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Ray Owens and Pierre-Daniel Sarte[*†]

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Abstract

This paper develops a two-region model of firm migration where moving is costly and firms have market power. In this setting, the decentralized equilibrium generates excessive inertia in firm movement relative to the "first best" solution. Because the decentralized solution is inefficient, the widespread notion that inducing firm movement between regions yields no net social gain does not necessarily hold. That is, firm migration does not amount to a "zero sum." Moreover, given the presence of inertia, and contrary to the prevalent view, we show that targeted subsidies that alleviate moving costs can lead to a "second best" outcome. We also show that once a dynamic dimension is considered, moving cost subsidies, while potentially welfare improving in a present value sense, may nevertheless generate transitional welfare costs in the short run. Consequently, it may be especially misleading to mainly consider contemporaneous conditions in evaluating regional incentive programs.

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[†]The views expressed in this paper are solely those of the authors and do not necessarily represent those of the Federal Reserve Bank of Richmond or the Federal Reserve System.

1 Introduction

Over the last decade, U.S. state and local governments have transferred billions of dollars to private corporations in location incentives. The payments are intended to attract corporations to the government's jurisdiction, and thus increase both regional employment and per capita income. A sizeable portion of these subsidies takes the form of offsets to firms' moving costs including site acquisition, utilities provision, and construction of the necessary infrastructure to begin operations. Because of the large sums involved, sometimes totaling $50 million or more for a single firm, these programs have generated a great deal of debate. A particular feature of these payments that has led to controversy is the notion that, from a social perspective, inducing firm movement yields no net gain since benefits to the winning location must necessarily be offset by matching losses in another region. This is often referred to as the "zero-sum" argument. It is worth noting that opposition to the use of moving subsidies has recently gained substantial political support. In 1997, the Distorting Subsidies Limitation Act was introduced before Congress. It proposes that "notwithstanding any other provision of law, none of the Federal funds provided to any State or local government may be used to provide any targeted subsidy."

In this paper, we introduce a simple theory of firm migration to sort out key features of this ongoing debate. Specifically, one notes that much of this controversy should hinge importantly on whether regional policies can ever be welfare improving. If the competitive equilibrium replicates the social optimum, it is a forgone conclusion that any policy that distorts the decentralized allocation is socially inefficient. In particular, any bidding among states that yields strictly positive moving subsidies would only be detrimental. This paper, therefore, explores the conditions under which decentralized firm migration may be suboptimal, asks what key features of the environment may lead to inefficiencies, and examines the regional policy tools that are likely to attenuate the implied distortions.

The present analysis emphasizes two considerations that are often left in the background. First, controversies surrounding moving subsidies have generally focused on firms with a substantial degree of market power. Holmes (1995) cites the example of BMW which received a $150 million incentives package to locate an assembly plant within the state of South Carolina. In 1995, similar type incentives were offered to Motorola in order to manufacture semi-conductor chips in Richmond, Virginia. While other examples abound, the typical firm concerned is relatively large and often faces a national demand curve for its product. Consequently, for the issues addressed in this paper, we allow firms to act as price setters. Second, we assume that migration costs matter in firms' location decisions.

The above setting leads to some interesting positive conclusions. First, the empirical literature seems to be relatively mixed as to the effects of states' incentive expenditures on firm location. Some studies, in fact, have estimated these effects to be surprisingly small.[1] In our framework, moving costs naturally lead to inertia in the migration process. As a result, state policies can indeed have a negligible impact on firm movement in some, though not all, cases. Second, it has been argued, notably by Burstein and Rolnick (1994), that by altering the competitive regional allocation of firms, payments that subsidize business location decisions are socially inefficient. In the authors' words, "the overall economy becomes less efficient because output will be lost as businesses are enticed to move from their best locations." In contrast, our setting implies that the decentralized spatial allocation of firms is suboptimal, both in the long run and in the transition to the steady state. In addition to the output distortions naturally induced by market power, a key feature of the analysis is that the decision to migrate is governed solely by profit differentials between regions. Thus, in deciding where to reside, firms fail to take into account the feedback effects of location on wages and employment.

Given that the decentralized spatial distribution of firms may not be Pareto optimal, the question then naturally arises: Does a role exist for the types of moving subsidies implemented in practice?[2] In this paper, we shall focus mainly on targeted payments that are designed to alleviate moving costs. By targeted, we mean that these subsidies apply to movers only as is almost always the case. They may include lump-sum cash transfers as well as subsidized -(or even free)- installation of infrastructure. The analysis gives several important normative conclusions. First, we find that despite the inertia in firm movement, there exist cases where regional targeted subsidies that reduce moving costs can induce a second best outcome. Second, policymakers often express concern that subsidies simultaneously offered by multiple regions may offset each other and, because they are costly to implement, ultimately result in a social loss.[3] Contrary to this concern, the model shows that because the spatial distribution of firms matters in determining the private return from moving, firm migration from one location to another can occur even when both regions offer identical moving subsidies. Finally, when a dynamic dimension is taken into account, moving costs subsidies, while potentially welfare improving in a present value sense, may nevertheless involve transitional welfare costs in the short run. Part of Burstein and Rolnick's intuition,

[1] See Mills (1997) or Dennis (1983) for instance, although Holmes (1998) provides evidence that state policies substantially affect manufacturing location.

[2] It is worth stressing that, *a priori*, a setting where the decentralized economy fails to attain the social optimum does not necessarily justify the use of subsidies. Depending on the exact nature of the underlying distortions, there can be too much firm movement relative to the first best outcome. In this case, moving subsidies may simply compound the problem by encouraging even more migration.

[3] See Rivlin (1995) for example.

therefore, remains.

This paper is organized as follows. Section 2 presents a static model of firm migration along with its decentralized solution. In section 3, we show that the spatial allocation of firms chosen by a benevolent planner differs from that of the competitive equilibrium. Section 3, therefore, also examines the long-run effects of targeted moving cost subsidies. Section 4 shows that decentralized firm location decisions may involve not only static but also dynamic inefficiencies, and focuses on the dynamic impact of moving cost subsidies. Section 5 offers some concluding remarks.

2 A Simple Model of Firm Migration

In this section, we develop a static theory of firm migration designed to sort out key aspects of the debate presented in the introduction.[4] As indicated earlier, the intent of payments that subsidize firms' location decisions is often to increase both regional employment and wages. The South Carolina Department of Commerce, for instance, explicitly states that the purpose of its incentive programs is to "raise the state's standard of living by bringing in jobs and increasing per capita income." To preserve these notions in our analysis, we assume that some regional segmentation exists in labor markets. This assumption creates a mechanism that puts upward pressure on wages and employment as firms migrate to a region. Furthermore, by reducing local profits, the upward movement in wages decreases firms' incentive to move. A stable distribution of firms, therefore, eventually emerges. Note that it is possible for regional wages to differ in equilibrium. Carlino and Mills (1993) indeed show that persistent wage differentials can exist across US states. Furthermore, unemployment rates in areas immediately surrounding high growth regions often remain consistently high. For example, in spite of Virginia's relatively high growth rate, West Virginia's unemployment rate has remained 4 to 5 percentage points above that of its neighbor over the last twenty years. How can we then account for this segmentation in labor markets in the face of wage differentials? According to Ciccone and Hall (1996), the simplest answer, and a realistic one, is that some workers may be devoted to specific areas on the basis of geographical considerations. Such considerations may include ties to family, climate, population density, etc... . In the authors' words, "these workers are willing to accept the lower wages in those locations."

Another important element of this static framework is that firms have the ability to set prices given a national demand curve for their product. This assumption is consistent with the fact that controversies associated with moving subsidies revolve around large firms with

[4] By static, we mean that firm migration is instantenous at this stage.

considerable market power. These firms generally serve a national market, and it is seldom that a move from one region to another occurs on the basis of local demand conditions. On the contrary, the prevalent perception is that "cost projections are a primary determinant of corporate location decisions."[5]

We now describe the basic framework in more detail.

2.1 Production and Market Structure

Consider a closed economy in which a single final good, y, is produced in a competitive sector. The technology is constant-returns-to-scale and uses a continuum of intermediate goods, $x(j)$, uniformly distributed on $(0, M]$, as well as an input, R, a constant that represents a natural resource. In particular, the production function for the final good is given by,

$$y = [\int_0^M x(j)^\alpha dj] R^{1-\alpha}, \text{ with } 0 < \alpha < 1, \tag{1}$$

where the intermediate goods are produced by imperfectly competitive firms. There are two regions with M_1 firms in region 1 and M_2 firms in region 2, where $M_1 + M_2 = M$. The total range of intermediate goods, M, is fixed, and we focus instead on the conditions that govern the allocation of firms between regions 1 and 2. The optimal choice of inputs utilization by final goods firms yields the following demand functions,

$$q = (1-\alpha)[\int_0^M x(j)^\alpha dj] R^{-\alpha}, \tag{2}$$

and

$$p(j) = \alpha x(j)^{\alpha-1} R^{1-\alpha}, \tag{3}$$

where q is the rental price of R and $p(j)$ the price of intermediate good $j \in (0, M]$. Observe that the demand function for intermediate inputs is not location specific. In this sense, intermediate goods firms' decision to migrate will be driven not by demand, but by cost considerations. Each firm j in region i, where $i = 1, 2$, uses labor, $l_i(j)$, as the only input in a constant-returns production technology,

$$x_i(j) = z_i^{\frac{1}{\alpha}} l_i(j), \tag{4}$$

where $x_i(j)$ denotes output and z_i is a technological shift parameter in region i. We interpret the case where labor is equally productive in both regions, $z_1 = z_2$, as a benchmark. It will be helpful to confine the analysis to that of a symmetric equilibrium within regions so that

[5] Extract from the Wall Street Journal Economic Focus, 06/10/98.

in each region, $x_i(j) = x_i$. Using equation (1), this directly implies that total output of the final good can be interpreted as the sum of regional outputs. That is,

$$y = \underbrace{M_1 x_1^{\alpha} R^{1-\alpha}}_{y_1} + \underbrace{(M - M_1) x_2^{\alpha} R^{1-\alpha}}_{y_2}. \tag{5}$$

Given equations (3) and (4), firms maximize profits, π_i, and solve

$$\max_{l_i} \ \pi_i = \alpha z_i l_i^{\alpha} R^{1-\alpha} - w_i l_i, \tag{6}$$

where w_i is the wage rate in region i denoted in units of the final good. The solution to this profit maximization problem yields a labor demand function by the typical firm in each location,

$$w_i = \left[\alpha^2 z_i R^{1-\alpha}\right] l_i^{\alpha-1}. \tag{7}$$

2.2 Households

Each location is populated by a large number of identical households that provide labor services in exchange for wages, receive firms' profits as dividends, and purchase goods for consumption. Households that work in each region are exclusively devoted to that region. As mentioned earlier, this devotion may include strong ties to the region's amenities including, perhaps, proximity to family. In practice, one's ties to a given location are not entirely insensitive to the wage being offered elsewhere. For the sake of transparency, however, the assumption of perfect segmentation is convenient as it allows for closed form solutions. [6]

The typical household in each region wishes to maximize overall utility, $\mathcal{U}_i$, as given by

$$\mathcal{U}_i = c_i - \frac{N_i^{1+\frac{1}{\sigma}}}{1+\frac{1}{\sigma}}, \text{ with } \sigma > 0, \tag{8}$$

where c_i denotes region i consumption, and $N_i < 1$ is the household's fraction of time spent working. This household also faces the following budget constraint,

$$c_i = w_i N_i + \frac{\sum_{i=1}^{2} M_i \pi_i}{2} + \frac{qR}{2}. \tag{9}$$

Observe that living in region 1 does not preclude households from receiving dividends derived from region 2 profits and vice versa. In other words, we allow for the existence of national financial markets. Claims to total profits from intermediate goods firms are divided equally

[6] We should stress that the policy implications below still hold as long as less than perfect labor mobility exists across regions. As long as some wage differential remains in equilibrium, the factor price equalization theorem fails to hold.

between regions 1 and 2. Household optimization leads to a labor supply function of the form,

$$N_i = w_i^{\sigma}, \tag{10}$$

in each location. The parameter σ, therefore, captures the Frisch elasticity of labor supply and is identical across regions. We are now almost ready to examine the mechanics of firm migration in this framework. To do this, however, we first need to understand how firm movement affects regional labor market conditions.

2.3 Firm Movement and Labor Market Implications

Labor market equilibrium requires that regional labor demand, summed across all firms, equal regional labor supply. That is,

$$M_i l_i = N_i \tag{11}$$

for $i = 1, 2$. Using equations (7) and (10), we can then obtain the market clearing wage in region i as

$$w_i = \left[\alpha^2 R^{1-\alpha} z_i\right]^{\frac{1}{1-\sigma(\alpha-1)}} M_i^{\frac{1-\alpha}{1-\sigma(\alpha-1)}}. \tag{12}$$

Since $\alpha < 1$ by assumption, firm migration into region i, as defined by an increase in M_i, leads to a rise in regional wages. On June 1 1998, Nucor Corp. announced that it would invest $300 million to build a steel plant near the small town of Winton, North Carolina, employing 300 production workers at salaries of $60 000 per year. According to a Wall Street Journal article covering the event, this represented a significant increase over the county's prevailing wages.[7] The intuition behind this result is clear. As more firms move into a region, total labor demand rises which puts upward pressure on wages. Moreover, regional employment, and hence output, naturally tends to increase in response to this higher wage. Using the labor supply equation (10), we obtain

$$N_i = \left[\alpha^2 R^{1-\alpha} z_i\right]^{\frac{\sigma}{1-\sigma(\alpha-1)}} M_i^{\frac{\sigma(1-\alpha)}{1-\sigma(\alpha-1)}}, \tag{13}$$

which rises with M_i, $i = 1, 2$. In the case of Winton, Nucor Corp's announcement was widely expected to reduce the pool of unemployed workers. According to the same Wall Street Journal article, "the job bonanza had residents thinking they had won the lottery." It is this effect of firm movement on both regional employment and output that is often used to justify targeted moving subsidies. However, since the total measure of firms is fixed, inducing a rise in output in region 1 through moving subsidies necessarily reduces output in

[7] Wall Street Journal Interactive Edition, 06/17/98.

region 2. Therefore, from the standpoint of a social planner, it may well be that payments that subsidize business location decisions imply no net efficiency gain. The latter notion is often referred to as the "zero sum" argument.

Given the mechanics of regional labor markets we have just described, we can derive the profits of a firm operating in region i as

$$\begin{aligned} \pi_i &= (1-\alpha)\alpha^{\frac{1+\sigma}{1-\sigma(\alpha-1)}} \left[\alpha^{\alpha\sigma} R^{(1-\alpha)(1+\sigma)} z_i^{1+\sigma}\right]^{\frac{1}{1-\sigma(\alpha-1)}} M_i^{\frac{-\alpha}{1-\sigma(\alpha-1)}} \\ &= \pi_i(z_i, M_i). \end{aligned} \tag{14}$$

Hence, $\partial \pi_i / \partial M_i < 0$ and regional profits fall as firms gradually move in. Note also that $\lim_{M_i \to 0} \pi_i = \infty$ while $\lim_{M_i \to M} \pi_i = \pi_i(z_i, M) < \infty$ is bounded. The key to explaining these results lies in equation (12). As the measure of firms operating in a region increases, labor costs, which in this case also depict marginal cost, generally rise. Consequently, firms attempt to reduce output and increase prices in an effort to maximize profits. In equilibrium, wages rise faster than the rate at which firms are able to adjust their output. Profits per firm, therefore, diminish with the total number of regional firms. This feature of the model lends inherent stability to the migration process.

2.4 The Incentive to Migrate and the Equilibrium Distribution of Firms

Given the set-up we have presented, firms evaluate locations in terms of profits only. In particular, the value of a permanent move to region 1 from region 2, say, is given by

$$\begin{aligned} V^{CE} &= \pi_1(z_1, M_1) - \pi_2(z_2, M_2) \\ &= B\alpha^{\frac{1+\sigma}{1-\sigma(\alpha-1)}} \left\{ \left[z_1^{1+\sigma} M_1^{-\alpha}\right]^{\frac{1}{1-\sigma(\alpha-1)}} - \left[z_2^{1+\sigma}(M-M_1)^{-\alpha}\right]^{\frac{1}{1-\sigma(\alpha-1)}} \right\}, \end{aligned} \tag{15}$$

where $B = (1-\alpha)\left[\alpha^{\alpha\sigma} R^{(1-\alpha)(1+\sigma)}\right]^{\frac{1}{1-\sigma(\alpha-1)}} > 0$. Similarly, the value of a move in the opposite direction is given by $-V^{CE}$. In the remainder of the paper, the superscript "CE" denotes "(imperfectly) competitive equilibrium". It immediately follows from equation (15) that $\partial V^{CE} / \partial M_1 < 0$. As firms migrate towards region 1, both the wage and employment rise in that location. At the same time, both the wage and employment tend to fall in region 2. Put together, these forces imply that the value of moving to region 1 decreases as the measure of firms in region 1 rises.[8] In addition, note from equation (14) that $\lim_{M_1 \to 0} V^{CE} = \infty$ while $\lim_{M_1 \to M} V^{CE} = -\infty$. Intuitively, since profits in a given region increase as firms locate production elsewhere, there eventually comes a point where the incentive to move switches

[8] Since the framework is symmetric, the converse is also true when firm migration goes the other way.

direction. The value of migrating to a location becomes arbitrarily large as the number of firms in that location approaches zero.

Having described the gains from migrating, we now note that moving production to a different location generally requires significant up-front resource costs. We interpret these as moving costs in the sense that they must necessarily be incurred in order to begin operations elsewhere. In practice, such costs may include transportation costs, construction of infrastructure inherent to production such as access roads and utilities provision, as well as legal costs including the procurement of all necessary permits. In our framework, we may imagine that each firm has access to a technology whereby κ units of output can be used to engineer a move between regions. Moving costs are the same regardless of the direction of movement.

Observe that whenever $V^{CE} > \kappa$, firms in region 2 have the incentive to migrate towards region 1. Alternatively, the reverse is true whenever $V^{CE} < -\kappa$. Firms choose to stay in their original location when

$$\left|V^{CE}\right| = \left|\pi_1(z_1, M_1) - \pi_2(z_2, M_2)\right| \leq \kappa. \tag{16}$$

Put another way, when $-\kappa \leq V^{CE} \leq \kappa$, the gain from moving in either direction fails to cover migration costs. Firms, therefore, remain at their original site.

In order to characterize the degree of decentralized firm movement, suppose some initial distribution of firms across locations whereby $M_1(0)$ and $M_2(0)$ firms operate in regions 1 and 2 respectively. Note that $M_2(0) = M - M_1(0)$. Then, starting from the initial spatial allocation, the number of firms that migrate to region 1, denoted by ΔM_1, is simply $M_1 - M_1(0)$. Conversely, since the total number of firms is fixed, $\Delta M_1 = -\left[M_2 - M_2(0)\right] = -\Delta M_2$.

Figure 1, panel (a), illustrates the nature of the competitive equilibrium in detail. The horizontal axis represents the measure of firms in region 1, which may lie anywhere on the interval $(0, M]$. The vertical axis compares the value of moving from location 2 to location 1 with the moving cost, κ. As indicated earlier, V^{CE} is strictly decreasing in M_1 with $\lim_{M_1 \to 0} V^{CE} = \infty$ and $\lim_{M_1 \to M} V^{CE} = -\infty$. Now, suppose that the number of firms located in region 1 is initially low so that $M_1(0) < \underline{M_1}$. Then, $V^{CE} > \kappa$ and firms have the incentive to move from region 2 to region 1. As firms continue to migrate, V^{CE} falls until eventually $V^{CE} = \kappa$. In this case, therefore, $\Delta M_1 = \underline{M_1} - M_1(0) > 0$ and $\Delta M_2 = (M - \underline{M_1}) - M_2(0) < 0$. Alternatively, suppose that firms are initially concentrated in location 1 with few firms in region 2. That is, $M_1(0) > \overline{M_1}$. Then $V^{CE} < -k$ and firms migrate to region 2. Firm movement settles down when $-V^{CE} = \kappa$, at which point $\Delta M_1 = \overline{M_1} - M_1(0) < 0$ and $\Delta M_2 = (M - \overline{M_1}) - M_2(0) > 0$. Finally, when $\underline{M_1} \leq M_1(0) \leq \overline{M_1}$, $\left|V^{CE}\right| \leq \kappa$ so that firms

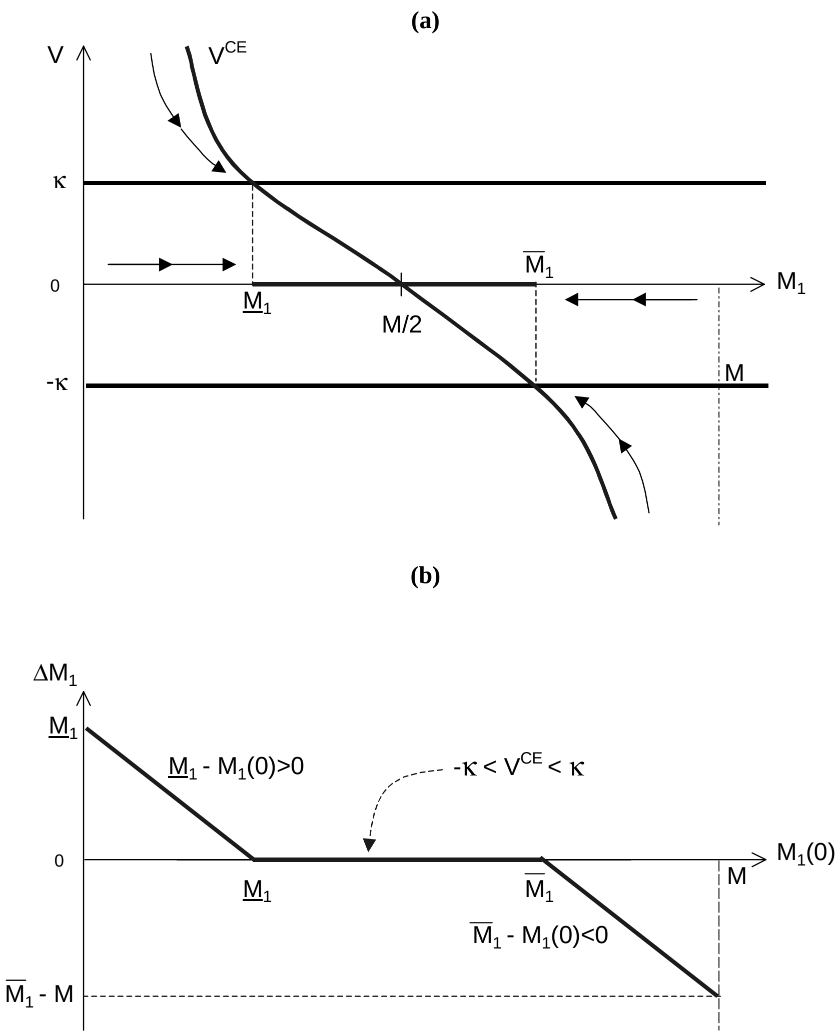

(a)
V
V^CE
κ
0
-κ
M_1
M_1
M/2
M_1
M
(b)
ΔM_1
M_1
M_1 - M_1(0)>0
-κ < V^CE < κ
0
M_1(0)
M
M_1
M_1
M_1 - M_1(0)<0
M_1 - M

Figure 1

do not find it worthwhile to move in either direction. In the latter case, the competitive and the initial spatial allocation of firms coincide and $\Delta M_1 = \Delta M_2 = 0$. In this sense, we may think of the interval $[\underline{M_1}, \overline{M_1}]$ as capturing the degree of migration inertia generated by costly firm movement. In Albuquerque and Rebelo (1998), analogous inertia arises in industrial structure when up-front investments are necessary to create a firm. Panel (b) of Figure 1 illustrates explicitly how the number of region 1 migrants changes with the initial distribution of firms. Observe that region 1 gains (loses) migrating firms whenever $M_1(0) < \underline{M_1}$ $(> \overline{M_1})$.

A crucial implication of moving costs is that firms operating in the same region can earn different profits in equilibrium. As we have just seen, when relatively few firms operate in region 1 initially, some region 2 firms find it worthwhile to migrate until $V^{CE} = \kappa$ or, alternatively,

$$\pi_1(z_1, \underline{M_1}) - \kappa = \pi_2(z_2, M - \underline{M_1}). \tag{17}$$

Consequently, firms that have migrated to region 1 earn $\pi_1(z_1, \underline{M_1}) - \kappa$ while firms initially in region 1 earn the full profits, $\pi_1(z_1, \underline{M_1})$. Since migrating firms would be no better off having stayed in region 2 by equation (17), this variation in earnings holds as an equilibrium.[9] Moving costs, therefore, constitute a wedge that breaks the symmetry in firms' regional opportunities. Moreover, it is precisely this wedge that will allow us to examine the impact of moving cost subsidies that specifically target migrants.

Before turning our attention to the socially optimal allocation of firms across regions, it is helpful to consider a simple comparative static exercise. Suppose that differences in labor productivity exist across locations. As in Ciccone and Hall (1996), these differences may derive from variations in population density which, in this context, we take as exogenous. Thus, and without loss of generality since the framework is symmetric, let $z_1 > z_2$. Using equation (15), this new assumption directly leads to an upwards shift in the locus V^{CE} in Figure 1, panel (a). Therefore, both $\underline{M_1}$ and $\overline{M_1}$ increase towards M. As a result, firms are now more likely to migrate towards region 1 rather than away from it *ex ante*.[10] Furthermore, given the regional labor market implications of firm migration, an increase in labor productivity in a given location would also be associated with a rise in both wages and employment in that location.

[9] Conversely, no firm initially in region 1 has an incentive to move to region 2 since $\pi_1(z_1, \underline{M_1}) > \pi_2(z_2, M - \underline{M_1})$

[10] We can think of $M_1(0)$ as a random variable uniformly distributed on $(0, M]$.

3 The Efficient Solution

We now formalize the way in which decentralized outcomes differ from those chosen by a benevolent social planner. As expected, this result emerges because firms are allowed some degree of market power in this environment. In addition, given the labor market distortions that follow, it matters crucially that they only consider profit differentials in deciding between locations.

We assume that the social planner weighs the utility of the representative household in each region equally. The interpretation of the planner, therefore, is similar to that of a Federal institution with no regional preference. Since utility is linear in consumption in (8), this assumption also implies that we need only keep track of aggregate consumption, denoted by $c = c_1 + c_2$, in the social welfare function. Because equation (5) can be used to represent aggregate output across regions, we may write the optimization problem faced by a benevolent planner as

$$\max_{c,\ \{N_i\}_{i=1,2},\ M_1} \mathcal{W} = c - \sum_{i=1}^{2} \frac{N_i^{1+\frac{1}{\sigma}}}{1+\frac{1}{\sigma}},\ \text{with } \sigma > 0 \tag{SP}$$

$$\text{subject to} \begin{cases} c & = M_1 x_1^{\alpha} R^{1-\alpha} + (M - M_1) x_2^{\alpha} R^{1-\alpha} \\ & -\kappa \left[\max\left(M_1 - M_1(0), 0\right) + \max\left(M_1(0) - M_1, 0\right)\right], \\ x_i & = z_i^{\frac{1}{\alpha}} \left[\frac{N_i}{M_i}\right],\ \text{for } i = 1, 2. \end{cases} \tag{18}$$

A rough interpretation of problem (SP), therefore, is one where the planner seeks to maximize the wealth of the economy. Observe that from her standpoint, migration is costly irrespective of direction. The optimality conditions associated with problem (SP) imply that

$$N_i = \left[\alpha R^{1-\alpha} z_i\right]^{\frac{\sigma}{1-\sigma(\alpha-1)}} M_i^{\frac{\sigma(1-\alpha)}{1-\sigma(\alpha-1)}} \tag{19}$$

in each region. Since $\alpha < 1$, comparing equations (13) and (19) immediately shows that decentralized employment in both locations is lower than that chosen by the planner. The underlying distortion lies in the pricing power of firms that serve a national market. In maximizing profits, these firms choose a level of output that is below the social optimum. This lower level of output is in turn associated with less labor input. The optimal allocation of firms across regions is now implicitly given by

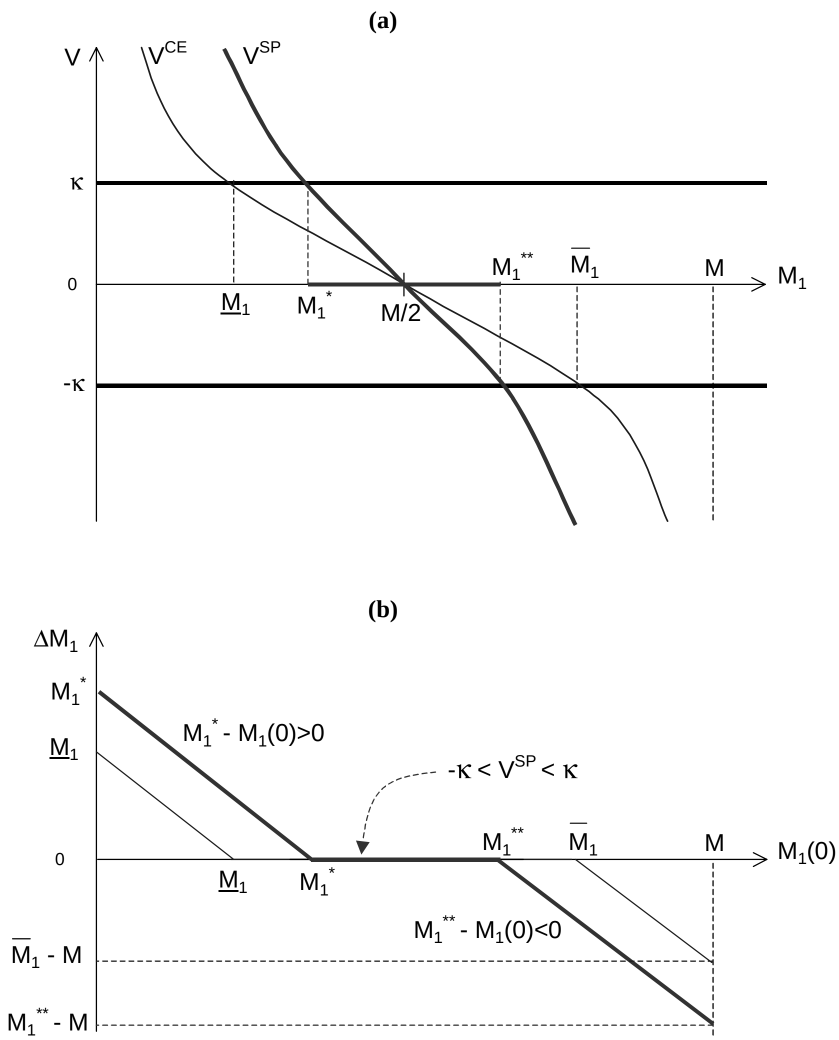
$$\begin{aligned} B\left\{\left[z_1^{1+\sigma} M_1^{-\alpha}\right]^{\frac{1}{1-\sigma(\alpha-1)}} - \left[z_2^{1+\sigma} M_2^{-\alpha}\right]^{\frac{1}{1-\sigma(\alpha-1)}}\right\} &= \kappa \quad \text{when } M_1 > M_1(0), \\ B\left\{\left[z_1^{1+\sigma} M_1^{-\alpha}\right]^{\frac{1}{1-\sigma(\alpha-1)}} - \left[z_2^{1+\sigma} M_2^{-\alpha}\right]^{\frac{1}{1-\sigma(\alpha-1)}}\right\} &= -\kappa \quad \text{when } M_1 < M_1(0), \end{aligned} \tag{20}$$

and $M_1 = M_1(0)$ otherwise, where $B = (1-\alpha)\left[\alpha^{\alpha\sigma} R^{(1-\alpha)(1+\sigma)}\right]^{\frac{1}{1-\sigma(\alpha-1)}}$. Let $V^{SP} = B\left\{\left[z_1^{1+\sigma} M_1^{-\alpha}\right]^{\frac{1}{1-\sigma(\alpha-1)}} - \left[z_2^{1+\sigma} M_2^{-\alpha}\right]^{\frac{1}{1-\sigma(\alpha-1)}}\right\}$ denote the social return from moving firms to region 1. It immediately follows by equation (15) that $V^{CE} = \alpha^{\frac{1+\sigma}{1-\sigma(\alpha-1)}} V^{SP}$ where $\alpha^{\frac{1+\sigma}{1-\sigma(\alpha-1)}} < 1$. That is, in choosing between sites, firms only consider the private value of moving which falls short of the social return. As we just established, private employment allocations are inefficient. Furthermore, by contrast to a social planner, firms fail to internalize the general equilibrium effects of location on employment and wages.

Figure (2a) illustrates how V^{SP} differs from V^{CE} as a function of M_1. Note first that, in the benchmark case where $z_1 = z_2$, V^{SP} and V^{CE} intersect the horizontal axis at the same point, $M/2$. This result reflects the fact that the distortional effects of market power are the same in either region. When both $V^{CE} > 0$ and $V^{SP} > 0$, the V^{SP} locus lies everywhere above V^{CE} since $\alpha^{\frac{1+\sigma}{1-\sigma(\alpha-1)}} < 1$. Alternatively, the reverse is true when $V^{CE} < 0$ and $V^{SP} < 0$. Let M_1^* and M_1^{**} solve equation (20) when $M_1 > M_1(0)$ and $M_1 < M_1(0)$ respectively. Then Figure 2, panel (a), directly illustrates that $[M_1^*, M_1^{**}] \subseteq [\underline{M_1}, \overline{M_1}]$. Simply put, the planner's solution implies less inertia in migration.

Figure (2b), therefore, indicates that whenever any firm movement takes place, a larger number of firms shifts location under the planner's solution than under the competitive equilibrium. Consider, for instance, the case where $M_1(0)$ is small so that firms are concentrated in region 2 initially. As we have just shown, the resulting degree of migration is given by $\Delta M_1 = \underline{M_1} - M_1(0) > 0$ in the private economy, but by $M_1^* - M_1(0) > \Delta M_1$ under the social optimum. Moreover, this result also holds when firms move in the opposite direction. It is in this sense that decentralized firm migration may not be socially efficient.

Figure (2a) also makes it apparent that an important factor in the analysis centers around the size of moving costs. As κ decreases, the competitive allocation of firms across regions converges to that of the planner's solution. In the limit, where $\kappa = 0$, $M_1^* = \underline{M_1} = \overline{M_1} = M_1^{**}$ and the degree of inertia in firm movement vanishes entirely. To better grasp the intuition behind this result, note that since the social value of migration, V^{SP}, is symmetric across regions, a benevolent planner chooses to allocate an equal number of firms in each location when $\kappa = 0$. In addition, when migration is costless, the decentralized equilibrium is such that firms only settle down when regional profits are equal. Since, in our benchmark case, the same opportunities exist in either region, the latter condition also implies an equal distribution of firms across locations, irrespective of the initial spatial allocation. Note, however, that although the private spatial distribution of firms coincides with that of the planner's when $\kappa = 0$, it does not follow that the economy attains the first best outcome. As the difference between equations (13) and (19) indicates, given the same value of M_i, the labor market distortion induced by market power remains.



(a)
V
V^CE
V^SP
κ
0
-κ
M_1
M_1*
M/2
M_1**
M̄_1
M
M_1
(b)
ΔM_1
M_1*
M_1
M_1* - M_1(0)>0
-κ < V^SP < κ
0
M_1
M_1*
M_1**
M̄_1
M
M_1(0)
M_1** - M_1(0)<0
M̄_1 - M
M_1** - M

Figure 2

3.1 Moving Subsidies in the Private Economy

Having established that the private economy fails to attain the social optimum, we now wish to address the effects of regional subsidies on the competitive equilibrium. We should stress that it is not our aim to investigate whether welfare improving subsidies would naturally be adopted by regional governments. In fact, Holmes (1995) suggests that this may not be the case when state governments are left to compete over policies. Nevertheless, we do show that from the vantage point of a Federal institution, there exist regional instruments that can lead to increased social welfare. In this paper, we focus mainly on targeted payments that alleviate moving costs. As we have just seen, partly because firms only consider profit differentials in choosing where to reside, the competitive equilibrium generates excessive inertia in firm movement relative to the efficient solution. It seems natural, therefore, that by reducing inertia altogether, targeted subsidies which directly lower the cost of moving would be welfare improving.

It should be clear, however, that moving cost subsidies cannot restore the planner's solution in this environment. To attain the first best outcome, the policy under consideration should uniformly remove the labor market distortion that dictates inefficient employment. We shall return to this point below. Whereas uniform policies of the latter type are seldom observed in practice, at the state level, targeted programs that either provide or subsidize up-front infrastructure such as plant access roads, buildings, and utility system upgrades are widely used. For instance, to attract new firms, the Virginia Department of Transportation "administers a program to assist in constructing industrial access roads to provide adequate access to new manufacturing or processing companies." This may include actually constructing "a new road from a publicly maintained road to the property line of the new industry when no road exists." Construction is typically scheduled for completion simultaneous with the start-up of plant operations. As far as the amounts involved are concerned, the maximum award for an industrial access road is $300,000. However, Virginia will fund an additional $150,000 if the amount is matched on a dollar for dollar basis from sources other than the Department of Transportation. Table 1 provides a brief summary of the number of US states offering similar incentives programs. A few states offer programs in all three categories presented in Table 1.

They include Alabama, Arkansas, California, Michigan, and West Virginia. It is also interesting that in some cases, states will go as far as offering up-front cash to entice firms to move. A notorious example along those lines involves the Amarillo (Texas) Economic Development Group which sent out checks worth $8 million each to 1350 companies in 1995. Upon moving to Texas, any company holding a check could cash it. In a letter accompanying

Table 1

Locational Incentive Programs Available to Offset Moving Costs by State- 1998

	AL	AK	AR	AZ	CA	CO	CT	FL	IA	ID	IL	IN	KS	LA	MD	ME	MI	MN	MO	MS	NC	NJ	NM	NY	OH	OK
Setup/Moving Costs																										
Site/Location[1]	✓	✓	✓	✓	✓	✓	✓	✓							✓		✓		✓		✓		✓			✓
Infrastructure[2]	✓	✓	✓		✓	✓		✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	
Regulatory[3]	✓		✓		✓		✓	✓	✓								✓	✓				✓		✓	✓	

	OR	PA	RI	SC	TN	TX	UT	VA	WA	WI	WV	**Total**
Setup/Moving Costs												
Site/Location[1]							✓				✓	**16**
Infrastructure[2]	✓	✓		✓	✓	✓		✓	✓	✓	✓	**30**
Regulatory[3]			✓							✓	✓	**14**

---

[1] "Site/Location" refers to programs that offset, either totally or partially, the cost to the firm of aquiring land and structures necessary to begin operations.

[2] "Infrastructure" refers to programs that offset, either toally or partially, one or more of the following costs to the firm:

A. connecting to waste disposal systems and/or to public utilities,

C. widening of and/or connecting to highways,

E. lengthening of airport runways used by the firm.

[3] "Regulatory" refers to programs that offset, either totally or partially, the cost to the firm of obtaining regulatory approval, such as permits, as well as assiting with the timeliness of the receipt of such approvals. In addition, these programs may offer monetary incentives to either purchase or construct equipment, as well as implement processes, that are environmentally friendly.

Source: "Directory of Incentives for Business Investment and Development in the United States," published by the National Association of State Devlopment Agencies the checks, Mayor Kel Seliger wrote "Maybe you thought we were kidding about the money. ... It is not an offer of a tax credit or a loan but actually represents cash available to you in the form of a grant."

As we have already hinted, because the decentralized equilibrium implies excessive inertia, targeted moving cost subsidies of the type we have just described can improve welfare. In fact, they can help the private economy reach a second best outcome. To see this, suppose we ask the question: What is the optimal spatial distribution of firms given the decentralized employment allocations in (13)? To answer this question, one must solve for a second best spatial allocation of firms that maximizes the objective function in (SP), subject to the constraints (18) and the private employment allocations (13). This spatial distribution of firms is implicitly given by

$$\begin{aligned} B\alpha^{\frac{\alpha\sigma}{1-\sigma(\alpha-1)}}\left\{\left[z_1^{1+\sigma}M_1^{-\alpha}\right]^{\frac{1}{1-\sigma(\alpha-1)}} - \left[z_2^{1+\sigma}M_2^{-\alpha}\right]^{\frac{1}{1-\sigma(\alpha-1)}}\right\} &= \kappa \quad \text{when } M_1 > M_1(0), \\ B\alpha^{\frac{\alpha\sigma}{1-\sigma(\alpha-1)}}\left\{\left[z_1^{1+\sigma}M_1^{-\alpha}\right]^{\frac{1}{1-\sigma(\alpha-1)}} - \left[z_2^{1+\sigma}M_2^{-\alpha}\right]^{\frac{1}{1-\sigma(\alpha-1)}}\right\} &= -\kappa \quad \text{when } M_1 < M_1(0), \end{aligned} \tag{21}$$

and $M_1 = M_1(0)$ otherwise, where $B = (1-\alpha)\left[\alpha^{\alpha\sigma}R^{(1-\alpha)(1+\sigma)}\right]^{\frac{1}{1-\sigma(\alpha-1)}}$. Letting $V^{2ndB} = B\alpha^{\frac{\alpha\sigma}{1-\sigma(\alpha-1)}}\left\{\left[z_1^{1+\sigma}M_1^{-\alpha}\right]^{\frac{1}{1-\sigma(\alpha-1)}} - \left[z_2^{1+\sigma}M_2^{-\alpha}\right]^{\frac{1}{1-\sigma(\alpha-1)}}\right\}$, Figure (3a) illustrates the nature of the solution. Note first that $V^{2ndB} = \alpha^{\frac{\alpha\sigma}{1-\sigma(\alpha-1)}}V^{SP}$ where $\alpha^{\frac{\alpha\sigma}{1-\sigma(\alpha-1)}} < 1$. Moreover, from equation (15), $V^{2ndB} = (1/\alpha)V^{CE} > V^{CE}$ when $V^{CE} > 0$. Letting M_1' and M_1'' solve equation (21) when $M_1 > M_1(0)$ and $M_1 < M_1(0)$ respectively, then Figure 3, panel (a), shows that $[M_1^*, M_1^{**}] \subseteq [M_1', M_1''] \subseteq [\underline{M_1}, \overline{M_1}]$. In other words, the amount of inertia implied by the second best solution falls somewhere between that implied by the competitive equilibrium and the efficient solution.

We can now easily show that the private economy can be made to attain this second best solution through the use of targeted moving cost subsidies. In particular, given that the employment allocations are given by equation (13) in both cases, it suffices for these subsidies to induce the spatial allocation of firms dictated by (21). To this end, suppose that the economy is decentralized, but that the federal government uses a lump-sum tax to finance a reduction in up-front moving costs by an amount $\tau \in (0, \kappa)$ in both regions. Following this policy, any migrating firm, regardless of direction, would only have to incur $\kappa - \tau$ units of output to switch locations. Since movers only are targeted, the total cost associated with this program would be $\tau\left[\max\left(M_1 - M_1(0), 0\right) + \max\left(M_1(0) - M_1, 0\right)\right]$, which might be financed evenly across locations. Furthermore, since lump-sum taxes are used, households' optimality conditions remain unchanged.

Figure (3b) illustrates that by setting $\tau = \widetilde{\tau}$, it is possible for the private economy to achieve the second best outcome *ex ante*. In other words, should migration occur when

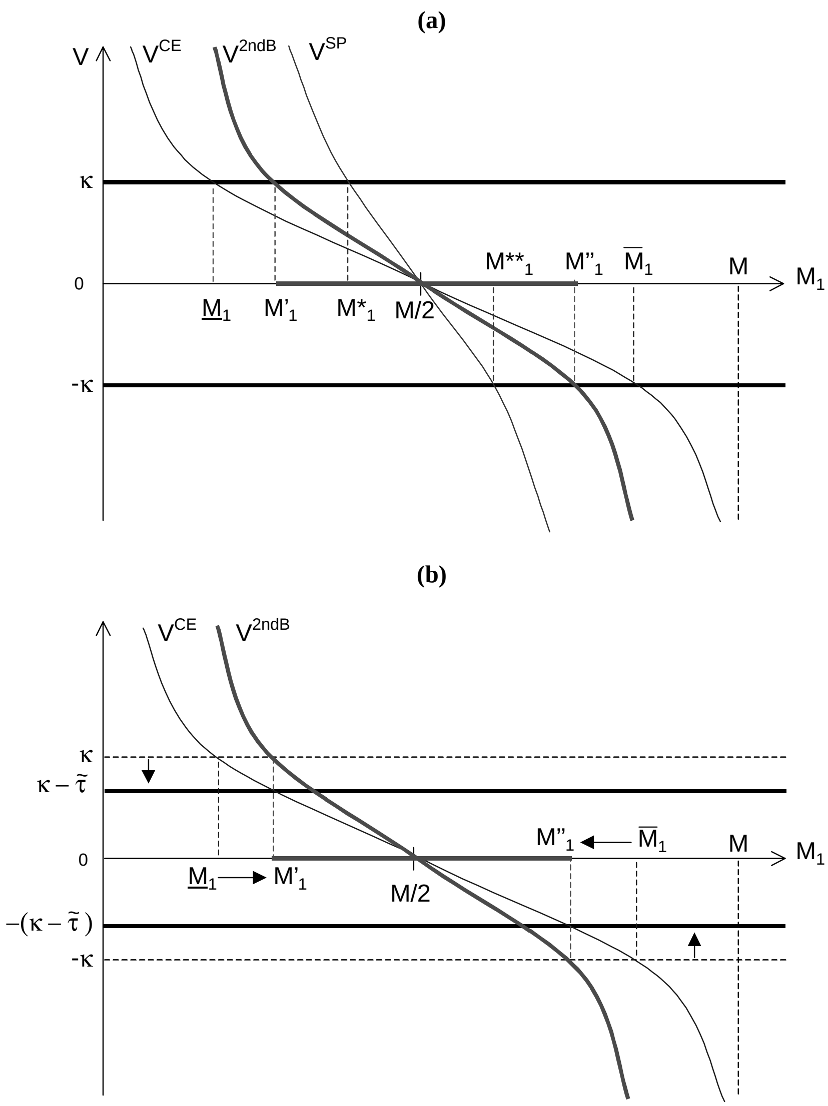

(a)
V
V^CE
V^2ndB
V^SP
κ
0
-κ
M_1
M'_1
M*_1
M/2
M**_1
M"_1
M̄_1
M
M_1
(b)
V^CE
V^2ndB
κ
κ − τ̃
0
−(κ − τ̃)
-κ
M_1
M'_1
M/2
M"_1
M̄_1
M
M_1

Figure 3

moving costs are given by $\kappa - \widetilde{\tau}$, firms will migrate so as to reproduce the spatial firm distribution dictated by the second best solution. Suppose, for instance, that $M_1(0) < M_1'$. Then, by reducing migration costs, the transfer in effect reduces inertia and causes firms in region 2 to migrate to region 1 up to M_1'. The equilibrium condition analogous to equation (17) is

$$\pi_1(z_1, M_1') - (\kappa - \widetilde{\tau}) = \pi_2(z_2, M - M_1'). \tag{17'}$$

As before, and in spite of the targeted subsidy, firms that initially operate in region 1 earn more than migrants from region 2. However, it is clear from equation (17') that movers are no worse off than those which stayed in region 2. This argument can simply be reversed for the case where $M_1(0) > M_1''$. From our analysis in the previous section, it can be easily shown that

$$\widetilde{\tau} = (1 - \alpha)\kappa < \kappa. \tag{22}$$

Because the competitive equilibrium implies excessive inertia, a targeted subsidy that is proportional to moving costs can indeed restore the second best allocation. Observe that conventional wisdom regarding the use of moving subsidies, whereby these should be set to zero, emerges as a limiting case. As the degree of market power held by intermediate goods firms vanishes, so that $\alpha \to 1$, $\widetilde{\tau} \to 0$. In this case, the competitive equilibrium, the second best solution, and the efficient solution all coincide. Note also that when $\kappa = 0$, the private economy replicates the second best solution since employment allocations are the same and $M_1 = M_2 = M/2$.

On a related note, an argument often cited in the literature suggests that subsidies simultaneously offered by multiple regions are socially wasteful. The intuition given is that, while these incentive programs are costly, they may well offset each other thus leaving the allocation of firms unchanged. This intuition, however, fails to take into account that the spatial distribution of firms matters in determining the private return from moving. Therefore, firms may have an incentive to migrate even when regional subsidies are identical. For example, suppose that $M_1(0) < M_1'$ in Figure (3b). In this case, firms have an incentive to migrate from region 2 to region 1 despite an identical subsidy of $\widetilde{\tau}$ offered in region 2. Alternatively, since the return from moving to region 2 is negative (i.e. $V^{CE} > 0$ so that $-V^{CE} < 0$), it is irrelevant what moving costs have to be incurred to migrate to that location.

Since migration costs are identical regardless of the direction of movement, the targeted subsidy required to induce the second best solution is the same in both locations *ex ante*. Of course, in practice, different regions generally offer different incentives packages. Clearly, asymmetric subsidies across regions may still serve to increase welfare compared to the competitive allocation.

Finally, one should observe that the effect of moving costs subsidies can, in fact, be negligible *ex post.* To see this, suppose that $M_1' < M_1(0) < M/2$ initially in Figure (3b). The number of firms in both regions is thus relatively close although there are less firms in region 1. Then, because the return from migrating does not cover moving costs, no migration occurs in the decentralized equilibrium. More importantly, implementing an incentives program that alleviates these costs by $\widetilde{\tau}$ does not change this result. Schneider (1985) indeed provides some evidence that state policies may have little impact on firm location. As we have just shown, this evidence naturally emerges in a setting where some inertia exists in firm movement. It should also be noted that moving subsidies can be set too high in this framework, in which case social welfare would suffer. In line with Burstein and Rolnick (1994), the degree of induced firm movement may be socially costly when $\tau > \widetilde{\tau}$ in either region.

Although widely used in practice, and potentially welfare improving, targeted subsidies that reduce up-front moving costs cannot ultimately induce the efficient solution. As is standard in models with imperfect competition, the policy tool needed in this case is one that *uniformly* removes the labor market distortion associated with decentralized employment allocations. Specifically, we now show that the first best solution may be attained in this environment using uniform wage subsidies across firms.[11] As observed by Holmes (1995), uniform policies are seldom implemented in practice. Suppose that firms in either region only have to incur a fraction $0 < \theta < 1$ of the wages paid to labor in that location. As in our previous example, the total cost of the program, $\sum_{i=1}^{2}(1-\theta)w_i N_i$, would be financed through lump-sum taxes levied evenly across all households. Given the wage subsidy, firms in region i now solve

$$\max_{l_i} \widetilde{\pi}_i = \alpha z_i l_i^{\alpha} R^{1-\alpha} - \theta w_i l_i. \tag{23}$$

Consequently, a modified labor demand function emerges for the typical firm in each location,

$$w_i = \theta^{-1}\left[\alpha^2 z_i R^{1-\alpha}\right] l_i^{\alpha-1}. \tag{24}$$

Using the labor market clearing condition (11), it follows that regional employment is now

$$N_i = \left[\theta^{-1}\alpha^2 R^{1-\alpha} z_i\right]^{\frac{\sigma}{1-\sigma(\alpha-1)}} M_i^{\frac{\sigma(1-\alpha)}{1-\sigma(\alpha-1)}}. \tag{25}$$

As shown in Figure 4, a uniform wage subsidy can potentially remove the distortion associated with market power and, therefore, stimulate a rise in regional employment. This can be seen directly by comparing equations (25) and (13) since $\theta < 1$. More importantly, the removal of this static inefficiency results in the optimal degree of firm migration. To see this,

[11] Targeted subsidies will not work since employment distortions would remain for a subset of firms.

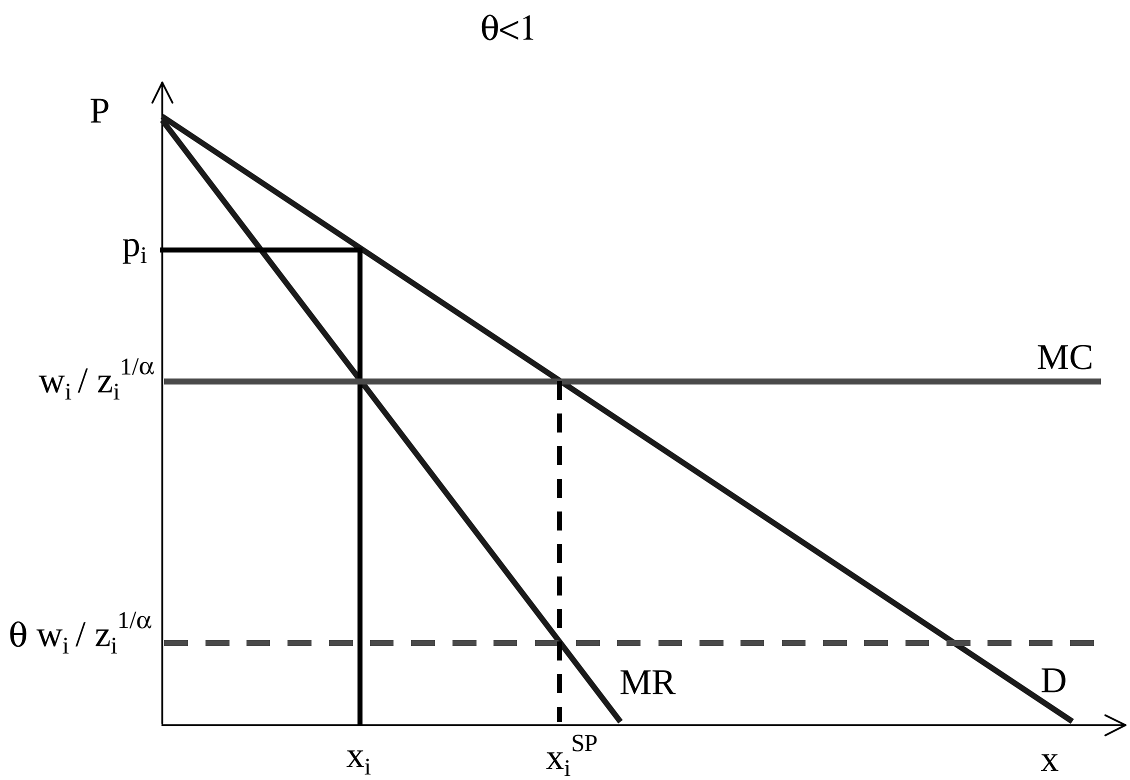


Figure 4

note that firms' profits are now given by

$$\begin{aligned}\widetilde{\pi}_i &= (1-\alpha)\left[\alpha^{\alpha\sigma}R^{(1-\alpha)(1+\sigma)}z_i^{1+\sigma}\right]^{\frac{1}{1-\sigma(\alpha-1)}}\alpha^{\frac{1+\sigma}{1-\sigma(\alpha-1)}}\theta^{\frac{-\sigma\alpha}{1-\sigma(\alpha-1)}}M_i^{\frac{-\alpha}{1-\sigma(\alpha-1)}} \\ &= \theta^{\frac{-\sigma\alpha}{1-\sigma(\alpha-1)}}\pi_i(z_i,M_i) > \pi_i(z_i,M_i).\end{aligned} \tag{26}$$

In a manner analogous to the previous section, define $\widetilde{V}^{CE} = \widetilde{\pi}_1(z_1,M_1) - \widetilde{\pi}_2(z_2,M_2)$. Since $\widetilde{V}^{CE} = \alpha^{\frac{1+\sigma}{1-\sigma(\alpha-1)}}\theta^{\frac{-\sigma\alpha}{1-\sigma(\alpha-1)}}V^{SP}$ by equations (26) and (15), it immediately follows that by setting $\theta = \alpha^{\frac{1+\sigma}{\sigma\alpha}} < 1$, $\widetilde{V}^{CE} = V^{SP}$, in which case the private economy mimics the social planner's solution.

4 Dynamic Distortions in Firm Migration

In section 3, we simply postulated that moving costs were fixed and independent of the number of movers. This assumption directly implied instantaneous firm migration. By contrast, Braun (1993) suggests that when moving costs vary with the number of migrants, the adjustment to equilibrium can display more gradual dynamics. This gain in realism, however, comes at the cost of a further distortion between the decentralized equilibrium and the social optimum. More importantly, regional incentive programs, while perhaps useful in making the private economy more efficient in the long run, may now involve transitional welfare costs in the short run. With respect to targeted moving cost subsidies for instance, it will be easy to see that the static analysis simply nets out these two effects and, therefore, misses an important dynamic implication of these particular programs.

In this section, time is continuous, indexed by $t \geq 0$, and the horizon is infinite. Suppose that the cost of moving between regions, expressed in units of the final good, rises with the flow of migrants per unit of time. As in Braun (1993), this feature of moving costs may reflect congestion externalities in the migration process. For instance, congestion effects may arise from the fact that the stock of office or warehousing space is relatively fixed in the short run. The Society of Industrial and Office Realtors (SIOR) indeed suggests that "in order to compete for major relocation companies, additional space must be made available relatively quickly." In 1994, while Charlotte, North Carolina, was being characterized as "one of the nation's business relocation hot spots," a spokesperson for SIOR indicated that it was also "being short-listed by certain prospects because there wasn't enough available space."[12] Put another way, the more firms move to a given region, the more costly it may become for any individual firm to set up production in that location. To capture these ideas, let a firm's

[12]The Charlotte Observer, 02/07/1995.

resource costs associated with moving between regions be given by

$$\phi(t) = \eta A(t) + \kappa, \text{ with } \eta > 0, \tag{27}$$

where $A(t)$ denotes the number of migrating firms per unit of time. For the sake of simplicity, let us concentrate on the case where the initial measure of firms in region 1, $M_1(0)$, is relatively small. In the remainder of the analysis, the flow of migrants is consequently given by $A(t) = \dot{M}_1(t) \geq 0$, where the "dot" notation represents time derivatives. This case will be sufficient to illustrate the main points of this section. To do this, we first describe the decentralized equilibrium in this dynamic environment.

The logic underlying the competitive equilibrium follows that of Braun (1993) relatively closely. As a result, we limit ourselves to the main arguments only. The solution to the household's problem in each region remains unchanged relative to section 2. In contrast, from the standpoint of an individual firm, the present value of a permanent move from region 2 to region 1 can now be written as

$$V^{CE}(t) = \int_t^\infty e^{-r(s-t)} \left[\pi_1(z_1, M_1(s)) - \pi_2(z_2, M_2(s))\right] ds, \tag{28}$$

where $r > 0$ is the interest rate. From equation (28), we can derive how the gain from switching locations evolves over time,

$$\dot{V}^{CE}(t) = -\left[\pi_1(z_1, M_1(t)) - \pi_2(z_2, M_2(t))\right] + rV^{CE}(t). \tag{29}$$

Based on the analysis in section 2, we know that some firms locate production in both regions in the decentralized steady state. In other words, not all firms choose to migrate. However, since firms are identical *ex ante*, the net benefit from moving can only be zero for a firm if it is zero for all firms. Therefore, in the decentralized equilibrium, firm migration must be such that the costs and benefits of moving at each date are equated. Formally, we have $V^{CE}(t) = \eta A(t) + \kappa$ for all t as firms migrate towards region 1. Alternatively, this condition implies that $A(t) = (V^{CE}(t) - \kappa)/\eta$. Hence, the equilibrium dynamics of the decentralized economy can be expressed as a set of two differential equations:

$$\begin{aligned} \dot{V}^{CE}(t) &= -B\alpha^{\frac{1+\sigma}{1-\sigma(\alpha-1)}} \left\{ \left[z_1^{1+\sigma} M_1(t)^{-\alpha}\right]^{\frac{1}{1-\sigma(\alpha-1)}} - \left[z_2^{1+\sigma} M_2(t)^{-\alpha}\right]^{\frac{1}{1-\sigma(\alpha-1)}} \right\} \\ &\quad + rV^{CE}(t) \end{aligned} \tag{30}$$

and

$$\dot{M}_1(t) = \frac{V^{CE}(t) - \kappa}{\eta}, \tag{31}$$

where we have written out profits explicitly in equation (29), and as before $B = (1-\alpha)[\alpha^{\alpha\sigma} R^{(1-\alpha)(1+\sigma)}]^{\frac{1}{1-\sigma(\alpha-1)}}$.

Note the similarity between equations (30) and (15). In particular, in the steady state where $\dot{V}^{CE}(t) = 0$ and $\dot{M}_1(t) = 0$, we have $V^{CE} = [\pi_1(z_1, M_1) - \pi_2(z_2, M_2)]/r$ and $V^{CE} = \kappa$ respectively. In essence, the decentralized steady state replicates the static equilibrium of section 2. The only difference lies in the value of moving, which is now explicitly given by the discounted present value of future profit differentials.[13] Further insights into the dynamic behavior of the private economy can be obtained by linearizing the system (30) and (31) in a neighborhood of the steady state. Appendix A shows that the linearized equations yield a second-order differential equation,

$$\ddot{V}^{CE}(t) - r\dot{V}^{CE}(t) + \frac{\psi(z_1, M_1)}{\eta} V^{CE}(t) = \frac{\psi(z_1, M_1)\kappa}{\eta}, \tag{32}$$

where $\psi(z_1, M_1) = d\pi_1(z_1, M_1)/dM_1 - d\pi_2(z_2, M - M_1)/dM_1 < 0$. The characteristic equation associated with equation (32) has one positive and one negative root, implying the saddle point property. The solution path characterizing the measure of region 1 firms over time is derived in Appendix A and given by

$$M_1(t) = M_1 + (M_1(0) - M_1)\, e^{\lambda^{CE} t},$$

where $\lambda^{CE} = \left(r - \sqrt{r^2 - 4\psi(z_1, M_1)/\eta}\right)/2 < 0$. As should be expected, the greater the degree of congestion externalities (i.e. the greater η), the slower is the speed of convergence to the steady state. In the limit, where η is arbitrarily large, λ^{CE} approaches zero and no firm movement takes place, $M_1(t) = M_1(0)$ for all t.[14]

How does this decentralized equilibrium compare with the social optimum? To answer this question, we let the benevolent planner solve the dynamic version of problem (SP) in section 3,

$$\max_{c(t),\, \{N_i(t)\}_{i=1,2},\, M_1(t)} \mathcal{W} = \int_0^\infty e^{-rt}[c(t) - \sum_{i=1}^{2} \frac{N_i(t)^{1+\frac{1}{\sigma}}}{1+\frac{1}{\sigma}}]dt, \text{with } \sigma > 0 \tag{SP'}$$

$$\text{subject to} \begin{cases} c(t) & = M_1(t)x_1(t)^\alpha R^{1-\alpha} + [M - M_1(t)]\, x_2(t)^\alpha R^{1-\alpha} - [\eta A(t) + \kappa]\, A(t), \\ x_i(t) & = z_i^{\frac{1}{\alpha}} \left[\frac{N_i(t)}{M_i(t)}\right], \text{ for } i = 1, 2, \text{ and} \\ A(t) & = \dot{M}_1(t),\ M_1(0) > 0 \text{ given.} \end{cases}$$

There are a few points worth noting about the control problem (SP'). First, since utility is linear in consumption, the rate of time preference ascribed to households is also the interest rate. Second, as migration costs are given by $\eta A(t) + \kappa$ per migrant, economy-wide

[13] In the steady state, $M_1(t) = M_1$ is constant. Therefore $\int_t^\infty e^{-r(s-t)} [\pi_1(z_1, M_1) - \pi_2(z_2, M_2)]\, ds = [\pi_1(z_1, M_1) - \pi_2(z_2, M_2)]/r$.

[14] Note that since $\psi(.) < 0$, $r^2 - 4\psi(.)/\eta > 0$.

resource costs associated with firm movement are convex in $A(t)$. This feature ensures that (SP') possesses an interior solution. Finally, it should be clear that the optimal choice of employment in each region, $N_i(t)$, involves a static decision and is still given by equation (19). Let $V^{SP}(t)$ denote the co-state variable associated with $A(t)$ or, alternatively, the marginal value of the stock $M_1(t)$. Then, solving the Hamiltonian associated with problem (SP') yields the following two differential equations:[15]

$$\begin{aligned} \dot{V}^{SP}(t) &= -B\left\{\left[z_1^{1+\sigma} M_1(t)^{-\alpha}\right]^{\frac{1}{1-\sigma(\alpha-1)}} - \left[z_2^{1+\sigma} M_2(t)^{-\alpha}\right]^{\frac{1}{1-\sigma(\alpha-1)}}\right\} \\ &\quad + rV^{SP}(t), \end{aligned} \tag{33}$$

and

$$\dot{M}_1(t) = \frac{V^{SP}(t) - \kappa}{2\eta}, \tag{34}$$

where $B = (1-\alpha)[\alpha^{\alpha\sigma} R^{(1-\alpha)(1+\sigma)}]^{\frac{1}{1-\sigma(\alpha-1)}}$.

Again, note the similarity between equations (33) and (20). As suggested by the static analysis earlier, a greater number of firms eventually operate in region 1 in the steady state relative to the decentralized economy. In addition, a new source of inefficiency arises in that the private rate of firm migration may be suboptimal along the transition path. We can most easily see this dynamic distortion by comparing equations (31) and (34). By integrating equation (33) with respect to time, we obtain that $V^{CE}(t) = \alpha^{\frac{1+\sigma}{1-\sigma(\alpha-1)}} V^{SP}(t)$ for all t where $\alpha^{\frac{1+\sigma}{1-\sigma(\alpha-1)}} < 1$. This result is analogous to that of section 3 in that, at all points in time, the private return from moving falls short of the social return.

This last observation does not necessarily imply that the private rate of migration is slower than optimal. In fact, equations (31) and (34) indicate that whether the decentralized speed of convergence is greater or less than that chosen by the planner hinges on whether $\alpha^{\frac{-(1+\sigma)}{1-\sigma(\alpha-1)}} \lesseqgtr 2$. The intuition underlying this finding should be relatively clear. On the one hand, the fact that $V^{SP}(t) > V^{CE}(t)$ suggests that firms should migrate at a faster rate. On the other hand, the congestion externalities associated with moving costs dictate slower migration along the transition path. In particular, the representative firm only considers its private moving costs without internalizing its impact on other firms. Of course, it is conceivable that these two forces may largely offset each other thus giving close to the optimal convergence rate. Formally, the solution for $M_1(t)$ under the social optimum is given by

$$M_1(t) = M_1^* + (M_1(0) - M_1^*)\, e^{\lambda^{SP} t}, \tag{35}$$

where $\lambda^{SP} = \left(r + \sqrt{r^2 - 4\alpha^{\frac{-(1+\sigma)}{1-\sigma(\alpha-1)}} \psi(z_1, M_1^*)/2\eta}\right)/2 < 0$.

[15] This is shown in Appendix B.

Having introduced gradual dynamics into the framework, albeit at the cost of a further distortion, we now revisit the types of targeted moving cost subsidies described in section 3. As the following example illustrates, an important result emerges in that, while potentially welfare improving in a net present value sense, these subsidies may nevertheless generate transitional welfare costs in the short run.

Figure 5, panels (a) through (d), captures the effects of introducing a permanent subsidy in region 1 that reduces fixed moving costs by 15%. Starting from the decentralized equilibrium, equation (31) now reads as $\dot{M}_1(t) = \left[V^{CE}(t) - \kappa + \tau_1\right]/\eta$ with $\tau_1 \in (0, \kappa)$.[16] Panel (a) shows that following the introduction of the subsidy, some firms find it worthwhile to move production into region 1. Since the decentralized level of aggregate production falls below that of the social optimum initially, this re-allocation is associated with a rise in total output in panel (b). The induced firm movement, therefore, is not a "zero sum." Despite this gain in output, however, panel (c) shows that the economy suffers a short-run loss in aggregate consumption. As indicated in panel (d), this finding is driven by the fact that the re-allocation of firms across regions may involve substantial resources. It may not be surprising, therefore, that such strong debate has emerged on these issues. In particular, part of Burstein and Rolnick's intuition relating to costly firm migration remains. As the economy moves towards its new steady state, firm movement settles down and aggregate migration costs tend back to zero. In the long run, the gain in aggregate consumption is equal to that of final output.[17]

Although we have introduced gradual dynamics through congestion effects, it is worth emphasizing that the short-run consumption loss that occurs might emerge in any set-up where firm movement is less than instantaneous. (i.e. $\kappa A(t)$ may be significant so long as $A(t)$ is significant). Observe that the present value of the consumption effect induced by the moving subsidy, as captured by areas $A + B$ discounted appropriately in Figure (5c), is still positive. Nevertheless, by netting out these two effects, a static analysis distinctly masks what could potentially be costly short-run adjustments in response to location incentive programs. This finding, therefore, suggests that in evaluating regional moving subsidies, it may be especially misleading to put too much emphasis on contemporaneous conditions.

[16] The parameter values used in this particular exercise are $\alpha = .5$, $\sigma = 1.25$, $z_1 = z_2 = 1$, $\kappa = .15$, and $\tau_1 = .02$.

[17] Since employment rises in region 1 and falls in region 2, the consumption effect ultimately dominates in the welfare calculation.

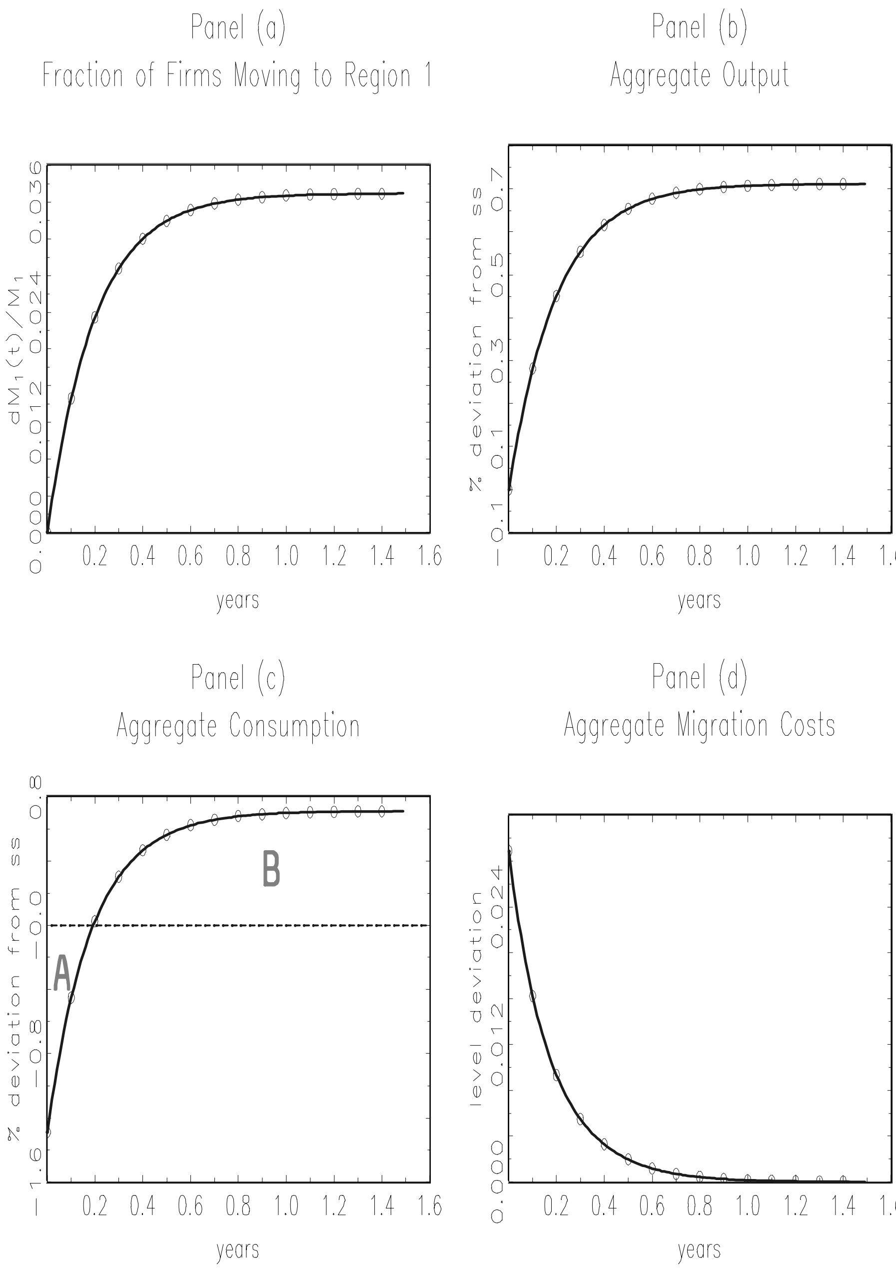

Panel (a)
Fraction of Firms Moving to Region 1
Panel (b)
Aggregate Output
Panel (c)
Aggregate Consumption
Panel (d)
Aggregate Migration Costs
years
% deviation from ss
level deviation
A
B

Figure 5

4.1 Cautionary Remarks

The results from both the static and dynamic analyses indicate that the effects of regional moving subsidies are not necessarily straightforward and, in some cases, socially desirable. These conclusions, of course, are most meaningful if the underlying features of the model capture reasonably well the key forces that govern firm migration. Two important features that we believe have been downplayed in earlier work, namely those of market power and migration costs, are emphasized in this paper. The second assumption, in particular, plays a key role in that it predicts some inertia in firm movement. While this framework is useful in addressing some of the incentives issues, it is necessarily limited in scope, and has shortcomings in a broader setting.

First, this framework remains silent on the role of public goods and services in the context of firm migration. As in Barro (1990), we may imagine that government expenditures finance some set of services that affect households' preferences. In this case, while moving subsidies may improve welfare through a more efficient regional re-allocation of firms, the taxes needed to finance these incentive programs would necessarily take away from other productive public spending. As a result, and depending on the utility derived from government services, one would naturally expect smaller moving subsidies to be welfare improving. Holmes (1995) specifically investigates the use of moving subsidies in a framework where public goods play a central role.

Second, to say that the decentralized equilibrium is suboptimal in no way implies that state governments would naturally improve upon this allocation. In a world where states compete with each other in order to attract firms and boost regional activity, the level of subsidies may well be bid up high enough to induce social welfare losses.[18] While this currently appears to be a widespread view, it remains that to prohibit the use of regional subsidies altogether may be socially inefficient.

Finally, in this paper, we have chosen to focus on the effects of regional public expenditures that help reduce firms' moving costs. Since moving costs are directly associated with inertia in this model, this focus was only natural. However, state governments also use many other targeted instruments to induce firm relocation including reductions in business taxes and financing at below market rates. It is not evident that these policy tools can also be used to reproduce a second best outcome.

[18] This is especially true if subsidies are financed through distortionary taxation, which we have implicitly discounted in this paper.

5 Conclusions and Directions for Future Research

The objective of this paper has been to sort out several theoretical features of the debate on the role of moving subsidies and their effects on firm location. In doing so, we have also tried to provide a relatively versatile framework that may be used to tackle additional questions, whether of a static or dynamic nature, in subsequent research. In addressing the issues first set out in the introduction, our analysis yields the following conclusions.

Regarding the positive aspects of the model, we have shown that when firms privately choose where to locate production, the resulting equilibrium may not be socially efficient, both in a static -(long-run),- and a dynamic sense. In addition to the labor market distortions that naturally arise when firms have pricing power, the fact that they only consider profit differentials generates excessive inertia relative to the efficient solution. Moreover, the fact that inertia arises is consistent with empirical findings that the impact of state policies on firm movement are relatively mixed. In particular, we find that in some cases, regional moving subsidies can have a negligible effect on firm location.

The model also yields some interesting policy insights. First, in spite of the inertia in firm migration, there exist cases where targeted subsidies that alleviate moving costs can induce a second best outcome. Relative to the competitive equilibrium, the induced firm movement is not a "zero sum." This result suggests that from the vantage point of a Federal institution, it may be worth allowing some room for regional incentives programs. The conventional wisdom, that moving subsidies are necessarily harmful, arises in our setting as a limiting case where market power tends to zero. Second, we have shown that subsidies simultaneously offered by multiple regions do not necessarily offset one another. Because the spatial distribution of firms matters in determining the return from moving, firm migration from one region to another can take place even when both regions offer identical subsidies. Finally, we have found that while moving costs subsidies may be welfare improving in a net present value sense, they can nevertheless generate transitional welfare costs in the short run. As a result, in evaluating these programs, it may be particularly misleading to consider a short horizon.

Having shown that a role exists for regional moving incentives, it would be interesting to next ask what forces likely shape these policies. Specifically, under what conditions are moving subsidies set too high or too low? In our framework, we may imagine that regional governments care about the utility of their constituents, raise taxes locally to finance moving subsidies, and play a duopoly game to arrive at specific policy outcomes. Understanding the forces involved in such a game may be an important next step in advancing the debate on firm relocation. In this paper, we hope to have established useful benchmarks that may allow these issues to be addressed in the future.

Appendix A: *Linearized dynamics of the decentralized economy in a neighborhood of the steady state.*

The differential equations governing the dynamic behavior of firm migration are:

$$\dot{V}^{CE}(t) = -\left[\pi_1(z_1, M_1(t)) + \pi_2(z_2, M - M_1(t))\right] + rV^{CE}(t) \tag{A1}$$

and

$$\dot{M}_1(t) = \frac{V^{CE}(t) - \kappa}{\eta}, \tag{A2}$$

with $M_1(0)$ given. Let M_1 and V^{CE} denote the measure of firms operating in region 1 and the private value of moving respectively in the long run. Then, linearizing equations (A1) and (A2) around the steady state yields

$$\dot{V}^{CE}(t) = -\psi(z_1, M_1)\left(M_1(t) - M_1\right) + r\left(V^{CE}(t) - V^{CE}\right) \tag{A3}$$

and

$$\dot{M}_1(t) = \frac{V^{CE}(t) - V^{CE}}{\eta}, \tag{A4}$$

where $\psi(z_1, M_1) = d\pi_1(z_1, M_1)/dM_1 + d\pi_2(z_2, M - M_1)/dM_1 < 0$. Differentiating (A3) with respect to time, and using (A4) to substitute for $\dot{M}_1(t)$, gives,

$$\ddot{V}^{CE}(t) - r\dot{V}^{CE}(t) + \frac{\psi(z_1, M_1)}{\eta}V^{CE}(t) = \frac{\psi(z_1, M_1)\kappa}{\eta} \tag{A5}$$

since $V^{CE} = \kappa$. The characteristic equation associated with (A5) is

$$x^2 - rx + \frac{\psi(z_1, M_1)}{\eta} = 0.$$

It has two roots,

$$\lambda^{CE} = \frac{r - \sqrt{r^2 - 4\psi(z_1, M_1)/\eta}}{2} < 0 \text{ and } \mu^{CE} = \frac{r + \sqrt{r^2 - 4\psi(z_1, M_1)/\eta}}{2} > 0.$$

Therefore, the paths that satisfy equation (A5) are given by

$$V^{CE}(t) - \kappa = \omega_0 e^{\lambda^{CE} t} + \omega_1 e^{\mu^{CE} t}, \tag{A6}$$

where ω_0 and ω_1 are arbitrary constants.

Starting with $V^{CE}(0)$, which remains to be determined as a function of $M_1(0)$, ω_0 and ω_1 must satisfy

$$V^{CE}(0) - \kappa = \omega_0 e^0 + \omega_1 e^0 = \omega_0 + \omega_1.$$

Moreover, since $\mu^{CE} > 0$, ω_1 must equal zero for $V^{CE}(t)$ to converge to κ. Hence, $\omega_1 = 0$ and $\omega_0 = V(0) - \kappa$ so that, from (A6),

$$V^{CE}(t) = \kappa + \left(V^{CE}(0) - \kappa\right) e^{\lambda^{CE} t}. \tag{A7}$$

Using equation (A7), we can re-write (A4) as

$$\dot{M}_1(t) = \frac{\left(V^{CE}(0) - \kappa\right) e^{\lambda^{CE} t}}{\eta}.$$

Integrating this last equation with respect to time gives

$$M_1(t) = \frac{\left(V^{CE}(0) - \kappa\right) e^{\lambda^{CE} t}}{\eta \lambda^{CE}} + \omega_2. \tag{A8}$$

Since $M_1(0)$ is given by history while $M_1(t)$ converges to M_1, it follows that $\omega_2 = M_1$ and

$$V^{CE}(0) = \left(M_1(0) - M_1\right) \eta \lambda^{CE} + \kappa.$$

This completes the solution.

Appendix B: *Solving the planner's problem in the dynamic economy.*

The present value Hamiltonian associated with problem (SP') is given by

$$\begin{aligned} \mathcal{H} &= e^{-rt}\left\{z_1 M_1(t)^{1-\alpha} N_1(t)^{\alpha} R^{1-\alpha} + z_2\left[M - M_1(t)\right]^{1-\alpha} N_2(t)^{\alpha} R^{1-\alpha} - \left[\eta A(t) + \kappa\right] A(t)\right\} \\ &\quad - e^{-rt} \sum_{i=1}^{2} \frac{N_i(t)^{1+\frac{1}{\sigma}}}{1+\frac{1}{\sigma}} + e^{-rt} V^{SP}(t) A(t). \end{aligned}$$

Consequently, the first-order conditions are

$$z_i \alpha N_i(t)^{\alpha-1} M_i(t)^{1-\alpha} R^{1-\alpha} = N_i^{\frac{1}{\sigma}} \text{ for } i = 1, 2, \tag{A9}$$

$$\begin{aligned} & -\left\{z_1(1-\alpha) M_1(t)^{-\alpha} N_1(t)^{\alpha} R^{1-\alpha} - (1-\alpha) z_2\left[M - M_1(t)\right]^{-\alpha} N_2(t)^{\alpha} R^{1-\alpha}\right\} \\ = \; & \dot{V}^{SP}(t) - r V^{SP}(t), \end{aligned} \tag{A10}$$

and

$$-2\eta A(t) - \kappa + V^{SP}(t) = 0. \tag{A11}$$

Substituting equation (A9) in (A10) directly yields equations (33) and (34) in the text.

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