Revista Argentina de Clínica Psicológica
2021, Vol. XXX, N°2,579-591
DOI: 10.24205/03276716.2020.4060

The incentive effect of government strategy under the competition of heterogeneous nursing homes

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Abstract

This paper constructs a competition model consisting of social nursing home and profit-making nursing home, and analyzes the influence of government service quantity subsidy strategy, service quality subsidy strategy and service quality intervention strategy on the service quality and profit of the two types of nursing home. Results show that the different old-age pension policies on service quality of different incentive effect, the government intervention, the standard is low, the quality of government service quality under the intervention strategy level will be lower than the number of subsidies subsidies policy, strategy and quality and the quality of consumer preferences, due to quality competition instead of number under the subsidy policy of quality incentive is the most significant.

Keywords: Social nursing homes; Profit-making nursing homes; Competition; Government strategy; Incentive effect

1. Introduction

According to the data released by the China National Committee On Aging, by the end of 2019, there were 254 million people over 60 years old in China, accounting for 18.1% of the total population, indicating a huge demand for social elderly care services. However, China's traditional long-term care model for the elderly is facing severe challenges, making it an inevitable choice for China to deal with the aging problem in China by vigorously advancing social elderly care services. The Party and the government are highly concerned about this issue, and have intensively introduced some policy documents to promote the development of elderly care services, such as the Opinions of the General Office of the State Council on Advancing the No. 5 [2019] of the General Office of the State Council). Supported by state policies, social capital has flooded into the elderly care services industry, and China's elderly care services industry has accelerated its industrialization. At present, there are mainly two types of elderly care institutions available for the elderly. One is public nursing homes, which are not profit-oriented, and the other is private for-profit elderly care institutions, which are mainly profit-oriented [1]. Consumers' preferences for the two types of nursing homes vary, but the key factors influencing their choice are service price and service quality. Therefore, how to set reasonable prices and service quality for elderly care institutions is an essential issue that needs attention.

In recent years, the government has offered a variety of incentive strategies for the development of elderly care institutions, mainly in different forms of subsidy strategies, including subsidy strategies by the number of the elderly served, subsidy strategies by service quality and subsidy strategies based on service quality standards. In the campaigns dedicated to encouraging elderly care institutions to offer quality services, governments at all levels introduced a number of measures. Then, do governmental strategies really motivate elderly care institutions to improve service quality and serve more people? It is the primary issue to be studied in this paper.

Some scholars preliminarily discussed this issue from the perspectives of macroscopic supply and microscopic operation. In terms of macroscopic supply, Li Yuling analyzed and concluded that the quality improvement of elderly care services in China is faced with supply-side structural contradictions, imperfect comprehensive supervision mechanism, low professional quality of practitioners, and low

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integration of medical and health care [2]. In the context of China's national situation, Yang Yiyong and Han Xintong proposed to enhance the leading role of the government, carry out systematic planning, and raise funds through multiple channels to provide quality assurance for elderly care services, and also focus on the skills training of service personnel to improve the quality of service personnel [3]. In terms of microscopic operations of elderly care institutions, some scholars explored the quality decision-making of elderly care services. Zhang Zhiyong explored the quality decision-making of elderly care services from the perspective of elderly care service integrator and supply chain, and argued that the service quality decision-making of elderly care institutions would be influenced by the scale of demand [4-5]. Ms Yueru et al. discussed the supply chain coordination of elderly care services from the perspective of service quality control, and suggested that different types of coordination contracts should be used to achieve supply chain coordination of elderly care services according to the actual operations [6]. By constructing a game model of service quality of government-involved elderly care institutions, Yue Xianghua and Lin Yuming found that increasing penalties and government subsidies could help restrain elderly care institutions from violating the rules, and also motivate them to improve service quality [7]. In addition, some scholars studied the service quality and price decisions of public and private elderly care institutions in China, respectively [8-11]. Further, some scholars studied the ways to improve the quality of elderly care services from the perspective of government, community, institutional, and leadership interventions.

The above studies have mainly explored the quality decision making in elderly care services from the perspective of the supply chain of elderly care services, a single public elderly care institution or a private elderly care institution. But there are mainly two deficiencies. First, no research has been conducted to explore the competition of service quality among different types of elderly care institutions given the consumption preference of the elderly. Second, the impact of different incentive strategies of the government on the improvement of service quality in elderly care institutions fails to be analyzed deeply.

In summary, we intend to give answers in this paper to how the consumption preferences of the elderly affect the quality and profit decisions of elderly care institutions, how different government strategies affect the quality and profit decisions of elderly care institutions and what government strategies are more effective in motivating elderly care institutions to improve service quality. Through the study of these questions, we aim to provide management suggestions to improve the quality of elderly care services and enhance the effectiveness of government strategies.

2. Problem Description and Symbol Definitions

2.1 Problem description

This paper investigates the impact of different government subsidies on the pricing and service quality of non-profit nursing homes(S) and for-profit nursing homes (P) in the context of competition between these two types of nursing homes. In the non-profit elderly care model, nursing homes are financed by the government and owned by the government, but operated by private enterprises. Due to the public nature of this model, this type of nursing homes does not aim at profit maximization, but will consider consumer surplus in the objective function. It is assumed that the non-profit nursing home has a unit demand cost of c_S , a level of service quality at q_S and serves the elderly at a price of p_S . Improving service quality will incur costs, such as increasing maintenance staff or providing staff training. Therefore, according to Guo Qian and Wang Xiaoli[9], Hong and Guo[12], it is assumed that service quality cost has a quadratic relationship with service quality level. The level of service quality q_S will generate the cost of service quality at $kq_S^2/2$, indicating that the higher the level of service, the higher the cost. In the for-profit elderly care model, nursing homes are built or leased by the firm itself. It is assumed that the cost per unit of demand is c_P and its market price is, p_P and that the quality of its elderly care services is q_P at a cost of $kq_P^2/2$. This type of nursing homes will aim at profit maximization.

Market demand for the elderly. The elderly demand function is developed according to the Hotelling model, assuming a linear market of length 1, represented by a line segment of [0,1]. The non-profit nursing home and the for-profit nursing home are located at the two ends of the linear market, respectively. Older adults are uniformly distributed in a linear market of length 1. The position of the elderly in the linear market indicates the ideal point of prefe-

rence of the elderly for nursing homes of different attributes. Seniors who prefer non-profit nursing homes are located closer to the non-profit nursing home. Similarly, seniors who prefer for-profit nursing homes are located closer to the for-profit nursing home. Older adults pay a unit utility cost when purchasing different quality of elderly care services, which is often seen as a switching cost resulting from the difference between the service and the older adult's preferences. The utility of the elderly is determined by the perceived quality, the price paid, and the switching costs. The effect function is therefore as follows:

$$U_S = \theta q_S - p_S - \eta x_S$$
$$U_P = \theta q_P - p_P - \eta x_P$$

Where θ indicates the sensitivity coefficient of the elderly to the quality of elderly care services. The greater θ, the more importance the elderly attach to service quality. η indicates the unit utility cost of the elderly switching between various elderly care institutions. x_S indicates the demand for non-profit elderly care institutions and x_P indicates the demand for for-profit elderly care institutions, x_P plus x_P is 1, indicating that the total social demand is 1.

The elderly choose the service of the nursing home based on the comparison of their utility. In case that $U_S > U_P$, the elderly will choose to purchase services in non-profit nursing homes. Otherwise, they will choose for-profit nursing homes . In case that $U_S = U_P$, the elderly's preference has undifferentiated utility, which means that $\bar{x} = \frac{\eta + p_P - p_S - \theta(q_P - q_S)}{2\eta}$. Therefore, the demand for non-profit and for-profit nursing homes is as follows:

$$x_S = \frac{\eta + (p_P - p_S) - \theta(q_P - q_S)}{2\eta}, \quad x_P = \frac{\eta - (p_P - p_S) + \theta(q_P - q_S)}{2\eta} \quad (1)$$

Non-profit nursing homes take into account the consumer surplus when maximizing benefits. Therefore, based on the demand under undifferentiated preferences, the consumer surplus of non-profit elderly care institutions can be obtained as CI_S below:

$$CI_S = \int_0^{\bar{x}} U_S dx = \frac{(p_S - p_P - \eta + \theta(q_P - q_S))(\eta + p_P + 3p_S - \theta q_P - 3\theta q_S)}{8\eta} \quad (2)$$

Government subsidies. In 2019, the General Office of the State Council issued the Opinions on Advancing the Development of Elderly Care Services, which made specific arrangements for the work of elderly care services and pointed out that subsidies should be given to nursing homes regardless of their attributes. Based on the reality, we compared the effectiveness of the subsidies based on the number of the elderly served with that of the subsidies based on service quality. Under the subsidy strategy by the number of the elderly served, the government subsidizes the nursing homes in accordance with the number of the elderly they serve as s_1, which is set as an incentive for nursing homes to absorb as many elderly people as possible. Under the subsidy strategy by service quality, the government subsidizes the nursing homes in accordance with their service quality as s_2. Referring to the study of Qian Guo and Hao-Li Wang [21], it is assumed that the cost of subsidy is quadratically related to the level of quality. The amount of government subsidies for non-profit nursing homes and for-profit nursing homes are marked as $s_2 q_S^2$ and $s_2 q_P^2$. This paper compares the impact of these two types of subsidy strategies on the pricing and service quality of nursing homes of different attributes by portraying the subsidies by the number of the elderly served and the subsidies by service quality.

2.2 Symbol definitions

The main parameters involved in this paper are shown in Table 1.

Table 1 Symbol definitions

Parameter	
i	Elderly care services model, $i = \{S, P\}$, where S represents non-profit elderly care institutions, P represents for-profit elderly care institutions
c_S	Unit operating costs of non-profit nursing homes
c_P	Unit operating costs of for-profit nursing homes

η	Unit utility costs for older adults switching between elderly care institutions
θ	Coefficient of relative consumer preference for price and quality
x_S	Demand for non-profit elderly care institutions
x_P	Demand for for-profit elderly care institutions
s_1	Government subsidy per unit price of elderly care services under the government subsidy strategy by the number of the elderly served
s_2	Government subsidy by service quality under the government subsidy strategy by service quality
s_3	Government subsidy by service quality under the government subsidy strategy by service quality intervention
$\bar{q}$	Minimum quality standards for subsidies under the government subsidy strategy by service quality intervention
k	Cost coefficient of service quality
Decision variables	
p_S	Market price of services in non-profit nursing homes
p_P	Market price of services in for-profit nursing homes
q_S	Service quality of non-profit nursing homes
q_P	Service quality of for-profit nursing homes

3. Modeling

In this study, a market competition model consisting of a non-profit nursing home and a for-profit nursing home was established. The effects of the government subsidy strategy by the number of the elderly served and the subsidy strategy by service quality on the pricing and service quality decision-making of the two nursing homes were analyzed. Superscripts l and t represent the subsidy strategy by the number of the elderly served and the subsidy strategy by service quality.

3.1 The subsidy strategy by the number of the elderly served

In the case of government subsidies for elderly residents, non-profit nursing homes aim to maximize profits that include consumer surplus, and the profit function is shown below.

$$\underset{p_S^l, q_S^l}{\text{Max}}\ \pi_S^l = \left(p_S^l - c_S\right)x_S^l - k\left(q_S^l\right)^2/2 + s_1 x_S^l + CI_S^l \tag{3}$$

From the above equation, the first term is the profit from the sale of non-profit nursing homes in the market, the second term is the cost of service quality, the third term is the government subsidy based on the number of elderly people served by elderly care institutions, and the last term is the consumer surplus. Non-profit nursing homes will decide the market price and service quality level based on welfare maximization. For for-profit nursing homes, the profit function is as follows:

$$\underset{p_P^l, q_P^l}{\text{Max}}\ \pi_P^l = \left(p_P^l - c_P\right)x_P^l - k\left(q_P^l\right)^2/2 + s_1 x_P^l \tag{4}$$

For-profit nursing homes aim to maximize their own profits.The first term in the above equation represents the profit generated by providing elderly care services to the market, the second term is the cost of service quality, and the third term is the government subsidy based on the number of the elderly served. Similarly, the elderly care services organization will decide its market price and service quality level. In the competitive model, the decision sequence of the two institutions is as follows: first, non-profit nursing homes and for-profit nursing homes decide their service quality level at q_S^l and q_P^l, and then decide their market price at p_S^l and p_P^l according to service quality according to service quality respectively.

According to the inverse solution method, the optimal market price is calculated first, and the result is shown in Proposition 1.

Proposition 1: Under the government subsidy strategy by the number of the elderly served, the optimal decisions of nursing homes are:

$$p_S^{l*} = c_P + 4\,c_S + 3\eta - 5s_1 + \frac{3\theta^2\left(s_1 - c_S\right)}{\theta^2 - k\eta},$$

$$p_P^{l*} = c_P + 2c_S + 2\eta - 3s_1 + \frac{2\theta^2\left(s_1 - c_S\right)}{\theta^2 - k\eta},$$

$$q_S^{l*} = \frac{\theta\left(c_S - s_1\right)}{\theta^2 - k\eta},\quad q_P^{l*} = 0.$$

By introducing Proposition 1 into the equations (3) and (4), the optimal profit functions of non-profit and for-profit nursing homes under the government subsidy strategy by the number of the elderly served, as

$$\pi_S^{l*} = \frac{k\left(s_1 - c_S\right)^2}{2k\eta - \theta^2},$$

$$\pi_P^{l*} = \frac{2\left(\theta^2 - k\left(c_S + \eta - s_1\right)\right)^2}{\left(\theta^2 - k\eta\right)^2}.$$

3.2 The subsidy strategy by service quality

When the government subsidized nursing homes, the demand function of the two types of elderly care institutions was still shown in Equation (1). In this case, the profit function of non-profit nursing homes is shown as follows.

$$\underset{p_S^t, q_S^t}{\text{Max}}\ \pi_S^t = \left(p_S^t - c_S\right)x_S^t - k\left(q_S^t\right)^2/2 + CI_S^t + s_2 q_S^t \quad (5)$$

From the above Equation, the first term is the profit of non-profit nursing homes selling in the market, the second term is the cost of service quality, the third term is the consumer surplus, and the last term is the government subsidy. Non-profit nursing homes will decide the market price and service quality level based on welfare maximization. For for-profit nursing homes, the profit function is as follows:

$$\underset{p_P^t, q_P^t}{\text{Max}}\ \pi_P^t = \left(p_P^t - c_P\right)x_P^t - k\left(q_P^t\right)^2/2 + s_2 q_P^t \quad (6)$$

From the above Equation, it is clear that the profit of for-profit nursing homes consists of three components: sales revenue, service quality cost, and government subsidy. Similarly, the two elderly care institutions first decide theservice quality q_S^t and q_P^t, and then decide the service price p_S^t and p_P^t. By calculation, Proposition 2 can be obtained.

Proposition 2: Under the government subsidy strategy by service quality, the optimal decision of nursing homes is expressed as follows:

$$p_S^{t*} = c_P + 4\,c_S + 3\eta - \frac{\theta s_2}{k} + \frac{3\theta\left(\eta s_2 - \theta c_S\right)}{\theta^2 - k\eta},$$

$$p_P^{t*} = c_P + 2\left(c_S + \eta + \frac{\theta\left(\eta s_2 - \theta c_S\right)}{\theta^2 - k\eta}\right),$$

$$q_S^{t*} = \frac{\theta c_S - \eta s_2}{\theta^2 - k\eta},\quad q_P^{t*} = \frac{s_2}{k}.$$

Substitute proposition 2 into Formula (5) and (6), and the optimal profit function of social nursing home and profit-making nursing home under the government service quality subsidy strategy can be respectively written

$$\pi_S^{t*} = \frac{c_S^2 k - 2\theta c_s s_2 + \eta s_1^2}{2k\eta - 2\theta^2},$$

$$\pi_P^{t*} = \frac{4k\eta\left(\theta^2 - k\left(c_S + \eta\right)\right)^2 + 8k\eta\theta s_2\left(\theta^2 - k\left(c_S + \eta\right)\right) + s_2^2\left(\theta^2 + k\eta\right)^2}{2k\left(\theta^2 - k\eta\right)^2}$$

By introducing Proposition 2 into the equations (5) and (6) , the optimal profit functions of non-profit and for-profit nursing homes under the government subsidy strategy by service quality can be obtained as

$$\pi_S^{t*} = \frac{c_S^2 k - 2\theta c_s s_2 + \eta s_1^2}{2k\eta - 2\theta^2},$$

$$\pi_P^{t*} = \frac{4k\eta\left(\theta^2 - k\left(c_S + \eta\right)\right)^2 + 8k\eta\theta s_2\left(\theta^2 - k\left(c_S + \eta\right)\right) + s_2^2\left(\theta^2 + k\eta\right)^2}{2k\left(\theta^2 - k\eta\right)^2}$$

3.3 The subsidy strategy by service quality intervention

In addition to direct subsidies based on service quality, the government can also provide incentives for nursing homes to improve their quality through service quality interventions. In this case, instead of subsidizing all nursing homes, the government only subsidizes nursing homes that achieve the service quality standards. Suppose that the government sets the subsidy quality standard at $\overline{q}$ and the subsidy per unit at s_3, and subsidizes the quality cost directly. The profit function of non-profit nursing homes can be therefore obtained as follows:

$$\underset{p_S^r, q_S^r}{\text{Max}}\ \pi_S^r = \left(p_S^r - c_S\right)x_S^r - k\left(q_S^r\right)^2/2 + CI_S^r + s_3\left(q_S^r - \overline{q}\right)^2 \tag{7}$$

From the above Equation, the first term is the profit of non-profit nursing homes selling in the market, the second term is the cost of service quality, the third term is the consumer surplus, and the last term is the government subsidy for service cost. Non-profit nursing homes will decide the market price and service quality level based on welfare maximization. For for-profit nursing homes, the profit function is as follows:

$$\underset{p_P^r, q_P^r}{\text{Max}}\ \pi_P^r = \left(p_P^r - c_P\right)x_P^r - k\left(q_P^r\right)^2/2 + s_3\left(q_P^r - \overline{q}\right)^2 \tag{8}$$

From the above Equation, it is clear that the profit of for-profit nursing homes consists of three components: sales revenue, service quality cost, and government subsidy. Similarly, the two elderly care institutions first decide theservice quality q_S^r and q_P^r, and then decide the service price p_S^r and p_P^r. By calculation, Proposition 3 can be obtained.

Proposition 3: Under the government subsidy strategy by service quality intervention, the optimal decisions of nursing homes are:

$$p_S^{r*} = c_P + 4\,c_S + 3\eta + \frac{2\theta s_3\overline{q}}{k - 2s_3} - \frac{3\theta\left(2\eta s_3\overline{q} + \theta c_S\right)}{\theta^2 - k\eta + 2\eta s_3}$$

$$p_P^{r*} = c_P + 2\left(c_S + \eta - \frac{\theta\left(2\eta s_3\overline{q} + \theta c_S\right)}{\theta^2 - k\eta + 2\eta s_3}\right),$$

$$q_S^{r*} = \frac{\theta c_S + 2\eta s_3\overline{q}}{\theta^2 - k\eta + 2\eta s_3},\quad q_P^{t*} = \frac{2s_3\overline{q}}{2s_3 - k}.$$

By introducing Proposition 3 into the equations (7) and (8) , the optimal profit functions of non-profit and for-profit nursing homes under the government subsidy strategy with service quality intervention can be obtained as follows:

$$\pi_S^{r*} = \frac{c_S^2\left(k - 2s_3\right) + 4\theta c_s s_3\overline{q} + 2s_3\left(\overline{q}\right)^2\left(k\eta - \theta^2\right)}{2k\eta - 2\left(\theta^2 + 2\eta s_3\right)},$$

$$\pi_P^{r*} = \frac{ks_3\left(\overline{q}\right)^2\left(k - 2s_3\right)}{\left(k - 2s_3\right)^2} + \frac{2\eta\left(\theta^2 - k\left(c_S + \eta\right) + 2s_3\left(c_S + \eta - \theta\overline{q}\right)\right)^2}{\left(\theta^2 - k\eta + 2\eta s_3\right)^2}.$$

3.4 Comparative analysis of government strategies

From the above analysis, it is clear that the optimal decisions of non-profit nursing homes and for-profit nursing homes will varygreatly under different government strategy scenarios. However, the extent to which the impact of different government strategies on the two types of nursing homes varies needs to be further examined. The impact of the subsidy strategy by the number of the elderly served, the subsidy strategy by service quality and the subsidy strategy by service quality intervention on the optimal selling price of non-profit nursing homes was analyzed. It can be found that in the feasible domain $k > \theta^2/\eta$ and $k < 2s_3$, when the government's unit price subsidy for the elderly s_1, the government's subsidy by service quality for nursing homes s_2 and the government's subsidy to meet or exceed the minimum service quality standard s_3 are within different thresholds, the effects of different government strategies on optimal selling price, optimal service quality and optimal demand for non-profit and for-profit nursing homes are significantly different. It leads to Propositions 4-8.

Proposition 4: Under different government strategies, the following can be concluded by

comparing the optimal service quality of non-profit nursing homes:

(1) When $\eta > \theta$ and $s_2 > \Gamma_{32}$, q_S^t is the highest; When $0 < s_1 < \Gamma_{31}$ and $0 < s_2 < \Gamma_{32}$, q_S^r is the highest; when $s_1 > \Gamma_{31}$ and $0 < s_2 < \Gamma_{32}$, q_S^l is the highest.

(2) When $\eta < \theta$ and $0 < s_1 < \Gamma_{31}$ and $s_2 > \Gamma_{32}$, q_S^t is the highest; when $0 < s_1 < \Gamma_{31}$ and $0 < s_2 < \Gamma_{32}$, q_S^r is the highest; when $s_1 > \Gamma_{31}$, q_S^l is the highest.

Where

$$\Gamma_{31} = \frac{4\eta s_3\left(c_S\theta + k\eta\bar{q} - \theta^2\bar{q}\right)}{2\theta\left(\theta^2 - k\eta + 2\eta s_3\right)},$$

$$\Gamma_{32} = \frac{2s_3\left(c_S\theta + k\eta\bar{q} - \theta^2\bar{q}\right)}{\theta^2 - k\eta + 2\eta s_3},\ \Gamma_{33} = \frac{\eta s_1}{\theta}.$$

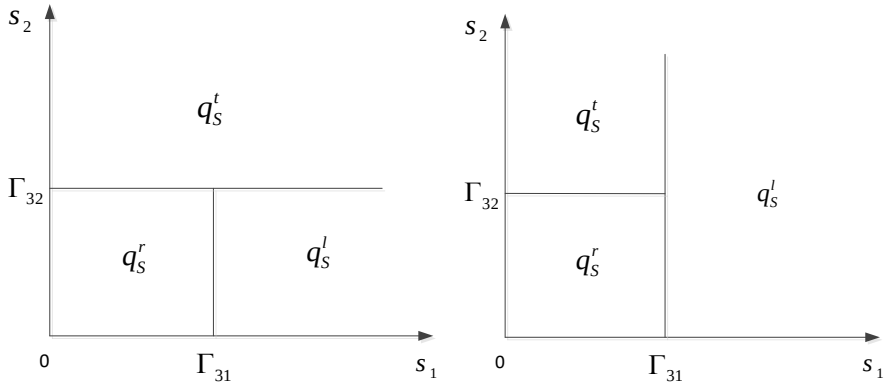

Figure 1 Comparison of optimal service quality of non-profit nursing homes

In order to have a better understanding of Proposition 6, the results can be represented as Figure 1. As shown in the figure, when it meets the condition $\eta > \theta$, the coefficient of switching cost is higher than the coefficient of preference for quality at the time. In this case, the lower the government quality standard ($\bar{q}$), the more the government's direct quality subsidies will stimulate the non-profit nursing homes to improve the service quality level. The higher the standard of government quality intervention ($\bar{q}$), the higher the service quality level that nursing homes will provide in order to meet the quality standard than other government strategies, meaning that the service quality under the subsidy strategy by service quality intervention will be the highest. However, the subsidy strategy by service quality intervention will be less effective in improving the level of service quality when the intervention standard ($\bar{q}$) is higher and the subsidy given at the time of intervention (s_3) is lower. At this point, subsidizing nursing homes based on the number of the elderly served may be a more favorable way to motivate the service quality level to improve. When it meets the condition $\eta < \theta$, it can be found that the highest level of service quality under the subsidy strategy by service quality shifts to the subsidy strategy by the number of the elderly served. It may be that when the preference coefficient for quality is higher than the switching cost coefficient, it means that improving quality will be a better incentive for the elderly to purchase services, but it will increase the quality competition between non-profit and for-profit elderly care institutions. Therefore, subsidies based on service quality do not provide incentives for nursing homes to improve their service quality, while subsidies based on the number of the elderly served have a more significant effect on their service quality.

Proposition 5: Under different government strategies, the following can be concluded by comparing the optimal service quality of for-profit nursing homes: In case that $2s_2s_3 < k\left(s_2 + 2\bar{q}s_3\right)$, $q_P^t < q_P^r$; otherwise, $q_P^t > q_P^r$.

The government's subsidy strategy by service quality intervention only targets non-profit nursing homes. Therefore, the impact of the subsidy strategy by service quality and the subsidy strategy by service quality intervention on the optimal service quality of for-profit nursing homes was discussed here. From Proposition 5, it can be seen that the factors that influence the effect of both strategies are mainly cost efficient of service quality k, the subsidy quality standard set by the government $\bar{q}$ and its unit

subsidy s_3, and the government subsidy on service quality of nursing homes s_2. There is no significant effect of government subsidies on the price of nursing homes s_1 on the implementation of different government strategies. It can be seen that, for for-profit nursing homes, the subsidy strategy by service quality or the subsidy strategy by service quality intervention works better than the subsidy strategy by service price.

Proposition 6: By comparing the optimal selling price of non-profit and for-profit nursing homes, it can be concluded that:

(1) When

$$0 < s_1 < \frac{2c_S k\eta + k\eta^2 - (c_S + \eta)\theta^2}{2k\eta - \theta^2},$$

$p_P^l < p_S^l$;

otherwise, $p_P^l > p_S^l$;

(2) When

$$0 < s_2 < \frac{k\eta(k\eta - \theta^2)}{2k\eta\theta - \theta^2}$$

Or

$$s_2 > \frac{k\eta(k\eta - \theta^2)}{2k\eta\theta - \theta^2}$$

And

$$c_S + \eta - \frac{k\eta^2}{2k\eta - \theta^2} > \frac{\eta s_2}{k},\ p_P^t < p_S^t;$$

otherwise, $p_P^t > p_S^t$;

(3) When

$$0 < \bar{q} < \left(\frac{k - 2s_3}{2\theta s_3}\right)\left(\frac{\eta(\theta^2 - k\eta + 2\eta s_3)}{2k\eta - \theta^2 - 4\eta s_3} - c_S\right),$$

$p_P^r < p_S^r$;

otherwise, $p_P^r > p_S^r$.

From Proposition 6, it can be seen that the subsidy methods implemented by the government under different strategies have a significant effect on the magnitude of the optimal sales price of non-profit nursing homes and for-profit nursing homes. The common ground lies in that under each strategy, the optimal sales price of non-profit nursing homes is either higher (or lower) than the optimal sales price of for-profit nursing homes when the corresponding subsidy strategy implemented satisfies a certain condition. In contrast, the magnitude of the optimal sales price of non-profit and for-profit nursing homes is the opposite of the aforementioned case when the corresponding subsidy strategy is implemented in a threshold range other than that condition.

Proposition 7: By comparing the optimal service quality of non-profit and for-profit nursing homes, it can be concluded that:

(1) When

$s_1 > c_S$, $q_P^l < q_S^l$;

otherwise,

$q_P^l = q_S^l = 0$;

(2) When

$0 < s_2 < kc_S / \theta$, $q_P^t < q_S^t$;

otherwise, $q_P^t > q_S^t$;

(3) When

$$0 < \bar{q} < \frac{c_S(2s_3 - k)}{2\theta s_3},\ q_P^r < q_S^r;$$

otherwise, $q_P^r > q_S^r$.

From Proposition 7, it is clear that in the case of the subsidy strategy implemented by the government by the number of the elderly served, the optimal service quality of non-profit nursing homes is higher than that of non-profit nursing homes only if the government's unit subsidyprice for the elderly s_1 is higher than the unit operating cost of non-profit nursing homes c_S. The optimal service quality of both non-profit and for-profit nursing homes is zero when the government's unit subsidy price s_1 for seniors is higher than the unit operating cost of non-profit nursing homes c_S. Generally speaking, nursing homes are willing to provide high quality elder care services only if the price is higher than the cost, because in a market-oriented environment, no nursing home is willing to operate at a loss. In the case of the subsidy strategy by service quality implemented by the government, the service quality of non-profit nursing homes is higher than that of for-profit nursing homes when it satisfies the condition $0 < s_2 < kc_S / \theta$. Otherwise, the service quality of for-profit nursing homes is higher. It shows that low government subsidies by service quality do not provide incentives for for-profit elderly care institutions to improve their service quality. However, if the subsidy level can be increased, the service quality level of for-profit elderly care institutions will

rise and become significantly higher than that of non-profit elderly care institutions. In the case of the subsidy strategy by service quality intervention implemented by the government, in addition to the influence of these three factors, c_S, k and θ, the subsidy is also influenced by the government's per unit subsidy s_3 when the subsidy quality standard $\bar{q}$ is exceeded. When the minimum service quality standard set by the government meets the condition $0 < \bar{q} < \frac{c_S(2s_3 - k)}{2\theta s_3}$, the service quality of non-profit nursing homes is higher than that of for-profit nursing homes, and vice versa.

Proposition 8: By comparing the optimal demand of non-profit and for-profit nursing homes, it can be concluded that :

(1) When $s_1 > c_S + \frac{1}{2}\left(\eta - \frac{\theta^2}{k}\right)$, $x_P^l < x_S^l$;

otherwise, $x_P^l > x_S^l$;

(2) When $s_2 > \frac{2c_S k + k\eta - \theta^2}{2\theta}$, $x_P^t < x_S^t$;

otherwise, $x_P^t > x_S^t$;

(3) When $\bar{q} > \frac{2c_S(2s_3 - k) + \eta(2s_3 - k)}{4\theta s_3}$, $x_P^r < x_S^r$;

otherwise, $x_P^r > x_S^r$.

From Proposition 8, we can find that when the government implements the subsidy strategy by the number of the elderly served and the subsidy strategy by service quality, the optimal demand of non-profit and for-profit nursing homes was affected by the unit operating cost of non-profit nursing homes c_S, cost efficient of service quality k, and the relative customer preference coefficient for price and quality θ and the unit utility cost of the elderly switching between elderly care institutions η. When the government's subsidy for the elderly per unit price s_1 and the government's subsidy for nursing homes by service quality s_2 was greater than a specific threshold value, the optimal demand of non-profit nursing homes was greater than that of for-profit nursing homes and vice versa. In the case of the government subsidy strategy by service quality intervention, in addition to being affected by the four factors mentioned above, the optimal demand for non-profit and for-profit nursing homes is also affected by the government's unit subsidies s_3 when the subsidized quality standard $\bar{q}$ is exceeded. Similarly, when the value is above a certain threshold, the optimal demand of non-profit nursing homes is higher than that of for-profit nursing homes; otherwise, it is lower than the optimal demand of for-profit nursing homes.

4. Numerical analysis

To further understand the optimal decisions of "non-profit" nursing homes and "for-profit" nursing homes under different scenarios, this paper will conduct numerical analysis. Referring to the existing studies in operational decisions of nursing homes under governmental actions [1], it is set as $c_s = 50$, $c_p = 40$, $\eta \in [1,10]$, $\theta \in [0,1]$, s_1=200, s_2=30, s_3=30, $k \in [1,2]$, $\bar{q}$=0.5. The effect of each variable on the service quality and profitability of different types of nursing homes will be examined by varying the parameter values.

4.1 Influence of the unit utility cost of the elderly switching between elderly care institutions

Figure 1 shows the relationship between the unit utility cost of the elderly switching between elderly care institutions η and the optimal service quality of non-profit nursing homes and for-profit nursing homes q^*. From Figure 1, it can be seen that as η rises, the service quality of non-profit nursing homes tends to decrease rapidly under the government subsidy strategy by the number of the elderly served. In the government strategy by service quality, it presents an increasing trend at first faster and then slower, and when it increases to a certain threshold, the quality level of elderly care services would exceed the level of service quality under the government subsidy strategy by the number of the elderly served. Under the government subsidy strategy by service quality intervention, it shows an extremely slow decreasing trend and the overall level is low. The service quality level of for-profit nursing homes is constant under all three government strategies, and is not necessarily related to the size of η, mainly manifested as $q^*_{st} > q^*_{sr} > q^*_{sl}$. The level of service quality under the government subsidy strategy by service quality is much higher than that under the

other two government strategies and the level of service quality under the other two strategies is lower, which indicates that the government subsidy strategy by service quality has a stronger incentive effect compared with the other two strategies.

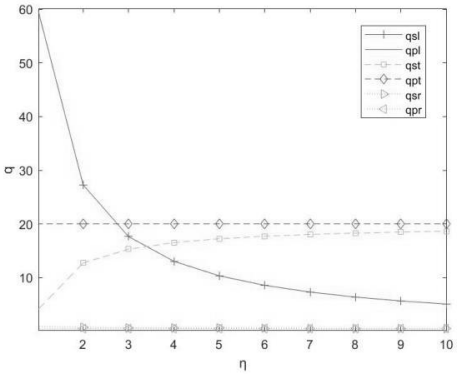

Figure 1 The relationship between η and q^*

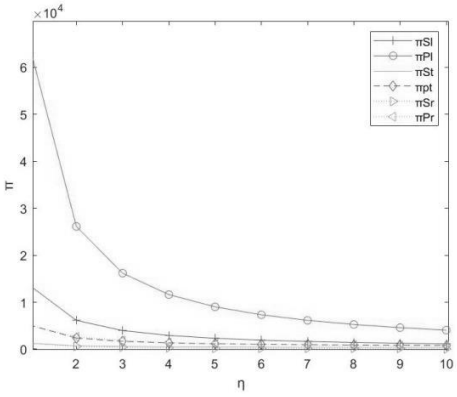

Figure 2 The relationship between η and π^*

Figure 2 analyzes the relationship between the unit utility cost of the elderly switching between elderly care institutions η and the optimal profits of non-profit nursing homes and for-profit nursing homes π^*. It shows that as η rises, the profits of non-profit and for-profit nursing homes present a declining trend under the three government strategies, expressed as $\pi^*_{Pl} > \pi^*_{Sl} > \pi^*_{Pr} > \pi^*_{Pt} > \pi^*_{St} > \pi^*_{Sr}$. Under the government subsidy strategy by the number of the elderly served, the profit of for-profit nursing homes were the highest but declined at the fastest rate, followed by that of non-profit nursing homes under the government subsidy strategy by the number of the elderly served. The profit of non-profit nursing homes varied insignificantly under the government subsidy strategy by service quality and the government subsidy strategy by service quality intervention. And there were no significant differences between the profits of for-profit nursing homes under the two government strategies. In both policy strategies, the profit level of for-profit nursing homes is higher than that of non-profit nursing homes. It suggests that the three government intervention strategies are conducive to improving the profitability of for-profit nursing homes and promoting the market-oriented advancement of elderly care services.

4.2 The influence of the relative consumer preference coefficient for price and quality

Figure 3 shows the relationship between the relative consumer preference coefficient for price and quality θ and the optimal service quality of non-profit nursing homes and for-profit nursing homes q^*. And it indicates that, as θ rose, the q^* coefficient of non-profit nursing homes rose rapidly under the government subsidy strategy by the number of the elderly served from the minimum level to the level exceeding that under other two strategies. The q^* coefficient of non-profit nursing homes declined under the government subsidy strategy by service quality, but its service quality was always higher than that under the government subsidy strategy by service quality intervention. However, the q^* coefficient of non-profit nursing homes rose extremely slowly under the government subsidy strategy by service quality intervention. And with the increase of θ, it maintained at a low level as a whole. The q^* coefficient of for-profit nursing homes was free from θ and $q^*_{pt} > q^*_{pr} > q^*_{pl}$. It indicates that the government subsidy strategy by service quality played a most significant role in stimulating the improvement of service quality in for-profit nursing homes .

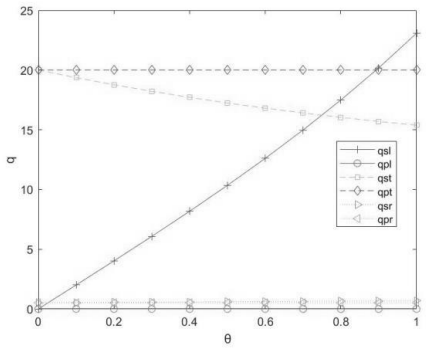

Figure 3 The relationship between θ and q^*

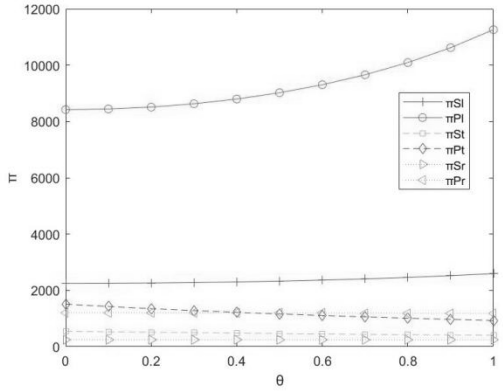

Figure 4 The relationship between θ and π^*

Figure 4 analyzed the relationship between the relative consumer preference coefficient for price and quality θ and the optimal profit of non-profit nursing homes and for-profit nursing homes π^*. As θ rose, $\pi^*_{Sl} > \pi^*_{St} > \pi^*_{Sr}$ and $\pi^*_{Pl} > \pi^*_{Pt} > \pi^*_{Pr}$. It can be seen that the profits of non-profit nursing homes and for-profit nursing homes were the highest under the government subsidy strategy by the number of the elderly served and the lowest under the government subsidy strategy by service quality intervention. The profit of non-profit nursing homes increased slowly under the government subsidy strategy by the number of the elderly served and declined extremely slowly under the government subsidy strategy by service quality, while changing insignificantly under the government subsidy strategy by service quality intervention. The profit of for-profit nursing homes rose first slowly and then faster under the government subsidy strategy by the number of the elderly served with the highest level on the whole, decreased slowly under the government subsidy strategy by service quality, and had no significant changes under the government subsidy strategy by service quality intervention. It indicates that the government subsidy strategy by the number of the elderly served positively promoted the profitability of non-profit and for-profit nursing homes.

4.3 Analysis of the influence of cost efficient of service quality

Figure 5 analyzed the relationship between the cost efficient of service quality k and the optimal service quality of non-profit nursing homes and for-profit nursing homes q^*. As k rose, $q^*_{st} > q^*_{sl} > q^*_{sr}$ and $q^*_{pt} > q^*_{pr} > q^*_{pl}$. In terms of the government strategy by service quality, the service quality of the two types of nursing homes is the highest. The overall level of profit of for-profit nursing homes is the highest under the government subsidy strategy by service quality, and it shows a decreasing trend. It was followed by the profit of non-profit nursing homes under the government subsidy strategy by service quality and the subsidy strategy by the number of the elderly served, presenting a declining trend. The profit performance of for-profit and non-profit nursing homes is not significantly different under the government subsidy strategy by service quality intervention. The results showed that this strategy had no significant effect on the profitability of the two types of nursing homes.

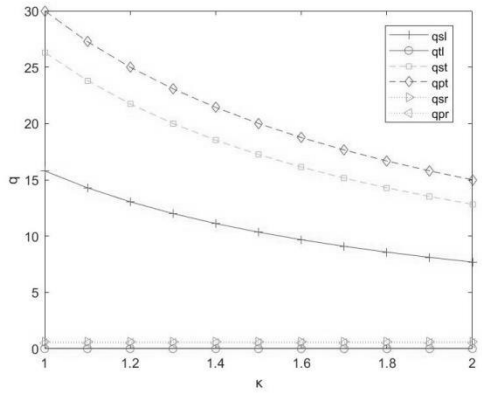

Figure 5 The impact of k on service quality

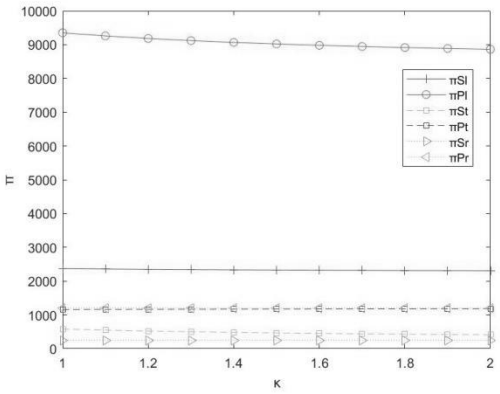

Figure 6 The impact of k on profits

Figure 6 analyzed the relationship between the cost efficient of service quality k and the optimal profits of non-profit nursing homes and for-profit nursing homes π^*. As k rose, $\pi^*_{Sl} > \pi^*_{St} > \pi^*_{Sr}$. It can be seen that the profit of non-profit nursing

homes declined at an extremely slow rate under the government subsidy strategy by service quality and the subsidy strategy by the number of the elderly served, but changed insignificantly under the government subsidy strategy by service quality intervention, with a lowest level of profit. For-profit nursing homes had the greatest profit under the subsidy strategy by the number of the elderly served but it declined at a slow rate. But it had no significant changes under the government subsidy strategy by service quality and the government subsidy strategy by service quality intervention, with no significant differences in profit level. It shows that with the increase of service quality cost, nursing homes will reduce the overall cost by reducing service quality, which will damage the quality of services provided by nursing homes for the elderly to a certain extent. At this point, the effect of the government strategy by service quality is obviously stronger than that of the government strategy by service quality.

The results show that the incentive effect of the government's elderly care strategy on the quality of elderly care services differs for elderly care institutions of different attributes. For non-profit elderly care institutions, the quality level under the subsidy strategy by service quality would be higher if the quality standards were set lower when consumers were more cost-sensitive. If the quality standards are raised, the subsidy strategy by service quality intervention will result in a significant increase in quality levels due to the higher standards. But in the absence of attractive subsidies at this time, the quality level of the subsidy strategy by the number of the elderly served would be higher. When consumers prefer quality, the government strategy by service quality is not conducive to incentivising nursing homes to improve service quality. The incentive effect of the strategy by the number of the elderly served on the service quality of nursing homes was more significant. For for-profit elderly care institutions, it is also found that unless high quality intervention standards are set, the government subsidy strategy by service quality tends to trigger higher service quality than the subsidy strategy by service quality intervention.

5. Conclusion

Comparing the quality levels under different strategies, it was found that under the government subsidy strategy by service quality, the lower government quality subsidy did not provide an incentive for for-profit elderly care institutions to improve the quality level.However, if the subsidy level can be increased, the quality of for-profit elderly care institutions will be significantly improved, which is higher than that of non-profit elderly care institutions. At the same time, it is found that under the government strategy by service quality intervention, if the quality intervention standard is moderate, It can better promote non-profit elderly care institutions to provide elderly care services of high quality. On the contrary, too high a standard of intervention may reduce the incentive effect. When the subsidy amount is higher or the quality intervention standard is higher, non-profit elderly care institutions will occupy more market demand because they can provide higher quality of elderly care services. Conversely, when government funding is limited, for-profit elderly care institutions have a higher market share. Compared to for-profit elderly care institutions, non-profit elderly care institutions are more sensitive to changes in various parameters due to their public nature. When the government subsidized nursing homes by the number of the elderly served, it was more beneficial for for-profit nursing homes to improve their profitability. The government subsidy strategy by service quality has a more significant effect on the improvement of service quality of for-profit nursing homes. It demonstrates that in the early stage of market-oriented advancement of elderly care services, it is necessary to improve the quantity and scale to promote the development of the industry, and the improvement of service quality should be carried out steadily.

Acknowledge

The National social science fund major project (No.17ZDA326); the Ministry of Education Humanities and social science planning fund project (No.19YJA630053); the Hunan social science fund key project (No. 19ZDB52)

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