Game theory-oriented research and simulation analysis of housekeeping credit

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Abstract. The paper studies credibility issues in the housekeeping industry based on the aspect of the theory of game. Domestic service personnel cut work and reduce time, business capabilities are not up to standard, and domestic enterprise supervision is not in place, causing consumers’ dissatisfaction. This article points out that housekeeping companies can strengthen the relationship with employees and encourage employees to choose integrity; housekeeping service personnel need to improve their self-service capabilities; at the same time, consumers need to respond to the situation based on facts. This can better maintain the integrity of the housekeeping industry and increase consumer satisfaction. The game results show that when the housekeeping enterprise strengthens supervision, the housekeeping service staff will tend to operate with integrity, and when the housekeeping service personnel are honest, the probability of consumer complaints will also decrease. Finally, this article uses Matlab to simulate the integrity of the housekeeping industry based on games for the first time, allowing us to more clearly understand the relationship between different factors and the decision-making probability of each party to verify the game results.

1. Introduction
In the context of supply-side structural reforms, the housekeeping industry is developing rapidly, and more and more families need housekeeping companies to provide related services. The issue of housekeeping integrity has also aroused people's attention. Wang Haiying et al. [1] pointed out that the main reasons for the lack of integrity in the housekeeping industry are: a large gap of employees in the housekeeping industry, a prominent contradiction between supply and demand, and unevenness of housekeeping service personnel. Cui Huanjin et al. [2] believe that improving the quality of personnel is conducive to business integrity management. Dong Changliang [3] proposed that the reasons for the lack of corporate integrity are related to the intensity of social supervision, the degree of information sharing, and the intensity of policy support. Xie Yunhui [4] mentioned that housekeeping companies will try to avoid their own responsibilities when formulating contracts, which is an irresponsible attitude to housekeeping service personnel and consumers. Wang Wei [5] believes that enterprises should strengthen the reward system for honest behavior and the punishment system for untrustworthy behavior. Chai Yanping [6] believes that the establishment of corporate integrity files is conducive to corporate integrity management. Different scholars have explained the reasons for the dishonesty of housekeeping enterprises, and put forward relevant suggestions on the construction of corporate integrity, which provides a good idea for this article. This article is mainly based on game theory to conduct research on domestic enterprises, domestic service personnel and consumers and make relevant suggestions.
2. Model assumptions and construction

2.1. Model assumptions
Make the following assumptions about domestic enterprises, domestic service personnel and consumers:

(1) Domestic enterprises, domestic service personnel and consumers are all rational people, and they all make choices based on their own profit maximization.

(2) The choice space of housekeeping enterprise strategy is "supervision" and "no supervision"; the choice space of housekeeping service personnel strategy is "integrity" and "distrust"; the choice space of consumer strategy is "complaint" and "no complaint".

(3) The probability of housekeeping enterprise supervision is \(x\), and the probability of non-supervision is \(1-x\); the probability of housekeeping service staff's integrity is \(y\), and the probability of dishonesty is \(1-y\); the probability of consumer complaints is \(z\), and the probability of no complaints is \(1-z\).

(4) When the housekeeping service personnel are dishonest or after the consumer complains, if the housekeeping enterprise conducts supervision, it will cause the housekeeping enterprise's reputation loss \(Rm\).

(5) As long as the housekeeping enterprise supervises the housekeeping service personnel, and the housekeeping service personnel conduct dishonest behavior, the housekeeping enterprise will impose a fine of \(B\) on the housekeeping service personnel.

(6) The income of the domestic enterprise after the cooperation is reached is \(R\); the supervision cost of the domestic enterprise is \(C_1\).

(7) The income obtained by the housekeeping service staff when they are honest is \(R_2\); the income obtained by the housekeeping service staff when they break their trust is \(R_3\), \(R_3 > R_2\); when the housekeeping service staff break their trust, there will be a loss of reputation \(R_y\), when the housekeeping service staff is broken and the housekeeping enterprise supervises When the company’s fine is \(B\).

(8) The cost of consumer complaints is \(C_3\); when the housekeeping service personnel receive the honest service, the utility is \(U_1\); when the housekeeping service personnel are dishonest service, the utility is \(U_2\); When the housekeeping service staff is dishonest, the consumer will receive compensation from the housekeeping company \(M\).

2.2. Model construction

Table 1. The game strategy matrix of domestic enterprises, domestic service personnel and consumers.

| Housekeeping business | Housekeeping staff | consumer |
|-----------------------|--------------------|----------|
| x,y,z                 | R-C1               | R2       | U1-C3    |
| x,y,1-z               | R-C1               | R2       | U1       |
| x,1-y,z               | R-C1-Rm-M+B        | R3-Ry-B  | U2-C3+M  |
| x,1-y,1-z             | R-C1-Rm+B          | R3-Ry-B  | U2       |
| 1-x,y,z               | R-M                 | R2       | U1-C3    |
| 1-x,y,1-z             | R                    | R2       | U1       |
| 1-x,1-y,z             | R-M                 | R3-Ry    | U2-C3    |
| 1-x,1-y,1-z           | R-M                 | R3-Ry    | U2       |

3. Game model analysis

3.1. The benefits of domestic enterprises, domestic service personnel and consumers

3.1.1. The expected return \(E_1\) of the supervision of housekeeping enterprises, the expected return \(E_2\) of non-regulation, the total return \(E_x\), and the derivative of \(E_x\) to \(x\) yield the following formula:

\[
E_1 = yz(R-C1) + y(1-z)(R-C1) + (1-y)z(R-C1-Rm-M+B) + (1-y)(1-z)(R-C1-Rm+B)
\]
\[
E_2 = yz(R - R_m) + y(1 - z)R + (1 - y)(1 - z)(R - R_m) \quad (2)
\]
\[
E_x = xE_1 + (1 - x)E_2 \quad (3)
\]
\[
\frac{\partial E_x}{\partial x} = B - C_1 - B*y - M*z + M*y*z + R_m*y*z \quad (4)
\]

3.1.2. The expected income \( E_3 \) of housekeeping service staff's integrity, the expected income \( E_4 \) of housekeeping service staff's dishonesty, the total income \( E_y \), and the derivation of \( E_y \) to \( y \) yield the following formula:
\[
E_3 = xzR_2 + x(1 - z)R_2 + (1 - x)(1 - z)R_2 \quad (5)
\]
\[
E_4 = xz(R_3 - R_y - B) + x(1 - z)(R_3 - R_y - B) + (1 - x)z(R_3 - R_y) + (1 - x)(1 - z)(R_3 - R_y) \quad (6)
\]
\[
E_y = yE_3 + (1 - y)E_4 \quad (7)
\]
\[
\frac{\partial E_y}{\partial y} = R_2 - R_3 + R_y + B*x \quad (8)
\]

3.1.3. The expected return \( E_5 \) of consumer complaints, the expected return \( E_6 \) of no complaints, the total return \( E_z \), and the derivation of \( E_z \) to \( z \) yield the following formula:
\[
E_5 = xy(U_1 - C_3) + x(1 - y)(U_2 - C_3 + M) + (1 - x)y(U_1 - C_3) + (1 - x)(1 - y)(U_2 - C_3) \quad (9)
\]
\[
E_6 = xyU_1 + x(1 - y)U_2 + (1 - x)yU_1 + (1 - x)(1 - y)U_2 \quad (10)
\]
\[
E_z = zE_5 + (1 - z)E_6 \quad (11)
\]
\[
\frac{\partial E_z}{\partial z} = M*x - C_3 - M*x*y \quad (12)
\]

The three equations are combined to solve the system of equations as follows:
\[
\begin{align*}
B - C_1 - B*y - M*z + M*y*z + R_m*y*z & = 0 \\
R_2 - R_3 + R_y + B*x & = 0 \\
M*x - C_3 - M*x*y & = 0
\end{align*}
\]

The values of \( x, y, \) and \( z \) obtained after solving the equations are:
\[
\begin{cases}
  x = \frac{R_3 - R_2 - R_y}{B} \\
  y = 1 - \frac{C_3}{M*x} \\
  z = \frac{C_1 - B(1 - y)}{R_m*y - M*(1 - y)}
\end{cases}
\]

3.2. Profit analysis for domestic enterprises, domestic service personnel and consumers

When housekeeping enterprises, housekeeping service personnel and consumers make strategic choices with the above-mentioned probability, the three will simultaneously achieve maximum benefits, and the relationship between the three will be relatively stable. The analysis that can be obtained from the above conclusions is as follows:

3.2.1. Analysis for domestic enterprises. For housekeeping enterprises, when the benefits of dishonesty by housekeeping service personnel are greater, housekeeping service personnel will tend to lose faith. At this time, the risk of housekeeping enterprises is greater, and the probability of housekeeping enterprises choosing supervision will be greater; when the fines and reputation loss caused by dishonesty are large, and when the benefits of honesty of housekeeping service personnel are large, housekeeping service personnel will choose integrity for their own benefit. At this time, housekeeping enterprises will also choose to reduce supervision in order to save supervision costs.
3.2.2. **Analysis for domestic service personnel.** For housekeeping service personnel, when the cost of complaints from consumers is greater, the probability of consumer complaints will decrease. At this time, housekeeping service personnel will choose to break their trust for their own benefit; when a housekeeping company pays more compensation to consumers in high age, domestic enterprises will choose to be inclined to supervision. At this time, domestic service personnel will choose honesty in order to avoid fines imposed on themselves by enterprises.

3.2.3. **Analysis for consumers.** For consumers, when the cost of supervision of housekeeping enterprises is higher, the probability of supervision of housekeeping enterprises will decrease, the dishonest behavior of housekeeping service personnel will increase, and the probability of consumer complaints will increase; when the compensation paid by housekeeping enterprises to consumers is higher, Consumers will file complaints in order to obtain greater benefits; when the housekeeping enterprises impose greater fines on the housekeeping service personnel, the housekeeping service personnel will reduce their untrustworthy behavior for their own benefit, and the probability of consumers’ complaints will decrease accordingly. The greater the reputation loss of domestic enterprises, the greater the tendency of domestic enterprises to supervise, the greater the probability of honesty of domestic service personnel and the lower the probability of consumer complaints.

4. **Simulation analysis**

Suppose that in a certain kind of transaction of a housekeeping enterprise, the income $R$ of the housekeeping enterprise after the cooperation is reached is 10 yuan per hour, the income $R_2$ of the housekeeping service staff is 5 yuan per hour when they are honest, and the income $R_3$ is 8 yuan per hour when the housekeeping enterprise is dishonest. The cost of supervision $C_1$ is 1.5 yuan per hour, the fine $B$ for housekeeping service personnel due to dishonesty is 2 yuan per hour, and the loss of corporate reputation $R_m$ caused by dishonesty is 3 yuan per hour, and the reputation of housekeeping service personnel for dishonesty $R_y$ is 2 yuan per hour, and the consumer's complaint cost $C_3$ is 1 yuan per hour; when the housekeeping service personnel break their trust, the consumer will receive the compensation $M$ of the housekeeping company 2 yuan per hour.

4.1. **Simulation results of strategy selection of domestic enterprises**

![Figure 1. Trend chart of influencing factors of domestic business enterprise strategy selection.](image)

It can be seen from Figure 1 that the probability of housekeeping enterprise supervision is positively correlated with the income of housekeeping service personnel's dishonesty; it is negatively correlated with the fines imposed on housekeeping service personnel, the income of housekeeping service personnel's integrity management, and the reputation loss of housekeeping service personnel, which is related to the above. The conclusion is consistent.

4.2. **Simulation results of domestic service staff's strategy selection**
Figure 2. Trend chart of influencing factors of domestic service staff's strategy selection.

It can be seen from Figure 2 that the probability of housekeeping service staff's integrity is negatively correlated with the cost of consumers' complaints; it is positively correlated with the compensation of housekeeping enterprises to consumers, which is consistent with the above conclusions. It is consistent with the above conclusion.

4.3. Simulation results of consumer strategy selection

It can be seen from Figure 3 that the probability of consumer complaints is positively correlated with the supervision cost of domestic enterprises; negatively correlated with the fines imposed on domestic service personnel by domestic enterprises; negatively correlated with the reputation loss of domestic enterprises; The compensation is positively correlated.

5. Conclusions
For domestic enterprises, the relationship with domestic service personnel needs to be strengthened. On the other hand, it is possible to implement the domestic service personnel system that is now respected by the state. When the housekeeping service personnel are more dependent on the enterprise, the enterprise will have greater controllability for the housekeeping service personnel, which can reduce the business risk of the enterprise and reduce the mobility of the entrepreneurial service personnel.

For domestic service personnel, self-service capabilities need to be improved. Only by improving their service capabilities and meeting the needs of customers, can housekeeping service personnel be able to keep their jobs for a long time, and due to the effect of word of mouth, the better and better development will be achieved.

For consumers, they must respond to the situation based on facts. There are two main points here: On the one hand, when consumers receive better services, they should not deliberately discredit the domestic business, entrepreneurs, and government service personnel for profit. On the other hand, when consumers are deceived, consumers should not swallow their anger, but have the courage to complain.
In short, while gaining benefits, domestic enterprises need to strengthen their relationship with domestic service personnel and increase their control over domestic service personnel; entrepreneurs and service personnel need to improve their service capabilities, ensure their own reputation, and make themselves better benefits; consumers need to respond to the situation based on facts and be able to effectively provide powerful help for the healthy development of the industry.

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