquiring the first parcel for a price of P_1. If he also acquires the second parcel for a price of P_2, his net return will be $V–P_1–P_2$, but if he fails, he can either hold onto the first parcel for a return of $v–P_1$ (as was necessary in the above model), or he can cancel the sale and get zero. Note that $P_1\geq R$ for the seller to accept the price P_1, which, coupled with (2), implies that $v–P_1\leq 0$. Thus, the buyer is at least as well off cancelling the first sale as going through with it, and is strictly better off if $v<R$. This implies that the buyer's threat point in negotiating with seller two is zero, while the seller's threat point, as above, is R. The Nash bargaining solution in this case is therefore

$$P_2 = \frac{V - P_1 + R}{2}. \tag{12}$$

Now move back to the buyer's negotiation with the first seller. If the buyer acquires this parcel and also anticipates acquiring the second, his return will be $V–P_1–P_2$, but if he fails he will get zero. The first seller again receives a net gain of $P_1–R$ from agreeing to a sale, and zero otherwise. Bargaining thus yields a price of

$$P_1 = \frac{V - P_2 + R}{2}. \tag{13}$$

Solving (12) and (13) simultaneously yields

$$P_1 = P_2 = \frac{V + R}{3}. \tag{14}$$

The resulting net return for the buyer is

$$V - P_1 - P_2 = \frac{V - 2R}{3}, \tag{15}$$

which is strictly positive by the assumption that the project is socially desirable (i.e., $V>2R$). The corresponding return for each of the sellers is

$$P_s - R = \frac{V - 2R}{3}, \qquad s = 1, 2. \tag{16}$$

Thus, the three parties end up sharing the total surplus equally, which is just the outcome under multi-lateral Nash bargaining with more than two equal players (Osborne and Rubinstein, 1990, p. 23). Unlike in the model with commitment, there is no inefficiency from the holdout problem here, even if $v<R$, because the buyer can cancel prior sales in event of a failed negotiation at any point in the assembly process.

Cooter (1985, p. 22) proposed the use of option contracts for land assemblers to overcome the moral hazard problem associated with compensation for takings (Blume, Rubinfeld, and Shapiro, 1984). Under this arrangement, the buyer purchases call options with all landowners that entitle him to buy their properties at pre-specified prices over some time interval. If and when the buyer exercises the options, the sellers cannot renegotiate the price.[4] Here we show that in addition to overcoming moral hazard (as shown by Cooter), the use of option contracts also overcomes the holdout problem.

We again illustrate the outcome for the case of n=2. Suppose that the buyer and seller one agreed on an option price of P_1, and so the buyer commences negotiating with seller 2. If they agree on a price P_2, then the buyer has three choices: he can exercise both options, yielding a return of $V–P_1–P_2$; he can exercise only one of the options, yielding a return of $v–P_s$ (s=1 or 2); or he can exercise neither option, yielding zero. Since $v–P_s \leq 0$ based on the above logic for s=1 and 2, he would never exercise only one option, so his threat point in negotiating with seller two is zero (i.e., exercise neither option). As a result, the Nash bargaining solution is again given by (12). Similar reasoning regarding negotiation between the buyer and seller one yields the expression in (13). The option prices for the two sellers are thus given by (14), and the resulting returns for the buyer and the sellers are given by (15) and (16), respectively. The outcome is therefore identical to that in the cancellation case, and the holdout problem is again avoided.

Generalizing these conclusions to the case of $n \geq 2$ sellers yields

$$P_s = \frac{V+R}{n+1}, \qquad s = 1,\dots, n \qquad (17)$$

$$P_s - R = \frac{V-nR}{n+1}, \qquad s = 1,\dots, n \qquad (18)$$

[4] Note that in this sense, eminent domain is a call option that the government can exercise under conditions specified in the Fifth Amendment—namely, provided that the land will be put to “public use” and that the option price constitutes “just compensation.”

$$V - \sum_{s=1}^{n} P_s = \frac{V - nR}{n+1}. \quad (19)$$

Thus, the *n*+1 players (*n* sellers plus the buyer) share the total surplus equally. Given these results, we can state:

Proposition 4: Under both the cancellation and option contract approaches, the buyer expects to receive a positive surplus from the project if and only if it is efficient.

Proof: The result follows immediately from (19) and (1). ■

This result highlights the importance of commitment in the previous model. In particular, it shows how prior purchases confer bargaining power on later sellers, given their knowledge that failure to complete these sales leaves the buyer with parcels that are worth less to him than the prices that he paid. The resulting bargaining advantage enjoyed by later sellers, given the buyer's commitment to previous sellers, is what gives rise to the inefficiency arising from holdouts. At the same time, commitment in contracting is valuable because it allows parties to plan based on the expectation that promises to buy or sell at previously negotiated prices will be honored. For example, if landowners must make some investment decisions prior to receiving commitments about parcel prices, as we illustrate in the next section, they may underinvest. Thus, while commitment contributes to the holdout problem, it can also help improve incentives to make non-salvageable investments.

5. The Buyer can Make an Up-Front Investment

This section extends the above model to allow the buyer to make an initial investment that enhances the value of the assembly project. This could represent planning expenses or investments in infrastructure. The purpose is to show that, while eliminating commitment can eliminate the holdout problem, it can also generate a different inefficiency, namely, a "holdup" problem.

Let x be the dollar amount of this investment and $V(x)$ the resulting gross value of the project, where $V'>0$ and $V''<0$. Assume that the investment must be made before the land is acquired and then is sunk (i.e., non-salvageable). Thus, it is only valuable if the project goes forward.

Since we assume that the project is profitable, the optimal investment, x^*, maximizes the net return,

$$V(x) - nR - x. \tag{20}$$

Thus, the first order condition defining x^* is[5]

$$V' - 1 = 0. \tag{21}$$

Now suppose that the buyer anticipates that he will succeed in acquiring all of the needed parcels, but expects to pay prices defined by (8) with V replaced by $V(x)$.[6] In other words, the choice of x occurs prior to sequential bargaining (with commitment) over parcel prices. The developer's expected profit prior to investing is therefore given by

$$V(x) - \sum_{s=1}^{n} P_s - x, \tag{22}$$

where $\sum_{s=1}^{n} P_s$ is defined by (10). We can now prove

Proposition 5: The buyer underinvests in x relative to the social optimum for any $n>0$.

Proof: Given (22), the first order condition defining the buyer's privately optimal choice of x, denoted $\hat{x}$, is given by

$$V'(x) - \frac{(2^n-1)V'(x)}{2^n} - 1 = 0,$$

[5] Condition (21) suggests that x^* is independent of the number of parcels. A better way to think of this, however, is that the $V(\cdot)$ function is defined for a project requiring n parcels, as in $V(x;n)$.
[6] Note that, because x is a sunk cost at the time that bargaining begins, it does not change the form of the prices that emerge from bargaining.

or

$$\frac{V\prime(x)}{2^n} - 1 = 0. \tag{23}$$

Comparing this condition to (21) immediately implies that $\hat{x} < x^*$ for n>0. ■

The buyer underinvests here, even though he expects to acquire all of the land needed for the project, because his non-salvageable investment increases V and thereby raises the price that sellers can extract in ex post bargaining. This source of inefficiency is generally attributed to the "holdup" problem.[7] The analysis in this paper reveals that this is distinct from the "holdout" problem as defined in the previous section. Note in particular that the *holdup* problem as described by Proposition 5 would plague the buyer even if n=1, which is the case in most contractual settings, whereas the *holdout* problem as characterized above required $n \geq 2$.

6. Conclusion

It has long been known by economists (and probably longer by developers) that the assembly of multiple separately-owned parcels of land for large scale development projects can be impeded by the holdout problem. The exact nature of the problem, and why it potentially prevents efficient assembly, however, has defied a clear description. Usually, it is vaguely attributed to monopoly power, high transaction costs, imperfect information, or some combination of these problems.

This paper has sought to increase our understanding of the source of the holdout problem by identifying a minimum set of factors that can give rise to it. We show that holdouts can arise in a model with complete information and ordinary Nash bargaining under the following conditions: (1) there are multiple landowners and bargaining with them occurs sequentially, (2)

[7] The holdup problem is also well-established in the literature. See, for example, Williamson (1975), Klein, Crawford, and Alchian (1978) and Goldberg (1985).

there is commitment during the bargaining process, and (3) partial assembly is inefficient. The model predicts that prices will rise as the assembly progresses, with the final seller receiving the highest price. It further implies that the sum of the prices paid to all sellers will exceed the aggregate reservation prices of sellers (the opportunity cost of the project) in the special case where individual parcels are worth less to the buyer than to sellers. This situation, we suggest, captures the paradigmatic holdout problem, and explains why some efficient projects will be foregone in the absence of government intervention to force sales. Approaches that eliminate commitment (e.g., the right of cancellation or the use of option contracts) can overcome this inefficiency, although lack of commitment can lead to a different (distinct) source of inefficiency, namely, the holdup problem.

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