The Dynamic Impacts of Employment Subcenters on Residential Land Price in Transitional China: An Examination of the Beijing Metropolitan Area

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Abstract: In recent decades, the emergence of “employment subcenters” and “polycentricity” has revealed that urban spatial structures are undergoing great changes throughout the world [1]. In China, studies have shown that many mega cities or big cities have been transformed into polycentric spatial structures. However, polycentric spatial structures’ impact on urban development requires further empirical research, including in relation to land price, commuting, and population distribution. Taking Beijing as an example, this paper discusses employment subcenters’ rise and evolution on residential land prices. Using the land transaction data for 2001–2013, this paper analyzes the residential market characteristics in terms of their temporal and spatial variation and studies the impact of employment subcenters on residential land prices using a Hedonic model of Beijing city for 2001–2004, 2005–2008, and 2009–2013. This paper finds that (1) Beijing’s employment subcenters increased from one in 2001 to four in 2004 and six in 2008, while the spatial distribution was diffused from the center of the city to the suburbs; (2) Beijing’s main center’s influence on residential land price is on the decline, while that of employment subcenters is on the rise, although their influence and scope of influence remain limited; (3) the impact of different employment subcenters on land prices is significantly different. The impact of Zhongguancun is very significant, while that of other employment sub-centers is relatively limited, particularly the “new town” employment subcenter. Based on this, this paper argues that with the development of subcenters of employment, their influence on urban development will become increasingly obvious. Therefore, urban policy-makers need to consider this influence and make corresponding strategic adjustments.

Keywords: employment subcenter; residential land price; Hedonic model; influence; Beijing

1. Introduction

In recent decades, the emergence of “employment subcenters” and “polycentricity” has revealed that urban spatial structures are undergoing great changes throughout the world [1]. Some studies have found that employment subcenters can not only lead to an increased population density and
property price near the subcenter, but also offer firms some of the benefits of an agglomeration economy, while reducing commuting costs, wages, and land prices [2]. The polycentric form is also thought to combine many of the advantages of large and small urban areas [2]. Additionally, polycentricity is still considered to be of benefit to the environmental sustainability and social cohesion of urban development [3]. Previous studies have explored the dispersal pattern in some large Western metropolises [4–6]. In contrast, the urban spatial form in developing countries has only shifted from monocentric to polycentric, and most of the literature focuses on the identification of employment subcenters [7–10]. But what is the effect of employment subcenters in developing country metropolises? The spatial structure of China’s cities has undergone dramatic and fundamental change owing to the redevelopment of old towns and their rapid expansion since the economic reform of the late 1970s [7, 11, 12]. During the planning economics, the form of Chinese cities was typically very compact, featuring a mixed pattern of residential and non-residential land uses. The land supply in cities is based on administrative allocation systems, not on competitive land markets, which lead to inefficient land use [13]. In order to improve land use efficiency, the land market was introduced by the Chinese government from Western countries, and the land supply in cities first through negotiation and later through competitive auctions [12, 14]. The old industrial use and old homes in urban central areas have been demolished to make way for new transport infrastructure, commercial developments, and high-end housing projects, leading to the formation and expansion of the central business district (CBD) [12, 15]. As a result, an employment center has emerged in the urban core. Since the second half of the 1990s, in order to alleviate the increasingly serious urban diseases, a polycentric spatial arrangement has been applied in urban plans and development, including industrial development zones, satellite towns, and new towns, leading to emerging employment subcenters in the suburbs [7, 16]. As a result, China’s urban landscape and formation have been fundamentally reshaped and restructured, to form some of the world’s most vibrant cities [11].

The purpose of research on urban spatial structure is to solve problems in urban development. Beijing, the capital city, is a typical case of China’s urbanization. Urban sustainable development was beset by numerous problems, including traffic congestion, air pollution, soaring land prices, and a lack of affordable housing due to the over-aggregation of population and economic activity in the city center [17]. In order to solve these problems, the government of Beijing has formulated many planning policies since the early 1990s to promote its transformation into a polycentric structure [7]. The consequent emergence of employment subcenters during the past decades has fundamentally reshaped and restructured the urban spatial structure of Beijing [7, 17–19]. While some studies have examined the effect of employment subcenters on population distribution [7, 18], a number of problems remain for investigation. First, can employment subcenters affect the surrounding area and even the residential land price of the whole city? Second, can the main center continue to influence residential price? The purpose of this paper is to address these empirical questions, using residential land price variations and a Hedonic model to examine the impact of the emerging employment subcenters on residential land values. It is hoped that the results gleaned will be useful for urban planning and management in the future.

This article’s contribution to the literature is to examine the applicability of urban spatial structure theories in transferring China, which differs from Western countries in terms of its institutions and policies. The structure of this paper is as follows: Section 2 comprises the literature review. Section 3 describes the study area, data, and methods used. Section 4 comprises an analysis of the temporal and spatial variation characteristics of the residential land market in Beijing. Section 5 provides analysis of the evolution of employment subcenters in Beijing. Section 6 uses the Hedonic model to study the influence of employment subcenters on residential land price. Finally, Section 7 comprises the conclusion and discussion.
2. Literature Review

In recent decades, increased attention has been paid to the analysis of polycentric urban development [1,4,20,21]. Many Metropolitan Areas (MAs) are characterized by their polycentric urban spatial structure [2,20,22,23], which is increasingly different from the archetype of the monocentric city [24–26]. The urban form not only affects the sustainability and social cohesion of the urban environment, but also plays a role in people’s lives [1,22]. Polycentricity is usually considered to combine many of the advantages of large and small cities, in that employment subcenters help explain surrounding patterns of employment density, population density, and land values [27–29]. Therefore, polycentricity is considered a desirable urban spatial structure, which not only produces greater agglomeration externalities, but also facilitates the achievement of social, economic, and environmental goals [3,30]. Polycentricity development is deemed a desirable territorial development policy in the European Union and the United States [21]. However, some empirical studies indicate that polycentricity can lead to heavier public investment and longer commuting distances [31,32]. As a result, the impacts of polycentric spatial structure on urban development remains an empirically underconfirmed topic [20].

The spatial structure of China’s cities has undergone profound change owing to their rapid development since the economic reform of the late 1970s. There are many factors influencing the transformation of urban spatial structure in China. The primary force is the establishment of the land market. Land use began to be guided by market force rather than administrative allocation. The land market has, on the one hand, forced industries to move to the suburbs, which has given rise to the development of the suburbs; on the other hand, land leasing has become local governments’ primary revenue source [33,34]. This has promoted suburbanization and urban sprawl, which creates the condition for the emergence of subcenters [35,36]. The second force is urban planning. The spatial development strategy of urban planning is to build a polycentric spatial pattern. Among the instruments used to achieve this, economic development zones, new town development, and university towns, which are actually the prototype of subcenters, are most often used [37,38]. The third force is the agglomeration of diseconomies. The agglomeration of economic activities in the city center has brought about a series of city diseases, which force the decentralization of economic activities. The fourth force is the construction of infrastructure in the suburbs [39,40]. This process has improved the attraction of the suburbs, contributed to the relocation of economic activities, and thereby altered the monocentric urban form.

Many studies have examined the formation of the polycentric pattern in China’s cities. These studies have mainly been conducted from three perspectives. The first perspective is population distribution, with most studies arguing that population suburbanization and polycentrism have been observed in many large cities [39–41]. The effect of employment subcenters on population distribution was empirically verified in Beijing [7]. The second perspective is employment distribution, with many studies confirming the emergence of employment subcenters [18,19,42]. The third perspective is land price, with most existing studies reflecting consensus on the effect of distance from the CBD in Beijing [11,12,43,44], while a few also show multiple urban centers to explain more of the variations in land and housing prices [15,36]. However, the effect of employment subcenters on land value remains an understudied topic. In fact, accessibility to the CBD is the major determinant of location-specific land values and site rents in the monocentric model [28], which is the starting point of Alson’s theories [1,24,28].

3. Research Area, Data, and Methods

3.1. Research Area

The selection of the research area comprises the whole area within the 10 km buffer zone outside the six rings of Beijing (Figure 1), including the main urban area of Beijing and the “New Town” area defined by urban planning in 2004.
Figure 1. Research area.

We selected this research area based on several considerations: (1) most of the area comprises a plain area, and the influence of topography on the distribution of the residential land can thus be avoided. (2) The total employment rate in the research region is approximately 70–80% of the whole city of Beijing (Huang et al. use the data of enterprises and institutions registered in Beijing in 2010, and calculated the number of enterprises and enterprises in the study area, accounting for 76.4% of the whole city of Beijing [7]). (3) The leased residential land parcels of the research region also accounted for more than 80% of Beijing as a whole (Table 1). (4) In view of the extent of the subway system, and assumptions about the commuting range of private cars, this area represents a reasonable commuting scope and can be regarded as an integrated labor market. Indeed, according to bus-pass data, the majority of transportation flow occurs within this area [45].

Table 1. The share of residential land parcel in the research area proportionate to Beijing (%).

| Period     | Number of Residential Land Parcels | Area of Residential Land Parcels |
|------------|-----------------------------------|----------------------------------|
| 2001–2004  | 76.93                             | 70.03                            |
| 2005–2008  | 81.60                             | 73.58                            |
| 2009–2013  | 83.55                             | 78.95                            |

3.2. Research Data

We employed the official land transaction data set (2001–2013) provided by the Beijing Land Resources Bureau website. This data set contains the address, size, transaction price, floor area rate, usage (residential, commercial, industrial, and mixed-use), transaction approach (negotiation, competitive auction) [12], and degree of land development of land parcels in Beijing (the land development has or not the capacity of supplying traffic, electricity, water, communication and drainage and land leveling, which means complete basic facilities and fine investment environment).
We also calculated the distance from each land parcel to Beijing’s urban center, Tiananmen, as well as to the employment subcenters, subway sites, parks, primary schools, or middle schools. Finally, we calculated the average unit price of each land parcel as follows (In China, land price is calculated in two ways: One is the land price, the land price per unit area; the other is the floor price, the land price per unit of construction planning area. Since the object of the study is the land itself, and the paper is to accurately analyze the changes in land-related factors, the paper uses the land price per unit area to indicate the land price):

\[
\text{Average unit price} = \frac{\text{land transaction price}}{\text{parcel area}}
\]

3.3. Methods

3.3.1. Determination of Employment Subcenters

A number of studies have been conducted on the identification of employment subcenters in Beijing [7,17–19,42]. In order to avoid the limitations and drawbacks of different methods, we used the literature to determine the employment subcenters in Beijing, and set a certain standard and principle: (1) the employment subcenters identified in the references cited should meet the period required for this article: that is, the years 2001, 2004, and 2008; (2) The employment subcenters identified should accord with people’s experience, cognition, and most scholars’ approval; (3) The employment subcenters identified should combine the density map of employment distribution in Beijing.

3.3.2. The Hedonic Model

The Hedonic model refers to the method of regressing the price of differentiated goods on quantities of characteristics associated with each good. The coefficients obtained from such a regression are called hedonic prices and are interpreted as the shadow prices of these characteristics. Land and housing markets are a typical field of application for such models, because a land or house is a bundle of utility-generating attributes rather than a single-attribute commodity [28,46–48]. Therefore, the Hedonic model has been applied in a large number of studies on the determinants of residential property or land values, where land prices are regarded as a (possibly nonlinear) function of each characteristic of the land parcels [11,28,36,46]. These characteristics include the structural attributes, neighborhood attributes, and location attributes of land parcels.

**Structural attributes.** These attributes include the area of each land parcel, permitted floor area, transaction approach, whether the land parcel is for mixed use, and the degree of land development. (1) Area of land parcel: Usually, the larger the land parcel, the lower the land price. (2) Floor area rate: The greater the distance from the center of the city, the smaller the permitted floor area will be. (3) Transaction approach: In this paper, the data of 2001–2004 showed that the vast majority of residential land parcels were transferred by negotiation, while in 2005–2013, most land was transferred by competitive auction. Therefore, we did not set the land transaction approach variable in 2001–2004. In the periods 2005–2008 and 2009–2013, two transaction approaches for residential land, negotiation and competitive auction, were present; thus, we only set the variable for whether the land was transferred by auction. Generally, the price of land is higher when it is sold by auction. (4) Whether the residential land is mixed-use: Generally, mixed land is more expensive. (5) The degree of development of the land: Whether the land is above the “five links and one leveling” is used as a dummy variable to indicate the degree of land development. The higher the degree of land development, the higher the price.

**Neighborhood attributes.** The neighborhood factors of land refer to the neighborhood environment of the residential land, including (1) the Euclidean distance from the parcel to the nearest subway station. The rapid development of subway transportation in Beijing may have influenced land price. We calculate the distance from the parcel to the subway station according to the opening time of the subway in Beijing (Table 2). (2) The Euclidean distance from the parcel to the nearest
park. (3) The Euclidean distance from the parcel to the nearest key primary or secondary school. There are many schools in Beijing, the quality of which obviously differ. Thus, parents attach great importance to their choice of school-district housing.

Table 2. Opening date of subway lines in Beijing (2001–2013).

| Residential Land Transaction Period | Corresponding Subway Opening Date | Corresponding Subway Lines Opened |
|------------------------------------|----------------------------------|----------------------------------|
| 2001, 2002                         | Before 2001                      | Lines 1 and 2                    |
| 2003—2006                         | 2003                             | Line 13 and Batong Line          |
| 2007                               | 2007                             | Line 5                           |
| 2008                               | 2008                             | Line 8 (Beitucheng—South Gate of Forest Park) Phase one of Line 10 Airport line |
| 2009                               | 2009                             | Line 4                           |
| 2010                               | 2010                             | Changping line, Daxing line, Fangshan line, Yizhuang line Line 10 (Wangjing west station to Sha Yu station) |
| 2011                               | 2011                             | Line 8 (Beitucheng—Huilongguan East Street) Line 9 (Guogongzhuang—Beijing West Railway Station) |
| 2012                               | 2012                             | Line 8 (Gulou Street-Beitucheng) Line 9: the whole line opening |
| 2013                               | 2013                             | Line 8: the whole line opening Line 10: the whole line opening |

Location attributes. This includes (1) distance to Beijing’s urban center. The distance from Tiananmen increased at three stages from 12.22 km to 20.15 km, and then to 21.90 km, which shows that the residential land market has a gradual diffusion trend from Tiananmen to the suburbs. The maximum values of the distance to Tiananmen at the three stages comprised 38.18 km, 43.42 km, and 46.08 km, which shows that the scope of the impact of Tiananmen is gradually expanding, and the boundaries of the city are gradually expanding outward. (2) Distance to the employment subcenter. The mean distances to the nearest subcenter at the three stages were 8.41 km, 15.92 km, and 12.79 km, showing that the distances first increased and later decreased. This reflects the fact that people first choose employment in the city center, and then gradually choose the employment subcenters.

Four models are established at different stages:

Model 1: Only consider the distance from each land parcel to Tiananmen (Monocentric city model).
Model 2: Consider the distance from each land parcel to the nearest employment subcenter (Polycentric city model).
Model 3: Consider the distance from each land parcel to each employment subcenter (Polycentric city model).
Model 4: Consider the limited impact of the employment subcenters, which is improved in model 3 by establishing a virtual variable, “whether the distance from the employment subcenters is within 10 km.”

① Models 1, 2, and 3 are as follows:

\[
\ln(Price_i) = \beta_0 + \beta_1 \ln X_{1,i} + \beta_2 \ln X_{2,i} + \beta_3 \ln X_{3,i} + \epsilon_i \tag{1}
\]

② Model 4 is as follows:

\[
\ln(Price_i) = \beta_0 + \beta_1 \ln X_{1,i} + \beta_2 \ln X_{2,i} + \beta_3 X_{3,i} + \epsilon_i \tag{2}
\]

\(Price_i\) is the land price of the residential land parcel, \(X_{1,i}\) reflects the land’s structural attributes, \(X_{2,i}\) reflects the land’s neighborhood attributes, \(X_{3,i}\) reflects the land’s location attributes, \(\beta_0\) is the constant,
\(\beta_1, \beta_2, \beta_3\) are the coefficient of factors, \(\epsilon_i\) is the error term, and \(X_{3,i}\) reflects the virtual variables representing locational factors.

We calculate the quantitative values of the independent and dependent variables. The following is the definition of the variables in the Hedonic model (Tables 3–6).

Table 3. Variable definitions.

| Dependent Variable Express Type Description |
|--------------------------------------------|----------------------------------|
| Unit price of residential land Price Successive Ratio of land transaction price to parcel land area |

| Variable Classification Independent Variable Variable Type Description |
|-------------------------------|-----------------------------|----------------------|
| Constant Constant |
| X1 Parcel area SIZE successive Area size of parcels |
| floor area ratio FAR successive Plot ratio of the parcel |
| The auction approach AUC dummy The auction is for auction |
| Mixed-use MIXED dummy Mix commercial facilities or public construction facilities |
| The degree of land development FIV-DEV dummy Above five links and one leveling |
| X2 Distance to the nearest subway station \(D_{subway}\) successive Shortest distance from the parcel to the nearest subway station |
| Distance to the nearest park \(D_{park}\) successive Comprehensive parks and exclusive parks with green spaces |
| Distance to the nearest key primary or secondary school \(D_{school}\) successive Public key primary or secondary schools |
| X3 Distance to Tiananmen \(D_{TAM}\) successive Shortest distance between the parcel and Tiananmen |
| Distance to employment subcenter \(D_{sub}\) successive Straight-line distance between the parcel and the nearest employment subcenter |
| X3' Distance to employment subcenter is less than 10 km \(D_{sub10\ km}\) dummy The parcel is within the range of 10 km of the employment subcenter |

Table 4. The descriptive statistics of variables in 2001–2004.

| N | Express | Unit | Average | Standard Deviation | Minimum Value | Maximum Value |
|---|---------|------|---------|--------------------|---------------|---------------|
| 1694 | Price | yuan/m² | 1040.22 | 4777.24 | 200.74 | 65,774.65 |

| N | Express | Unit | Average | Standard Deviation | Minimum Value | Maximum Value |
|---|---------|------|---------|--------------------|---------------|---------------|
| 1694 | SIZE | m² | 26,642.63 | 49,074.05 | 54.00 | 657,487.00 |
| 1694 | FAR | —— | 3.73 | 2.52 | 0.19 | 19.00 |
| 1694 | AUC | —— | —— | —— | —— | —— |
| 1694 | MIXED | —— | —— | —— | —— | —— |
| 1694 | FIV-DEV | —— | —— | —— | —— | —— |

| X2 | \(D_{subway}\) | km | 4.60 | 4.18 | 0.02 | 30.38 |
| 1694 | \(D_{park}\) | km | 5.11 | 4.70 | 0.01 | 26.21 |
| 1694 | \(D_{school}\) | km | 3.21 | 3.57 | 0.02 | 23.60 |

| X3 | \(D_{TAM}\) | km | 12.22 | 6.34 | 1.09 | 38.18 |
| 1694 | \(D_{sub}\) | km | 8.41 | 5.47 | 0.46 | 33.77 |

| X3' | \(D_{sub10\ km}\) | —— | —— | —— | —— | —— |
4. Temporal and Spatial Variation Characteristics of the Residential Land Market

4.1. Temporal Variation Characteristics of Residential Land Market

The development of the residential land market can be divided into three stages since 2000 in Beijing, marked by specific patterns of urban land market development. Each stage is now discussed in some detail (Figure 2).

Early-transforming stage (2001–2004). The average unit price of residential land in this phase is 1040 yuan/m$^2$. Land supply is more abundant, the demand for land is brisk, most land parcels are sold by negotiation, and the average unit price is lower. This is the initial stage of land transaction toward marketization.

Slowly developing stage (2005–2008). The average unit price rose to 7090 yuan/m$^2$ at this stage. Since 31 August 2004, the government has tightened residential land supply in Beijing, and gradually improved the mechanism of the real estate market [49]. As a result, the land transaction size has greatly reduced and the land price is rising year by year.

Fast-rising stage (2009–2013). The average unit price rose to 15,200 yuan/m$^2$ at this stage. To some extent, the 2008 Beijing Olympic Games contributed to the development of Beijing’s residential land trading market. Furthermore, the government of China implemented a stimulus economics policy of a 4 trillion investment to deal with the problems of the Global Financial Crisis in 2008, with much
government stimulus economics investment into industrial real estate [50]. As a result, the real estate price and land price rose rapidly.

![Figure 2. Residential land transactions in the research area.](image)

According to the residential land price change, as well as considering that most scholars choose economic census data from 2001, 2004, and 2008 to study the employment subcenters of Beijing, the study period was divided into three stages: the early-transforming stage (2001–2004), the slowly-developing stage (2005–2008), and the fast-rising stage (2009–2013). We calculated the size and average unit price of residential land in these three stages (Table 7).

| Period          | 2001–2004 | 2005–2008 | 2009–2013 |
|-----------------|-----------|-----------|-----------|
| Total number of parcels (blocks) | 1694 | 164 | 259 |
| Parcel total area (km²) | 44.9 | 15.6 | 21 |
| Planning gross floor area (km²) | 106.1 | 29.5 | 40.9 |
| Total transaction price (100 million yuan) | 467 | 1095 | 3192 |
| Average unit price (yuan/m²) | 1040 | 7090 | 15,200 |

4.2. The Spatial Variation Characteristics of Residential Land Market

We used the GIS spatial analysis tool to make the Kriging interpolation map for the unit price of residential land. The result shows that the price inside is higher than the price outside and the north is priced higher than the south. The distribution of land price is obvious in the circle structure and changes with time. As time goes on, the circle structure of land price weakened in three stages, the distribution of land price became more scattered, and the influence of Tiananmen as the center of the city was dismissed (Figure 3).

In the early-transforming stage (2001–2004), the land price’s circle structure was most obvious. The farther away from Tiananmen, the lower the land price. The highest land price was around the center of the city, mainly concentrated in the city center, and the land price in new town was lower.

In the slowly developing stage (2005–2008), the circle structure weakened. The highest land price was also near the center of the city, especially the northeast between the second ring and the tricyclic, but in the surrounding areas the land price increased; for example, Tongzhou also has a high land price distribution.

In the fast-rising stage (2009–2013), the distribution of land price was more dispersed and the high land price in the city outside the region had a greater distribution: for example, Changping and Mentougou.
Figure 3. Cont.
5. Determination of Employment Subcenters

5.1. Selection of Potential Employment Subcenters

We identified the potential employment subcenters using the literature (Table 8), and applied the following rules: (1) Employment subcenters in close proximity to each other were amalgamated into one. For example, Haidian Street and Shangdi Street are close to Zhongguancun, so the two were united as Zhongguancun Street. (2) The employment subcenters with the same location but different names were amalgamated into one. (3) The areas that were selected more were regarded as potential employment subcenters. The areas selected more as the alternative “2001 employment subcenters” are CBD and Zhongguancun. The areas selected more as the alternative “2004 employment subcenters” are CBD, Zhongguancun, Olympic Park, Tongzhou New Town, and Shunyi New Town. The areas selected more as alternative “2008 employment subcenters” are CBD, Financial Street, Zhongguancun, Olympic Park, Changping New Town, Shunyi New Town, Tongzhou New Town, and Fangshan New Town.

We did not take Financial Street and CBD into account when determining the employment subcenters, for the following reasons: (1) The development of Beijing differs from that of foreign cities. In foreign cities, there is a CBD with the highest employment density and many employment congregates, while in Beijing, Tiananmen Square, as a symbol of the city center, is not the real employment center [17]. (2) Within the 10 km radius of Tiananmen, there are mainly old towns and ancient buildings, and this area comprises only 6.8% (300 km$^2$) of the study area [17], which can be seen as a point. (3) The east and west sides of Tiananmen Square are Financial Street and CBD, which are all within the 10 km radius. The collinearity test showed a collinearity problem among the logarithms of the distances from parcel of land to Tiananmen, CBD, and the Financial Street (Table 9). Therefore, this paper did not take the Financial Street or CBD into account.
Table 8. Potential employment subcenters obtained using the literature.

| Year | Employment Sub-Centers       | Scholars                                      | Number of Studies |
|------|------------------------------|-----------------------------------------------|-------------------|
| 2001 | CBD                          | GuYizhen [51], Qin Bo [15], ZouYonghua [36]   | 3                 |
|      | Financial Street             | Null                                           | 0                 |
|      | Zhongguancun (including      | GuYizhen [51], Qin Bo [15], ZouYonghua [36], Wang Wei [52] | 4                 |
|      | Haidian Street and Shangdi   | Street                                        |                   |
|      | Olympic Park                 | Qin Bo [15]                                    | 1                 |
| 2004 | CBD                          | GuYizhen [51], Wang Wei [52], Zhou Haiyan [53], Xiao Yizhuo [54], ZouYonghua [36], Qin Bo [15] | 6                 |
|      | Financial Street             | Xiao Yizhuo [54], Wang Wei [52]               | 2                 |
|      | Zhongguancun                 | GuYizhen [51], Sun Tieshan [18], Wang Wei [52], Zhou Haiyan [53], LvYongqiang [55], Xiao Yizhuo [54], ZouYonghua [36], Qin Bo [15] | 8                 |
|      | Olympic Park                 | ZouYonghua [36], Qin Bo [15], LvYongqiang [55] | 3                 |
|      | GuCheng Street in Shijingshan | GuYizhen [51], Sun Tieshan [18]               | 2                 |
|      | Tongzhou New Town (Xinhua  | GuYizhen [51], Sun Tieshan [18], Wang Wei [52], LvYongqiang [55] | 4                 |
|      | Street)                      |                                               |                   |
|      | Shunyi New Town (Capital     | GuYizhen [51], Sun Tieshan [18], Wang Wei [55], ZouYonghua [36], LvYongqiang [55] | 5                 |
|      | Airport)                     |                                               |                   |
|      | Fangshan New Town            | Sun Tieshan [18]                              | 1                 |
|      | Yihuang, Da Xing District    | Wang Wei [52]                                  | 1                 |
| 2008 | CBD                          | Liu Xiaoquan [42], LvYongqiang [55], Yu Huili [54] | 3                 |
|      | Financial Street             | Liu Xiaoquan [42], Yu Huili [56]              | 2                 |
|      | Zhongguancun                 | Liu Xiaoquan [42], Sun Tieshan [18], Zhou Haiyan [53], Huang Daquan [17], LvYongqiang [55], Yu Huili [56] | 6                 |
|      | Olympic Park                 | Liu Xiaoquan [42], LvYongqiang [55], Yu Huili [56] | 3                 |
|      | Jiuxiangqiao                | Liu Xiaoquan [42], Zhou Haiyan [53]           | 2                 |
|      | Changping New Town           | Liu Xiaoquan [42], Huang Daquan [17], LvYongqiang [55] | 3                 |
|      | Shunyi New Town              | Liu Xiaoquan [42], Sun Tieshan [18], Huang Daquan [17], LvYongqiang [55] | 4                 |
|      | Tongzhou New Town            | Huang Daquan [17], Sun Tieshan [18], LvYongqiang [55] | 3                 |
|      | Yizhuang                     | Liu Xiaoquan [42], Yu Huili [56]              | 2                 |
|      | Gucheng Street               | Liu Xiaoquan [42], LvYongqiang [55]           | 2                 |
|      | Fangshan New Town            | Liu Xiaoquan [42], Sun Tieshan [18], Huang Daquan [17], LvYongqiang [55] | 4                 |

Table 9. Results of the collinearity test.

| Model 1 | Collinearity Statistics | Model 2 | Collinearity Statistics |
|---------|-------------------------|---------|-------------------------|
|         | Tolerance | VIF   | Tolerance | VIF  |
| \( \ln D_{\text{TAM}} / \ln D_{\text{JRJ}} \) | 0.061 | 16.393 | 0.073 | 13.699 |

Dependent variable: Logarithm of land unit price; Note: \( D_{\text{JRJ}} \) is the distance to the Jinrong Street and VIF is Variance Inflection Factor.
5.2. The Identified Employment Subcenters

The identified employment subcenter in 2001 was Zhongguancun. Zhongguancun is one of the most densely populated areas of science, education, and human resources in China. The identified employment subcenters in 2004 were Zhongguancun, Olympic Park, Tongzhou New Town, and Shunyi New Town. Olympic Park is a comprehensive public activity center including sports events, exhibition centers, science and culture, leisure, shopping, and many other functions. The identified employment subcenters in 2008 were Zhongguancun, Olympic Park, Tongzhou New Town, Fangshan New Town, Changping New Town, and Shunyi New Town. All identified employment subcenters were drawn on the map (Figure 4): The map shows the change in the number of employment subcenters from one in 2001 to four in 2004 and six in 2008. It also shows the trend whereby employment subcenters spread from the urban center to the urban suburbs.

![Figure 4. Cont.](image-url)
Figure 4. Distribution chart of employment subcenters in three different time periods.
6. The Impact of the Evolution of the Employment Subcenters on the Price of Residential Land

6.1. Results from the Models

Model 1’s (Monocentric model) goodness of fit decreases with time (0.648–0.638–0.621), possibly due to the increasing diversity of factors affecting the price of residential land, and some factors may not be taken into account (Tables 10–12). Model 2’s goodness of fit is better than that of Model 1, and with time, the improvement degree of goodness of fit increased. We conclude that the polycentric model has a better explanatory power than the monocentric model.

Table 10. Regression results of the Hedonic model from 2001–2004 (t-values).

| Variable Classification | Independent Variable | Model 1 (Single Center) | Model 2 (Nearest Sub Center) | Model 3 (All Subcenters) | Model 4 (10 km within Subcenters) |
|-------------------------|----------------------|-------------------------|-----------------------------|-------------------------|----------------------------------|
|                         |                      | Constant 10.107 *** (75.557) | 10.178 *** (74.674) | 10.556 *** (58.832) | 9.856 *** (55.417) |
|                         |                      | SIZE −0.087 *** (−5.485) | −0.093 *** (−5.688) | −0.060 *** (−5.733) | −0.088 *** (−5.582) |
|                         |                      | FAR 0.332 *** (19.937) | 0.331 *** (19.937) | 0.328 *** (19.733) | 0.336 *** (19.727) |
|                         |                      | MIXED 0.310 *** (20.347) | 0.311 *** (20.029) | 0.303 *** (19.476) | 0.314 *** (20.325) |
|                         | X1                   | lnD_{subway} −0.022 (−1.319) | −0.013 (−0.772) | −0.023 (−1.388) | −0.025 (−1.499) |
|                         |                      | lnD_{park} −0.036 (−1.399) | −0.012 (−0.444) | −0.014 (−0.528) | −0.032 (−1.229) |
|                         |                      | lnD_{school} −0.097 *** (−5.050) | −0.071 ** (−3.349) | −0.053 * (−2.477) | −0.088 *** (−4.428) |
|                         | X2                   | lnD_{TAM} −0.296 *** (−10.678) | −0.284 *** (−9.529) | −0.212 *** (−6.720) | −0.252 *** (−8.136) |
|                         |                      | lnD_{sub} −0.083 ** (−3.078) |                          |                          |                          |
|                         |                      | lnD_{sub—ZGC} −0.188 *** (−5.337) |                          |                          |                          |
|                         | X3’                  | D_{sub—ZGC10 km} 0.080 * (2.320) |                          |                          |                          |
|                         |                      | Adjust R² 0.648 | 0.650 | 0.653 | 0.651 |
|                         |                      | N 1694 | 1694 | 1694 | 1694 |

Note: *** was significant at the 0.001 significant level; ** was 0.01, significant level was significant; * was 0.05, significant level was significant.

Table 11. Regression results of the Hedonic model from 2005–2008 (t-values).

| Variable Classification | Independent Variable | Model 1 (Single Center) | Model 2 (Nearest Sub Center) | Model 3 (All Subcenters) | Model 4 (10 km within Subcenters) |
|-------------------------|----------------------|-------------------------|-----------------------------|-------------------------|----------------------------------|
|                         |                      | Constant 9.972 *** (25.752) | 9.827 *** (24.787) | 11.687 *** (16.637) | 8.945 *** (18.325) |
|                         |                      | SIZE 0.031 (0.582) | 0.032 (0.625) | −0.002 (−0.040) | −0.017 (−0.326) |
|                         |                      | FAR 0.211 ** (3.310) | 0.229 *** (3.618) | 0.269 *** (4.260) | 0.203 ** (3.276) |
|                         |                      | AUC 0.251 ** (4.703) | 0.244 *** (4.835) | 0.254 *** (4.999) | 0.237 *** (4.364) |
|                         |                      | MIXED 0.047 (0.936) | 0.046 (0.807) | 0.028 (0.569) | 0.043 (0.899) |
|                         |                      | FIVE—DEV 0.146 ** (2.806) | 0.149 ** (3.073) | 0.102 ** (3.227) | 0.129 ** (2.734) |
### Table 11. Cont.

| Variable Classification | Independent Variable | Model 1 (Single Center) | Model 2 (Nearest Sub Center) | Model 3 (All Subcenters) | Model 4 (10 km within Subcenters) |
|-------------------------|----------------------|-------------------------|-----------------------------|-------------------------|----------------------------------|
| X2                      | lnD_{subway}         | −0.192 ** (−2.651)      | −0.224 (−2.299)             | −0.071 (−0.692)         | −0.066 (−0.787)                  |
|                         | lnD_{park}           | 0.013 (0.233)           | 0.022 (0.420)               | 0.044 (0.832)           | −0.004 (−0.074)                  |
|                         | lnD_{school}         | −0.089 (−0.998)         | −0.110 (−1.248)             | 0.086 (0.836)           | 0.030 (0.336)                    |
|                         | lnD_{TAM}            | −0.278 ** (−3.366)      | −0.291 ** (−3.563)          | −0.205 * (−2.358)       | −0.283 ** (−2.496)               |
|                         | lnD_{sub}            | −0.180 * (−2.232)       |                             |                         |                                  |
|                         | lnD_{sub—ZGC}        |                          |                            |                         | −0.472 ** (−3.178)             |
|                         | lnD_{sub—OLY}        |                          |                            |                         | 0.130 (1.138)                   |
|                         | lnD_{sub—TZ}         |                          | −0.073 (−0.829)             |                         |                                  |
|                         | lnD_{sub—SY}         |                          | −0.103 * (−2.422)          |                         |                                  |
| X3                      | D_{sub—ZGC10 km}     |                          |                            | 0.174 * (2.359)         |                                  |
|                         | D_{sub—OLY10 km}     |                          |                            | 0.177 * (2.232)         |                                  |
|                         | D_{sub—TZ10 km}      |                          |                            | 0.183 ** (2.594)        |                                  |
|                         | D_{sub—SY10 km}      |                          |                            | 0.141 ** (2.636)        |                                  |
|                         | Adjust R²             |                          | 0.638                       | 0.647                   | 0.667                            |
|                         | N                    |                          | 164                         | 164                    | 164                              |

Note: *** was significant at the 0.001 significant level; ** was 0.01, significant level was significant; * was 0.05, significant level was significant.

### Table 12. Regression results of Hedonic model from 2009–2013 (t-values).

| Variable Classification | Independent Variable | Model 1 (Single Center) | Model 2 (Nearest Sub Center) | Model 3 (All Subcenters) | Model 4 (10 km within Subcenters) |
|-------------------------|----------------------|-------------------------|-----------------------------|-------------------------|----------------------------------|
| X1                      | Constant             | 9.678 *** (31.310)      | 9.852 *** (31.198)          | 12.275 *** (13.813)    | 9.007 *** (25.686)               |
|                         | SIZE                 | −0.087 (−1.817)         | −0.080 (−1.678)             | −0.083 (−1.776)        | −0.084 (−1.962)                  |
|                         | FAR                  | 0.211 *** (4.010)       | 0.201 *** (3.846)           | 0.221 *** (4.267)      | 0.211 *** (4.191)                |
|                         | AUC                  | 0.169 ** (2.828)        | 0.184 *** (3.585)           | 0.143 *** (2.700)      | 0.112 * (2.249)                  |
|                         | MIXED                | 0.366 *** (7.401)       | 0.372 *** (7.570)           | 0.377 *** (7.796)      | 0.359 ** (7.817)                 |
|                         | FIVE—DEV             | 0.117 * (2.578)         | 0.113 * (2.529)             | 0.125 ** (2.808)       | 0.100 ** (3.290)                 |
| X2                      | lnD_{subway}         | −0.010 (−0.190)         | 0.003 (0.064)               | 0.037 (0.677)          | 0.035 (0.731)                    |
|                         | lnD_{park}           | −0.031 (−0.662)         | −0.016 (−0.526)             | −0.030 (−0.614)        | −0.082 (−1.716)                  |
|                         | lnD_{school}         | 0.005 (0.095)           | −0.013 (−0.252)             | 0.000 (0.003)          | 0.011 (0.192)                    |
Table 12. Cont.

| Variable Classification | Independent Variable | Model 1 (Single Center) | Model 2 (Nearest Subcenter) | Model 3 (All Subcenters) | Model 4 (10 km within Subcenters) |
|-------------------------|----------------------|-------------------------|-----------------------------|--------------------------|----------------------------------|
|                         | lnD_{TAM}            | -0.205 ***              | -0.173 **                   | -0.147 *                 | -0.144 *                         |
|                         |                      | (-3.678)                | (-3.027)                    | (-2.139)                 | (-2.343)                         |
|                         | lnD_{ABI}            | -0.108 *                |                            |                          |                                  |
|                         |                      | (-2.279)                |                            |                          |                                  |
|                         | lnD_{sub}            | -0.202 *                |                            |                          |                                  |
|                         |                      | (-3.120)                |                            |                          |                                  |
|                         | lnD_{sub−ZGC}        | 0.194                   |                            |                          |                                  |
|                         |                      | (1.951)                 |                            |                          |                                  |
|                         | lnD_{sub−OLY}        | -0.116                  |                            |                          |                                  |
|                         |                      | (-1.585)                |                            |                          |                                  |
|                         | lnD_{sub−TZ}         | -0.143 *                |                            |                          |                                  |
|                         |                      | (-2.103)                |                            |                          |                                  |
|                         | lnD_{sub−SY}         | -0.189 **               |                            |                          |                                  |
|                         |                      | (-2.934)                |                            |                          |                                  |
|                         | lnD_{sub−CP}         | 0.196 **                |                            |                          |                                  |
|                         |                      | (2.943)                 |                            |                          |                                  |
|                         | lnD_{sub−FS}         | 0.160 *(2.077)          |                            |                          |                                  |
|                         | lnD_{sub−FS10 km}    | 0.168 **                |                            |                          |                                  |
|                         |                      | (3.510)                 |                            |                          |                                  |
|                         | lnD_{sub−CP10 km}    | 0.100 **                |                            |                          |                                  |
|                         |                      | (3.304)                 |                            |                          |                                  |
|                         | lnD_{sub−FS10 km}    | 0.123 *                 |                            |                          |                                  |
|                         |                      | (2.162)                 |                            |                          |                                  |
| Adjust R²               |                     | 0.621                   | 0.656                       | 0.647                    | 0.689                            |
| N                       |                     | 259                     | 259                         | 259                      | 259                              |

Note: *** was significant at the 0.001 significant level; ** was 0.01, significant level was significant; * was 0.05, significant level was significant.

6.2. Changes in Tiananmen’s Impact on Residential Land Price

Using the regression results, we can obtain the change in the coefficient of distance from the Tiananmen variable in Model 1. The coefficients of the three stages are −0.296, −0.278, and −0.205 respectively, which shows that the impact of Tiananmen gradually reduced (Figure 5).

Assuming that only the relationship between the distance from Tiananmen and the land price is considered, and controlling the other variables, the results of Model 1 of the three stages are plotted. The slope of the curve represents the coefficient of the distance from the Tiananmen variable. The intercept of the ordinate indicates the constant. The ordinate value indicates the price level in the city center. The intercept of the abscissa indicates the city’s range, which is the price level of boundary agricultural land. Curve 1 represents stage 2001–2004, curve 2 represents stage 2005–2008, and curve 3 represents stage 2009–2013.

From curve 1 to curve 2, the absolute value of the slope decreases from 0.296 to 0.278, indicating that the influence on land price of Tiananmen as the city center weakened. The vertical intercept also reduced, indicating that the city center residential land price level declined, from 24,514 yuan/m² to 15,962 yuan/m². The abscissa intercept increased, indicating that the city expanded. In conclusion, the result shows that Tiananmen’s impact on land price weakened. Apart from market forces, the administrative factors of intervention’s impact are very large, and the city continued to spread outward in a “pie” style expansion.
Figure 5. Comparison of the results of Model 1 in three stages.

From curve 2 to curve 3, the absolute value of the slope decreases from 0.278 to 0.205, indicating that the influence on land price of Tiananmen as the city center weakened once more. The vertical intercept has increased, indicating that the residential land price in the urban center rose, from 15,962 yuan/square meter to 19,380 yuan/square meter. The abscissa intercept has increased, indicating that the continuous improvement of traffic conditions reduced the cost of the commute to the city center, thus increasing some of the residential expenses near the city center. With the continuous implementation of administrative power, the city is still constantly spread out. Therefore, both administrative power and traffic conditions have greatly impacted the urban expansion of Beijing.

6.3. The Influence of the Nearest Neighboring Sub-Centers

The influence of the nearest employment subcenters on the price of residential land is significant, and the overall trend is increasing over time, with the third stage falling slightly (−0.083−0.180−0.108). One possible reason may be that the influence of some suburban employment subcenters is insufficient. The results indicate that the employment subcenters have, as a whole, gradually produced certain agglomeration effects.

6.4. The Impact of Various employment Subcenters and the Scope of the Impact

It was found that the influence of Zhongguancun on residential land price was significant. It was still significant after the restriction of the scope of influence, indicating that Zhongguancun’s influence range was large. The influence of Olympic Park before the restriction of the scope was not significant, but significant after the restriction, indicating that its influence is limited. The influence of Shunyi New Town and Changping New City is relatively large, while the scope of Tongzhou New Town and Fangshan’s influence on New Town is limited.
7. Conclusions and Discussion

To date, little research has been conducted on how the development of employment subcenters affects land price in the context of developing countries. Taking Beijing as a case, this paper first analyzed the temporal and spatial variation characteristics of Beijing’s residential land market, and then, by applying four Hedonic models, investigated the dynamic impacts of the identified employment subcenters on the price of residential land from 2001–2013. This led to several findings.

First, the spatio-temporal change in the transaction price of residential land in Beijing is large. The unit price of residential land rose after 31 August 2004, particularly after 2008. The change in land price distribution is obvious: (1) The circle structure weakened, and (2) The distribution of land price became more scattered. These changes reflect that the city center’s influence on residential land price weakened.

Second, the urban spatial structure of Beijing is constantly changing, and the number of employment subcenters gradually increased, while the spatial distribution of employment subcenters gradually spread to the suburbs. In 2001, the only employment subcenter was Zhongguancun. In 2004, three new subcenters emerged, namely Olympic Park, Tongzhou New Town, and Shunyi New Town. In 2008, in addition to the former subcenters, two new towns, Changping and Fangshan, grew into new subcenters.

Third, the influence on land price of Beijing’s main center Tiananmen is declining. The model results showed that the coefficient of the distance to Tiananmen changed from $-0.296$ in 2001–2004 to $-0.278$ in 2005–2008 and then to $-0.205$ in 2009–2013, which indicates that the impact of Tiananmen on residential land price distribution has gradually reduced; however, the coefficient from 2009 to 2013 retained a high value, showing that Tiananmen still has a strong effect in structuring residential land price.

Fourth, the influence of the employment subcenters is on the rise. The explanatory power of the polycentric model keeps increasing, while that of the monocentric model is just the opposite. This indicates that the subcenters have affected the distribution of residential land price, which was formerly dominated by a monocentric pattern. More specifically, the absolute value of coefficients and its significance have been increasing, which directly showed the stronger effect of the employment subcenters.

Fifth, the effects of subcenters were varied and some of them can only exert effects in a limited scope. Zhongguancun always has significant effects on residential land price at each stage, perhaps as a result of its long development history, large employment scale, and educational resources. The effects of Olympic park were limited, as its coefficients were only significant after restricting the sample within a 10 km scope. The effects of the New Towns were also quite different: Shunyi and Changping had a relatively large influence, while Tongzhou and Fangshan’s influence was limited. This may be related to the development strategies of Beijing, which have paid more attention to the development of the north parts.

Compared with previous studies, this paper will contribute to the existing literature in several ways. First, this paper has supplied evidence that land price has also been affected by employment subcenters from a dynamic view, and that the effects will increase with the development of subcenters. Second, this paper further shows that the polycentric models are also effective in a transitional economy, in which land use is dominated by both the land market and the government [7,36,57]. Third, many omitted variables that can affect land price have been added as control variables, which excludes the effect of unobserved variables on land price. In other words, this paper supplies a more reliable result than previous studies.

This study shows that in Beijing, a typical city in China, the administrative power and improvement of traffic conditions have gradually weakened the city center’s impact on the price of residential land, while increasing the impact of employment subcenters. This conclusion is consistent with the big cities of Western countries. However, the process of urban development in China is slower than in the West, and the development of employment subcenters is still at the beginning
stage. Therefore, the influence range of employment subcenters is limited. This paper suggests that the government will increase the development of and investment in employment subcenters, particularly the New Towns in the suburbs, increase their infrastructure construction, and expand their scope of influence. We plan to do further research on other land use types in the future.

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