Industrial Policy and Competing Jurisdictions

by

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1. Introduction

The competition among state and local governments to attract industry is highly visible. States routinely hand out large subsidies and special tax packages to induce businesses to build plants in their states. In a piece that has attracted widespread attention, Burstein and Rolnick (1995) argue that subsidies and special deals are counterproductive. They urge the federal government to limit the ability of states to offer these special deals.

To understand the effects of such a proposal, it is necessary to understand why states would want to offer these special deals. One common explanation is the *tax-base* motivation for subsidies. When a factory opens up in a state, the discounted value of the taxes paid by the factory may more than offset the costs of subsidies and public spending on infrastructure associated with the factory. If the factory would not locate in the state without a subsidy, the state has a clear incentive to offer a subsidy.

A second common explanation for subsidies is the *economic-development* motivation. It is thought by many that if a state is successful in landing an auto plant, then this will expand the demand for local auto-part suppliers, which will then expand the demand for the suppliers of the suppliers, and so on. There is a notion that if the auto plant locates in the state there will *demand-spillover* benefits for other firms in the state.

There exists a large body of theoretical work in the public finance literature that analyzes the competition among jurisdictions to attract industry. For the most part, the models in this literature focus on the tax-base motivation for subsidies.[1] There is also a large body of work in

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[1] See for example, Wilson (1986), Black and Hoyt (1989) and my own work, Holmes (1995). There are exceptions as I will discuss in Section 2.

the economic development literature on the use of subsidies. For the most part, this literature considers environments where jurisdictions make decisions in isolation rather than environments where jurisdictions compete with each other.[2]

While there is a vast number of papers in this general literature, there appears to me to be an important gap in the literature. There does not exist an analysis of competing jurisdictions in a model where jurisdictions attempt to attract industry because of demand-spillover benefits. Despite all of the attention given to the tax-base motivation in the public finance literature, the demand-spillover explanation gets as least as much and probably more attention in the popular press than the tax-base motivation. (This claim is certainly true if the demand-spillover explanation can be interpreted as having something to do with "jobs.") It is a useful exercise to see if commonly made informal arguments can be given a firm theoretical foundation in a formal model.

This paper has two goals. The first goal is to develop and analyze a model in which states compete to attract industry and in which economic development is the motivation for this competition. The second goal of the paper is to evaluate, in the context of the model, the Burstein-Rolnick proposal banning subsidies.

The model I develop follows along the lines of the *big-push* model of Murphy, Shleifer and Vishny (1989). There is a large variety of differentiated products in the economy and some firms have market power in their particular market niches. Hence, for some products price is above marginal cost. When a new plant locates in a state it buys a disproportionate amount of its inputs from local suppliers. Since some of these supplier prices are above marginal cost, there is a demand-spillover externality the a prospective plant does not internalize in its location decision. The Murphy, Shleifer and Vishny (1989) model captures the intuition of the multiplier effect discussed above. An opening of a new plant leads to increases in demand for local suppliers which in turn leads to further increases in the demand for local suppliers, and so on.

In the model that I develop, the equilibrium of competition between the states may or may not result in subsidies. A key question addressed by the paper is what factors determine whether or not subsidies are offered in equilibrium. A related question is how the equilibrium subsidy varies with the parameters of the model.

The second concern of this paper is the welfare analysis of the Burstein-Rolnick proposal banning subsidies. On this issue I obtain some common-sense results. In some cases, adoption of the proposal would increase national welfare and in other cases it would decrease national welfare.

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[2]The strategic trade literature is am important exception.

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The adoption of the ban improves welfare when the number of factories is fixed at the national level; i.e., when the competition just shifts around a fixed stock. In this case, the subsidies lead to no benefit at the national level but do entail costs. In particular, taxes must be collected to finance the subsidies and these taxes lead to distortions in other parts of the economy. The cases where adoption of the ban harms national welfare occur when plant location decisions are not zero sum; i.e. when subsidies expand the total number of factories at the national level.

2. Relation to the Previous Literature

To be completed later

Relation to Holmes (1995), Courant (1995), Krugman and Venables (1995), Oates and Schwab (1988, 1991) and others.

Relation to strategic trade literature.

3. The Model

There is a set of differentiated product types $h \in [0, 1]$ on the unit interval. A composite good is produced with the production function

(1) $\quad q = e^{\int_0^1 \ln x(h) dh}$.

This production function is constant returns to scale and has a constant elasticity of substitution equal to one.

There are two locations, state 1 and state 2. There is a unit measure of individuals at each location. The individuals who live in state i are called *state-i residents*. These individuals consume an amount c of the composite good and supply an amount L of labor services. The utility function of these individuals is

$$u(c, L) = c - \frac{L^2}{2}.$$

There are two alternative technologies for producing the intermediate input h, the *traditional technology* and the *manufacturing technology*.

With the *traditional technology*, one unit of labor produces one unit of product. There is free access to this technology for everyone in the economy. Hence, the competitive price of good h if it is made through the traditional technology is $p^c(h) = w$, where w is the wage per unit of labor.

The manufacturing technology exists only for a certain subset of intermediate goods. Here, one unit of labor produces $\alpha > 1$ units of output. In any case where a firm has access to the

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manufacturing technology for a particular product h, the firm has a monopoly over access to the technology. Given the production function (1), the derived demand curve for any intermediate good h will have unit elasticity. Hence, a monopoly manufacturer in competition with the traditional technology will always set price equal to the wage to match the competitive sector price, $p^m(h) = w$.

Consider an individual choosing among the intermediate goods h to construct one unit of the composite. Since in any equilibrium all prices are identical, $p(h) = w$, the individual will always employ equal amounts of all goods. If the individual employs x units of each good h, the amount of composite so constructed is

$$q = e^{\int_0^1 \ln x \, dh} = e^{\ln x} = x.$$

Hence, the total expenditure required to assemble one unit of the composite is w; i.e. the price of one composite unit equals the price of one labor unit. Normalize both prices to equal 1.

In state 1, for each product h on the interval $[0, \gamma]$ there exists a firm who has a monopoly on the manufacturing technology for that good. These firms are owned by the state-1 residents. I will call these firms the *domestic monopolists in state 1*. Assume $\gamma < \frac{1}{2}$. Assume that at the beginning of the period these firms are already in business. In other words, they do not have to pay any fixed cost to obtain access to the manufacturing technology.

Analogous to the situation in state 1, in state 2 for each product h on the interval $[\gamma, 2\gamma]$ there exists a firm who has a monopoly on the manufacturing technology for that good. These firms are owned by the state 2 residents.

There is one final group of firms that I call the *mobile firms*. Initially these firms are located in neither state. These firms are initially not in business but may enter by paying a fixed cost. There is a continuum of these firms having a measure 2λ for some $\lambda < (\frac{1}{2} - \gamma)$. The mobile firms are indexed by $z \in [-\lambda, \lambda]$. If firm z pays the fixed cost, it has a monopoly on the manufacturing technology for product $h = 2\gamma + \lambda + z$. Note that if all the mobile firms were to pay the fixed cost, they would cover the range $[2\gamma, 2\gamma + 2\lambda]$ of products. Recall that monopoly firms in state 1 cover the range $[0, \gamma]$ while monopoly firms in state 2 cover the range $[\gamma, 2\gamma]$. In the residual range of products $[2\gamma + 2\lambda, 1]$ there never exists a monopoly manufacturer and these residual goods are always produced with the traditional technology.

A mobile firm z has to choose whether or not to enter and if it enters it has to choose which state to locate in. If the firm enters it pays a fixed cost that in general will depend upon which state the firm locates in as well as the firm's type z. Let $f_1(z)$ be the fixed cost incurred by firm z

if it locates in state 1 and $f_2(z)$ be the cost of locating in state 2. Further assumptions about these functions will be made below. The fixed cost is in terms of the composite good given by (1). Hence the composite good serves as a final consumption good as well as an intermediate input for mobile firms.

The assumption that the fixed cost is in terms of the composite good is an important way that this model differs from the original Murphy, Shleifer, and Vishny (1989) setup. In that model the fixed cost is denominated in labor units. My setup makes the demand spillover externalities stronger. When a mobile firm locates in a state, to satisfy its fixed cost requirement it purchases intermediate goods from suppliers that have marked the prices of these goods above marginal cost. In constrast, in the Murphy, Shleifer, and Vishny setup, the firm pays a price equal to the social marginal cost; i.e., the wage. I conjecture that if I were to change the model so that the fixed cost was denominated in labor units, there would be no equilibrium subsidies in the model.

Each state has a government. The government of state i has the power to offer a subsidy of s_i dollars to each mobile firm that locates within the state. Let m_i be the measure of mobile firms that choose to locate in state i. The government's expenditures on subsidies is then $m_i s_i$. This expenditure must be financed by a proportionate tax t_i on labor. If a representative individual supplies L_i labor units in state i, it pays total taxes of $t_i L_i$. Each government is required to balance its budget so that $m_i s_i \leq t_i L_i$.

Assume that trade in differentiated inputs between the two locations is infeasible. (In later versions of this paper I plan to consider the case where some trade is possible and examine the impact of tariffs.)

The sequence of events in the economy is as follows. There are four stages. In stage 1 the two governments simultaneously make the subsidy offers s_1 and s_2. In stage 2 the mobile firms make their entry decisions. At this stage, some subset of the set of mobile firms choose to locate in state 1, another subset choose to locate in state 2, and the rest locate neither place. In stage 3, the two governments pick the tax rate t_1 and t_2. In stage 2 production and consumption decisions are made.

The domestic monopolists act to maximize profit. The profits are distributed to the local residents. The mobile firms are not treated as residents and do not receive shares of the profits of the domestic monopolists. The government of each state acts to maximize the utility of the residents of the state.

4. Case 1: The No-Linkage Case

In the analysis of the model I will consider two extreme cases. The two cases will vary by the assumptions made about how the fixed cost at the two locations depends on the type z of a mobile firm. In the first special case there is no linkage between the two jurisdictions. In this special case, the actions in one state have no effect on what happens in the other state.

Recall that the mobile firm types are indexed by $z \in [-\lambda, \lambda]$. For z in the bottom half of this interval, $z \in [-\lambda, 0]$, suppose that $f_1(z) = \phi + \theta|z|$ and $f_2(z) = \infty$. This assumption says that is infeasible for mobile firms in this set to locate in state 2 (the fixed cost is infinite). It is possible to locate in state 1 at a cost that rises with the absolute value of z. The situation is symmetric for z in the top half of the interval, $z \in [0, \lambda]$. For these mobile firms assume that $f_2(z) = \phi + \theta|z|$ and $f_1(z) = \infty$. For these firms it is impossible to locate in state 1.

Given these assumptions, there is no interaction between the two states. Each state can be examined in isolation. So here I will look at what happens in state 2. I will ignore the location subscript to keep the notation simple. With these assumptions the analysis essentially boils down to the original Murphy, Shleifer, Vishny setup with the significant difference that the fixed cost is in terms of the composite good rather than labor.

Suppose the tax rate is t in the state and the subsidy is s. I will solve for the equilibrium in the economy ignoring the budget balance constraint. From the budget balance condition I will then derive the equilibrium tax rate t as a function of the subsidy s. I will conclude by determining the optimal subsidy s.

I begin by looking at the problem of the residents. Recall that the equilibrium price of the composite equals the wage and that the wage is normalized at 1. Residents receive a share b of the profits of the domestic monopolist. Residents choose a labor supply L. After paying the tax t on their labor income, residents have an after-tax income of $(1 - t)L + b$ which they spend on consumption. Residents solve the problem of picking a work level L to maximize utility,

$$\max_L (1 - t)L + b - \frac{L^2}{2}.$$

From the first-order necessary condition of this problem,

$$L = 1 - t.$$

Consider the problem of the mobile firms. For $z < 0$, $f_2(z) = \infty$, so none of these locate in state 2. For $z > 0$, $f_2(z) = \phi + \theta z$. It is clear that the value of entry is decreasing in the mobile firm type z. Hence the entry rule will always be some cutoff $\hat{z}$ such that $z < \hat{z}$ enter and $z > \hat{z}$ do not.

Suppose the entry rule is given by $\hat{z}$. Then the measure of entry is given by

$$m = \int_0^{\hat{z}} dz = \hat{z}$$

Recall that there is a measure γ of domestic monopolists. Adding to this the monopolists from new entry, the measure of goods with the monopoly manufacturing technology is

$$\mu = \gamma + m.$$

Next consider the question of how much is made of each intermediate input h in the state. Let x denote this amount. Recall that since the price of each good is the same, equal amounts of each good are produced. This must equal

$$\mu \frac{x}{\alpha} + (1 - \mu)x = L$$

The left-hand side is the total labor requirements. A fraction μ of all the intermediate goods are made with the manufacturing technology for which one labor unit produces α output units. So for such goods $\frac{x}{\alpha}$ units of labor are required to produce x units of output. The remaining fraction $1 - \mu$ of the goods are made with the traditional technology. The right-hand side is the amount of labor supplied. Solving for x yields

$$
\begin{aligned}
(2) \quad x &= \frac{L}{1 - \frac{(\alpha-1)}{\alpha}\mu} \\
&= \frac{L}{1 - \frac{(\alpha-1)}{\alpha}(\gamma + m)}
\end{aligned}
$$

This simple equation highlights a key aspect of this model. As the measure m of mobile firms locating in the state increases, the output x of each differentiated good increases.

Let π^d denote the profit of a domestic monopoly manufacturer. Each monopolist has sales of x and costs of $\frac{1}{\alpha}x$ so profit equals

$$(3) \quad \pi_1^d = x - \frac{1}{\alpha}x = \frac{\alpha - 1}{\alpha}x.$$

Now consider the profit of a mobile firm that locates in the state. Its profit equals the profit of its domestic counterparts, minus the fixed location cost, plus the subsidy

$$\pi^m(z) = \frac{\alpha - 1}{\alpha}x - \phi - \theta z + s$$

The entry condition is such that if $\hat{z} = 0$ (so there is no entry) then profit for the marginal entrant must be nonpositive, $\pi^m(\hat{z}) \leq 0$. If $\hat{z} = \lambda$ (so all enter) then the profit of the marginal entrant must

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be nonnegative, $\pi^m(\hat{z}) \geq 0$. In the interior case where $\hat{z} \in (0, \lambda)$, the profit of the marginal entrant must be exactly zero, $\pi^m(\hat{z}) = 0$. It is possible to show that for any value of t and s, there always exists at least one cutoff rule $\hat{z}$ that satisfies the entry condition. If θ is large enough, there will be a unique such cutoff rule. In this discussion we will focus on this latter case. Let $\hat{z}(s, t)$ be the cutoff rule that solves this entry condition.

Given a choice of subsidy s, the budget balance constraint for the government is that

$$tL(t) = s\hat{z}(s, t)$$

Let $t^*(s)$ be the tax rate that solves this condition given the subsidy is s. Assume the solution is unique.

Now consider the choice problem of the government. The choice of the subsidy s determines the tax rate $t^*(s)$ and the cutoff $\hat{z}^*(s)$ for entrants. Under plausible assumptions, the tax rate $t^*(s)$ increases the subsidy and the entry cutoff $\hat{z}^*(s)$ also increases. The utility of a resident as a function of the subsidy s is

$$
\begin{aligned}
w^*(s) &= (1 - t^*(s))L^*(s) + b^*(s) - \frac{L^*(s)^2}{2} \\
&= \frac{(1 - t^*(s))^2}{2} + b^*(s)
\end{aligned}
$$

The equilibrium subsidy s^e maximizes $w^e(s)$.

It is straightforward to construct examples in which the optimal subsidy is strictly positive. To see the intuition why, suppose that initially the subsidy is zero and consider what happens when the subsidy is increased above zero. There are several effects.

The first effect is that taxes must be raised to finance the subsidies. This decreases labor supply. This is a cost of the subsidy since it distorts the labor/leisure choice. However, for a small subsidy the cost of this distortion is small.

The second effect of the subsidy is a transfer from residents to mobile firms. This effect on the welfare of residents is obviously negative.

The third effect of the subsidy is that it increases the number of mobile firms that chose to locate in the state. This is a strictly positive effect on resident welfare because of the demand spillover externality. Prices are above marginal cost for the domestic monopoly manufacturers. As can be seen in (3), the profit of domestic monopolist is proportional to the volume of sales. So increased purchases mean increased profit for the domestic monopolists which ultimately are distributed to the local residents.

5. Case 2: Competition for a Fixed Set of Manufacturers
A. Description of the Special Case

This section considers the second special case. In this section, unlike the previous one, there are important links between the two states. If a state is able to attract one more mobile firm to locate in the state, then one less mobile firm locates in the other state. Thus, the number of manufacturers is fixed at the national level. The subsidies offered by states are an attempt to shift the distribution of this fixed set of manufacturers.

The structure of the fixed cost is as follows. Consider first mobile firms with $z < 0$. For such firms, the fixed cost equals $f_1(z) = \phi$ and $f_2(z) = \phi + \theta|z|$. All of these firms have an equal cost to locate in state 1. They differ in the cost to locating in state 2. Those firms with values of z close to zero find the two locations close substitutes. Those with high absolute values of z find the alternate locations to be poor substitutes..

Analogously, for $z > 0$, assume that $f_2(z) = \phi$ and $f_1(z) = \phi + \theta z$. These firms all have a lower cost to locate in state 2.

Assume that ϕ is low enough (negative if necessary) such that in the outcome of competition between the states all the mobile firms locate in one of the two states.

The structure of fixed costs here is analogous to a Hotelling model. The parameter z is an indicator of the relative preference for state 2 rather than state 1. A mobile firm at the endpoint $z = -\lambda$ has a strong preference for state 1 and at the endpoint $z = \lambda$ a strong preference for state 2. A mobile firm in the middle $z = 0$ is indifferent between the two. It is clear that in any equilibrium there must be a cutoff $\hat{z}$ such that $z < \hat{z}$ locate in state 1 and $z > \hat{z}$ locate in state 2.

B. Calculating The Equilibrium

Recall the sequence of events in the model. First, the governments choose the subsidies s_1 and s_2. Second, the mobile agents make their location choices. As just discussed, these choices can be summarized by a cutoff rule $\hat{z}$. In the third and fourth stages the tax rates and output levels are determined.

The state variables as of the beginning of the third stage are the subsidies s_1 and s_2 and the cutoff $\hat{z}$. The measure of mobile firms locating in state 1 is $m_1 = \lambda + \hat{z}$ while the measure of mobile firms locating in state 2 is $m_1 = \lambda - \hat{z}$. The analysis of this stage of the game is identical to the single-state analysis of the previous section for what happens given a subsidy s in the state and given that m mobile agents locate in the state. Hence, we can use this analysis to determine the equilibrium output per product in each state $x_i(s_i, \hat{z})$ as a function of the subsidy in the state

and the cutoff $\hat{z}$ (which determines the measure of entry in the state).

Now consider the entry process at stage 2. If the cutoff $\hat{z}$ is at an interior value, $\hat{z} \in (-\lambda, \lambda)$, the returns to type $\hat{z}$ of locating in the two states must be equal,

$$\frac{(\alpha - 1)}{\alpha} x_1(s_1, \hat{z}) - \phi - \theta z + s_1 = \frac{(\alpha - 1)}{\alpha} x_2(s_2, \hat{z}) - \phi + s_2.$$

(Without loss of generality I assume that $\hat{z} \geq 0$ for this equation). This can be rewritten as the relative return to locating in state 1 versus state 2,

$$(4) \qquad \frac{(\alpha - 1)}{\alpha} [x_1(s_1, \hat{z}) - x_2(s_2, \hat{z})] + [s_1 - s_2] - \theta \hat{z} = 0.$$

The first term is the difference in operating profits between the two locations. This difference will depend upon the relative volume of sales at the two locations. The second term is the difference in subsidies. The third term is the difference in fixed cost. Given that $\hat{z} \geq 0$, the fixed cost is lower for the firm at location 2 by an amount $\theta \hat{z}$.

Let $\hat{z}^*(s_1, s_2)$ solve (4). We can see that there are two offsetting effects on the left-hand side of (4) of increasing $\hat{z}$. An increase in $\hat{z}$ tends to make the first term larger. This follows because it increases the number of entrants at state 1, increasing the sales volume at state 1 making the state relatively more attractive. The last term is strictly decreasing in $\hat{z}$. This follows because as the cutoff $\hat{z}$ is increased, the marginal mobile firm tends to have a relatively stronger preference for state 2. In the examples I focus on, the latter effect outweighs the former effect. In this case there is a unique $\hat{z}^*(s_1, s_2)$ solving (4). In these examples $\hat{z}^*(s_1, s_2)$ increases in s_1 and decreases in s_2. In other words, holding the rival states subsidy as fixed, an increase in the subsidy increases the number of mobile firms that build factories within the state.

Let $w_1^*(s_1, s_2)$ and $w_2^*(s_1, s_2)$ be the welfare levels of the residents in states 1 and 2 given that the subsidies (s_1, s_2) are chosen in stage 1. A symmetric equilibrium is a subsidy s^e so that

$$s^e = \arg \max_s w_1^*(s, s^e).$$

C. Analysis of the Equilibrium

A primary goal of this paper is to determine whether or not the symmetric equilibrium subsidy s^e is ever positive. The answer is that for some sets of parameter values the equilibrium subsidy is positive.

Another goal of this paper is to understand what assumptions are needed in order that the equilibrium subsidy be positive. In addition, how does the subsidy vary with the parameters of the model?

It must first be noted that the equilibrium subsidy can very well be negative. In this model, the state governments might in effect tax the mobile firms. This surely holds when $\gamma = 0$ in which case there are no domestic monopolists. In this case, attracting mobile firms confers no spillover demand to domestically-owned firms. The is no point in handing out subsidies in this case. There is a point in taxing the mobile firms. Here the governments gain by making the mobile firms pay for the right to locate in the state. Since the mobile agents view the states as differentiated products, the tax rate is not bid down to zero. This happens for the same reason that price is not driven down to marginal cost in an oligopoly model with Bertrand competition and differentiated products.

It is worth noting that even though I started this paper trying to get away from tax base issues, these issues have crept in anyway. But the existence of these considerations makes it less likely that a government would offer subsidies. The state governments have to balance two issues when thinking about how to handle mobile firms. In one respect mobile firms can be view as a source of tax revenue. In another respect they can be view as a source of demand spillover effects for local firms.

One critical consideration in the analysis is that the parameter θ cannot be too small. This parameter determines the degree to which the mobile firms regard the two states as imperfect substitutes. If $\theta = 0$, the locations are perfect substitutes. In this case, a symmetric equilibrium may not exist. Shifting more mobile firms from state 2 to state 1 makes state 1 relatively more attractive and this may induces more firms to shift to state 1. If θ is increased above zero than this increased differentiation is a force that tends to spread the firms out. So to have a symmetric equilibrium θ cannot be to small. (Of course there is nothing inherently wrong with the model if the only equilibrium is an asymmetric equilibria. Nevertheless, it sharpens the focus of this paper to consider only symmetric equilibria.)

At the other extreme if θ is large, then any symmetric equilibrium will involve a negative subsidy, i.e. a tax. With large θ the firms find the two states to be poor substitutes. In this case the governments will tax the firms in equilibrium, in effect, selling real estate.

This discussion raises the issue as to whether or not there exists intermediate levels of θ where it is sufficiently large that a symmetric equilibrium exist but not so high as to result in a negative subsidy. The answer is that there does exist such a range of θ, at least for the values of the other parameters that I have considered.

6. Analysis of the Burstein-Rolnick Proposal

The Burstein-Rolnick proposal can be modeled by assuming that the federal government imposes a constraint that subsidies be nonnegative in both states, $s_1 \leq 0$ and $s_2 \leq 0$. What is the effect of this policy on the welfare of residents?

First, consider case 1, where there is no linkage between the two states. That is, when a state offers a subsidy, it is creating a new factory that would not otherwise exist in another state. In this case the welfare effect of the policy can never be positive and sometime it is negative. The state government is picking the allocation that maximizes the welfare of the residents in the state. By limiting the choice set of the state government, the welfare level of the state residents is reduced.

Next consider case 2, where there is competition for a fixed set of manufacturers. Suppose that without regulation there is a unique symmetric equilibrium and that the subsidy is positive, $s^e > 0$. The equilibrium cutoff in this case is $\hat{z} = 0$ and λ mobile firms locate in each state. In addition, the governments have to set taxes at some positive amount $t^e > 0$ to finance the subsidies. If the discounts are banned, the same set of firms locate in each state. However, the governments lower taxes to zero since there no longer are subsidies to finance. The policy leads to a strict increase in resident welfare. It also leads to a strict increase in the total of resident welfare plus mobile firm welfare; i.e., total surplus. This follows because without the ban there are labor taxes that distort the labor supply decision. If the policy is adopted, these distorting taxes are eliminated, and total welfare increases.

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