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INDUSTRIAL BLACKMAIL OF LOCAL GOVERNMENTS

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Abstract

A dynamic model of inter-governmental competition for investment is presented, where the investment represents a potentially large source of tax revenue for the local governments, and the local productivity of investment is uncertain. A single firm decides where to locate its new plant in each period by conducting an auction, soliciting bids from the local governments. Equilibrium subsidies from the local governments are derived, as well as conditions under which the firm will switch locations between periods.

A second issue addressed in this paper is local government strategic investment in infrastructure. We consider a two-stage game in which local governments first choose a level of infrastructure (which is costly to build), then participate in the sequential auction described above. It is shown that, even if the costs of building the infrastructure are the same in each location, in equilibrium the local governments will choose different levels of infrastructure and the region which chooses the highest level will be better off. Moreover, when the level of infrastructure is endogenous in the manner described, federally administered programs designed to increase the level of infrastructure in the less attractive region will make the firm strictly better off, without necessarily increasing the payoffs to either of the two local governments.

INTRODUCTION

Intergovernmental competition for private investment is a pervasive phenomenon. Local incentive programs, designed to attract investment, are common in most OECD countries.[1] When large investment projects are being considered, local governments will often go further by tailoring firm-specific tax/subsidy agreements. In Canada, for example, the Quebec provincial government recently provided $5 million (Canadian) in subsidies to Hyundai Auto Canada Inc., in return for building a new plant in that province.[2] In recent years intergovernmental competition for large capital projects such as this has become fierce: in the United States, municipalities have been said to enter "bidding wars" using firm-specific agreements to attract plants. For example, Mazda Motor Corp. actively solicited bids from various local governments in the U.S. when deciding where to locate its new plant. It finally accepted an offer from Flat Rock, Michigan worth $120 million (U.S.), prompting the mayor who negotiated the deal to denounce the process as "industrial blackmail".[3] This paper presents a model which analyses this process, using the theoretical framework of sequential auctions.

The existing literature on tax competition is voluminous, but it focusses primarily on incentive programs that apply to any firm that is considering doing business in the region, rather than on firm-specific agreements for particular projects.[4] In a seminal paper, Doyle and van Wijnbergen (1984) modelled a firm which bargains with different governments sequentially in a bilateral monopoly setting. This model was used to provide an explanation of tax holidays. A similar approach was used by Bond and Samuelson (1986). Both these papers assume that the firm deals with only one local government at a time, rather than negotiating simultaneously with several governments. Black and Hoyt (1989) consider simultaneous negotitations, but their analysis is essentially static, in that the location choice is a once-and-for-all decision. In this paper we present a multi-period model with simultaneous negotiations between the firm and the different local governments at each point in time. We model the bidding process formally as an auction in each period. This allows for the possibility that the firm will switch the location of its plant after an initial period, when some information about local productivity conditions has been revealed. It also allows for a clear characterization of the size of subsidies as a function of expected productivity differentials and sunk costs.

Another issue addressed in this paper is local government investment in infrastructure. For example, government investment in roads, bridges, and ports can affect the expected profits available to firms locating plants in that region. Similarly, local regulations concerning trade union activity, environmental conditions, land use by-laws, and so on can affect private investment decisions.[5] We consider a two-stage game in which local

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[1] In the United States, a handbook is available outlining the various incentive programs availble in the different states. (See National Association of State Development Agencies, et. al., (1983).) Chandler and Trebilcock (1986) survey the regional incentive programs implemented in different OECD countries.

[2] The Financial Post, July 5, 1989, p.3.

[3] The Globe and Mail, August 26, 1989, p.B1.

[4] For a comprehensive survey of the tax competition literature, see Wildasin (1986).

[5] A rather notorious example of this sort of behaviour was the 1979 amendment of the Nova Scotia Trade Union Act which required that any unionization in a

governments first choose a level of infrastructure (which is costly to build), then participate in the sequential auction described above. It is shown that, even if the costs of building the infrastructure are the same in each location, the regional governments will choose different levels of infrastructure and the region which chooses the highest level will be better off. Moreover, when the level of infrastructure is endogenous in the manner described, federally administered programs designed to increase the level of infrastructure in the less attractive region will make the firm strictly better off, without necessarily increasing the pay-offs to either of the two regional governments. The layout of the paper is as follows: section II presents a two-period model where a firm solicits bids, in each period, from local governments when deciding where to locate its plant. Section III extends the model by allowing the governments to first choose a level of infrastructure. Section IV uses the model to analyse the effects of interregional transfers. Finally, section V presents a conclusion, and some suggestions for further research.

II. BIDDING WARS BETWEEN REGIONS [6]

There are two regions (A and B) which compete for the firm's plant, in each of two time periods. Locating a plant in either region requires a sunk cost of k; thus, if the firm relocates between periods, it incurs the cost twice. The surplus available in either region, denoted y_i, $i = A,B$, is uncertain prior to actual production in that region. It is common knowledge that

$$y_i = x_i + \varepsilon_i \qquad i = A, B \tag{1}$$

where ε_A and ε_B are iid with common distribution function $F(\cdot)$ and associated density function $f(\cdot) = F'(\cdot)$. We assume

$$E\varepsilon_i = 0 \quad \text{and} \quad F(0) \leq 0.5, \tag{2}$$

where E denotes expectations. All parties are risk-neutral, and regional governments seek to maximize expected tax revenues. All agents share a common discount rate, β.

The sequence of decision-making and information revelation is as follows. At the beginning of the first period, $F(\cdot)$, x_A, and x_B are common knowledge; neither the firm nor either regional government has any private information about actual surpluses within either region. Based on the (common) expectations about available surpluses, the regional governments participate in an ascending-bid oral auction. The governments' "bids" are subsidy

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manufacturing company with two or more "interdependent" manufacturing locations within the province must be done on a company wide basis, rather than plant by plant. It has been alleged that this was done to encourage Michelin Tires to build a third plant in that province. (Tupper, (1986)).

[6] The model in this section is similar to the one in King and Welling (1989). The models differ in two respects: KW consider only two possible values of productivity in each region, and allow for the possibility that the type of the firm is unknown. The model here allows a much more general distribution of productivity in each region, but eliminates any consideration of a matching problem between the firm and a region. The major results are unchanged.

[7] Note that sealed bid auctions are not renegotiation proof, as the firm may be induced to play one region off against another to obtain a better price,

packages offered to the firm; a package determines the sharing of the surplus between the firm and the regional government. Once the firm has chosen a location, and incurred the fixed cost k, the actual surplus in the chosen region is revealed to all three decision-makers, production takes place and the first period surplus is divided between the firm and the winning government. As the firm does not produce in the region which did not win the first period auction, nothing is learned about the surplus available in that region.[8] At the beginning of the second period, the regional governments again enter an auction to determine the firm's second-period location. If the firm chooses not to move, no additional information is revealed; if it relocates, the surplus in the second region is revealed once the fixed cost has been incurred in that region. Once the firm's decision has been made, production occurs, and the second-period surplus is divided.

Given the sequencing of actions and information revelation, first period decisions are based on expectations of second period decisions. Moreover, second period decisions are based on a comparison of known with uncertain outcomes. In setting up the agents' first period objective functions, it will prove convenient to use the following function:

$$\mu(z) \equiv E\max\{\varepsilon,z\} = zF(z) + \int_z^{\infty} \varepsilon f(\varepsilon)d\varepsilon \tag{3}$$

The expectation is taken with respect to the random component of production in the location chosen in the first period. At the time of the second period auction, the actual value of this random variable is common knowledge. The expected value of the random component in the other location is zero (by (2)). Hence, the relocation decision is based on a comparison of $(x_i+\varepsilon_i)$ and (x_j-k), (where i denotes the location of the firm in period 1). Relocation will not raise the expected available surplus if $(x_j-k) < (x_i+\varepsilon_i)$ or $\varepsilon_i > x_j-x_i-k$. Therefore an important determinant of the first period decisions is $E\max\{\varepsilon_i, x_j-x_i-k\}$. Note that

$$\mu'(z) = F(z) \in [0,1] \tag{4}$$

It is assumed that no agent can commit to future actions. The model is therefore solved recursiveiy.

Period 2

Assume the firm located in region i in period 1. The second period surplus available in region i, $y_i = x_i + \varepsilon_i$, is therefore known to all agents. Since no information has yet been gathered on the other region, region j, the common expectation of the surplus available there is $Ey_j = x_j$. Relocating the plant in the second period means incurring the fixed cost k again, so the relevant payoff in region j is the expected net surplus, x_j-k. Given these possibilities, the second period auction generates the following pay-offs to

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resulting in an oral or second price auction. It can be shown that although the firm would prefer a sealed bid first price auction, the regions are better off under the oral auction.

[8]In KW, observation of the first period surplus provided additional information about the firm's type.

the firm and the two regional governments, respectively:[9]

$$\text{firm receives } \min\{y_i,\ x_j-k\} \tag{5a}$$

$$\text{region i receives } \max\{0,\ y_i-x_j+k\} \tag{5b}$$

$$\text{region j receives } \max\{0,\ x_j-k-y_i\} \tag{5c}$$

The results of the second period auction can now be used to derive the results of the first period auction: the initial location choice of the firm, and the net subsidy offered by the winning region to the firm.

Period 1

Consider first the bidding strategy of region A; region B's strategy can then be derived by symmetry. If region A wins the first period auction, thusbecoming region i in period two, the expected surplus over the two periods is

$$S_{wA} \equiv E\{x_A+\varepsilon_A - k + \beta\max\{0,\ x_A+\varepsilon_A-x_B+k\}\} \tag{6}$$

$$= (1+\beta)x_A - (1-\beta)k - \beta x_B + \beta\mu(x_B-x_A-k)$$ [10]

In all cases, expectations are taken with respect to ε_A, since the expectation with respect to ε_B was taken in the calculation of (5b). If region A does not win the firm in the first period, it becomes region j in period two, and the expected surplus over the two periods is then

$$S_{\ell A} = \beta E\max\{0,x_A-k-(x_B+\varepsilon_B)\} = \beta\mu(x_A-k-x_B) \tag{7}$$

Here the expectation is taken with respect to ε_B, since this will be revealed once the firm has established its plant in region B in the first period.

In the first period auction, the maximum region A will bid is that amount which leaves it indifferent between winning and not. This gives region A's bid as

$$b_A = S_{wA} - S_{\ell A} = x_A - k + \beta[x_A-x_B+k+\mu(x_B-x_A-k)-\mu(x_A-x_B-k)] \tag{8}$$

By symmetry, region B's maximum bid in the first period will be

$$b_B = S_{wB} - S_{\ell B} = x_B - k + \beta[x_B-x_A+k+\mu(x_A-x_B-k)-\mu(x_B-x_A-k)] \tag{9}$$

Notice that the two regions' maximum bids are identical if $x_A = x_B$, and each region's maximum bid is strictly increasing in its own expected surplus:

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[9] An ascending bid auction has the article being purchased for a price equal to the second highest value, by the bidder with the highest value. In this model each regional government is willing to offer a tax/subsidy package which allows the firm to retain at most the entire expected surplus, net of the fixed cost. For a survey of auction theory, see McAfee and McMillan (1987).

[10] Note that, for any constant a,

$$E\max\{a+\varepsilon,0\} = a + E\max\{\varepsilon,-a\} = a + \mu(-a)$$
$$E\max\{a-\varepsilon,0\} = E[a-\varepsilon + \max\{\varepsilon-a,0\}] = E[a-\varepsilon-a + \max\{\varepsilon,a\}]$$
$$= -E\varepsilon + E\max\{\varepsilon,a\} = \mu(a) \text{ since } E\varepsilon = 0.$$

$$\frac{\partial b_A}{\partial x_A} = 1 + \beta[1 - F(x_B - x_A - k) - F(x_A - x_B - k)] > 0^{11} \tag{10}$$

The corresponding partial for region B is completely symmetric. Therefore the region with the larger expected surplus has the larger maximum bid, and wins the firm in the first period.

Without loss of generality, we assume $x_A > x_B$. It follows that region A wins the firm in the first period. Let p_A denote the price region A actually pays for the firm ex ante (ie. the firm's payoff in period 1 is p_A). This is equal to the maximum bid region B could offer, so

$$p_A = b_B = x_B - k + \beta[x_B - x_A + k + \mu(x_A - x_B - k) - \mu(x_B - x_A - k)] \tag{11}$$

In the first period, the firm receives the surplus (net of the fixed cost), plus any net subsidy from the regional government. This subsidy will be positive if p_A exceeds $(x_A - k)$, the expected net surplus. The distribution of the surplus in the first period can now be summarized.

Proposition 1:

Suppose $x_A > x_B$. Then in the first period the firm locates its plant in region A, and receives an ex ante net subsidy of σ, given by

$$\sigma(\Delta,k) = -(1+\beta)\Delta + \beta[k + \mu(\Delta - k) - \mu(-\Delta - k)], \tag{12}$$

where k is the fixed cost, and $\Delta \equiv x_A - x_B > 0$. The subsidy is increasing in k, and decreasing in Δ, the difference in expected regional surpluses. If $\sigma < 0$, the firm contributes to the regional government's tax revenues in the first period.

Proof: In the first period, the regional government of region A receives $(x_A - k - p_A)$; the firm receives p_A. The net subsidy to the firm is therefore $\sigma = p_A - (x_A - k)$; (14) is derived using (11). Denoting the partial of σ with respect to variable j by σ_j, and using (4),

$$\sigma_\Delta = -(1+\beta) + \beta[F(\Delta - k) - F(-\Delta - k)] < 0 \tag{13a}$$

$$\sigma_k = \beta[1 - F(\Delta - k) + F(-\Delta - k)] > 0 \tag{13b}$$

■

The value of the net subsidy received by the firm in the first period is given in Proposition 1. It is also shown that the subsidy is increasing in the sunk cost, and decreasing in the difference in the expected surpluses of the winning and the losing regions. Both these results accord with intuition. The higher the sunk cost, the less mobile the firm once it has built a plant and, from (5a), the lower the firm's expected pay-off in the second period. Hence the greater must be the initial subsidy to induce the firm to locate in

[11] This uses (4) above.

either region. The greater is Δ, the greater the relative advantage of the more productive region, and therefore the larger the share of the surplus in that region which can be retained by the regional government without losing the firm.

Since the subsidy depends upon the distribution of the ε_i's, without specifying $F(\cdot)$ it is not in general possible to determine whether the firm receives a positive or negative net subsidy for particular (k,Δ) pairs. The following corollary to Proposition 1 shows that when regions are identical ex ante, the subsidy will be positive for any positive sunk cost.

Corollary:

If the regions are identical ex ante, the firm will receive a net subsidy from the government in the region it chooses so long as there is some sunk cost involved in building a plant. The more disparate the regions, the greater must be the fixed cost for the firm to receive a subsidy.

Proof: From (12), $\sigma(0,k) = \beta k > 0$, and

$$\left.\frac{dk}{d\Delta}\right|_{\sigma \text{ constant}} = -\frac{\sigma_\Delta}{\sigma_k} = \frac{1 + \beta - \beta[F(\Delta-k) + F(-\Delta-k)]}{\beta[1 - F(\Delta-k) + F(-\Delta-k)]} \tag{14}$$

$$\geq 1 \text{ iff } 1 \geq 2\beta F(-\Delta-k)$$

which holds since $F(-\Delta-k) \leq F(0) \leq 0.5$ by (1).

This result is also intuitive: so long as k is strictly positive, the region which wins the firm in the first period has an advantage in the second period. The first period value of this advantage is βk, and this is bid away to the firm in period 1 through Bertrand competition. Although the firm receives a subsidy in the first period, this subsidy is repaid through second period taxes, provided the firm stays in the region. The firm will move in the second period only if ε_A is sufficiently below zero - in particular, below $(-\Delta-k)$.

Although the fixed cost is a barrier to mobility in the second period, it is not absolute: once the actual surplus available in region A is revealed, the firm must decide where to produce in the second period. If ε_A is high, the firm will not move, but a low actual surplus in period 1 may cause the firm to switch locations in the second period. The probability of moving to region B in period 2 is[12]

$$\text{Prob}(x_A+\varepsilon_A \leq x_B-k) = \text{Prob}(\varepsilon_A \leq -\Delta-k) = F(-\Delta-k) \tag{15}$$

Provided the support of $F(\cdot)$ is large enough, there is a positive probability of switching locations in the second period. This probability is strictly decreasing in both k and Δ: ex ante, relocation is less likely the higher is the fixed cost of building a plant, and the greater is the disparity between the mean surpluses in the two regions. We state this as a proposition.

[12]Recall that by assumption $\Delta \equiv (x_A-x_B) \geq 0$, so the firm chooses region A in period 1.

Proposition 2:

Given enough uncertainty about the available surplus, there is a positive probability that the firm will move in the second periodto the other region. Switching locations is less likely the greater is the fixed cost, and the larger is the difference between the expected surpluses in the two regions.

This positive probability of switching is reflected in the determination of the subsidy. From (12), the subsidy is strictly increasing in $[\mu(\Delta-k)-\mu(-\Delta-k)]$; using (2), this can be approximated in terms of the probability of switching :

$$\mu(\Delta-k)-\mu(-\Delta-k) = \int_{-\Delta-k}^{\Delta-k} \mu'(z)dz = \int_{-\Delta-k}^{\Delta-k} F(z)dz \in [2\Delta F(-\Delta-k),2\Delta F(\Delta-k)] \qquad (16)$$

Loosely speaking then, the larger is the probability of switching, $F(-\Delta-k)$, the larger the subsidy tends to be.[13]

Because we have modelled this as a two-period game, the firm can never expect to receive a net subsidy in the second (final) period. However, ex post net subsidies to newly attracted firms are consistent with our model. This model makes no predictions about the form of the net subsidy granted to the firm; in particular, a given level of expected taxes could be obtained by a number of combinations of lump-sum subsidies and tax rates. If the firm does move to region B in the second period, it pays expected net taxes of T_{2B}, where

$$T_{2B} = x_B - k - x_A - \varepsilon_A$$

(This is calculated from (5a).) This could be achieved by any combination of a lump-sum (L) and a marginal component (τ) such that the region's total expected revenues were equal to

$$T_{2B} = \tau(x_B-k) - L$$

The taxes actually paid by the firm would be equal to $\tau(y_B-k)$; if realized productivity in region B turned out to be low, the ex post subsidy to the firm could turn out to be positive.[14]

The analysis above has assumed uncertainty about the surplus available in either region. The following Proposition summarizes the predictions of this analysis for the special case of full and perfect information.

Proposition 3:

Suppose there is no uncertainty about the surplus available in either region. Then the firm locates its plant in region A in the first period, and stays there. The net subsidy to the firm in the

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[13] This is not a causal relationship. For example, *ceteris paribus* a decrease in Δ will increase both the probability of switching and σ, for any given F.

[14] In 1987 the Newfoundland government offered a $15 million (Canadian) package to the Sprung Environponics cucumber greenhouse. (The Calgary Herald, May 12, 1987, p. C1) The company accepted this offer, and left Calgary for St. John's. The firm proved to be no more successful in Newfoundland than it had been in Calgary, and the December 1988 crop failure precipitated a political upheaval in Newfoundland. The analysis in this paper suggests that the Newfoundland government's offer may have been rational ex ante.

first period is

$$\sigma = \begin{cases} \beta k - (1+\beta)\Delta & \Delta \leq k \\ -\Delta & \Delta > k \end{cases}$$

Proof:

In the certainty case, $\varepsilon_i = 0$, so $\mu(z) = \begin{cases} 0 & z < 0 \\ z & z \geq 0 \end{cases}$.

Substituting this into (12) yields the subsidies above.

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III. INFRASTRUCTURE AS A STRATEGIC VARIABLE

It was assumed in the previous section that the expected surplus in region i was exogenously determined. In general, we observe regional governments creating legal and capital infrastrutures which are intended to improve the climate for business in their regions.[15] In this section we add a prior stage to the two-period game above, and allow regions to make costly investments which increase x_i. We show that the assumed difference between the regions can arise endogenously, and the regions' equilibrium decisions break ex ante symmetry.

Before the first period bidding begins, region i can create x_i at cost $\gamma(x_i)$, where $\gamma(\cdot)$ is increasing and strictly convex. If the initial position has $x_A = x_B = 0$, then expenditures by region A increase Δ, region B's expenditures decrease Δ, and equal expenditures by both regions leaves Δ unchanged. The pay-offs to region A from investing in x_A are

$$\pi_A(x_A) = \begin{cases} S_{wA} - p_A & \text{if } x_A > x_B \\ S_{\ell A} & \text{if } x_A < x_B \end{cases}$$

Using (6), (7), and (11), this can be rewritten as

$$\pi_A(x_A) = \begin{cases} (1+2\beta)\Delta + \beta[2\mu(-\Delta-k) - \mu(\Delta-k)] & \text{if } \Delta > 0 \\ \beta\mu(\Delta-k) & \text{if } \Delta < 0 \end{cases} \tag{17}$$

By symmetry, region B's pay-off from investing in x_B can be obtained from (17) by replacing Δ ($-\Delta$) with $-\Delta$ (Δ).

The Nash equilibrium to this game has each region choosing the level of its own investment which maximizes its expected net pay-off, taking the expenditure level of the other region as given. The first step in describing the equilibrium is Lemma 1:

Lemma 1: If the regions are identical at the beginning of the game, there does not exist a symmetric pure strategy equilibrium to the investment game. There does exist an asymmetric pure stategy equilibrium.

Proof: Region A chooses x_A to maximize $\pi_A - \gamma(x_A)$, taking x_B as given.

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[15] Black and Hoyt (1989) cite examples of offers of a public school and a robotics institute. See also foot-note 5.

Evaluating the partial of the objective function wrt x_A at $\Delta = 0$ yields

$$\left.\frac{\partial \pi_A}{\partial x_A}\right|_{\Delta=0} = \begin{cases} (1+2\beta) - 3\beta F(-k) - \gamma'(x_A) & \text{if } x_A \geq x_B \\ \beta F(-k) - \gamma'(x_A) & \text{if } x_A < x_B \end{cases} \tag{18}$$

This partial is equal to zero at $\Delta = 0$ iff $1+2\beta = 4\beta F(-k)$. Since $F(0) \leq 0$, $4\beta F(-k) \leq 2\beta < 1+2\beta$, so this condition is never satisfied.

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Given Lemma 1, we focus on asymmetric pure strategy equilibria and assume $x_A > x_B$.

From the regions' optimization problems, assuming $\Delta > 0$, the Nash choices of investment satisfy[16]

$$\text{region A:} \quad \gamma'(x_A^*) = 1 + 2\beta - \beta[2F(-\Delta-k) + F(\Delta-k)] \tag{19a}$$

$$\text{region B:} \quad \gamma'(x_B^*) = \beta F(-\Delta-k) \tag{19b}$$

Since $\gamma(x)$ is convex, and $F(0) \leq 0.5$, these expressions yield $x_A^* > x_B^*$. Even though region A wins the firm in the first period, region B may choose $x_B^* > 0$, since higher values of x_B raise the probability that the firm will choose to switch locations in the second period.

In equilibrium, region A wins the firm in the first period, but does so as a consequence of greater expenditures to attract the firm. In spite of these greater costs, there is no ambiguity in the ranking of the expected rewards: the region which makes the greater investment to attract the firm has the larger expected pay-off. To see this, let $\pi_i(x_i|x_j)$ denote the expected pay-off of region i as a function of x_i given region j has chosen x_j. Then,

$$\pi_A(x_A^*|x_B^*) - \gamma(x_A^*) \geq \pi_A(x_B^*|x_B^*) - \gamma(x_B^*) > \pi_B(x_B^*|x_A^*) - \gamma(x_B^*)$$

The first inequality follows because region A chooses x_A^* optimally given x_B^*, while the second holds because region B's pay-off is strictly decreasing in x_A and $x_A^* > x_B^*$.

The results of this analysis are summarized in Proposition 4.

<u>Proposition 4</u>:

> If regional governments are able to make costly investments which increase the expected surplus available from locating a plant in their regions, and this investment is equally costly in each region, then in equilibrium the regions will choose different levels of investment and, hence, will not be equally attractive to

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[16] This section assumes that the second order conditions for the regions' optimal plans are satisfied. That is, $2\beta f(-\Delta-k) - \beta f(\Delta-k) - \gamma''(x_A^*) < 0$ and $\beta f(-\Delta-k) - \gamma''(x_B^*) < 0$ at $\Delta = x_A^* - x_B^*$.

firms. The region which makes the higher expenditure will be better off.

IV. REGIONAL SUBSIDIES AND INTER-REGIONAL TRANSFERS

The analysis of the previous section showed that competition between the regions for large capital investment could generate a situation in which the region which made the greater effort to attract a firm would be better off. A common feature of federal states is some form of equalization grants and/or regional incentive program, where the federal government transfers wealth between lower levels of government in order to encourage the development of regional industrial bases. Although the model in this paper cannot provide a full analysis of such programs, some consequences of regional subsidies can be examined.

Consider amending the model of the previous section to incorporate subsidization of region B.[17] There are two obvious forms of subsidization to consider: lump-sum grants, and matching subsidies. With lump-sum grants, the value of x_B increases by the amount of the grant, independent of the level of $\gamma(x_B)$; with matching grants, the regional government must still make some expenditures from its own budget. Either of these will have the effect of raising the level of region B's investment for any given level of x_A. Region A's reaction function is implicitly defined in (19a) above; totally differentiating this condition with respect to x_A and x_B, and rearranging, yields

$$\frac{dx_A}{dx_B} = \frac{\beta[f(\Delta-k) - 2f(-\Delta-k)]}{\gamma''(x_A*) + \beta[f(\Delta-k) - 2f(-\Delta-k)]} \tag{20}$$

Assuming the SOC for a maximum is satisfied, the denominator of the expression in (20) is positive. The numerator may be positive or negative, depending upon the particular distribution.[18] If it is positive, the entire expression is positive, but less than unity. This implies that although subsidization of the region which is less attractive to foreign capital does induce the more attractive region to undertake additional investment to maintain its relative attractiveness, the compensation is less than full. If the numerator is negative, but Δ is still positive, then subsidizing the less developed region will lower A's optimal level of infrastructure. In either case, the subsidization reduces the disparity between the regions.

The only agent who is certain to gain from this subsidization is the firm, which is able to extract a larger payment from the regions. Recall that, from Proposition 1, the net subsidy to the firm is decreasing in Δ: the more disparate the regions, the less the winning region must pay to bribe the firm to choose it rather than the poorer region. By making the regions more alike, the subsidy to the poorer region increases the price the firm can extract in the auction, and hence reduces the share of the surplus which remains in the regions. The subsidy does result in a larger total surplus; however, it is easy to show that the winning region will be made worse off

[17] We ignore the source of this subsidy, and view it as manna from heaven. A more complete treatment of subsidies would be explicit about financing.

[18] For instance, it is strictly negative for a uniform distribution.

overall. From (17), region A's pay-off is $\pi_A(x_A*) - \gamma(x_A*)$; totally differentiating this with respect to x_B, using (20) and (19a), yields

$$\frac{d[\pi_A(x_A*)-\gamma(x_A*)]}{dx_B} = -\gamma'(x_A*) < 0$$

Although subsidization of the poorer region does succeed in decreasing the gap between the regions, it is not necessarily the case that the poorer region benefits from such transfers. In the second period, only if ε_A is sufficiently low will the firm move to region B. Subsidization of region B increases $F(-\Delta-k)$, the probability of relocation, as well as the second period tax revenues of the poorer region if the firm does move.[19]

This analysis assumes that the only benefit from winning the firm is the increased tax revenues. In practice, the subsidization of region B and the induced investment in region A may have employment benefits which outweigh the gains of the firm. Moreover, if the subsidization makes the regions more attractive to other firms, the loss on this single firm may be a necessary cost. Of course, $\gamma(x)$ could be interpreted as costs net of these benefits.

V. CONCLUSION AND EXTENSIONS

Inter-governmental competition for lumpy capital can take many forms. In this paper we present a multi-period model in which local governments compete via auctions for a plant being built by a single firm. Since a sunk cost is incurred when the plant is built in the first period, mobility in subsequent periods is limited, giving the first period winner a second period advantage. This allows the region in which the firm initially locates to extract a share of the surplus produced in subsequent periods, without fear of the firm being bid away to another region. The firm trades these future tax payments for current subsidies and tax concessions. The magnitude of the subsidy is increasing in the level of the sunk cost, and decreasing in the disparity between the regions.

Within this framework we also analyze regional governments' incentives to invest in infrastructure to make their regions more attractive to outside capital. It is shown that differences between the regions emerge endogenously, and attempts (by a federal authority, say) to reduce these differences may merely transfer rents to the firm.

In this paper, regional governments face a two-period budget constraint: any net subsidy paid to the firm in the first period must be balanced by expected net taxes in period two. Black and Hoyt (1989) present a one-period model in which local governments' bids for capital projects are financed by a reduction in the tax burden of current citizens. In their model, the local governments provide public goods which have relatively large fixed costs. With declining average costs for the public good, the larger labour force which the investment attracts lowers the per capita tax of the citizens, and the subsidy to the firm does not require an increase in net taxes.

Although Black and Hoyt do allow for some uncertainty about the relative productivity of the firm in a particular location, they do not consider the complications introduced by the possiblity of plant relocation once actual productivity is revealed. The contemporaneous financing of any subsidy makes relocation irrelevant in their model. In our model, the possibility of

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[19] This can be seen from (5c).

relocation is an important determinant of the price actually paid by the winning region in the first period, and there is a positive probability that a firm which experiences a low outcome in the first period will be courted and won by another region. Future research which blended these two models would allow for a richer description of the consequences of intergovernmental competition, and analysis of the effects of various policies within federal states.

Another possible extension could introduce a sequence of firms which approach the two regions. If the firms can be of different types, then it may be possible to have an equilibrium where the regions specialize in the type of infrastructure that they offer.

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