An Efficient War Between The States: A Model of Site Location Decisions under Asymmetric Information

Glenn J. Platt
Dept. Of Economics
Richard T. Farmer School of Business
Miami University
Oxford, OH 45056
E-mail: plattgj@muohio.edu
Phone: (513) 529-1258
Fax: (513) 529-6992

April 15, 1997
DRAFT

Abstract

This paper develops a model of firm location where communities differ by exogenous endowments of a factor of production. Firms choose to locate based on local subsidies to production. Community and firm optimal strategies are then examined. Through the introduction of information asymmetries about the communities' endowments, equilibrium bidding strategies for communities are found. The results show that auction institutions used by firms may in fact be signaling on the part of communities. These results also indicate that community bids reveal information, and restrictions on this bidding may do more harm than good.

Key Words: Plant Location; Tax Competition; Asymmetric Information

JEL Classification Codes: R3; H7; D8

War Between The States: A Model of Site Location Decisions under Asymmetric Information

Recent trends in state subsidization of industry (re)location have led many to wonder if we have entered a "new war between the states" [*Financial World* v160 n18 (1991)]. Indeed, in the last decade states and localities have offered increasingly expensive and diverse incentive packages to attract industry. In 1984, Nissan was offered what was then one of the largest incentive packages ever, of $11,000 per employee; then, in 1993, Mercedes-Benz AG accepted Alabama's offer of $200,000 per employee (which included agreeing to purchase a fleet of 2,500 Mercedes for state use).[1] Such incentive packages have led some to call for the legal restriction of such practices, from putting a cap on the most a state can offer a firm to simply not allowing states and localities to offer *any* incentives to firms. While there is little doubt that firms are extracting more and more of the rents from location, it is not clear that this trend is the result of destructive competition between the states or simply an institutional method to most efficiently match localities and firms. This paper will develop a model of plant location and optimal strategies for communities and the firm. Then, through the introduction of information asymmetries, the last section of the paper examines the various institutions for determining site location as well as optimal bidding strategies for communities, given these institutions.

1. Motivation

Consider the full-information economy consisting of a single monopolist and a sufficiently large number of interested buyers. Economic theory tells us that rents, which are traditionally distributed between buyer and seller in a competitive economy (i.e., many buyers and sellers), will be taken increasingly by a perfectly discriminating monopolistic seller as the number of buyers increases. This intuition can be extended to consider the single firm "selling" its plant location to many localities who are competitively "buying" the location by offering incentive packages. The natural conclusion of this narrative is that the firm reaps nearly all the rents of the transaction. Viewing this model from the normative standpoint, one is led to ask what type of locality is likely to win such a bidding war, how the division of rents will change if the number of bidding localities is small, what strategies can be employed by the firm and locality to maximize each of their expected rents and what role information plays in these strategies.

The extensive empirical literature addressing the components of the site location decision elucidates the level of complexity of a such a process.[2] Clearly a plant's decision to locate in a given community cannot be reduced to one or two decision variables. It is an arduous, complicated process that involves considerable planning and defining of needs on the part of the locating firm as well as an assessment of the capacity of the locality to offer varying incentives. Furthermore, *ex post* determination of whether the community's costs outweigh the benefits will often depend upon how one chooses to measure the long term "ripple" benefits of a site location.[3] The empirical literature that examines these questions often treats the community as naive in not considering the bidding strategies of other communities. This paper will develop a model by assuming a similar naivete' and then extend the model, in Section 4, to allow for communities to consider bidding strategies of other communities. The previous literature also implicitly assumes that information is symmetrically distributed between community and firm and that the choice of bidding institution used by the firm is not relevant. This highly unrealistic assumption runs counter to the process firms use to choose a site in the first place. If firms were fully informed about each community being considered for a site, there would be little need for successive rounds of bidding by communities. Firms would simply choose the community that maximized profit and "demand" the incentive that the community would have offered in equilibrium bidding. The process of study, review, and bidding undertaken by firms is a clear indication that they are attempting to extract as much information as possible. Hence, any model of site location must take into account the role of strategic information acquisition and transmission in the bidding process. Black and Hoyt (1989) do consider strategy, but in a full information framework. They argue that there exists a possibility of socially efficient bidding for firms when firms are fully aware of productivity differences between communities. By establishing differing public service levels/costs across communities (due to scale economies), they show that firms responding to bids by communities may locate efficiently.

2. The Model

This model will abstract from the complexity of the plant location decision by reducing the location decision to two dimensions: the labor market and government-provided incentives (tax rates, subsidies, etc). In a standard model of site location, the labor environment has been empirically shown to be important to both communities (seeking employment and political benefits) and firms (seeking low wages and a favorable labor environment). Although they are more automated than in the past, industrial (manufacturing) plants remain highly dependent upon labor; they are, consequently, very sensitive to the skill and cost of labor at a potential site location. Right-to-work legislation and lack of unionization are key elements of the labor environment (Bartik, 1984 and Schmenner, Huber, & Cook, 1987). Indeed, the "auto alley" developing in the Midwest has primarily blazed a path from one non-unionized site to another (Milward & Newman, 1989). High unemployment and associated low wages are common among these, as well as other sites chosen for industrial location (Coughlin et al., 1991 and Gyourko, 1987). The unemployment rate for states in this "auto alley" has been anywhere from 16 to 49% higher than the national unemployment rate at the time of the plant location.

The widely accepted second component of the location decision, the role of taxation and subsidies, is more controversial than the labor component. The role taxation plays in the decision process has been in question since Due's pioneering 1961 paper. The extent to which this literature has answered the question varies according to empirical methods. Sources of these variations are highlighted in McGuire (1985) and Papke & Papke (1986).[4] While there has been considerable literature denying the effect of taxes on location decision, there has been a revival of the long held belief that taxes are, indeed, relevant.[5] The maintained premise of this research is that taxes *are* significant, to some extent, and depending on the stage of the corporate decision process, possibly very relevant to the location decision.

Manufacturing decisions are often made relative to marginal factors of production, such as the cost of utilities,[6] quality of local roads, highway and air access, and other publicly provided goods. Many incentive packages offered by local governments include discounts on utility rates, construction of power plants, roads, or even airports (Milward & Newman, 1989).[7] Hence, the modeling of the "tax" component will be done in a sufficiently general form that it can be interpreted as anything which affects the marginal product of the firm, including public services.

The policy tools available to the community attempting to attract firms are rather limited. As important as the labor market is to the firm, communities have little control (in the short term) over the labor market. This model will treat the labor market as exogenous.[8] In terms of the tax/subsidy component, localities *can* set tax rates or allow a tax blackout to varying degrees, based upon local law,[9] build roads, set utility rates, and determine the quality other public services. Thus such a tax/subsidy will be the choice variable for communities in the model.

Suppose there are n communities being considered by a single firm for the location of a single plant. Each community, indexed by $i = 1,\ldots n$, has a fixed population of J citizen/workers.[10] It is assumed that communities are identical in all respects, save one. Each community differs, exogenously, in wage rate,[11] $w_i > 0$. This heterogeneity is a result of non-mobile factors in labor and production markets. Assume, without loss of generality, that the indexing of communities is increasing in wage, thus w_1 is the lowest wage community and w_n is the highest wage community.

Each community levies a production tax[12] rate, t_i, on the incoming firm, where $t_i \in \{\mathbb{R}|t_i \in [-1,1]\}$. Since t_i can be either positive or negative, it can be thought of as a marginal tax or marginal subsidy, respectively.[13] Revenues from the tax are returned to the community in the form of a lump sum cash redistribution per citizen, g_i. If the tax is negative, this redistribution becomes a lump sum tax on the citizens.[14] The locating firm has a *production function*, $F(\cdot)$. The firm will hire $L > 0$ workers regardless of where it chooses to locate, where $L \leq J$. Hence the production function can be written as $F(L,\cdot)$. The other arguments will be suppressed and the function will hereafter be referred to as $F(L)$. The monotone function $\bar{w}(w_i)$, maps the wage that existed before the firm locates in the community, w_i, *into the wage that exists after the* firm locates in the community, $\bar{w}$.

All members of community i are assumed to have identical Von Neumann-Morgenstern utility functions, defined as *U(c)*, where c is a non-negative consumption bundle. *U(c)* is assumed to be concave and increasing. Assuming a majority-rule political institution, the tax rate is chosen by voting. At this point in the model, all members of the community are identical; thus, the median voter is simply the representative member of the community. Since there are two states of the world possible for the voter, she has two problems to consider: State 1, in which she maximizes utility when the firm has chosen to locate in another community, and State 2, in which she maximizes utility given that the firm locates in her community. These two problems are outlined below.

State 1: The firm locates in community -i.

$$Max_c \; U(c) \tag{1}$$

subject to the constraint:

a) $w_i \geq c$

State 2: The firm locates in community i.

$$Max_c \; U(c) \tag{2}$$

subject to the constraints:

b) $\bar{w}(w_i) + g_i \geq c$

c) $t_i \, F(L) \geq Jg_i$

where a) constrains the voter to consume a value equal or less than the exogenous community wage (letting the price of the numeraire consumption bundle be one), b) constrains the voter to consume a value equal or less than the wage plus the redistribution (note that the redistribution can be negative), and c) is a community redistribution budget constraint. This maximization can be partially solved trivially, since the constraints a), b), and c) will hold with equality. Equations 1 and 2 can then be rewritten in terms of t only.

State 1: The firm locates in community -i.

$$Max_t \; u(w_i) \tag{3}$$

State 2: The firm locates in community i.

$$Max_t \; u\left(\bar{w}(w_i) + \frac{t\,F(L)}{J}\right) \tag{4}$$

The firm's objective is to choose a community, w_i, along with a proposed tax rate, t_i, which will maximize profits. This objective is solved by the following.

$$Max_{w_i \in \{w_1,\dots,w_n\}} \Pi(t_i,w_i) = p(1-t_i)F(L) - \bar{w}(w_i)L \tag{5}$$

where p is the market price of the good produced by the firm.

Lemma 1. *The median voter in community i will (weakly) prefer the firm to locate in community i if* $\tau_i \in [t_i, 1]$, *where* τ_i *is defined implicitly by*

$$u\left(\bar{w}(w_i) + \frac{\tau_i F(L)}{J}\right) = u(w_i) \tag{6}$$

Proof: The value of τ_i implicitly defined by the above equation represents the tax rate/subsidy that makes the voter indifferent between the firm's location in community i and location in community -i. Since, given a w_i, $u(\cdot)$ is increasing in t, any $t \succ \tau_i$ raises utility above the indifference threshold and the voter strictly prefers the plant's location in community i. ■

The characterization of the function $\tau(w_i)$ is crucial to understanding the relationship between a community's wage and how much the community will choose to offer a prospective locating firm.

Lemma 2. *The function which maps exogenous previous wage,* w_i, *into maximum subsidy (minimum tax rate) is*

$$\tau(w_i) = \left[w_i - \bar{w}(w_i)\right]\frac{J}{F(L)} \tag{7}$$

Proof: Equation 7 is found by equating the utility functions in equation 6 and solving for τ. Note that this function is not dependent upon the functional form of utility, but will depend on the functional form of the wage relationship, $\bar{w}(w_i)$.■

3. Results

We will begin by examining the full information scenario in order to provide a benchmark by which to compare the asymmetric information cases. In this scenario, each community offers tax rate $\tau_i(w_i)$ in exchange for the site location.[15] Firms maximize equation (5) *knowing* w_i. The firm then locates in the community that maximizes firm profits. Note that as w_i increases, the community can "afford" to pay more for the firm, but likewise is becoming more expensive for the firm.

Proposition 1 shows that the firm will find a tax-wage combination that maximizes profits but may find that there does not exist a bidding community with that wage since there are a discrete number of communities[16]. Thus, the firm will look at the communities with wages just above and below the profit maximizing wage and will choose the community that yields higher profits. These communities are indexed i^H and i^L, respectively.

Proposition 1.

$$\text{Let} \begin{cases} i^L = \operatorname{argmin}_{\{i \mid w_i \geq w^*\}} \left| w_i - w^* \right| \\ i^H = \operatorname{argmin}_{\{i \mid w_i \leq w^*\}} \left| w_i - w^* \right| \end{cases} \text{where } w^* \text{ satisfies} \tag{8}$$

$$\frac{\partial \tau(w^*)}{\partial w} = -\frac{\partial \bar{w}(w^*)}{\partial w} \frac{L}{pF(L)}$$

If $i^L = i^H$, *then the firm will locate in the community with wage* w^*. *If* $i^L \neq i^H$, *then the firm will locate in* i^L *if* $\Pi(t_{iL}, w_{iL}) > \Pi(t_{iH}, w_{iH})$ *or in community* i^H *if* $\Pi(t_{iL}, w_{iL}) < \Pi(t_{iH}, w_{iH})$.

Proof: This follows trivially from the fact that w^* that satisfies equation 8 is the first order condition for the maximization of equation 5 substituting in equation 7. Since there are a discrete number of communities, the probability that a community will have wage w^* is quite small. In the case where there is no community with wage w^*, a single peaked profit function implies that the wage just above w^* or below w^* will yield the second best outcome, depending on the parameterization of the profit function. ■

It is possible to further examine the types of communities that will be chosen by the firm by further restricting the function $\bar{w}(w_i)$ to be concave. Concavity implies that low wage communities will receive a small wage increase. As wages rise, so does the wage increase until at some point the pre-existing wage becomes so high that the wage increase begins to decline (see Figure 1f for a representation of $\bar{w}(w_i)$ and the associated $\tau(w_i)$). Note that a *linear* or *convex* $\bar{w}(w_i)$ implies that the profit maximizing location for the firm will *always* be the lowest wage community or the highest wage community (see Appendix A). The concave parameterization allows for the possibility of intermediate location, which is reflective of patterns of plant location described in the empirical literature. There is empirical evidence that as wage levels increase past some point, state expenditures to attract industry decrease (de Bartolome & Spiegel 1993)[17].

Corollary 1.

The profit maximizing firm will not choose the community with the highest subsidy offer, instead trading lower subsidy for lower wages.

Proof: In analyzing incentives facing the communities, it will be useful to characterize three types of communities. Type one communities have $w_i \in \{w|\bar{w}' = \partial\bar{w}(w_i)/\partial w_i > 1\}$. Type two communities have $w_i \in \{w|\bar{w}' \leq 1 \text{ and } \bar{w} \geq w_i\}$. Type three communities have $w_i \in \{w|\bar{w}' < 1 \text{ and } \bar{w} < w_i\}$. Figure 2 presents $\tau(w_i)$ as strictly convex since equation 7 is the difference of a linear and a concave function. Furthermore, $\tau(w_i)$ is strictly decreasing for type one communities, and strictly increasing for type two and three communities. Thus, the minimum value of $\tau(w_i)$ will be where $\partial\bar{w}(w_i)/\partial w_i = 1$. Note that type one communities are within $[0,w_a]$, type two are within $(w_a,\bar{w}_b]$, and type three are within $(\bar{w}_b,\infty)$. Equation 8 implies that since both of the right hand terms are strictly positive, the left hand term must be negative and therefore the community that maximizes the firm's profit must be of type one. ■

As wage increases for a type one community the wage premium increases and thus the incentive offer increases. Type two communities can offer substantial incentives but have an unfavorable labor market for the firm. Type three communities recognize the firm will have a deleterious effect on the labor market and will only have the firm locate if the firm pays the community "for its troubles," i.e. $t > 0$. This unlikely behavior of type three communities, an artifice of the concavity assumption on $\bar{w}(w_i)$, is consistent with the empirical regularity of many firms not locating in particularly high wage communities.

What is interesting to note is that the firm *does not* choose to locate in the community that offers the highest subsidy. Instead, the firm would rather trade off subsidy for lower wages, and it continues to trade off until, essentially, the marginal value of each is equated. The amount of subsidy that is traded away depends, not only on the wage gradient, but on the ratio $L/pF(L)$. As this ratio gets smaller, *ceteris paribus*, the profit maximizing w^* approaches w_a. If it is assumed that there is a fixed amount of capital in production, more capital intensive industries (e.g., high technology industries) will opt for a community with high subsidies and higher wages. A firm that is in a more labor intensive industry (e.g., the automobile industry) will opt for a community with lower subsidies but compensating low wages.

4. Asymmetric Information Models

The strategy for examining asymmetric information models is as follows. We will consider the basic auction as a potential model of site location. The simple auction model argues that the firm is only concerned with one thing - maximizing the incentive offer that it receives. The firm would like locate in the community which bids the highest and extract the full rent [$\tau(w_i)$], but the firm may be unaware of the maximum a community is willing to pay. This type of analysis requires us to assume a discrete number of communities, but extends to a continuum fairly simply.

After comparing this to the benchmark full information case, we will consider the more realistic case where the firm would like to minimize production costs while maximizing the incentive offer. Again, the firm is unaware of the maximum the community is willing to offer. The community will signal some information in it's bid of t_i. The firm interprets this information and then chooses a location. This analysis is then compared to the auction and full information models and conclusions are drawn.

For simplicity we will assume that the information asymmetry is that each community has private information about its factor of production - w_i[18]. While it may seem unusual, since wages are observable, to assume that the firm cannot know this information, recall that the use of w_i is an abstraction and can be considered any community-specific factor of production owned by the citizens. If the firm is asymmetrically informed about ***any*** location-dependent factor needed by the firm for production and owned by members of the community, the model will yield the same results. Furthermore, the mapping of w into $\bar{w}$ is clearly dependent on skill, loyalty, and other unobservables. In terms of functional form, one might just as easily conceive of firms being uninformed about the parameterization of $\bar{w}(w_i)$. In terms of the functional form discussed in Appendix A, the firm may be uninformed about the value of b.

4.1 The Basic Auction

While the full information model offers many insights, it does not explain why a firm would want to solicit bidding from a set of communities, as is often seen in practice. The full information model implies that the firm would simply determine which community has the profit maximizing wage and maximum bid, then locate in that community. Clearly, it is an abstraction to assume that firms have full information about the amount of incentive a community would be willing to pay for a site location.

In this section, the assumption of full information in the above model is relaxed in order to examine the equilibrium implications when the firm has asymmetric information about the communities.

Consider the following restriction of the model presented in section 2.[19] The utility of the median voter of community i when the firm locates outside of community i is defined as

$$u(w_i) = w_i \tag{9}$$

The utility of the median voter of community i when the firm locates in community i is defined as

$$u[\bar{w}(w_i)+t_iK] = \bar{w}(w_i)+t_iK \tag{10}$$

where $K = F(L)/J$. Thus, the gross rents from getting the firm to locate in community i can be interpreted as the difference between the wage paid by the firm, $\bar{w}$, and the wage received without the firm, w_i. Since the community median voter must pay $-t_iK$ to get the firm, one can subtract it from the gross rent and consider this amount the net rent from the firm's location. In terms of the model, the gross (community) rent function

$$R_g[\bar{w}(w_i),w_i] = \bar{w}(w_i)-w_i \tag{11}$$

and the net (community) rent function

$$R_n[\bar{w}(w_i),w_i,t_i;K] = \bar{w}(w_i)-w_i+t_iK \tag{12}$$

First consider the special case where $\bar{w}(w_i) = \bar{w}$. With this function, the firm is constrained to pay the same amount regardless of location. This constraint could be because the firm must pay a high wage to keep unions out or because the firm must pay a wage consistent with wages paid in other plant locations. The rationale for considering this special function is that the firm will maximize profits by choosing the community that bids the lowest tax rate (highest subsidy). This choice can be seen by examining the firm's profit function

$$Max_{t_i}\ \Pi(t_i) = p(1 - t_i)F(L) - \bar{w}L \tag{13}$$

which clearly implies the firm would like to choose the community with the lowest t.

The profit function in equation 13 implies the firm wants the community with the lowest t_i, which is community w_1 (see Fig. 1a). The problem is then determining *which* community has the lowest t_i. Thus, the firm will set up an auction where each community bids a tax rate, s. Assume the underlying distribution of wages is common knowledge and is represented by G(w) and the associated probability density function, g(w). G(w) is assumed to be continuous, differentiable, and independently, identically distributed (IID). The optimal strategies for three types of auctions - English auction, second price sealed bid auction, and first price sealed bid auction - can then be derived.

An English, or traditional auction is where the seller solicits and announces increasing bids to a group of bidders, who each have a separate value of the good for sale. The price is increased until no one will bid higher and then the good is sold to last bidder. The second price auction is where each bidder submits one sealed bid and the good is sold to the highest bidder for the value of the *second highest* bid. Both of these auctions have dominant Nash equilibria, in that bidding strategies are invariant in regard to the bids of other players. The dominant bidding strategy for an English auction is that a community continues to bid for a plant location as long as the bid, s, is less than $(w_i - \bar{w})(1/K)$ or $R_n[\bar{w}(w_i), w_i, s; K]$ is positive. This strategy implies that the community that gets the firm will be the community with the lowest wage, w_1. The low wage community will pay $s = (w_2 - \bar{w})(1/K) - \epsilon$ ($\epsilon > 0$). The strategy for the second price auction is that each community bids $s = (w_i - \bar{w})(1/K)$, their true "value" for the firm. "Value" is defined here as the amount of rents the community gets when the firm locates, as established in equations 11 and 12. Thus the lowest wage community will pay an amount equal to the value of the firm to the community with the next highest wage. Since ϵ is the rents accrued by the community, and this number is positive, there will always be rents gained by communities with these auction strategies.

The first price sealed bid auction is where each bidder submits a sealed bid and the good is sold

$$R_n[\Delta w_i, s_i; K] = \Delta w_i + s_i K \tag{14}$$

to the highest bidder for the highest bid. Define $\Delta w_i = R_g(\cdot) = \bar{w} - w_i$ and subsequently the distribution function $H(\Delta w_i)$. Thus the net rent function for a median voter bidding s_i is

The equilibrium concept used for first price Vickrey auctions is the Nash solution. The traditional approach to solving first price auctions assumes that there is a symmetric bidding strategy $S(\Delta w_i)$, which is monotonically decreasing and maps Δw_i into bids, s_i. The probability that all other communities bid more than s_i is $[H(S^{-1}(s_i))]^{n-1}$, where n is the number of bidding communities. Thus, community i's expected payoff from following the symmetric strategy is

$$E[R_n(\Delta w_i, s_i; K)] = (\Delta w_i + s_i K)[H(S^{-1}(s_i))]^{n-1} \tag{15}$$

Lemma 3. *The optimal Nash bidding strategy for community i is*

$$S(\Delta w_i) = -\frac{\Delta w_i}{K} + \frac{\int_{\Delta w_n}^{\Delta w_i} [H(x)]^{n-1}\, dx}{K[H(\Delta w_i)]^{n-1}} \qquad i = 1,\ldots,n \tag{16}$$

Proof: See Appendix B.

The bid of community i can be broken into two parts. The first term on the right side of equation 16 is the value of the firm to the community. The second term is the amount under the value that the community will shave its bid, where $\Delta w_n = (\bar{w} - w_n)$ for the community with the highest wage.

It is possible to examine this result in more detail by looking at the special case where $G(w)$ is uniform over $[0,\bar{w}]$. Uniformity of $G(w)$ implies that $H(\Delta w_i)$ is also distributed uniformly over $[0,\bar{w}]$. Then solving equation 16 will find the optimal Nash equilibrium bidding strategy.

$$S(\Delta w_i) = -\frac{\Delta w_i}{K} + \frac{\Delta w_i}{Kn} \tag{17}$$

Note that as $n \to \infty$, the bid, s_i, will tend to $\Delta w_i/K$, and net rents to the community will go to zero. The intuition is that the probability of another community bidding just below your bid goes to one. But if n is a small number, expected net rents to the community will be significantly positive. It can be shown that if the firm sets a maximum tax rate it will consider in the bidding process, the expected bid will be higher than it would be if there were no ceiling to bidding.

By examining the previous three auction institutions, one can compare optimal strategies for communities that want to maximize rents given that the firm only cares about maximizing the incentive bid offered by the community. For the English auction, the optimal strategy is to bid as long as net rents are positive. In the second price auction, the optimal strategy is to bid the tax rate that yields zero net rents. The first price auction, though more complicated, yields an optimal strategy where communities take their zero rent bid and shave it by the belief that another community could beat the bid.

The implication for the competitive community is that the community will always get rents from any of the three auctions. The rents accrued will be inversely proportional to the number of communities bidding for the firm. The firm would then want to maximize the number of bidding communities to get the largest share of firm rents as possible, by minimizing community rents. Communities, on the other hand, would want to limit the number of other bidding communities, if they had such control. While there is no formal structure of auctions for plant location, the conventional notion is that bids from one community are not completely revealed by the firm to other communities, much like the two sealed-bid auctions examined in this section.

4.2. The Signaling Model

Consider the model developed in section 2 while continuing to assume that w_i is known only to community i and that w is distributed according to the IID unimodal distribution function, G(w). The asymmetric information game that arises in this case is distinctly different than the auction game in section 4.1 for three reasons. First, the goal of the seller, the firm, is not to maximize the bid, but rather to maximize profits. The profit-maximizing point is not where the bid is maximized, as in proposition 1, but at some higher t: $\tau(w^*)$. The second difference between these games is that the relationship between net community rents and w is not one-to-one. That is, for a given bid s_i, there is more than one community that could make such a bid. An example where identical bids can be offered by the same community can be seen in Figure 2, where the bid $s = t^*$ can be made by any $w \in [w^*, w_2]$. Consequently, the game becomes a signaling game where the firm wants to maximize expected profits given a signal, the bid s_i, about what the wage is for community i. And lastly, this game differs from the auction game, in that it returns to the assumption made in section 2 that there are a continuum of communities as opposed to a discrete number. This assumption is made to avoid the bargaining problem that would arise given a discrete number of communities, as well as for ease of exposition.

There are a continuum of communities $[w_1, w_n]$ which are making bids solicited by a single firm looking to locate a single plant. The order of play is that each community submits a simultaneous sealed bid, $s \in S$, which is a proposed tax rate/subsidy. The firm then chooses among the submitted bids to decide where to locate the plant. The profit function of the firm, given a bid of s_i, will now be defined as

$$E\left[\Pi(s_i)\right] = p(1-s_i)F(L,\cdot) - E\left[\bar{w}(w_i) \mid s_i\right]L \tag{18}$$

The firm's problem is to choose an $s_i^* \in S_c$, where S_c is the set of bids submitted by the communities that satisfies the condition below.

$$s_i^* \in S_C \text{ Such That } E\left[\Pi(s_i^*)\right] \geq E\left[\Pi(s_{-i})\right] \ \forall s_{-i} \in S_C$$

The firm then locates in:

a) Community i, if that community submits bid s_i^* and no other community bids s_i^*.

Or

b) Community j, where $j \in C^*$, the set of communities that bids s^*, where j is drawn from a uniform distribution over C^*.

Community i chooses $s_i \in S$ such that the firm locates in community i with probability $PR(s_i|s_{-i})$ and

$$PR(s_i|s_{-i})\left(\bar{w}(w_i) + s_i K\right) + \left(1 - PR(s_i|s_{-i})\right)w_i \geq PR(s_i'|s_{-i})\left(\bar{w}(w_i) + s_i' K\right) + \left(1 - PR(s_i'|s_{-i})\right)w_i$$
$$\forall s_i', \forall s_{-i} \in S$$

That is, if $PR(s_i|s_{-i})$ is the probability that the firm will locate in community i for bid s_i and given a vector of strategies used by all of the other communities, the expected net rent associated with this probability is (weakly) higher than the net rent associated with the probability that results from community i choosing any other strategy, s_i'.

In order to examine a reasonable subset of equilibria, the intuitive criterion will be used to refine the equilibria. The intuitive criterion (Cho & Kreps, 1987) states that if a community could not benefit from taking an out of equilibrium action regardless of the beliefs of the firm, then the firm will place zero probability on the possibility that these out of equilibrium actions are taken by the community. Specifically, the firm will update its beliefs given a bid s, by placing zero probability that the bid was sent by a community that would get negative net rents from getting the firm to locate for bid s. The previous assumptions regarding the information sets of firms and communities will be maintained. That is, the firm and all of the communities know $\bar{w}(\cdot)$, $\Pi(\cdot)$, and $\tau(\cdot)$. Each community knows its own w_i, but not any other w_{-i}, and both the firm and the community have identical beliefs about the distribution of w.

These beliefs are represented by a unimodal IID distribution function G(w).

The expected wage of a community given a bid s_i can be found as follows. Since $\tau(w_i)$ is convex, if the firm receives a bid of s_i, the firm can update its beliefs about the wage of the community since there will be communities that will not rationally be able to bid s_i. Let w_a be the wage such that $\tau(w_a)$ is the *min* of $\tau(w_i)$, and $\tau_a = \tau(w_a)$. Consider the following two functions

$$w^1:\mathbb{R}\to[0,w_a) \quad \text{such that} \quad w^1(s_i) = \tau^{-1}(s_i) \tag{19}$$

$$w^2:\mathbb{R}\to[w_a,\infty) \quad \text{such that} \quad w^2(s_i) = \tau^{-1}(s_i) \tag{20}$$

The firm will update its beliefs about the wage in community i given a bid of s_i by following Bayes Rule. When the firm receives a bid of s_i, the firm knows that the community which made the bid must have a wage $w_i \in [w^1(s_i),w^2(s_i)]$, as seen in Figure 2. If the firm receives a bid of $s = \tau(w^*)$, any community with wage $w^{**} \notin [w^*,w_2]$, would receive negative net rents from the firm accepting the bid since $\tau(w^{**}) > s$. Thus, the firm will update following Bayes Rule and consequently the expected wage, given a bid s, can be defined as

$$E[w|s] = \int_{w^1(s)}^{w^2(s)} \frac{g(x)}{G(w^2(s)) - G(w^1(s))}\, x\, dx \tag{21}$$

In order for the firm to compute expected profits, it must evaluate the expected wage it will pay in a community that bids s, which is defined as

$$E[\bar{w}(w_i)|s] = \int_{w^1(s)}^{w^2(s)} \bar{w}(x)\frac{g(x)}{G(w^2(s)) - G(w^1(s))}dx \tag{22}$$

In order to completely characterize equilibria, consider two complementary sets of distributions;

the first is where the expected wage for a given bid is higher than the wage of the highest incentive bidding community, w_a. Lemma 4 demonstrates that if the expected wage is bigger than w_a for any bid, it will be bigger for all possible bids. Proposition 2 then demonstrates that if the expected wage is bigger than w_a for any bid s, all communities will bid the zero rent bid $t(w_i)$ and the firm will choose community w_a.

Lemma 4.

If $E[w|s] \geq w_a$ *for any* $s \leq 0$, *then* $E[w|s] \geq w_a$ *for* $\forall s \leq 0$

Proof: The assumptions on the second derivative of $\bar{w}(w_i)$ imply that the slope of $t(w)$ at $w^1(s)$ will always be steeper than the slope of $w^2(s)$ for a given s. The steeper slope, in turn, implies $w_a - w^1(s) < w^2(s) - w_a$ $\forall s$. The unimodality of $G(w)$ implies that if there is more mass over the range $[w_a, w^2(s)]$ than over $[w^1(s), w_a]$ for *some* s, then for any smaller s the updated distribution will essentially be proportionally "pushing up" the pdf over the new range; hence, the relationship will be true for the new s. The unimodality, though sufficient to prove the lemma, is not necessary. ■

4.3 Semi-Separating Equilibrium

The following proposition demonstrates that there always exists an intuitive sequential equilibrium where each community reveals its value of the firm and where the firm chooses a community that maximizes its expected profit.

Definition 4.3: A Semi-Separating Equilibrium is an equilibrium where there is a bidding strategy $s(\cdot)$ such that if $\tau(w_i) = \tau(w_j)$, then $s(w_i) = s(w_j)$. Such a strategy implies that each community will bid the tax rate that yields zero net rents. Since the function $\tau(\cdot)$ is convex, there will be a range of bids where there are two communities making the same bid; hence, there is not complete separation.

Proposition 2. *If* E[w|s] $\geq w_a$ *for some* $s \in S_c$*, then a sequential equilibrium bidding strategy is* $s(w_i) = \tau(w_i)$*. The firm will then locate in the community with wage* w_a.

Proof: Consider the firm's problem; since $\tau(w_a)$ is the *min* of $\tau(w_i)$, then $\tau(w_a) \leq \tau(w_i)\ \forall i$. Hence, if $s(w_a) = \tau_a$, all other communities can rationally bid no less than $s \geq \tau_a$. Since $E[w|s] \geq w_a$ for some s, it is true for all s, by lemma 4, thus $s_i \geq s_a = \tau_a$ and $E[w|s_i] \geq w_a$. Equation 22 then shows that expected profit from a bid of any s_i will be less than profit from accepting bid τ_a, which corresponds to wage w_a with certainty. There is no gain to deviation by the communities, since bidding a lower tax rate than $\tau(w_i)$ is not rational and bidding a higher tax rate will not increase the chance of getting the firm for communities with wage $w_i \neq w_a$. Community w_a will be worse off if it deviates and bids more than t_a since the firm will end up accepting the bid by the community with wage $w_a - \epsilon$ or $w_a + \epsilon$. ■

This equilibrium bidding strategy is interesting because the optimal strategies for both the communities and the firm are identical to the dominant strategy in the second price auction examined in the beginning of section 4. Furthermore, note the stark contrast with the full information outcome. With the full information, the firm does *not* choose the highest of all possible bidders, but rather the community that satisfied a first order condition and bids a higher tax rate than $\tau(w_a)$. Consequently, the firms would be expected to set up an auction to choose the plant location whenever $E[w|s] \geq w_a$ for some s. But such a decision would only hold true for one class of distributions. The following section considers the complementary set of distributions.

4.4 Pooling Equilibria

Given the assumptions on the distribution of G(w), there are two exhaustive sets of distribution functions. The first was examined in the previous section, where $G(w) \in \{G(w)|E[w|s] \geq w_a\}$. This section examines a sequential equilibrium where $G(w) \in \{G(w)|E[w|s] < w_a\}$. In this case, though, there will be a set of communities that will have incentive to mimic each other by bidding the same s.

Proposition 3. *If* $E[w|s] < w_a$, *there exists an* $\hat{s}$ *such that communities with* $w \in [w^1(\hat{s}), w^2(\hat{s})]$ *bid* $\hat{s}$ *and all other communities bid* $s(w_i) = 0$ *(i.e., they do not bid). The firm will locate in a random community that bids* $\hat{s}$.

Proof: Consider the firm maximizing expected profits as defined in equation 19. Define the function $\bar{w}_e(s)$ which maps bids, s, into expected wages, thus $\bar{w}_e(s) = E[\bar{w}|s]$. Given the assumptions on the distribution function, this function will be monotone and decreasing, as seen in Figure 4. Thus, maximization of equation 18 implies

$$\frac{\partial \bar{w}_e(s)}{\partial s} = -\frac{pF(L)}{L} \tag{23}$$

Define $\hat{s}$ as the solution to equation 23; thus, all communities with $w \in [w^1(\hat{s}), w^2(\hat{s})]$ will bid $\hat{s}$. In order to see why this is a sequential equilibrium, consider off-equilibrium behavior. If a community that is pooling at bid $\hat{s}$ deviates by bidding a lower tax rate, s_d, the firm will know that communities whose $\tau(w_i) > s_d$ could not rationally make the deviation; hence the firm places zero probability of those communities being the deviator (this belief is the intuitive criterion). Thus when the firm updates to find $E[\bar{w}|s_d]$, the expected wage will lie in the function $\bar{w}_e(s)$. However, $\hat{s}$ is the bid that the firm will accept for all of the bid/wage combinations given by the function $\bar{w}_e(s)$. An analogous argument can be made to show that a deviation to a higher tax rate will not be optimal for a community pooling at bid $\hat{s}$. The communities that pool at $s = 0$ will have no incentive to deviate since any bid $s < \hat{s}$ corresponds to lower expected profit for the firm since profit is maximized at $\hat{s}$. Similarly, a bid of $\hat{s}$ or lower is not rational since the community will receive negative net rents and be worse off. Thus, the communities pooling at $s = 0$ will be best off bidding $s = 0$. Actually, there are a continuum of pooling equilibria since the communities pooling at $s = 0$ are indifferent among all bids less than $\hat{s}$. ■

The implication of propositions 1 and 2 is that the decision of whether to pool or separate in bidding strategy is dependent upon the nature of the distribution. If there is sufficient reason to believe that the wages are in the lower end of the distribution (relative to w_a), that is, it is somewhat likely that a bid was made by the more preferable low wage community, firms are willing to believe the bid was made by such a community. However, if the distribution is such that there is a strong likelihood of a community having a higher wage than w_a, any bid made by the community will likely be considered by the firm as coming from the less preferable, high wage community. Consequently, it is in the communities' best interest to pool, masking true wages, since the majority of the communities are considered undesirable by the firm.

In summary, there are two types of equilibria possible in the asymmetric information game. If the firm does not know the wage associated with a given community, the communities will separate and bid the highest subsidy they can afford to bid. The community may also choose to pool with other communities and bid a lower subsidy than the maximum affordable. The decision to use either of these strategies will depend upon the distribution of wages across communities.

5. Policy Implications and Conclusions

The concern that communities are paying "too much" for firms as a result of competition with other communities seems unlikely given the results presented in this model. If a single community deviates and bids irrationally by bidding more than the firm's value, the firm will still not locate in the community in the pooling equilibrium. In the semi-separating equilibrium, irrational bids will only affect equilibrium if the irrational community bids higher than the community with the highest value for the firm. This scenario is not only very unlikely, but potentially *very* costly for the community. Furthermore, what appears to be an auction institution used by firms has *identical* strategies as the signaling model. The use of auctions may indicate that the competition between localities is actually a method of information transmission valuable to both the communities and the firm.

The model also suggests that the rents to a community are theoretically very high. Thus, simply looking at raw subsidies offered by communities without accounting for such factors as capital/labor input ratios, the number of other bidding communities, or the nature of information asymmetries can be a misleading exercise.

It has been suggested that a higher level government should restrict competition by communities for firm location, since this competition is destructive. In particular, one could consider communities competing in bids of environmental regulation. It has been suggested that communities will lower environmental standards below socially efficient levels in order to get the firm. Consider the implications of a higher level of government fixing a maximum (or in terms of the model, minimum) bid of $\check{s}$ in propositions 2 and 3. In proposition 2, if $\check{s}$ is less than τ_a, there is no effect. If $\check{s}$ is more than τ_a, there will be pooling among all the communities that can rationally bid $\check{s}$. The firm will then pick a community, in expectation that has a higher wage and a higher tax rate. Such a policy clearly will not benefit the firm, though communities that had zero probability of the firm locating will now have a positive probability of the firm locating and accruing rents. The highest bidding community, on the other hand, would be opposed to such a policy since the policy will reduce the probability of getting the firm to be less than 1.

The implication of an imposed maximum subsidy is similar to those examined in proposition 3. If $\check{s} \geq s^*$, then $\check{s}$ will be the new pooling equilibrium. However, in this case the set of communities who will oppose such a policy may be rather large since the group of pooling communities at bid s^* will have a lower probability of getting the firm at bid $\check{s}$. Furthermore, the firm will, in expectation, be worse off always and hence would oppose such a policy. So, the net welfare effect is that the restriction reduces welfare. Thus, the model also implies that the result of Oates & Schwab (1988), where competition among homogeneous communities leads to socially efficient levels of environmental quality, can be extended to an asymmetric information setting.

The model also provides positive implications about the strategies of a central government made up of individual communities. Consider a voting body where each community is represented by one vote, such as the U.S. Congress. The model implies that maximum subsidy legislation could pass if the set of communities who experience an increase in probability of getting the firm by pooling at the maximum bid outnumbers the communities who were able to bid the second best pooling or separating bids.

While empirical structural estimation of signaling models is very difficult, some of the implications of the model are testable. For instance, one would expect to see two distinctly different bidding patterns. Some plant location decisions should invoke a large set of nearly identical bids as implied by proposition 3. Such bids ought to occur when there is a strong likelihood of the bid coming from a community with high costs of production. Other plant locations would be given to communities that bid the highest. This pattern of bidding ought to occur when there is a strong likelihood that there will be a low cost of production in the bidding communities. In general, one should see firms locating in communities where wages are in the low end of the distribution.

This model will hopefully be the foundation for a more general examination of the role of information in the process of plant location decisions. One of the more interesting extensions of this model would be to allow for uncertainty about the firm's profitability. A problem that communities can have with plant location is that there is a large up-front "investment" that the community gives in terms of the incentive package. Unfortunately there always exists the possibility that the plant could fail in a short period of time after receiving the incentive package. For instance, Volkswagen received a generous package from the state of Pennsylvania and Westmoreland county, but ended up closing it's plant before production was up to capacity and the community was left "holding the bag" in the process. In discussing the problems of GM and the proposed closing of the Willow Run plant, Newsweek (11/9/92) argues that "[p]lant closings like Willow Run's are making towns think twice about offering tax abatements in exchange for jobs." By introducing uncertainty about the plant profitability, there will be an insurance problem where the community's bid will reflect the assumed risk of giving the incentive bid before the profitability of the plant is known.

This paper has constructed a simple model of community competition for the location of a single firm. By contrasting the full information case where the community does not choose the highest bidding community, with the asymmetric case, there are a number of interesting conclusions. There exists a broad class of beliefs that yield a separating equilibrium where communities reveal their true value for the firm's location and the highest bidding community *will* get the firm. The equilibrium strategies of communities are identical to strategies for a second price auction when there is a continuum of communities. There is also a complementary class of distributions that yields a pooling sequential equilibrium satisfying the intuitive criterion. In this equilibrium, communities will, in expectation, receive rents, while the separating equilibrium will yield rents only when there is a discrete number of communities.

While the empirical literature has varying and broad results, the simplified model developed here presents a cohesive structure that ties these results together in a theoretical framework. Most notably, the debate over the role of taxation and incentive bids in the location decision can be re-examined. The results of the model show that the firm will locate in the high bidding community *only* under certain information conditions. Empirical studies over industries where communities tend to pool in their bids will lead to conclusions that the bid, itself, is irrelevant to the corporate location decision. However, this result would be a misleading since the bid is a signal about the how profitable the firm the firm can be in that particular community. Within a particular industry, the distribution of factor costs across the set of possible site locations will significantly affect the bidding strategy of the community and consequently needs to be accounted for in empirical studies. The low wages, low unionization, and high unemployment found in the most recent set of automobile plant locations can be explained by the model: all these firms attempted to choose communities that have the most to gain by the firm's location. The variance in estimation of these effects stems from the asymmetric information firms have about the cost of production within these communities.

Appendix A

Consider the parameterization of the labor market, $\tilde{w} = a + bw^c$, where w is the wage in the community before the firm enters, $\tilde{w}$ is the wage the firm pays once it locates in the community, a and b are linear constants, and c allows for the possibility of a nonlinear relationship. Equation 5 can now be expressed as

$$Max_{w_i \in \{w_1,\ldots,w_n\}} \Pi(w_i) = pF(L) - pJ(w_i - a - bw_i^c) - (a + bw_i^c)L \quad \textbf{(24)}$$

Note for linear parameterizations of $\tilde{w}(w_i)$, the profit maximizing solution will be a corner solution: w_1 or w_n. Consider the most basic of parameterizations - where the firm pays the same wage regardless of where it locates, i.e. $a > 0$, $b = 0$. Substituting these values into the above equation trivially implies that the firm will maximize profit by choosing the lowest wage community. This is not only because a low wage is desirable, but also because the lowest wage community also has the lowest $\tau(w)$ (highest subsidy). Fig. 1a illustrates an example of $\tilde{w}(w_i)$ and $\tau(w_i)$ for this parameterization. Now consider $\tilde{w}(w_i)$ where the firm pays a fixed premium above the market wage regardless of location, where $a > 0$, $b = 1$, and $c = 1$. Equation 24 again is maximized when w is minimized. This is because all communities offer the same bid (see $\tau(w_i)$ and $\tilde{w}(w_i)$ in Fig. 1b). Since all bids are identical, the firm again is compelled to choose the lowest wage community.

Now consider a simple story of labor supply and demand where the firm shifts out the labor demand curve. A convex labor supply curve implies that the wage increase to $\tilde{w}$ will be highest for communities that already have high wages, e.g. $a \geq 0$, $b > 1$, and $c = 1$. See Fig. 1c for a graphic interpretation. In this case the firm may choose w_1 or w_n, depending on the parameters: If $L < [pJ(b-1)]/b$ then the firm locates in w_n and if $L > [pJ(b-1)]/b$ then the firm locates in w_1. Consider an alternative parameterization, where lower wage communities receive a proportionally higher wage increase than higher wage communities, i.e. $a \geq 0$, $0 < b < 1$, and $c = 1$ (see Fig. 1d). This case is similar to the above solution, but note that the inequality will always be greater than, hence the firm will always want to locate in the lowest wage community, w_1, which will also offer the highest bid, much like the first parameterization discussed.

The rather unrealistic implications of these parameterizations are driven by the assumption of linearity in $\bar{w}(w_i)$. Consider the general convex form for $\bar{w}(w_i)$, where $a \geq 0$, $b > 0$, and $c > 1$ (see Fig. 1e). The convexity implies that amount of the wage increase declines as wages increase and then, at some point the wage increase begins to rise as wages rise. Thus low and high wage communities experience a dramatic increase in wages if the firm locates while middle wage communities experience relatively small wage increases if the firm locates. Equation 24 can then be written as

$$\prod = [pF(L) + pJa - La] - pJw_i - b(pJ - L)w_i^c \qquad \textbf{(25)}$$

If $pj < L$, the profit maximizing community is w_1 since $\prod$ will be a decreasing function. If $pj > L$ the profit function is convex, consequently, the maximum will lie at w_n, unless the profits at w_1 are greater than those at w_n, or

$$w_n < \sqrt[c-1]{\frac{pJ}{b(pJ-L)}}$$

in which case, the firm locate at w_1.

The final parameterization of interest is that of a concave function, where $a \geq 0$, $b > 0$, and $0 < c < 1$ (see Fig. 1f). The implication of such a parameterization is that low wage communities receive a small wage increase, as wages rise so does the wage increase until at some point the pre-existing wage becomes so high the wage increase begins to decline. Equation 25 implies that if $pJ < L$, then the firm locates at w_1 otherwise the firm locates at w^* where

$$w^* = \sqrt[c-1]{\frac{pJ}{cb(pJ-L)}}$$

Appendix B

Proof of specification of Nash bidding function of first price sealed bid Vickrey auction.

The solution for maximizing expected rents over possible bids, s_i, can be found by solving the first order condition for equation 14. Thus $\partial E[R_n]/\partial s_i = 0$. The envelope theorem implies that $dE[R_n]/d\Delta w_i = \partial E[R_n]/\partial \Delta w_i$. Differentiating equation 14 with respect to Δw_i yields $\partial E[R_n]/\partial \Delta w_i = [H(S^{-1}(s_i))]^{n-1}$. Since we are assuming that all communities are using the same symmetric Nash bidding strategy function, $S(\Delta w_i)$, then $S(\Delta w_i) = s_i$. This, in turn, implies that

$$dE[R_n]/d\Delta w_i = [H(\Delta w_i)]^{n-1}.$$

Then solve the above differential equation using the boundary condition that the community that values the firm the least, e.g., the community with the lowest Δw_i, gets zero utility. That is, $S(\Delta w_{min}) = \Delta w_{min}/K$. Substituting the Nash condition into the solution to the differential equation and solving for $S(\Delta w_i)$ yields equation 15.

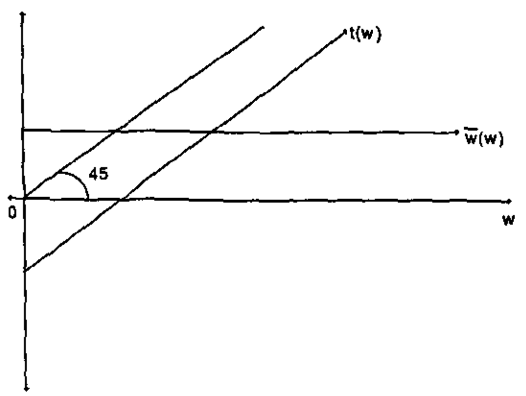

Fig. 1a

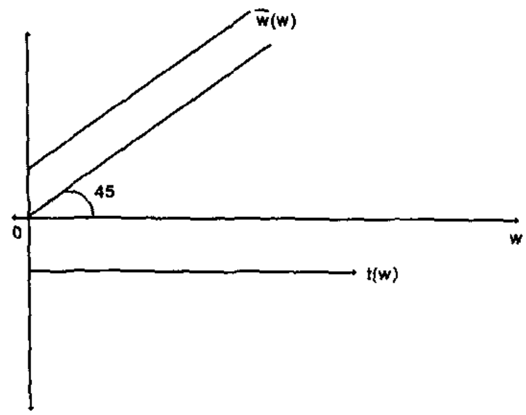

Fig. 1b

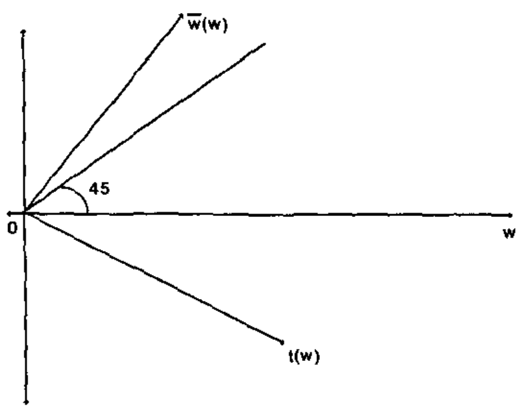

Fig. 1c

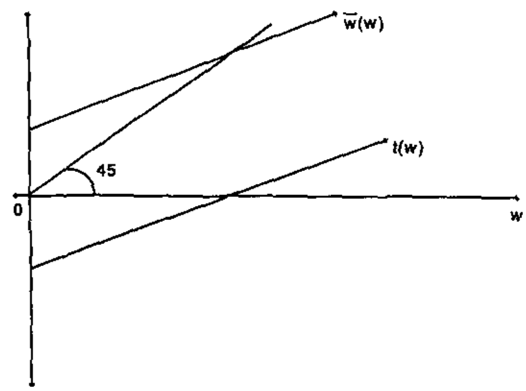

Fig. 1d

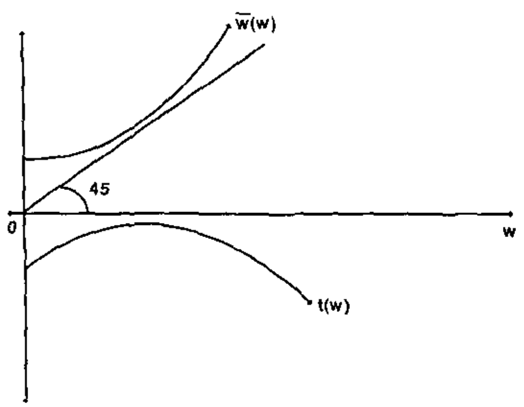

Fig. 1e

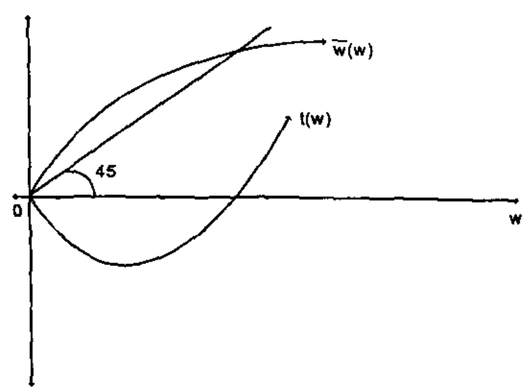

Fig. 1f

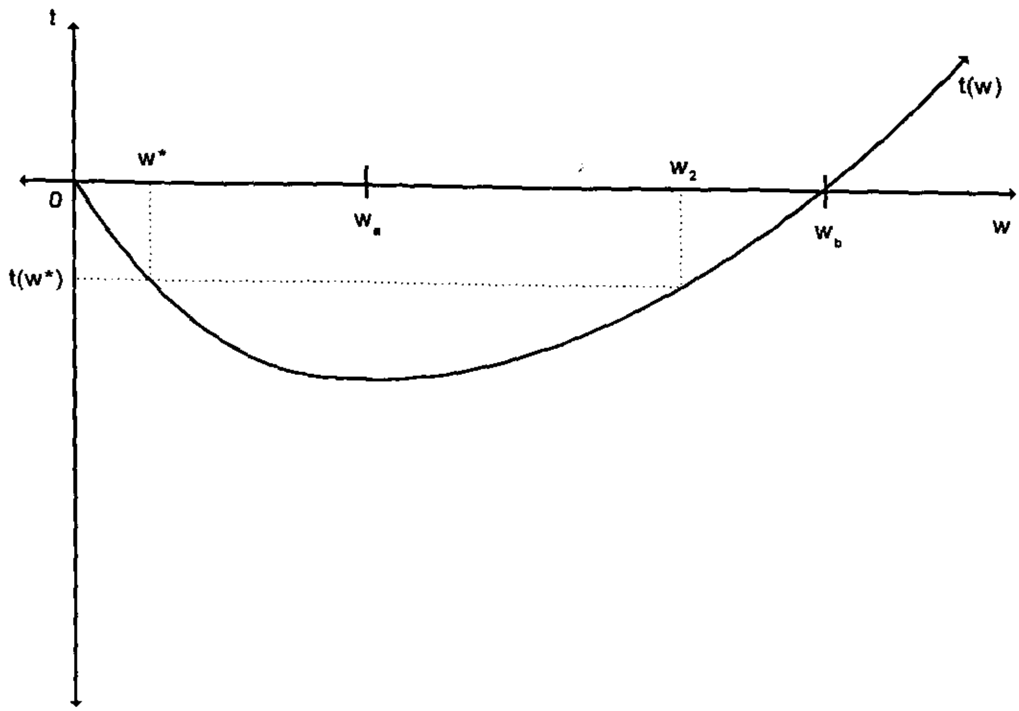

Figure 2

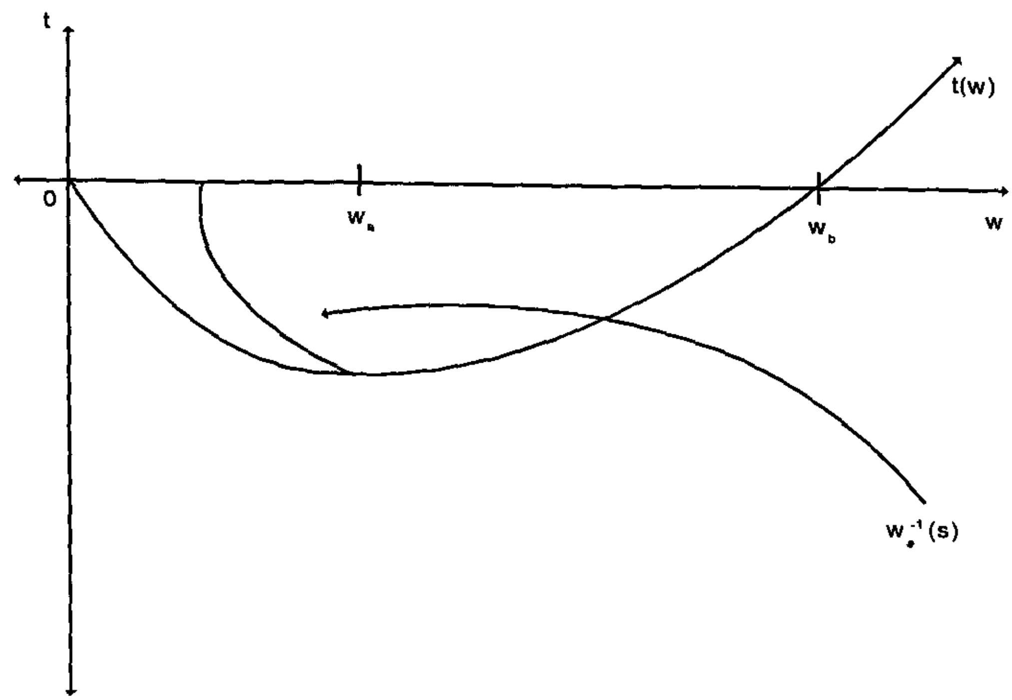

Figure 3

References

Bartik, T.J., 1984, Business Location Decisions in the U.S.: Estimates of the Effects of Unionization, Taxes, and Characteristics of States, Journal of Business and Economic Statistics 3, 14-22.

Bartik, T.J., 1991, Who Benefits from State and Local Economic Development Policies? (W.E. Upjohn Institute for Employment Research, Michigan).

Bartik, T.J., C. Becker, S. Lake, and J. Bush, 1987, Saturn and State Economic Development, Forum for Applied Research and Public Policy, Spring, 29-40.

Biglaiser, G. and C. Mezzetti, 1995, Competition for Business among Jurisdictions with Re-election Concerns, University of North Carolina Working Paper.

Black, D.A. and W.H. Hoyt, 1989, Bidding For Firms, American Economic Review 79, 1249-1256.

Blair, J.P. and R. Premus, 1987, Major Factors in Industrial Location: A Review, Economic Development Quarterly 1, 72-85.

Bond, E.W. and L. Samuelson, 1986, Tax Holidays as Signals, American Economic Review 76, 820-826.

Cho, I. and D. Kreps, 1987, Signaling Games and Stable Equilibria, Quarterly Journal of Economics 102, 179-221.

Coughlin, C.C., J.V. Terza, and V. Arromdee, 1991, State Characteristics and the Location of Foreign Direct Investment Within the United States, The Review of Economics and Statistics 74, 675-683.

de Bartolome, C.A.M. and M. Spiegel, 1993, Regional Competition for Domestic and Foreign Investment: Evidence from State Development Expenditures, NYU and University of Colorado at Boulder Working Paper.

Due, J.F., 1961, Studies of State-Local Tax Influences on the Location of Industry, National Tax Journal 14, 163-173.

Gyourko, J., 1987, Effects of Local Tax Structures on the Factor Intensity Composition of Manufacturing Activity across Cities, Journal of Urban Economics 22, 151-164.

Herzog, H.W. Jr. and A.M. Schlottmann, eds., 1991, Industry Location and Public Policy, (University of Tennessee Press, Knoxville).

Markusen, J.R., E.R. Morey, N. Olewiler, 1995, Competition in Regional Environmental Policies when Plant Locations are Endogenous, Journal of Public Economics 56, 55-77.

Marvel, M. and W. Shkurti, 1993, The Economic Impact of Development: Honda in Ohio, Economic Development Quarterly 7, 50-62.

McGuire, T.J., 1985, Are Property Taxes Important in the Intrametropolitan Location Decisions of Firms? An empirical analysis of the Minneapolis-St. Paul Metropolitan Area, Journal of Urban Economics 18, 226-234.

Milward, H.B. and H.H. Newman, 1989, State Incentive Packages and the Industrial Location Decision, Economic Development Quarterly 3, 203-222.

Muthoo, A., 1995, On the Strategic Role of Outside Options in Bilateral Bargaining, Operations Research 43, 292-297.

Newman, R.J. and D.H. Sullivan, 1988, Econometric Analysis of Business Tax Impacts on Industrial Location: What Do We Know and How Do We Know It?, Journal of Public Economics 23, 215-234.

Oates, W.E. and R.M. Schwabb, 1988, Economic Competition Among Jurisdictions: Efficiency Enhancing or Distortion Inducing?, Journal of Public Economics 35, 333-354.

Papke, J.A. and L.E. Papke, 1986, Measuring Differential State-Local Tax Liabilities and Their Implications for Business Investment and Plant Location, Working Paper No.6. Center for Tax Policy Studies, Purdue University.

Papke, L., 1986, The Influence of Interstate Tax Differentials on the Birth of New Firms: Estimates of a Poisson Process, Working Paper, Center for Tax Policy Studies, Purdue University.

Papke, J., 1985, The Taxation of the Saturn Corporation: Intersite Microanalytic Simulations, Working Paper, Center of Tax Policy Studies, Purdue University.

Roback, J., 1982, Wages, Rents, and the Quality of Life, Journal of Political Economy 90, 1257-78.

Schmenner, R.W., J.C. Huber, and Cook, R.L., 1987, Geographic Differences and the Location of New Manufacturing Facilities, Journal of Urban Economics 21, 83-104.

Wilson, J.D., 1986, A Theory of Interregional Tax Competition, Journal of Urban Economics 19, 296-315.

Wilson, J.D., 1987, Trade, Capital Mobility, and Tax Competition, Journal of Political Economy 95, 835-854.

Endnotes

[1] Milward and Newman (1989) and The Wall Street Journal (11/24/93 pp.A1, A6).

[2] See Blair & Premus (1987), Milward & Newman (1989), and Herzog & Schlottmann (1991).

[3] See Bartik, et al (1987) and Marvel & Shkurti (1993).

[4] Result vary depending on the specificity of industry, measure of effective tax rate, dependent variable used, and other regression specific factors.

[5] See Bartik (1984, 1991), Blair & Premus (1987), Milward & Newman (1989), Newman & Sullivan (1988), L. Papke (1986), and Papke & Papke (1986).

[6] The Saturn plant, for instance, is largely automated relative to other automobile plants, consequently, utility rates are a significant factor of production.

[7] In order to finalize a deal with BMW, South Carolina offered to rebuild the Andersonville airport in order to accommodate international flights (Wall Street Journal 5/4/93).

[8] L. Papke (1986) demonstrates that site location in some industries can be entirely explained by exogenous state heterogeneity.

[9] A short term tax blackout, though, should not significantly affect any long term decisions made by a firm with a sufficiently low discount factor (Papke, 1985) under full information. Bond & Samuelson (1986) demonstrate that under uncertainty, a short term tax blackouts can be used as a signal.

[10] The assumption of a fixed population is made for ease of exposition. All of the general results hold if there is a non-negative cost associated with the relocation of labor. Bartik (1991) estimates that households require incentives on the order of 10-20% of household income to relocate.

[11] Communities can differ in *any* factor of production, without loss of generality of results. In fact, Roback (1982) shows that regional differences in wage can be explained largely by variation in exogenous local attributes.

[12] Any policy tool that affects the marginal cost of production will yield the same results.

[13] Since tax rates are often determined by referendum, the model will assume the tax choice mechanism to be a majority rule vote over tax rates. Since all members of the community are identical, the decision is made by the median voter. Though this is an identical strategy to assuming a representative agent, the model's results could be affected by the assumption of whether or not the median voter is employed by the firm if the wage increase to the firm employee is higher than that of other members of the community. For an examination of some of the public choice considerations in bidding for site locations, see Biglaiser and Mezzetti (1995).

[14] The model uses redistribution as opposed to a public good, in order to ease exposition in the case where g is negative. Since all communities have the same population, the model does not allow public good scale economies explanations for community bidding (Black & Hoyt, 1989).

[15] It will be assumed that indifferent communities would prefer to have the firm locate within the community. Note that the structure of the game does not allow for the possibility of the community gaining any rents from the transaction. This is done for ease of exposition. There is a developing literature on bargaining with outside options which indicates that the division of rents in a full information setting will depend on the discount rates of both parties as well as the value of the outside option or minimum "acceptable" bid (Muthoo, 1995). One could define $t_j(\cdot)$ as the subgame perfect equilibrium first period bid by the community as defined in the bargaining literature.

[16]Note that if there is a continuum of communities, the firm simply chooses the profit maximizing community which has the wage w^* satisfying equation 8.

[17] Concavity implies that a) $\partial\bar{w}(w_i)/\partial w_i > 0$ and b) $\partial^2\bar{w}(w_i)/\partial w_i^2 < 0$. Furthermore, assume c) $\lim_{w_i \to \infty}[\partial^2 \bar{w}(w_i)/\partial w_i^2] = 0$ and d) that $\partial^2\bar{w}(w_i)/w_i^2$ is monotone.

[18] This is referred to as a private value auction in the literature.

[19] This risk neutral specification of the utility function is used for ease of exposition in presenting a benchmark.