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ARTICLE

The spatiotemporal impact of urban elderly care facilities on residential value and the resulting governance implications

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Abstract
As the world is increasingly witnessing an aging society, the demand for elderly care facilities has gradually increased. However, there is controversy regarding the impact of 'establishing elderly care facilities on surrounding residents' in both academia and urban governance practices. To clarify this debate and introduce innovation to the discussion, this paper addresses the influence mechanism (that is, the amenity effect or the 'not-in-my-back-yard' effect) of the establishment of elderly care facilities on surrounding housing prices. Based on the data of 26,215 gated residential communities and 595 elderly care facilities in Shanghai and using a fixed-effect regression, we find that elderly care facilities have nonlinear effects. After considering distances from residential communities, establishment time, and different types of elderly care facilities, the results indicate significant heterogeneity. The conclusions have important policy implications for selecting suitable locations to build elderly care facilities and balance the dual interests of local governments and the private sector.

Keywords Urban elderly care facilities · Surrounding housing prices · Amenity effect · NIMBY effect · Governance implications

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1 Introduction

Aging has become an important issue in urban development, and the demand for elderly care services is increasing. The establishment of elderly care facilities (ECFs) has gradually emerged in fast-aging countries such as China. Over 150,000 facilities are providing elderly care services in China, including nursing homes, welfare houses, and homes for elderly veterans, according to a recent report issued by the Chinese Aging Well Association (CAWA).[1]

Quality of life among the elderly population is largely related to ECFs, which can provide convenient services and generate positive externalities for surrounding residents (Desalvo, 1974). The impact of these facilities is called the amenity effect, that is, they attract residents to live closer to them for easier access to their services and thus have a positive impact on local property prices (Christianson & Faulkner, 1981; Kurvinen & Tyvimaa, 2016; Tang et al., 2012; Tyrväinen, 1997).

At the same time, ECFs can also cause some negative externalities, such as exposure to unpleasant noise, air pollution, crowds, traffic, or even health hazards, which together are known as the not-in-my-back-yard (NIMBY) effect. These concerns may result in residents not being willing to live too close to these facilities, which in turn may lower the surrounding housing prices (O'Hare, 1977; Sims et al., 2008; Bakker et al., 2012; Peng & Chiang, 2015).

However, it is still unclear which effect dominates. Some scholars have examined the impact of such facilities on the value of surrounding houses, and have found no significant change because of the complexity of the potential influence channels (Koebel et al., 2004; Hoen et al., 2010). As Benford et al. (1993) and Peng and Chiang (2015) have noted, some facilities such as ECFs and hospitals are typical examples of semi-obnoxious facilities, because residents have contradictory attitudes to them: Being close to them is favourable for convenient service, but being too close is worrying because of the negative effects. Therefore, this paper attempts to evaluate the overall impact of the establishment of elderly care facilities.

As China is increasingly becoming an aging society, the demand for elderly care services is increasing. According to China's *Statistical Yearbook*, in 2017, China had 240 million people over the age of 60, accounting for 17.33% of the overall Chinese population, while the proportion of people over 65 years was 11.39%. However, there are only 155,000 facilities and 7,448 million beds providing elderly care in China, far from meeting the current demands of the elderly. For example, the provision of ECFs by the public sector is slow and cannot meet the demands of the rapidly growing elderly population in Shanghai, one of the first-tier Chinese cities (see Fig. 1). In this situation, the Shanghai Municipal Government has continuously promulgated policies to encourage the provision of ECFs by the private sector and promoted financial subsidies. Therefore, home-based elderly care and ECFs provided by the private sector are gradually becoming the prevailing trend.

At present, we are paying more and more attention to the attitudes of surrounding residents towards the establishment of an ECF. Before construction, we have to evaluate the overall externalities of the facilities and reduce potential negative effects. That is, when livelihood facilities are in conflict with local personal benefit, how can the

[1] See https://www.shine.cn/news/nation/1902089243/.

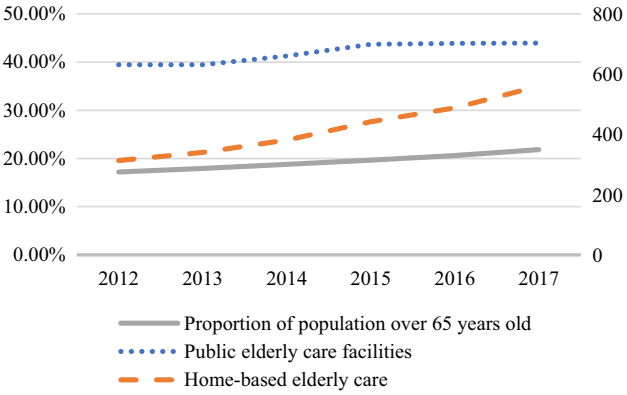

Fig. 1 The development of elderly care facilities (ECFs) and population aging in Shanghai. *Source*: Shanghai Bureau of Statistics, http://tjj.sh.gov.cn/

relationship be balanced and how can the NIMBY effect among residents be alleviated? This is another important question this article seeks to answer.

The contribution of this article mainly include three aspects. First, we summarize two effects of the establishment of ECFs on the surrounding housing prices, the amenity effect and the NIMBY effect, which may help to enrich the previous literature. Second, our empirical analysis was conducted using rich data of all commodity housing communities and ECFs in Shanghai, and reveals that the impacts of ECFs on the surrounding housing prices are non-linear. Third, the findings of this paper have important policy implications for urban governance. For example, a rapidly aging country such as China should consider how to avoid negative externalities when selecting a suitable location for establishing an ECF.

The remainder of this paper is structured as follows. In section two, we discuss the relevant literature and propose the conceptual framework of this paper. Section three describes the data and variables and discusses the econometric specification and identification strategy. Section four presents the empirical results, and the fifth section are conclusions and policy implications.

2 Literature review and conceptual framework

The principal starting point in reviewing the literature is the two conflicting ways in which the establishment of ECFs may impact the surrounding residential value. On the one hand, we refer to the general theory regarding the effects of public goods or service facilities on housing prices, that is, ECFs may improve the residential value of the surrounding areas and demonstrate positive externalities. On the other hand, we reveal its possible negative social effects and explain why the NIMBY effect occurs. Combining these two theories, we deduce the impact of ECFs on residential value and its heterogeneity. Then we present the conceptual framework of this paper.

2.1 The amenity effect of the supply of urban public service facilities

Previous studies have suggested that urban public service facilities or quasi-public goods, including parks, green spaces, forests, high-quality schools, shopping centres, cinemas, etc., which serve as amenities, have positive spillover effects on the value of surrounding house prices (Oates, 1969; Tang et al., 2012; Tiebout, 1956; Tyrväinen, 1997). Based on 'Vote With Their Feet' (Tiebout, 1956), it is suggested that these facilities provide convenient services and a comfortable environment, or a pleasant mood, and people will want to live close to them, thereby raising the property prices of the surrounding residential areas.

As a public service facility, an ECF is regarded as an amenity and its existence will increase the value of surrounding houses (Christianson & Faulkner, 1981; Brunes et al., 2016; Kurvinen & Tyvimaa, 2016; Miller, Nikaj & Pender, 2015; Tang et al., 2012; Tyrväinen, 1997). For instance, Christianson and Faulkner (1981) have analysed the positive impact of hospitals as a livelihood facility on surrounding communities in the United States and found that the total income of the community, which is directly and indirectly stimulated by hospital expenditure, ranges from $700,000 to $1 million. Brunes et al. (2016) discussed the impact of urban filling and development projects on the value of surrounding real estate and found that filling development has a positive spillover effect on surrounding house prices in low-income areas. Furthermore, when it comes to evaluating the possible impact of medical structures or the establishment of ECFs, as Gilbert et al. (1998) have pointed out, people tend to overestimate the degree of aversion and the duration of their dislike of the event.

Some literature has focused on the impact of the establishment of public service facilities in Chinese cities (such as Shanghai) on the surrounding housing prices and its social effects. For example, Li et al., (2015, 2019) used data at different geographic scales to examine the relationship between public service provision and housing prices in Shanghai. They found that both government redistribution expenditure and development expenditure are positively correlated with housing prices. In other words, the accessibility of public services has a significant housing price capitalization effect, but there are significant differences between central urban areas and outer suburbs.

Xiao et al. (2019) used a big data approach to investigate another public service provision, the spatial provision of urban green spaces, to revisit the environmental justice issue and found that there was residential segregation in Shanghai.

2.2 The NIMBY effect of semi-obnoxious facilities

As mentioned above, an ECF is a semi-obnoxious facility similar to a hospital: while providing convenient services to the surrounding residents, it may also have some negative effects, such as unpleasant noise, air pollution, crowds, traffic, or even health hazards. These effects make people reluctant to live too close to such a facility, which results in the NIMBY effect and lowering the surrounding property prices (Bakker et al., 2012; Faulkner et al., 2015; O'Hare, 1977; Sims et al., 2008; Peng & Chiang, 2015). Farber (1998) has noted the economic risks of improper land use, which can negatively impact surrounding house prices. It can be concluded that the literature regarding the impact of livelihood facilities on residential value mainly focuses on changes to the surrounding environmental quality. For example, Eshet et al. (2007) have estimated the external value of an Israeli waste transfer station and found that its establishment may produce considerable

externalities; that is, with every 1% increase in the distance between a house and the local transfer station, the average house price per unit rose by 0.06%. Gibbons (2015) has studied the impact of the establishment of wind power plants on the surrounding housing prices and demonstrated that small wind power plants reduced house prices within 2 km by 5–6%, while large power plants reduced house prices within 2 km by 12%. Zhang et al. (2017), Wagner et al. (2017), and Yang, Wang, Zhou and Wang (2018) have also explored how some livelihood facilities have a negative influence on the surrounding housing prices. Finally, it is worth mentioning Wu and Li's (2018) findings regarding the spatial effect of neighbourhood avoidance using a geographic information system, and that the negative impact of the establishment of gas stations on the surrounding housing prices demonstrated circular radiation.

In addition to the factors that cause the NIMBY effect of public service facilities, it is also possible that differences among residential groups lead to the exclusion of local people. Because local residents wish to protect and maintain the reputation of their properties, they will tend to rule out any potentially harmful factors, even if the development and operation of such facilities are required by the whole of society (Dmochowska-Dudek & Bednarek-Szczepa, 2018). Davidson and Howe (2014) and Kontokosta (2015) described these phenomena in detail, demonstrating that the construction of homeless residential buildings around communities can cause residents to feel 'trapped'. Lyons and Loveridge (1993) examined the influence of the construction of subsidized housing on the value of the surrounding houses. The results demonstrated that the construction of subsidized housing had a small but significant negative effect on the surrounding housing prices. Koschinsky (2009) obtained similar results. Pendal (1999) has pointed out that, due to differences in race, class, or family status, welfare facilities such as housing assistance cause the NIMBY effect. Ellen et al. (2012) confirmed that districts in which dwellings are built under the Housing Choice Voucher Program have higher crime rates caused by the low-income group, and district development is negatively impacted. Oakley (2010) also demonstrated that personal feelings oppose and hinder the construction of social and public service facilities.

2.3 Heterogeneity of the NIMBY effect

Some literature points out that the effects are obviously heterogeneous, that is, the results may vary depending on the time when the facility was established and the distance people are separated from it. Bellettini and Kempf (2013) have noted that neither the NIMBY effect nor the amenity effect can guarantee optimal decision-making, because of the optimal provision and location of public goods. It is reasonable to conclude that the relationship between livelihood facilities such as hospitals and ECFs and the value of the surrounding property is extremely complex, and is affected by multiple factors such as geography, scale, and neighbouring areas.

Considering the above heterogeneities, some methods proposed by scholars to alleviate the NIMBY effect also reflect the complexity of the impact of livelihood facilities on the surrounding environment, which may be neutralized by government initiatives. O'Sullivan (1993) proposed using voluntary auctions to host 'harmful facilities' in a city with a low bidding price, but these should be compensated by high bidding prices. Gallardo et al. (2014) considered that residents should be given financial incentives to improve the acceptance of public facilities in an area; in other words, a large amount of financial compensation could be used to alleviate the NIMBY effect of the host community. Krohn and Damborg

(1999) also considered that the initial support rate for wind power plants would differ from that post-construction. However, the implementation of material incentives for moral virtue can more effectively alleviate dissatisfaction with facilities. Frey (1996) noted that compensation for local dissatisfaction cannot improve the approval rate of facilities' construction, and may even make the public feel excluded, causing a decline in the approval rate.

2.4 Conceptual framework

As can be deduced from the above literature review, it is difficult to provide a unified judgment regarding the impact of the establishment of ECFs due to the possible mixed impacts of the amenity effect and the NIMBY effect. This has led to many studies not finding a significant relationship between public facilities and surrounding property values (Bakker et al., 2012; Jones & Eiser, 2009; Phillips et al., 2014; Sims et al., 2008; Wilton, 1998). Based on this situation, we attempt to put forward the theoretical framework of this paper. On the one hand, the establishment of ECFs to provide public service facilities, represents the amenity effect and may increase the value of surrounding residential areas; on the other hand, the establishment of ECFs may also reduce surrounding residential values due to certain subjective and objective concerns of the local people caused by NIMBY effects. In addition, we reasonably infer that the impact of ECFs may differ according to the time, geography, distance, and compensation policy. That is, the influence channels of ECFs on the surrounding residential values may be heterogeneous and may also be related to other factors, such as geography and time of establishment. On that basis, we conduct further empirical analysis by using the micro data of Shanghai.

3 Methodology

3.1 Data and variables

The data used in this paper are mainly of two sources. The first source comprises average housing prices of the residential community in Shanghai per month from January 2015 to February 2017, obtained from Lianjia company, China's largest real estate agency (http://sh.lianjia.com). The second source includes all the ECFs and their features in Shanghai from the website of an elderly service agency (http://www.shanghaiyanglao.com). This study examined the specific situations of 26,215 gated residential communities[2] and 595 ECFs in Shanghai. We then geo-matched the data of average housing prices of residential communities per month and ECFs, which yielded a total of 51,556 sample observations.

The data incorporate the relevant characteristics of the residential communities, such as geographical location, transaction time, average residential price, distance from the city centre (People's Square), and distance from the nearest ECF, and the characteristics of the ECFs, including geographical location, construction date, features (public construction with public management, public construction with non-government management, non-government construction with non-government management, or Sino-foreign joint venture), scope of services (within the area, or outside the

[2] Because they are all commercial houses, housing prices are more sensitive to changes in supply and demand.

Table 1 Descriptive statistics

Variable	Description	Obs	Mean	SD	Min	Max
Distance	Distance between residential communities and ECFs (m)	51,556	954.4	1,107	5.535	35,318
District	Districts in which residential communities are located (Huangpu = 1, Xuhui = 2, Changning = 3, Jingan = 4, Putuo = 5, Zhabei = 6, Hongkou = 7, Yangpu = 8, Minhang = 9, Baoshan = 10, Jiading = 11, Pudong New Area = 12, Jinshan = 13, Songjiang = 14, Qingpu = 15, Fengxian = 16, Chongming = 17)	51,566	8.042	4.053	1	17
Bed_left	Vacancies in ECFs	49,370	25.15	52.91	0	448
Fee	Maximum fee for ECFs	48,715	6191	8329	15	91,000
Size	Size of ECF (m^2)	44,362	4547	5449	120	45,000
Est	Years of the establishment of the ECF	44,595	12.51815	10.598	0	114
Range	Service range (within this area = 1, outer area = 0)	51,566	0.0388	0.193	0	1
Loc	Position of ECFs (Central area = 0, suburbs = 1)	51,566	0.533	0.499	0	1
Hyear	Year of settlement in the residential community	51,566	2016	0.587	2015	2017
Hmonth	Month of settlement in the residential community	51,566	6.752	3.600	1	12
Buildyear	Year of completion of the residential community	51,566	2001	7.862	1911	2016
Hprice	Average residential community price (yuan / m^2)	51,566	42,860	18,524	72.20	288,770
Discenter	Distance from the residential community to People's Square (m)	51,556	12,142.1	8904.404	96.35064	82,092.44
Hage	Housing age in a residential community (year of Transaction—year of completion)	51,566	14.58	7.892	0	105
Elderly	The elderly population in the area where ECFs are located (2010 Census Data)	51,566	15,215	6,076	316	29,504

Source: Lianjia company, http://sh.lianjia.com, and the website of an elderly service agency, http://www.shanghaiyanglao.com. All of the following tables (Tables 2, 3, 4, 5, 6, 7 and 8) are based on the same data sources as in Table 1

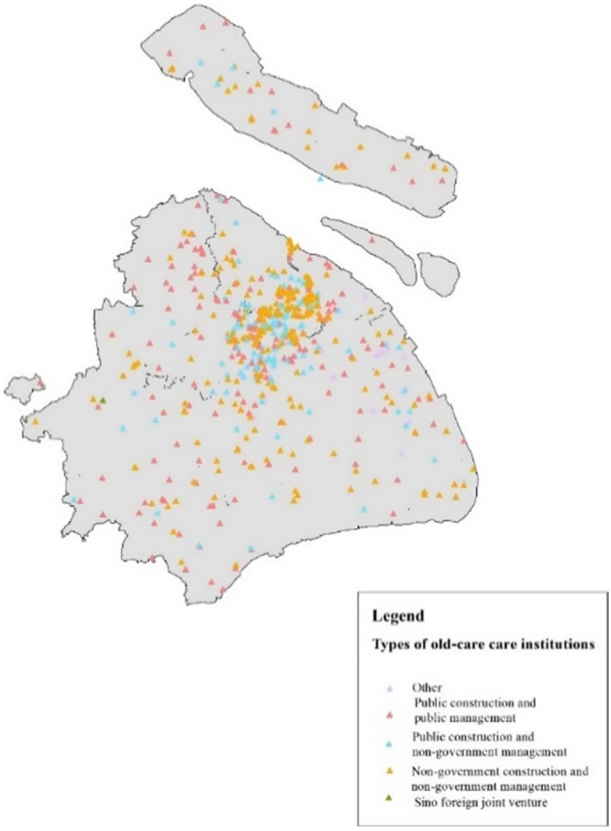

Fig. 2 Spatial distribution of ECFs

area), target audiences (older people, elderly people living alone, or patients with cognitive disorders), scale, and medical conditions (medical institutions, long-term home nursing services, or cognitive care). The specific variables and descriptive statistics used in the study are listed in Table 1.

At the same time, as illustrated in Figs. 2 and 3, we matched the geographic location of the ECFs with the locations of residential communities. Figure 2 illustrates the spatial distribution characteristics of ECFs. In terms of the total number, ECFs in Shanghai are relatively abundant; they are mainly based on public construction with non-government management, and non-government construction with non-government management.

From the perspective of spatial distribution, ECFs are located in all districts but are mainly concentrated in the central area, demonstrating the phenomenon of decreasing distribution from the central area to the suburbs and remote suburbs. This trend is mainly caused by the difference in the distributions of the elderly population in each district. Figures 3 below illustrates the housing price distribution of residential communities within 500 m from ECFs. We can only see that the prices of houses in residential communities mostly range between 0 and 20,000 yuan, but it cannot be deduced directly that the establishment of an ECF has a significant positive or negative impact on the surrounding housing prices.

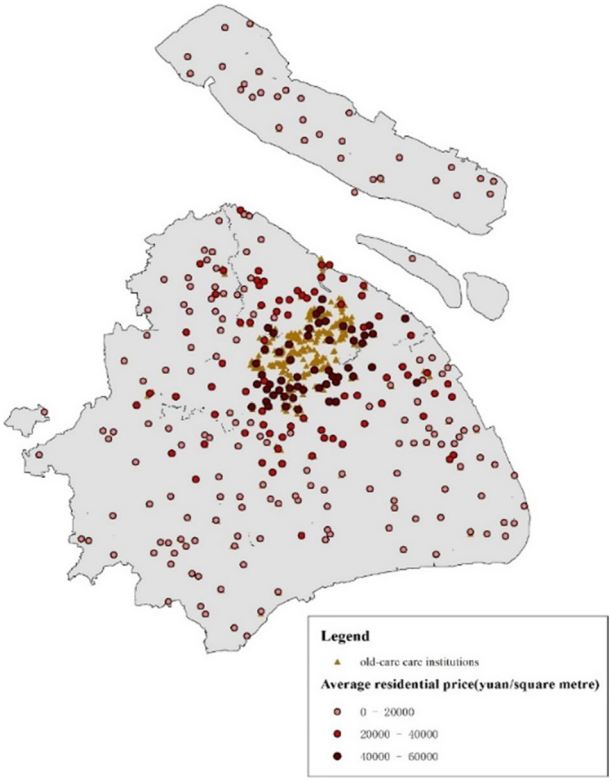

Fig. 3 Spatial distribution of residential communities' prices within 500 m of the ECFs. *Source*: Lianjia company, http://sh.lianjia.com, and the website of an elderly service agency, http://www.shanghaiyanglao.com

3.2 Econometric specifications

To examine how the establishment of ECFs affects the surrounding residential values, we used the hedonic price model as the benchmark model. The dependent variable is the average price of houses in the surrounding residential community (yuan/m^2, price per square meter), and the independent variables mainly include the characteristics of the ECFs and the characteristics of the residential community. The regression model is calculated as follows:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + D_1 + D_2 + \text{Time} + \mu_1 \quad (1)$$

where Y represents the average residential price, X_1 represents residential characteristics, X_2 represents the features of the ECFs, D_1 is the dummy of the service scope of the ECFs, D_2 is the variable of the distribution area of the ECFs, Time stands for the year and month in which the residential community was established, and μ_1 represents the error term.

To explore the impact of the establishment of ECFs on surrounding housing values more comprehensively, this paper established the following six models. The first model analyses the impact of ECFs on housing prices, and whether the establishment of such facilities negatively affects housing prices. The second model analyses the effects at different distances. The third model distinguishes the impacts in different districts (central areas, suburban communities). The fourth model analyses the different impacts of ECFs before and after their establishment. The fifth model analyses the differences of the impacts of different functions and

Table 2 Effects of the establishment of ECFs on residential prices

	(1)	(2)	(3)
	OLS	District FE	Two-way FE
Variables	lnhprice	lnhprice	lnhprice
Lndistance	−0.000	0.001	0.001
	(0.002)	(0.002)	(0.002)
Lndiscen	−0.358***	−0.359***	−0.426***
	(0.003)	(0.003)	(0.003)
Hage	0.000	0.000	−0.004***
	(0.000)	(0.000)	(0.000)
Lnsize	−0.012***	−0.010***	−0.009***
	(0.002)	(0.002)	(0.002)
Est	0.000	0.000	0.001***
	(0.000)	(0.000)	(0.000)
Bed_left	0.000**	0.000***	0.000***
	(0.000)	(0.000)	(0.000)
Lnfee	0.012***	0.012***	0.014***
	(0.003)	(0.004)	(0.003)
Range	0.034***	0.029**	0.026***
	(0.012)	(0.012)	(0.010)
Constant	13.828***	13.813***	13.889***
	(0.046)	(0.048)	(0.042)
Observations	41,281	41,281	41,281
R-squared	0.373	0.374	0.613
District FE		Yes	Yes
Time FE			Yes

(1) the standard errors of regression coefficients are in parentheses. (2) ***, **, * indicate levels of significance at 1%, 5%, 10%, respectively

different target audiences on the values of housing. The sixth model analyses the differences of the impacts of the establishment of ECFs on house values in areas with different aging populations.

The models are analysed using ordinary least squares (OLS), the district fixed effect, and the two-way fixed effect, incorporating the time fixed effect and district fixed effect, respectively. The identification strategy focuses on two steps: The first step is to estimate the average effect of the establishment of ECFs on the surrounding housing prices. The second step is based on the time (monthly) of the establishment of the ECF and the distance between a house and a facility (e.g., a radius of 500 m, 500–1000 m, 1000–1500 m, and 1500–2000 m). We expect that if the amenity effect is dominant, the establishment of an ECF will increase the surrounding housing prices, while nearby housing prices will fall if the NIMBY effect prevails. Of course, there may be heterogeneity across different distances and time periods.

4 Results

4.1 Effects of ECFs on residential values

Table 2 above presents the impact of ECFs on the surrounding housing prices using the regression methods of OLS, district fixed effects, and two-way fixed effects. We found that the influence of various ECF characteristics on the surrounding housing prices is significantly different. Specifically, the distribution of ECFs (lnsize) demonstrates a significant NIMBY effect: the larger the scale of ECFs in an area, the lower the housing prices of residential communities. This finding is consistent with previous studies on the NIMBY effect (Ellen et al., 2012; Eshet et al., 2007; Wagner et al., 2017; Yang et al., 2018). However, the time of establishment (est), the charge (lnfee), the demand situation (bed_left), and the service group (range) of ECFs will increase the prices of surrounding residential communities. That is, ECFs also function as amenities. The longer the time since establishment, the higher the level of convenience of surrounding services. The charge of ECFs reflects the active demand or high quality, which may increase the value of the surrounding area. Vacant beds demonstrate that the local elderly have insufficient demand for ECFs: the lower the occupancy, the smaller the negative effect on the surrounding areas. Furthermore, if the service scope is limited to a given area, the housing prices in that area will increase. These conclusions are in line with the findings of Christianson and Faulkner (1981) and Miller et al. (2015).

However, we also find that the distance between a residential community and the nearest ECF (Lndistance) does not have a significant effect on housing prices. Therefore, we should further examine whether this result will differ when the distance changes. Furthermore, in terms of distinguishing the two effects, it is also necessary to classify and analyse the distance, establishment time, and heterogeneity of ECFs. Therefore, the next section analyses the impacts of different distances, suburban differences, time, the features of the ECFs, the service group, and the proportion of the elderly population in the district.

4.2 Effects at different distances

Table 3 demonstrates the influence of ECFs on the surrounding housing prices at different distances from the residential community. According to the results presented in column 4 of Table 3, an ECF produces a NIMBY effect within 500 m from a residential community, while the residential prices are 2.7% lower when there is an ECF in the area than when there is no ECF. Apart from the service facility being within 500 m of residential communities, ECFs are seen as convenient facilities and indicate the amenity effect. For every 500 m distance away from ECFs, residential prices increase by 6.1%, 12.6%, and 5.9%, respectively. Between 500 and 1500 m, the impact increases with increased distance. Moreover, after controlling for time and district effects, the influence improves slightly.

4.3 Effects between central areas and suburbs

Table 4 explores the impact of suburban differences. Columns 2 and 4 indicate that the impact of ECFs on housing prices differs between suburbs and central areas. The NIMBY effect, as represented by the size of the ECF, and the amenity effect, caused by the fees of ECFs in suburban areas, are both higher in the suburbs than in the central areas, after controlling for the fixed effects of both time and district. The reason may be that land supply is

Table 3 Effects at different distances

Variables	(1) OLS lnhprice	(2) District FE lnhprice	(3) Time FE lnhprice	(4) Two-way FE lnhprice
Lndistance	−0.000	0.002	−0.000	0.001
	(0.002)	(0.002)	(0.002)	(0.002)
Lndiscen	−0.342***	−0.343***	−0.411***	−0.407***
	(0.003)	(0.004)	(0.003)	(0.004)
Hage	−0.000	−0.000	−0.005***	−0.004***
	(0.000)	(0.000)	(0.000)	(0.000)
Lnsize	−0.013***	−0.011***	−0.013***	−0.010***
	(0.002)	(0.002)	(0.002)	(0.002)
Est	0.000	0.000	0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)
Bed_left	0.000**	0.000**	0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)
Lnfee	0.013***	0.012***	0.016***	0.015***
	(0.003)	(0.004)	(0.003)	(0.003)
Range	0.032***	0.029**	0.021**	0.026***
	(0.012)	(0.012)	(0.009)	(0.010)
Whether there is an ECF within 500 m of the residential community (1 = yes, 0 = no)	−0.020***	−0.020***	−0.027***	−0.027***
	(0.006)	(0.006)	(0.005)	(0.005)
Whether there is an ECF within 500 to 1000 m of the residential community (1 = yes, 0 = no)	0.050***	0.049***	0.062***	0.061***
	(0.007)	(0.007)	(0.006)	(0.006)
Whether there is an ECF within 1000 to 1500 m of the residential community (1 = yes, 0 = no)	0.106***	0.105***	0.127***	0.126***
	(0.007)	(0.007)	(0.006)	(0.006)
Whether there is an ECF within 1500 to 2000 m of the residential community (1 = yes, 0 = no)	0.050***	0.050***	0.059***	0.059***
	(0.008)	(0.008)	(0.007)	(0.007)
Constant	13.602***	13.584***	13.693***	13.619***
	(0.049)	(0.051)	(0.044)	(0.046)
Observations	41,281	41,281	41,281	41,281

Table 3 (continued)

Variables	(1) OLS lnhprice	(2) District FE lnhprice	(3) Time FE lnhprice	(4) Two-way FE lnhprice
R-squared	0.378	0.378	0.618	0.619
District FE		Yes		Yes
Time FE			Yes	Yes

(1) the standard errors of regression coefficients are in parentheses. (2) ***, **, * indicate levels of significance at 1%, 5%, 10%, respectively

Table 4 Effects between the central area and suburbs

	(1) Suburbs	(2) Suburbs	(3) Central area	(4) Central area
Variables	lnhprice	lnhprice	lnhprice	lnhprice
Lndistance	0.001	0.001	0.001	0.002
	(0.003)	(0.002)	(0.003)	(0.002)
Lndiscen	−0.362***	−0.427***	−0.355***	−0.425***
	(0.004)	(0.005)	(0.004)	(0.005)
Hage	0.001***	−0.003***	−0.000	−0.005***
	(0.000)	(0.000)	(0.000)	(0.000)
Lnsize	−0.012***	−0.011***	−0.013***	−0.009***
	(0.003)	(0.003)	(0.003)	(0.002)
Est	0.001**	0.001***	0.000	−0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Bed_left	0.000	0.000***	0.000***	0.000**
	(0.000)	(0.000)	(0.000)	(0.000)
Lnfee	0.028***	0.025***	0.006	0.011***
	(0.007)	(0.006)	(0.004)	(0.003)
Range	0.034**	0.025**	0.041*	0.034*
	(0.013)	(0.011)	(0.025)	(0.020)
Constant	13.712***	13.613***	13.858***	13.908***
	(0.076)	(0.090)	(0.061)	(0.059)
Observations	21,625	21,625	19,656	19,656
R-squared	0.367	0.599	0.379	0.628
District FE		Yes		Yes
Time FE		Yes		Yes

(1) the standard errors of regression coefficients are in parentheses. (2) ***, **, * indicate levels of significance at 1%, 5%, 10%, respectively

more limited and demand for ECFs is higher in central areas, but high-quality ECFs in the suburbs command a higher premium. Moreover, the establishment time of the ECF has the opposite effect in suburbs versus central areas. The older the establishment of the ECF is, the more likely the amenity effect will be in the suburbs and the more likely the NIMBY effect will be in urban areas.

4.4 Effects before and after the establishment of ECFs

Table 5 displays the influence of different periods before and after the establishment of ECFs. Column 4 indicates that ECFs have a significant negative impact on the prices of residential communities both before and after their establishment, although the negative impact increases gradually after their establishment. Compared with Table 2, the impact of the age of ECFs (Est) on housing prices changes from a positive to a negative effect, after controlling for factors before and after the establishment of ECFs. Within 6–24 months before the establishment of an ECF, the effect begins to become significantly negative and absolute values go up. Similarly, the NIMBY effect was still observed 48 months after the establishment of an ECF. The distance between residential communities and the nearest ECFs (Lndistance) indicates a significant positive impact. The closer to an ECF a residential community is, the lower the housing prices will be.

Table 5 Effects of different periods

Variables	(1) OLS lnhprice	(2) District FE lnhprice	(3) Time FE lnhprice	(4) Two-way FE lnhprice
Lndistance	0.005	0.012***	0.002	0.007**
	(0.003)	(0.003)	(0.003)	(0.003)
Lndiscen	−0.383***	−0.387***	−0.420***	−0.420***
	(0.004)	(0.005)	(0.004)	(0.005)
Hage	−0.000	−0.001**	−0.003***	−0.003***
	(0.000)	(0.000)	(0.000)	(0.000)
Lnsize	−0.031***	−0.030***	−0.020***	−0.019***
	(0.003)	(0.003)	(0.003)	(0.003)
Est	−0.077***	−0.079***	−0.026***	−0.026***
	(0.004)	(0.004)	(0.003)	(0.003)
Bed_left	0.000***	0.000***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)
Lnfee	0.007	0.004	0.010	0.008
	(0.007)	(0.007)	(0.006)	(0.007)
Range	0.034**	0.016	0.030**	0.019
	(0.015)	(0.016)	(0.013)	(0.013)
Within 24–48 months before the establishment of the ECF (1 = yes, 0 = no)	0.148***	0.133***	0.006	−0.005
	(0.027)	(0.027)	(0.022)	(0.022)
Within 12–24 months before the establishment of the ECF (1 = yes, 0 = no)	0.017	0.005	−0.042**	−0.045**
	(0.026)	(0.026)	(0.021)	(0.021)
Within 6–12 months before the establishment of the ECF (1 = yes, 0 = no)	−0.103***	−0.112***	−0.066***	−0.069***
	(0.026)	(0.026)	(0.022)	(0.022)
Within 0–6 months before the establishment of the ECF (1 = yes, 0 = no)	−0.050*	−0.054**	−0.030	−0.029
	(0.026)	(0.026)	(0.022)	(0.021)
Within 0–6 months after the establishment of the ECF (1 = yes, 0 = no)	−0.048*	−0.051**	−0.032	−0.033
	(0.026)	(0.026)	(0.021)	(0.021)

Table 5 (continued)

	(1) OLS	(2) District FE	(3) Time FE	(4) Two-way FE
Variables	lnhprice	lnhprice	lnhprice	lnhprice
Within 6–12 months after the establishment of the ECF (1 = yes, 0 = no)	−0.176*** (0.026)	−0.190*** (0.026)	−0.107*** (0.022)	−0.118*** (0.021)
Within 12–24 months after the establishment of the ECF (1 = yes, 0 = no)	−0.238*** (0.025)	−0.272*** (0.025)	−0.112*** (0.021)	−0.130*** (0.021)
Within 24–48 months after the establishment of the ECF (1 = yes, 0 = no)	−0.473*** (0.026)	−0.515*** (0.026)	−0.198*** (0.022)	−0.216*** (0.022)
Constant	14.590*** (0.084)	14.680*** (0.084)	14.434*** (0.077)	14.462*** (0.077)
Observations	16,087	16,087	16,087	16,087
R-squared	0.449	0.454	0.560	0.562
District FE		Yes		Yes
Time FE			Yes	Yes

(1) the standard errors of regression coefficients are in parentheses. (2) ***, **, * indicate levels of significance at 1%, 5%, 10%, respectively

Table 6 Effects of different types of ECFss

	(1) Whether there are medical institutions in ECF (1 = yes, 0 = no)	(2) Whether long household insurance is fixed in ECF (1 = yes, 0 = no)
Variables	lnhprice	lnhprice
Lndistance	−0.000 (0.003)	0.001 (0.002)
Lndiscen	−0.417*** (0.006)	−0.414*** (0.003)
Hage	−0.004*** (0.000)	−0.004*** (0.000)
Lnsize	−0.005 (0.004)	−0.006*** (0.002)
Est	0.001** (0.000)	0.000** (0.000)
Bed_left	0.000* (0.000)	0.000 (0.000)
Lnfee	0.013** (0.007)	0.028*** (0.005)
Range	0.077*** (0.015)	0.030*** (0.011)
Constant	13.789*** (0.086)	13.635*** (0.053)
Observations	14,685	34,451
R-squared	0.584	0.605
District FE	Yes	Yes
Time FE	Yes	Yes

(1) the standard errors of regression coefficients are in parentheses. (2) ***, **, * indicate levels of significance at 1%, 5%, 10%, respectively

4.5 Heterogeneity analysis

4.5.1 Effects of different types of ECFs

Table 6 displays the two main types of ECFs, medical institutions and long household insurance, and the influence of relevant characteristics on the surrounding housing prices. It can be seen that, similar to the results in Table 2, other characteristics of the two main types of ECFs indicate a significant amenity effect, except for the NIMBY effect of size (Lnsize). Compared to the results in column 3 of Table 2, the results in columns 1 and 2 of Table 6 indicate that the impact of the scope of services (Range) on the surrounding housing prices is 7.7% and 3%, respectively, which increase by 2.6% and 0.4%, respectively.

4.5.2 Effects among different target audiences

Table 7 lists the services provided by ECFs for different target audiences, including the three categories of the elderly, the elderly living alone, and cognitive disorder patients.

Table 7 Effects among different target audiences

	(1) Whether the scope of service includes the elderly (1 = yes, 0 = no)	(2) Whether the scope of service includes the elderly living alone (1 = yes, 0 = no)	(3) Whether the scope of service includes cognitive disorder patients (1 = yes, 0 = no)
Variables	lnhprice	Lnhprice	lnhprice
Lndistance	0.006 (0.005)	0.011** (0.005)	0.007*** (0.002)
Lndiscen	− 0.465*** (0.007)	− 0.458*** (0.007)	− 0.430*** (0.006)
Hage	− 0.005*** (0.001)	− 0.005*** (0.001)	− 0.004*** (0.000)
Lnsize	− 0.010 (0.007)	− 0.007 (0.007)	− 0.016*** (0.002)
Est	0.003 (0.005)	0.005 (0.005)	0.000 (0.000)
Bed_left	− 0.002 (0.002)	0.001 (0.001)	0.000** (0.000)
Lnfee	0.009 (0.015)	0.014 (0.016)	0.004 (0.006)
Constant	14.310*** (0.144)	14.123*** (0.159)	13.988*** (0.078)
Observations	5,823	6,035	19,364
R-squared	0.658	0.656	0.613
District FE	Yes	Yes	Yes
Time FE	Yes	Yes	Yes

(1) the standard errors of regression coefficients are in parentheses. (2) ***, **, * indicate levels of significance at 1%, 5%, 10%, respectively

Table 8 Effects in different districts

	(1) Proportions of the Elderly less than or equal to 33%	(2) Proportions of the Elderly more than 33%
Variables	lnhprice	lnhprice
Lndistance	0.001 (0.003)	0.002 (0.002)
Lndiscen	−0.390*** (0.006)	−0.447*** (0.004)
Hage	−0.003*** (0.000)	−0.005*** (0.000)
Lnsize	−0.003 (0.002)	−0.012*** (0.002)
Est	0.000 (0.000)	0.000** (0.000)
Bed_left	0.000 (0.000)	0.000*** (0.000)
Lnfee	0.022*** (0.006)	0.010*** (0.003)
Range	−0.079*** (0.023)	0.073*** (0.010)
Constant	13.426*** (0.075)	14.172*** (0.051)
Observations	15,199	26,082
R-squared	0.580	0.636
District FE	Yes	Yes
Time FE	Yes	Yes

(1) the standard errors of regression coefficients are in parentheses. (2) ***, **, * indicate levels of significance at 1%, 5%, 10%, respectively

After considering this factor, the distance between the nearest ECFs (Lndistance) and residential communities is positive (columns 2 and 3), which indicates that the closer a residential community is to an ECF, the lower its housing prices will be. After considering this heterogeneity, most of the amenity effects generated by features of ECFs are absorbed and no longer significant.

4.5.3 Effects in different areas

Table 8 analyses the different impacts of ECFs in areas with varied proportions of the elderly population. According to statistics released by the Shanghai Civil Affairs Bureau 2018, the proportion of elderly people over the age of 60 in Shanghai is 33%. Thus, we divided the sample into two groups. In one group, the proportion of the elderly population in the area is less than or equal to 33%, while in the other group, the proportion of the elderly population in the area exceeds 33%.

The findings demonstrate that ECFs with more elderly people living in the residential communities lead to a greater NIMBY effect, and the negative impact of the scale of the ECFs (Lnsize) and the residential establishment time (Hage) is greater. It is worth mentioning that, with an increase of the proportion of the elderly population in a area, the effect of

the service scope (Range) changes from the NIMBY effect to the amenity effect. This also verifies that, to a certain extent, the demand groups determine the effect of ECFs.

5 Conclusion and discussions

This study investigated the impact of the establishment of ECFs on the values of houses in the surrounding residential communities and their heterogeneity. The findings demonstrate that, on the whole, the establishment of ECFs has a nonlinear impact on surrounding housing prices. Specifically, the size of an ECF has a NIMBY effect on housing prices: the bigger the ECF, the lower the housing prices of the surrounding residential community. However, some other features, such as vacancies, service scale, and year of establishment, demonstrate the amenity effect, which will increase the surrounding housing prices. After considering the distances between facilities and their nearest residential areas, the establishment times, and the different features of ECFs in Shanghai, the results were found to be clearly heterogeneous. We believe some of these findings will contribute to enriching the literature.

The policy implications of our findings may help local governments or other providers of ECFs to distinguish between amenity effects and NIMBY effect caused by the establishment of the ECFs. First, as a particularly important phenomenon in urban governance, although we are always worried about the NIMBY effect when making decisions about whether or not to establish an ECF, our study found that we should not be too concerned about the NIMBY effect, once we determine the appropriate size of the ECF in advance. At the same time, given the reasons for the NIMBY effect, the surrounding community residents should receive advice about the construction of an ECF in the community, in order to eliminate the impact of the NIMBY effect. When it comes to land selection criteria, we conclude that one should consider reserving a certain amount of space, which can reduce the negative NIMBY response. Second, considering that the establishment of ECFs will reduce or increase the prices of housing in the surrounding residential community, perhaps we should properly guide the expectations of the surrounding residents to prevent the fluctuation of housing prices. Governments should consider subjective initiatives and the interests of residents in urban planning and enterprises should pay more attention to location decisions when planning ECFs. Lastly, considering the heterogeneity of the effects, establishing ECFs is not a simple process and is affected by many factors. As Gallagher (2006) noted, a large number of community promotions before, during, and after the establishment of ECFs and corresponding facilities is conducive to solving the problem of the NIMBY effect. In addition to the influence of site selection and time, the establishment of ECFs should also take into account the characteristics of the local population, such as the proportion of the elderly population, in order to promote the rationalization of the scale and radiation range of facilities to maximize social welfare.

We admit that this paper has certain limitations. For example, with regard to the data collection, due to the lack of personal information and the subjective attitudes of the surrounding communities, there may be the possibility of inaccurate estimates of the supply of and demand for ECFs. In terms of the study design and data analysis, we only estimated the possible impacts and theoretical analysis, rather than using rigorous cause-and-effect identification. Nevertheless, our findings still have academic significance and practical implications for urban governance.

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