Telecommunication Technologies and Optimal Location of Office Firms

Se-il MUN

Graduate School of Information Sciences
Tohoku University Aoba-ku Sendai 980, JAPAN

Received May 9, 1994; final version received August 22, 1994

This paper presents a model for optimal location of office firms in the circumstances that firms can communicate with each other not only face-to-face but also by telecommunications. We derive the conditions for optimal allocation and show that the decentralized market system fails to achieve the optimal location due to the external economies of agglomeration. Properties of the optimal location and the impacts of telecommunication technologies are investigated by means of numerical simulations.

KEYWORDS: Office location, Telecommunication technology, optimal land use

1. Introduction

Urban area is characterized by extensive interactions among various activities. These interactions are performed among people or organizations located at different geographical points, so distance is an important factor in location decision for urban activities and, consequently, in urban spatial structure.

Telecommunication is a means to overcome distance for exchange of information among people and organizations. The recent dramatic developments in telecommunication technologies should have great impacts on the spatial structure of cities. This topic has already attracted interest in recent years: for example, Salomon (1985), Sasaki (1990, 1993), Ota and Fujita (1993).

Among the various types of urban activities, we focus on the office sector. It is considered that office activities are greatly affected by telecommunication technologies, since information is the most important commodity that the office firms deal with. Office firms must communicate with each other for information exchanges, transactions, etc. Therefore, the location decision of a firm affects the costs and benefits of other firms through the changes in the distances, or accessibility between firms (see, for example, Goddard (1977), O'Hara (1977), Fujita and Ogawa (1982), Mun and Yoshikawa (1993)). This implies that the externality effects of agglomeration are present in office location. In this case, the market mechanism fails to achieve the efficient resource allocation. Although several articles have been devoted to the study of the optimal location of office firms (for example, Tauchen and Witte (1984), Tabuchi (1986), Kanemoto (1990)), they have neglected the possibility of communication via telecommunication means.

Mun (1993) analyzed the impacts of decreases in telecommunication costs on travel demand, the location of office firms and city size. It was shown that travel demand may be either increased or decreased by a decrease in telecommunication cost, depending on the parameter values and the stages of technological development. Spatial distribution of office firms within the city is decentralized by telecommunication cost reduction while city size is expanded. However, the issue of resource allocation was not considered in that paper.

The present paper aims to analyze the optimal location of office firms in the circumstances that firms can communicate not only face-to-face but also by telecommunications. We compare the optimal solution with the market solution, and investigate how the difference between the two solutions is affected by the developments in telecommunication technologies. We adopt the model of office location developed by Mun (1993).

The next section of the paper reviews the prototype model and presents the equilibrium condition in the decentralized market economy. Section 3 develops a planning model for optimal location of office firms, and derives the optimal conditions. The properties of optimal solution and the impacts of telecommunication technologies are analyzed in section 4. Section 5 concludes the paper.

2. The Model

The review in this section is mainly based on Mun (1993). Suppose that a city consists of $I$ discrete zones ($i = 1, 2, \ldots, I$). Each zone has identical size, and the locational characteristics of sites within each zone are identical. The distance between a firm in zone $i$ and any other firm in zone $j$ is represented by the distance between the centers of each zone, $t_{ij}$. All firms located in the city are homogeneous with respect to technologies.
2.1 The quality of information and communication costs

The quality level of information in communication is considered in our model. Let us assume that quality level of communication is represented by a single variable, \( q \). We further assume that, the greater the value of \( q \), the higher the quality level of communication.

It is natural to suppose that each firm conducts several rounds of communications, each of which may be at a different quality level. Let us introduce a variable, \( n(q) \), which represents the demand for communications at each quality level. \( n(q) \) is defined as the density function, and it is assumed to be distributed over the range \([q_l, q_u]\), where \( q_l \) and \( q_u \) are the lower and upper bounds of the quality level, respectively. Thus \( n(q) \) must satisfy the following condition,

\[
\int_{q_l}^{q_u} n(q) \, dq = 1. \tag{1}
\]

The form of \( n(q) \) depends on the characteristics of the activities in each type of firm, therefore is given exogenously in our analysis.

Two types of communication modes are considered, i.e. face-to-face contacts and telecommunications. Let us denote by \( c_i^h(q) \) the cost for communications of quality level \( q \) from a firm in \( i \) to a firm in \( j \), by mode \( h \), \( h = 1, 2 \), where \( h = 1 \) and \( 2 \) correspond respectively to face-to-face contacts and telecommunications. These costs are specified as follows

\[
c_i^1(q) = \epsilon t_{ij}, \tag{2}
\]

\[
c_i^2(q) = f t(q), \tag{3}
\]

where \( \epsilon \) is the monetary and time cost per unit distance of travel, \( t_{ij} \) is the distance between zones \( i \) and \( j \), \( f \) is fees for the use of telecommunications facilities per unit time, and \( t(q) \) is the time required to conduct the communication of level \( q \), which is an increasing function of \( q \). Note that \( c_i^2(q) \) does not depend on the distance to the other firms, as intra-city telephone charges are adopted.

The choice of mode for communication is described as follows. Each firm chooses the mode \( h \) for communication of level \( q \) if

\[
c_i^h(q) = \min \{ c_i^1(q), c_i^2(q) \}. \tag{4}
\]

The average cost for communication \( TC_{ij} \) can be written

\[
TC_{ij} = \int_{q_l}^{q_u} n(q) \min \{ c_i^1(q), c_i^2(q) \} \, dq. \tag{5}
\]

It is assumed that \( c_i^1(q_l) > c_i^2(q_l) \) and \( c_i^1(q_u) < c_i^2(q_u) \). This assumption guarantees that the higher (lower) level communication is necessarily conducted by face-to-face contacts (by telecommunications). Then, \( TC_{ij} \) can be rewritten as

\[
TC_{ij} = \int_{q_l}^{q_u^*} n(q)c_i^1(q) \, dq + \int_{q_u^*}^{q_u} n(q)c_i^2(q) \, dq, \tag{6}
\]

where \( q_u^* \) is determined so that the following relation holds

\[
c_i^1(q_u^*) = c_i^2(q_u^*), \tag{7}
\]

that is, \( q_u^* \) is determined so that the costs for communication by each mode are indifferent at \( q_u^* \).

By using the specifications in (2) and (3), Eq. (7) can be rewritten as

\[
\epsilon t_{ij} = ft(q_u^*). \tag{8}
\]

Communication at a lower level than \( q_u^* \) is conducted by telecommunication systems while that at levels higher than \( q_u^* \) is conducted by face-to-face contacts. Thus, the share of face-to-face contacts for communication between \( i \) and \( j \) is calculated by

\[
Q_{ij} = \int_{q_l}^{q_u^*} n(q) \, dq. \tag{9}
\]

2.2 Behavior of a firm

Let us first consider the outcome of communication activity. By communicating with other firms, each firm gets something which contributes to its production, such as information, clients, etc. We call this a ‘benefit from communication’ and denote it by \( V_i \). \( V_i \) is represented as follows
\[ V_i = \sum_{j=1}^{I} \sum_{n=1}^{N_f} v(x_{ij}^n), \quad (10) \]

where \( N_f \) is the number of firms in \( j \), \( x_{ij}^n \) is the amount of communication from a firm in \( i \) to a firm \( n \) in \( j \), \( v(\quad) \) is an increasing and concave function. (10) implies that the firm can gain greater benefits if it communicates with many different firms. The concavity of \( v(\quad) \) implies that the marginal gain from contacts per firm is decreasing since the benefits (such as information) obtainable from any individual source are limited.

If we assume that it is inconsequential which firms in \( j \) a firm in \( i \) communicates with, then
\[ x_{ij}^1 = x_{ij}^2 = \cdots = X_{ij}/N_f, \]
where \( X_{ij} \) is the amount of total communication from a firm in \( i \) to firms in \( j \), that is
\[ X_{ij} = \sum_{n=1}^{N_f} x_{ij}^n. \quad (11) \]

Thus (10) is rewritten as
\[ V_i = \sum_j N_f v\left(\frac{X_{ij}}{N_f}\right). \quad (12) \]

It is assumed that the inputs for production of a firm are \( V_i \) and the labor for routine work, \( Z_i \). The production function is \( F(V_i, Z_i) \). Also, each firm occupies a certain area of office space, \( G \), which is assumed to be a given constant. The profit of a firm is defined by
\[ \pi_i = pF(V_i, Z_i) - wZ_i - r_iG - \sum_j X_{ij}TC_{ij}, \quad (13) \]

where \( p, w, \) and \( r_i \) are the prices of products, the wage rate, and the rent per unit floor space, respectively. Each firm chooses the level of communication \( X_{ij} \), the mode for communication, level of routine work \( Z_i \), and location \( i \), so as to maximize its profit. Recall that the choice of communication mode has been explained in 2.1.

The first order conditions are as follows
\[ \frac{\partial F}{\partial V_i} - \frac{\partial F}{\partial X_{ij}} - TC_{ij} = 0 \quad (14) \]
\[ p = w = 0. \quad (15) \]

To solve explicitly the conditions (14) and (15), we specify the form of the functions as follows
\[ v\left(\frac{X_{ij}}{N_f}\right) = \left(\frac{X_{ij}}{N_f}\right)^\sigma, \quad 0 < \sigma < 1 \quad (16) \]
\[ F(V_i, Z_i) = V_i^aZ_i^b, \quad a + b = 1, \quad a, b > 0. \quad (17) \]

Incorporating these specifications into (14) and (15), and by manipulation, we obtain the following solutions
\[ X_{ij}^* = \left(\frac{(\sigma a)p^{1/a}}{b}\right)^{1/(1-\sigma)} N_f TC_{ij}^{1/(\sigma-1)} \]
\[ Z_i^* = \left(\frac{(\sigma a)p^{1/a}}{b}\right)^{1/(\sigma-1)} (\sum_j N_f TC_{ij}^{\sigma/(\sigma-1)}). \quad (18) \]

### 2.3 Supply of office floor

Suppose that the office floor is constructed and supplied by the developers. We assume that there exist many developers in the city, and thus they behave as price takers. The developer's profit per unit land area is defined as
\[ \phi_i = r_i I_i - c I_i^\beta - \Omega_i, \quad (20) \]
where \( I_i \) is floor area ratio, \( \Omega_i \) is the land rent, and \( c, \beta \) are parameters. The first term of the RHS is the rent revenue, the second term is the construction cost and the last term is the payment of the land rent to the landowners.

The first order condition with respect to \( I_i \) is
\[ r_i - \beta c I_i^{\beta-1} = 0. \quad (21) \]
2.4 Spatial equilibrium of office location within a city

Here, we consider the equilibrium in which the total number of firms is fixed by $TN$. From the assumption of identical firms, all firms achieve the same profit level $\pi^*$, regardless of their location in a city. Then, if we denote an equilibrium distribution of firms by $(N_1^*, N_2^*, \cdots, N_T^*)$, the equilibrium conditions are written as

$$\pi_i = \pi^*, \quad \text{if} \quad N_i^* > 0$$

$$N_i^* = 0, \quad \text{if} \quad \pi_i \leq \pi^*.$$  \hspace{1cm} (22a)

$$N_i^* = 0, \quad \text{if} \quad \pi_i \leq \pi^*.$$  \hspace{1cm} (22b)

Note that $\pi_i$ in the above equations is the maximized profit with respect to $X_i$ and $Z_i$, which is obtained by putting Eqs. (18) and (19) into Eq. (13).

The next condition for equilibrium is that, at each $i$, the floor space occupied by office firms is equal to the supply of office floor

$$LA_i I_i = N_i^* G,$$  \hspace{1cm} (23)

where $LA_i$ is the land area used for office buildings in district $i$. And $LA_i$ cannot exceed the fixed land area in each district, $T_i$.

$$LA_i \leq T_i.$$  \hspace{1cm} (24)

Furthermore, from the assumption of perfect competition among developers, the profit of each developer must be zero.

$$r_i I_i - c I_i^D - \Omega_i = 0.$$  \hspace{1cm} (25)

Finally, since the total number of firms in the city is fixed at $TN$, the sum of the number of firms in each zone must be $TN$.

$$\sum_i N_i^* = TN.$$  \hspace{1cm} (26)

From (21) and (23), the equilibrium rent for office floor can be obtained by

$$r_i = \beta c (N_i^* G / LA_i)^{\gamma - 1}.$$  \hspace{1cm} (27)

3. Optimal location of office firms

3.1 Optimal location within a city

The definition of optimal location depends on the objective function. This paper considers the efficiency of resource allocation as the criterion. Since the household sector is neglected in our study, the objective of the city government is to maximize the net value of output in the city (the value of output net of payment for labor, communication cost and office construction cost).

$$Y = \sum_i N_i \{p F(V_i, Z_i) - w Z_i - \sum_j X_j T C_{ij} \} - \sum_i LA_i c I_i^D.$$  \hspace{1cm} (28)

It is shown that the net value of output defined above is equal to the sum of firms’ profits, developers’ profits and total land rent$^2$.

Maximizing $Y$ is subject to the following constraints

$$LA_i I_i = N_i G,$$  \hspace{1cm} (23)$'$

$$LA_i \leq T_i.$$  \hspace{1cm} (24)$'$

$^1$The assumption that the total number of firms, $TN$, is fixed is relaxed later, when optimal city sizes are discussed.

$^2$The total profit of office firms in a city is calculated by using eq. (13), as follows

$$Y_i = \sum_i N_i \{p F(V_i, Z_i) - w Z_i - r_i G - \sum_j X_j T C_{ij} \}.$$

Similarly, the total profit of developers is calculated by using eq. (20), as follows

$$Y_2 = \sum_i LA_i \{r_i I_i - c I_i^D - \Omega_i \}.$$

Total land rent in a city is

$$Y_3 = \sum_i LA_i \Omega_i.$$

It is easily shown that, incorporating the relation (23), $Y_1 + Y_2 + Y_3$ yields eq. (28).
\[ \sum_i N_i = TN \]  
\[ N_i \geq 0. \]  
\[ (26') \]  
\[ (29) \]

The Lagrange function is defined as
\[ L = Y + \sum_i \mu_i (LA_i - N_i(G)) + \sum_i \tau_i (T_i - LA_i) + \Gamma (TN - \sum_i N_i) + \sum_i \Theta_i N_i \]  
\[ (30) \]

where \( \mu_i, \tau_i, \Gamma \) and \( \Theta_i \) are respectively Lagrange multipliers associated with (23)', (24)', (26)' and (29).

The first order conditions with respect to \( X_{ui}, Z_i, I_i, LA_i \) and \( N_i \) are as follows
\[ \frac{\partial F}{\partial V_i} \frac{\partial V_i}{\partial X_{ui}} - TC_{ui} = 0 \]  
\[ (31) \]
\[ \frac{\partial F}{\partial Z_i} - w = 0 \]  
\[ (32) \]
\[ -\beta c l_i^{\rho - 1} + \mu_i = 0 \]  
\[ (33) \]
\[ \mu_i I_i - c l_i^\rho - \tau_i = 0 \]  
\[ (34) \]
\[ pF(V_i, Z_i) - wZ_i - \sum_j X_{ui} TC_{uj} + \sum_i N_i p \frac{\partial F}{\partial V_j} \frac{\partial V_j}{\partial N_i} - \Gamma - \mu_i G + \Theta_i = 0 \]  
\[ (35) \]
\[ \Theta_i N_i = 0, \]  
\[ (36) \]

and (23)', (24)', (26)', (29).

We compare the above conditions for optimal allocation with the conditions for market allocation in the previous section. (31) and (32) are equivalent to (14) and (15), respectively. This implies that optimal allocation of communication activity and routine work is attained when each firm chooses them so as to maximize individual profit. \( \mu_i \) can be interpreted as rent per unit floor space. Thus (33) is equivalent to (21). That is, optimal floor area ratio is attained by profit maximization of each developer. \( \tau_i \) can be interpreted as land rent per unit area. Thus (34) is equivalent to (25), stating zero-profit for each developer. (35) is the condition for the optimal distribution of office firms. Noting that the first three terms plus the sixth term on the LHS of (35) is equivalent to a firm’s profit, as defined in (13), and considering (36), we can rewrite (35) as
\[ \text{if } N_i > 0, \quad \pi_i + \delta_i = \Gamma \]  
\[ (37a) \]
\[ \text{if } N_i = 0, \quad \pi_i + \delta_i \leq \Gamma \]  
\[ (37b) \]

where
\[ \delta_i = \sum_j N_j p \frac{\partial F}{\partial V_j} \frac{\partial V_j}{\partial N_i}, \]  
\[ (38) \]

\( \delta_i \) is the sum of the changes in the productivity of all firms in the city caused by an increase in the number of firms in district \( i \). This is the externality effects of agglomeration: as the number of firms increases at a location, the productivity of nearby firms becomes greater (since, for instance, opportunity of communication is increased). Although a firm considers the benefits it obtains from the agglomeration, it does not take account of the benefits that the other firms obtain from its own location.

The condition (37) states that the sum of the profit of individual firms and the external effects is the same among all locations where firms are located. It is seen that the optimal condition (37) is different from the condition for market equilibrium (22). To attain the optimal location of firms in a competitive economy, it is necessary to subsidize each firm by the amount equal to the externality effects. Under this policy of subsidization, each firm has no incentive for relocation, since profit plus subsidy are the same in all locations, as in eq. (37).

3.2 Optimal location among cities: the optimal city size

Thus far, the total number of office firms in the city is fixed and given exogenously. Since we assume that the office sector is the only production activity in the city, the city size is equivalent to the total number of firms in a city, which is \( TN \) on the RHS of (26) in the model.

Suppose that there are many cities in an economy, and all cities are identical. We further assume that the total number of office firms in the economy is fixed and given exogenously. Thus the following relation holds
\[ TT = mTN, \]

where \( m \) and \( TT \) are the number of cities and the number of firms in the economy, respectively. The objective of the government is to maximize the net value of output in the whole economy, i.e. \( m \ Y \). This is equivalent to maximizing the net value of output per firms in each city. The problem to be solved is
Maximize \( Y/TN \), with respect to \( X_{ij}, Z_i, I_i, LA_i, N_i \) and \( TN \), subject to (23)', (24)', (26)' and (29)
where \( Y \) is defined by (28). Note that \( TN \) is now a variable.

By applying the same procedure as in the previous section, we obtain the same conditions as (31) to (37). Furthermore, the optimal condition with respect to city size, \( TN \), is reduced to

\[
\sum_i N_i \delta_i = \sum_i LA_i \tau_i,
\]

where the LHS is the sum of subsidies to achieve optimal location of firms in a city and the RHS is the sum of land rent in a city. The above condition states that the expenditure for subsidies is just covered by the revenue from the 100% tax on land rent. This is a version of the Henry-George theorem, which is obtained as the condition for optimal city size in various contexts, such as local public goods, external economies, etc. (see, for example, Arnott (1979), Wildasin (1986), Kanemoto (1990)).

4. Properties of optimal location and the impacts of telecommunication technologies

In this section, numerical simulations are performed to examine the properties of the optimal solutions, and compare them with the equilibrium solutions. Then the impacts of telecommunication technologies are investigated.

In numerical analyses, the city is divided into 49 zones, as shown in Figure 1. Each district is a square with sides of unit length. Parameter values were set arbitrarily, as listed in Table 1.

Spatial distribution of office firms for optimal and equilibrium cases is shown in Figure 2'. This shows that the shapes of the distribution are similar in both cases: density of firms is highest in the central zone, and decreases with distance from the center. Optimum distribution is more concentrated than at equilibrium. In other words, the agglomeration in central locations is too small in a market equilibrium. This is because each firm does not take account of the agglomeration benefits of other firms caused by its own location. The above result suggests that policies to promote agglomerations of firms are necessary to attain the optimal distribution as a market equilibrium.

One policy to correct the market failure shown above is location-dependent subsidies to firms that are calculated by (38). Figure 3 depicts the spatial variation of the subsidies. It is seen that the amount of the subsidies is the highest at the central zone and decreases with distance from the center. This implies that the externality effect of new entry is the largest at the central location.

Let us turn to the analysis on the impacts of telecommunication technologies. Figure 4 shows optimal distribution of office firms for two values of telecommunication cost, \( f \). It is seen that the distribution is more dispersed.

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3Professor Komei Sasaki, the editor of this journal, raised a question on the definition of the objective function in this section. His argument is summarized as follows:
Since there are three groups in our model, changes in city size may make some groups worse off but other groups better off. Let us denote the city size maximizing the objective function by \( TN^* \). Prof. Sasaki argued that, for \( TN^* \) to be truly optimal, even if some groups lose by changing the city size to \( TN^* \), the sum of gains of other agents must exceed the sum of loss. In such case, hypothetical compensations can make all groups better off.

Since \( TN^* \) maximizes \( Y/TN \), the following relation holds between \( TN^* \) and any city size \( TN \neq TN^* \):

\[
\frac{Y^*}{TN^*} > \frac{Y}{TN}
\]  

(a)

where \( Y^* \) is the net value of output when city size is \( TN^* \). Recall that the total number of firms in the economy is fixed, i.e. \( mTN = mTN^* = TT \). Then the relation (a) can be rewritten as \( m^*Y^* > mY \). This inequality is expanded, in view of footnote 1, as follows

\[
[m^* \sum_i N_i \pi^*_i - m \sum_i N_i \pi_i] + [m^* \sum_i LA_i \phi^*_i - m \sum_i LA_i \phi_i] + [m^* \sum_i LA_i \Omega^*_i - m \sum_i LA_i \Omega_i] > 0
\]

(b)

where \( \pi^*_i, \phi^*_i \) and \( \Omega^*_i \) are, respectively, the profit of a firm, the profit of a developer and land rent per unit of land area, when city size is \( TN^* \). The LHS of (b) is changes in the sum of the profit of firms plus the profit of developers plus land rent, for all cities in the economy. The inequality (b) shows that the sum of gains exceed the sum of loss.

3(39) was derived as follows. The first order condition with respect to \( TN \) is

\[
\frac{Y}{TN^3} + \Gamma = 0.
\]

If we multiply both sides of the above equation by \( N_i \) and sum over all zones, we obtain (39).

In Figure 2, the horizontal axis shows the coordinate where the origin is set at the center of city. Note that the absolute values of the coordinate shown on the horizontal axis indicate the distance from the center. The vertical axis shows the number of firms on line a-a in Figure 1.
Location of Office

Fig. 1 A hypothetical city for numerical analysis.

Fig. 2 Optimal and equilibrium distributions of office firms.

Table 1. Parameter values for numerical analysis.

<table>
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<th>Parameter</th>
<th>Value</th>
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Fig. 3  Amount of subsidy by location.

Fig. 4  Telecommunication costs and the optimal distribution of firms.
when telecommunication cost is lower. By decreasing telecommunication cost, it becomes possible for firms to keep extensive communication between distant locations. This leads to a decrease in the demand for central locations, where the accessibility is the highest.

We will now examine the effects of telecommunication cost on the difference between the optimal and equilibrium solutions. In Figure 5, the net values of output for the optimal and equilibrium cases are plotted against various values of telecommunication costs. It is seen that in both cases the net values of output for both cases increase at increasing rate as the telecommunication cost decreases. Furthermore, the difference between the optimal and equilibrium cases decreases as the telecommunication cost decreases.

Thus far, the total number of office firms in the city is fixed and given exogenously. Figure 6(a) depicts the locus of the net values of output per firm, obtained by solving the maximization problem (28)–(29) for various values of $TN$, where $f$ is fixed at 1.0. The optimal city size has been defined as that maximizing the net value of output per firm. In Figure 6(a), the optimal city size is determined by point $O$.

On the other hand, Figure 6(b) depicts the locus of the equilibrium profit that is obtained by solving (22)–(27) for various values of $TN$. At the equilibrium city size, the profit level must be equal among all cities. In the market system, it is difficult to change the number of cities as in the optimal case. This is because coalitions by a large number of firms to form a new city are impractical. As argued by Kanemoto (1980), we can only say that the equilibrium city size must be greater than $TN^A$ in the figure, where the profit level attains its maximum (see Kanemoto (1980), pp. 64–65). The equilibrium city size can take any values greater than $TN^A$, which may be greater or smaller than the optimal city size. In Figure 7, two loci are drawn for different levels of telecommunication costs. If telecommunication cost, $f$, is lower, the locus of the net values of output per firm shifts upward and the optimal city size is expanded from $TN^o$ to $TN'^o$. This implies that firms will be concentrated in fewer cities when telecommunication cost is reduced. This result is in contrast to that presented previously in Figure 4, that the distribution of firms in a city is more dispersed when telecommunication cost is lower: more concentration in inter-city level and more decentralization in intra-city level.

5. Conclusion

Recognizing that the developments of telecommunication technologies have great impacts on economic activi-

![Graph](image)

Fig. 5 Telecommunication costs and net values of output for optimal and equilibrium location.
ties and the spatial structure of cities, policy makers and planners have to understand the way in which changes occur. Then the next step is to find the policy means to achieve the desirable state of cities that policy-makers want to achieve. The optimal location argued in this paper is based on efficient resource allocation, which is one alternative of the desirable state.

This paper presents the conditions for optimal location of office firms, and shows that the decentralized market system fails to achieve optimal location due to the external economies of agglomeration. The formula to compute the amount of subsidy is shown, which is necessary to achieve optimal location in the decentralized market system. The properties of the optimal location and the impacts of telecommunication technologies are investigated by means of numerical analysis. The results are summarized as follows:

1. The optimal distribution in a city is more concentrated than for an equilibrium distribution.
2. The optimal distribution in a city is decentralized by the decreasing telecommunication cost.
3. When city size is fixed, the lower the telecommunication cost, the smaller the difference between the optimal and equilibrium distributions.
4. The optimal city size becomes larger as the telecommunication cost is decreased.

The results here are obtained under a restrictive setting: for instance, the household sector and types of firms other than offices are neglected; negative externalities of agglomeration, such as congestion, are also neglected,
etc. Therefore, the results obtained in this paper are not immediately applicable to practical policy making. Nevertheless, simple model is still useful to illuminate the fundamental forces behind the problem to be solved.

Acknowledgements

I would like to thank the editor and two anonymous referees of this journal for useful comments on an earlier version.

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