Impacts of Incentive Contracts for Tour Guides on Service Quality under Asymmetric Information

Abstract: Tour guide plays an important role for achieving the overall service quality of a tourism supply chain. The service quality of tour guide can be improved by promoting service effort & service ability that are asymmetric information to travel agency. Two types of incentive contracts are commonly used by travel agency to motivate tour guide improving the service quality. These are a pooling contract distinguishing service efforts and a menu contract distinguishing service efforts and service abilities. The results of analyzing and simulating show that the menu contract dominates the pooling contract. The menu contract can not only screen service abilities of tour guide, but also motivate tour guide to improve service efforts. Moreover, in menu contract, the utilities of travel agency are increased, the employment of tour guide can be improved, the relation between travel agency and tour guide is strengthened and the service quality of tourism is enhanced.

Keywords: service quality; service ability; service effort; asymmetric information; incentive contract

1. Introduction

Tourists’ satisfaction greatly demonstrates the development and service quality of the tourism industry. However, tourists’ satisfaction in most countries is still at a basic form of
low level, and has a downward trend. The increasing complaints on service quality concentrate on the lack of professional knowledge and response for tourist of tour guides (China Tourism Academy, 2013). As the tour guide is the leader of the entire tourism activities, his service quality directly affects tourists’ satisfaction. High-quality service of tour guides can effectively improve customers’ satisfaction, enhance travel agencies’ reputation and image in the market. On the contrary, low-quality service can cause the potential long-term losses for travel agencies and tour guides, even a confidence crisis in the tourism industry, thus harming the overall interests of the tourism supply chain. The increasing requirements of tourists on service quality make the price competition bring limited profit to travel agencies. The travel agencies have begun to enhance the quality of tourism service. (Guo, 2009; Augustyn, 1998)

As tour guides are the service suppliers of travel agencies, they provide services for tourists directly. Therefore, tour guides represent the service image, and their service quality will badly affect the image of travel agencies and the whole service quality of the tourism supply chain. Tour guides can improve their service quality from two ways: one is service efforts, i.e., the quantity of service that supplies to the tourists, like serving tourists in tour guides’ rest periods, etc; the other is service abilities, i.e., the professional skills that the tour guides owned, like the knowledge on scenic spots and the ability of understanding tourists’ mentality, etc. But service efforts and service abilities of tour guides are asymmetric information for travel agencies. How to identify service abilities and service efforts of tour guides is a very important and difficult problem for travel agencies. It is two kinds of asymmetric information that cause a low service quality and the contradiction
between the travel agencies, tour guides and tourists. Zhang (2009) pointed out that using incentive contracts to solve conflicts in the tourism industry is an effective way and a new direction. This paper addresses the incentive contract designed by travel agencies to decrease asymmetric information of tour guides, thus improving the service quality.

The rest of the paper is organized as follows. The associated literature is reviewed in Section 2, and the problem is described in Section 3. Two types of contracts are designed and analyzed in Sections 4 and 5, respectively. An application of numerical study is presented in section 6. Section 7 concludes this paper and presents some issues for future research.

2. Literature review

The section surveys the literature about incentive contracts on service qualities in two distinct aspects: one is service qualities on the service industry; the other is incentive contracts on asymmetric information.

2.1 Service quality on service industry

Based on summarizing the studies about customer satisfaction in 1970’s, Parasuraman, Zeithaml and Berry (1985) presented the theoretical framework of service quality. Zeithmal (1981) considered that service qualities was the judgment and evaluation by overall service experience of consumers. Parasuraman, Zeithaml and Berry (Parasuraman, 1985; Zeithaml, 1988; Zeithamal, 1996) carried on a series of studies based on the research of Zeithmal (1981) and draw the following conclusions: customers’ perception on service quality is realized through the contact process of the market, as well as the difference between the desired and
actual experience of service quality.

In service economy era, the service industry plays a very important role in global economy, and service quality is the core of service industry. The high-quality and humanized service is regarded as the key to improve image and competitiveness in hotel service industry (Chen, 2013). Large (2009) proposed that the service quality of a hotel is closely related to the staffs’ behavior. Augustyn (1998) proposed the service quality is the lifeline and the basic guarantee of the sustainable development of the tourism industry. Caro (2010) found tourists’ perception of the service quality come from the three aspects: personal interaction, physical environment and tourism results. In the information era, technology innovation inevitably affects communication between service suppliers and potential tourists. Elliot (2013) constructed a virtual tourism community model, and showed that its service quality plays an important role on the members’ satisfaction and trust. In addition, Chow (2014), Wittman (2014) and Cheng (2013) studied the relationship between service quality, customers’ satisfaction and price in air service industry.

2.2 Incentive contracts under asymmetric information

Holmstrom’s (1987) study on the design of incentive mechanism with asymmetric information on the agent’s behavior is a classic example. He showed the agents’ laziness can damage the interests of the principals, and the principals should design incentive contracts and adjust parameters of the contracts to improve agents’ efforts. Based on Holmstrom’s study, Chao (2009) found that manufactures can design a menu contract to decrease the cost caused by the asymmetric information and improve the quality of the products, when the product quality of suppliers is unknown by manufactures.
At present, there are some literatures on two kinds of asymmetric information, mainly on adverse selection and moral hazard. After researching contracts on adverse selection and moral hazard, Demougin (1989) thought in many cases the optimal incentive contracts could be found. Iyer (2005) constructed a principal-agent model to solve adverse selection and moral hazards. By this principal-agent model, Ford as a principal can screen the ability and resource allocation of suppliers as an agent during the outsourcing process of Ford automobile products. Niu (2013) designed incentive contracts under continuous asymmetric information on service abilities and service efforts of tour guides.

2.3 Literature review

From above survey, we know that much literature studied the importance of service quality in the service industry and the contract design under asymmetric information in manufacturing industry. But most literature researches the importance of service quality from qualitative research, and few researchers focus on the incentive contracts designed by travel agencies under more than one kind of asymmetric information. How much does the service quality of tour guides affect the performance of travel agencies and how to affect the performance? Some quantitative researches should be carried on to study tour guides’ service quality. In order to provide some decision support to the travel agency, this paper studies the scheme that designs incentive contracts to screen service abilities of tour guides and improve service efforts of tour guides from the angle of travel agencies.
3、Problem Description

3.1 Description of variables and relations

This paper considers a tourism market consisting of a travel agency, tourists and tour guides with high service abilities and low service abilities. The travel agency and tour guides are rational and have independent decision-making power. The travel agency is risk neutral and the tour guides are risk aversion (Zhang, 2009). Before serving tourists, the travel agency has charged a fee from tourists, which can be regarded as a fixed income of the travel agency.

Because the fixed income can be treated as a constant in modals, it has no effect on the problem analysis. This paper only considers the income during serving tourists, which can be regarded as variable income.

The service abilities of the tour guides are denoted as \( k_H \) and \( k_L (k_H > k_L) \). The travel agency does not understand the service abilities of tour guides, but knows the priori probability on their service abilities:

\[
P(k|k = k_H) = q \quad \text{and} \quad P(k|k = k_L) = 1 - q \quad (q \in [0,1])
\]

The number of tourists willing to consume during travelling is denoted as \( Q \) and the service effort of tour guides is denoted as \( e \). The higher \( k \) is, the greater \( Q \) is. And the higher \( e \) is, the greater \( Q \) also is. In addition, \( Q \) is also affected by tourism market condition \( \theta \), for example, the shopping environment and market disciplines. The higher \( \theta \) is, the higher \( Q \) will be. Therefore, \( Q = ke + \theta + \varepsilon \) (\( \varepsilon \sim N(0, \sigma^2) \)) (see Cao, 2009), where \( \varepsilon \) represents the market uncertainty (e.g., weather conditions and road construction, etc), and satisfies the normal distribution where its mean is 0 and its variance is \( \sigma \).

The travel agency cannot observe the service process of tour guides, but can obtain the service performance by sharing the commission together. Therefore, at the end of a service
cycle, the tour guides obtain the linear payment from the tour agency (Gibbons, 2005):

\[ S(Q) = \alpha + \beta pQ \]  
\( \alpha \) is the fixed payment, \( \beta \) is the commission rate, and \( p \) is the average net profit that the travel agency obtains from per tourist.)

The cost of tour guides is related to service efforts and service abilities of tour guides. To achieve the same performance, the higher the service abilities are, the less cost tour guides will pay than those tour guides with low service abilities. But the costs of two types of tour guides will increase when the service efforts increases. And both costs satisfy the law of increasing marginal. Therefore, on the basis of the literature (Chen 2005; Tian 2011; Cao 2009), we further express the cost function of tour guides as \( C(k, e) = \frac{1}{2c}e^2 \) (\( c \) denotes the coefficient of costs of the tour guides and \( c > 0 \)).

The tour guides will get reservation utility when they don’t cooperate with the travel agency. The reservation utility of the tour guides with different service abilities is supposed to be different. To simplify the problem, this paper assumes that no matter how the service abilities of tour guides are, the reservation utilities are \( \pi_0 \). Please refer to Cakanyildirim (2012) on the incentive contracts with different reservation utilities.

### 3.2 Modeling Utilities

Without loss of generality, this paper adopts the utility function with negative exponential (Laffont, 2002) \( u(w) = -\exp(-\rho w) \) to express the party’s utility where the game party’s net revenue is \( w \), and the \( \rho \) denotes the coefficient of risk aversion.

(1) The utility function of the tour guides. The stochastic income \( \omega \) of the tour guides consist of the linear payment and the effort costs, that is

\[ \omega = S(Q) - C(k, e) \]  
(1)
It’s obvious that \( \omega \sim N(\alpha + \beta p(ke + \theta) - \frac{1}{2k} ce^2, (\beta p\sigma)^2) \). So, the expected utility of the tour guides with the coefficient of risk aversion \( \rho \) and constant risk aversion is

\[
E[u(\omega)] = -\int_{-\infty}^{\infty} \frac{\exp(-\rho \omega)}{\sqrt{2\pi} \beta p\sigma} \cdot \exp \left[ \frac{[\omega - \alpha - \beta p(ke + \theta) + ce^2/(2k)]^2}{2(\beta p\sigma)^2} \right] d\omega
\]

\[
= -\exp[-\rho(\alpha + \beta p(ke + \theta) - \frac{1}{2k} ce^2 - \frac{1}{2} \rho(\beta p\sigma)^2)]
\]

Formula (2) shows the maximum utility of the tour guides equals to the maximum expected revenue. So, the tour guides’ goal maximizes the following the deterministic equation:

\[
\pi = \alpha + \beta p(ke + \theta) - \frac{1}{2k} ce^2 - \frac{1}{2} \rho(\beta p\sigma)^2
\]

(3) The utility function of the travel agency. Because the travel agency is risk neutral(\( \rho = 0 \)), its utility is equivalent to its expected revenue. The utility function of the travel agency is

\[
\pi_A = p(1 - \beta) (ke + \theta) - \alpha
\]

(4)

4. Design of Incentive Contracts under Asymmetric Information

4.1 Pooling Contracts under Asymmetric Information on Service Efforts

When the travel agency cares about only the tour guides’ service efforts without regard to their service abilities, the tour guides have one kind of asymmetric information, that is, the service effort. The travel agency will only provide a pooling contract for the tour guides’ choice. The pooling contract doesn’t distinguish the tour guides’ abilities, and only emphasize how to motivate the tour guides to improve service efforts (Laffont, 2002; Zhang, 2009). Therefore, the contract only considers the moral hazard after signing the contract, without caring the adverse selection before signing the contract. The design and execution
of the contract between the tour agency and the tour guides is a typical Stackelberg game. The travel agency, as the leader, is the first mover, and the tour guides as the followers select the optimal service effort after the travel agency’s action. The sequence of the pooling contract between the travel agency and the tour guides is described in Figure 1.

![Figure 1: Game sequence of the pooling contract](image)

Because the service effort of the tour guides is private information, the travel agency cannot observe it. When the travel agency adopts the pooling contract \((\alpha, \beta)\) to motivate the tour guides, the optimal contract parameters must satisfy the following models.

\[
\max_{(\alpha, \beta)} \pi_A = q[p(1-\beta)(k_H e + \theta) - \alpha] + (1-q)[p(1-\beta)(k_L e + \theta) - \alpha] \tag{5}
\]

\[
s.t. \quad e_H \in \arg \max_{e} \{\alpha + \beta p(k_H e + \theta) - \frac{1}{2k_H} ce^2 - \frac{1}{2} \rho(\beta p\sigma)^2\} \tag{6}
\]

\[
e_L \in \arg \max_{e} \{\alpha + \beta p(k_L e + \theta) - \frac{1}{2k_L} ce^2 - \frac{1}{2} \rho(\beta p\sigma)^2\} \tag{7}
\]

\[
\alpha + \beta p(k_H e + \theta) - \frac{1}{2k_H} ce^2 - \frac{1}{2} \rho(\beta p\sigma)^2 \geq \pi_0 \tag{8}
\]

\[
\alpha + \beta p(k_L e + \theta) - \frac{1}{2k_L} ce^2 - \frac{1}{2} \rho(\beta p\sigma)^2 \geq \pi_0 \tag{9}
\]

Among above-mentioned models, \(e_H\) and \(e_L\) denote the optimal service effort of the tour guides with high and low service abilities, respectively. Formula (6) and (7) are the incentive compatible constraints. These constraints ensure that the tour guides will work
hard after signing the contract and the optimal service efforts which the tour guides choose are exactly the service efforts the tour agency wants. Formula (8) and (9) are the participation constraints and these constraints ensure that the tour guides can get the utility not less than the reservation utility after signing the contract. The goal of the travel agency is maximize formula (5) by adjusting parameters $(\alpha, \beta)$ in the pooling contract.

4.2 Menu Contracts under Asymmetric Information on Service Efforts & Abilities

In the actual operation of the tourism supply chain, motivating the tour guides to improve service efforts is an important way, but not the only way to improve the service quality. It is essential for us to choose excellent tour guides and implement effective incentives from the very beginning. But at the cooperation starting, the travel agency doesn’t understand the true service ability of the tour guides and the tour guides may misrepresent their service abilities for self purpose, which is the phenomenon that the travel agency is often unwilling to see. At this time, the travel agency has less information: firstly, it doesn’t understand the service ability of tour guides before signing the contract; secondly, it can’t observe service efforts of tour guides after signing the contract. So, the tour guides have two kinds of private information. To further enhance the tour guides’ service quality, the travel agency should not only induce the tour guides to improve service effort with ex post contract, but also screen the service abilities of tour guides with ex ante contract. These ensure the employed tour guides having good moral and talent, and further improve the tourism service quality from the perspective of moral and talent.

The travel agency can provide a suitable contract to tour guides with different service abilities, namely the menu contract, to insure the good moral and talent. According to the
principle of Myerson (1979), to judge the true service abilities of the tour guides, the tour guides selecting suitable contract can obtain more utility than the one selecting unsuitable contract. That is to say, every tour guide will choose the contract that is most suitable for their true service abilities. By this way, the menu contract has its screening function for the tour guides and eliminates the tour guides’ motivation to misrepresent their service abilities.

The sequence of the menu contract between the travel agency and the tour guides is described in Figure 2.

![Figure 2: Game sequence of menu contract](image)

As there are only two kinds of service abilities for the tour guides, the menu contract designed by the travel agency can only include two groups of contracts\{\((\alpha_H, \beta_H), (\alpha_L, \beta_L)\)\} \((\alpha_H, \beta_H)\) and \((\alpha_L, \beta_L)\) denote the fixed payment and commission rate with high service ability and low service ability, respectively. The tour guides with high and low service abilities will consciously select \((\alpha_H, \beta_H)\) and \((\alpha_L, \beta_L)\), respectively. The travel agency can understand the tour guides’ real service ability with ex ante contract by the contract’s screening function, and can motivate the tour guides to improve their service efforts by the contract’s incentive function. The optimal function of parameters must satisfy the following models:

\[
\max_{(\alpha_H, \beta_H),(\alpha_L, \beta_L)} \pi_A = q[p(1-\beta_H)(k_He+\Theta)-a_H]+(1-q)[p(1-\beta_L)(k_Le+\Theta)-a_L] \quad (10)
\]
\[
\begin{align*}
\text{s.t. } & \quad \max_{\pi_{ij}} = a_H + \beta_{ij} p(k_i e_H + \theta) - \frac{1}{2k_{ij}} c e_{ij}^2 - \frac{1}{2} \rho(\beta_{ij} p\sigma)^2 \geq \\
\max_{\pi_{ih}} = a_L + \beta_{ih} p(k_i e_H + \theta) - \frac{1}{2k_{ih}} c e_{ih}^2 - \frac{1}{2} \rho(\beta_{ih} p\sigma)^2 \geq \\
\max_{\pi_{il}} = a_L + \beta_{jl} p(k_j e_L + \theta) - \frac{1}{2k_{il}} c e_{il}^2 - \frac{1}{2} \rho(\beta_{jl} p\sigma)^2 \geq \\
\max_{\pi_{ih}} = a_H + \beta_{ih} p(k_i e_L + \theta) - \frac{1}{2k_{ih}} c e_{ih}^2 - \frac{1}{2} \rho(\beta_{ih} p\sigma)^2 \geq \\
\quad a_H + \beta_{ij} p(k_i e + \theta) - \frac{1}{2k_{ij}} c e^2 - \frac{1}{2} \rho(\beta_{ij} p\sigma)^2 \geq \pi_0 \\
\quad a_L + \beta_{ij} p(k_i e + \theta) - \frac{1}{2k_{ij}} c e^2 - \frac{1}{2} \rho(\beta_{ij} p\sigma)^2 \geq \pi_0
\end{align*}
\]

where \(\pi_{ij}(i, j \in \{H, L\})\) denotes the utility of the tour guides with the service ability \(i\) when they choose the contract \((\alpha_j, \beta_j)\). \(e_i\) denotes the service effort when the tour guides with the service ability \(i\) choose \((\alpha_i, \beta_i)\), and \(\bar{e}_i\) represents the service effort when the tour guides with the service ability \(i\) choose \((\alpha_i, \beta_i)\). Formula (11) include several meanings: the first one is that the tour guides will work hard after signing the contract, the second one is that the optimal service efforts which the tour guides choose are exactly the service efforts the tour agency wants, the third one is that the tour guides with high service ability choosing contract \((\alpha_H, \beta_H)\) can obtain more utility than they choosing contract \((\alpha_L, \beta_L)\), which ensures the senior tour guides won’t pretend to be the junior one. And the rational tour guides will choose the optimal service effort to maximize their utility, which ensures the tour guides will work hard. Formula (12) has the similar economic meaning. Formula (13) and (14) are the participation constraints, i.e., the cooperation of the tour guides with the travel agency will gain more than the non-corporation of them. The goal of the travel agency is to maximize formula (10) by adjusting parameters.
\{(\alpha_H, \beta_H); (\alpha_L, \beta_L)\} \text{ under the constraints.}

5. Analysis of Incentive Contract

5.1 Analysis of Pooling Contract

The travel agency doesn’t know the service effort of tour guides, so he designs the pooling contract to maximize his utility. Tour guides determine their service efforts according to the pooling contract, and the tour agency will determine his fixed payment and the commission rate judging from the service efforts of the tour guides. With reverse solution (the solving process can be found in appendix A), we get proposition 1:

**Proposition 1:** The optimal fixed payment and commission rate in the pooling contract designed by the travel agency satisfy the following configurations:

\[
\beta^{SB} = \frac{k_L^3 + q(k_H^3 - k_L^3)}{k_L^3 + 2q(k_H^3 - k_L^3) + c\rho\sigma^2}, \quad (15)
\]

\[
\alpha^{SB} = \pi_0 - \beta^{SB}p^\theta \frac{1}{2c} (\beta^{SB})^2 (k_L^3 - c\rho\sigma^2). \quad (16)
\]

\(\alpha^{SB}\) decreases as \(\theta\) increases. And \(\alpha^{SB}\) will be negative when \(\theta\) is large enough.

That’s to say, with the development of the tourism market, the tour guides will gain less fixed payment under the pooling contract. The fixed payment can be negative, and the negative fixed payment is the capitation fees or the quality deposit which the travel agency charges from the tour guides when they guide the tour group.

**Lemma 1:** In the pooling contract, the optimal commission rate designed by the travel agency is \(\beta^{SE} \in (0, 1)\). The function of \(q\) on \(\beta^{SE}\) are as following: (1) if \(k_L > \sqrt[3]{c\rho\sigma^2}\), \(\beta^{SE}\) will decrease as \(q\) increases; if \(k_L < \sqrt[3]{c\rho\sigma^2}\), \(\beta^{SE}\) will increase as \(q\) decreases. (The proof can be found in appendix B).
The economic explanation is: when the proportion of the tour guides with low service ability is less than a certain level, the increasing proportion of the tour guides with high service ability will increase the commission rate, that is, **strengthen the incentive to the tour guides**; otherwise, the increasing proportion of the tour guides with high service ability will decrease the commission rate, that is, **weaken the incentives to the tour guides**.

5.2 Analysis of Menu Contract

The rational tour guides will choose their right menu contract according to their true service abilities, and will determine their optimal service effort according to the menu contract designed by the travel agency. The travel agency will determine his optimal fixed payment and commission rate of tour guides with high service ability and low service ability respectively. With reverse solution (the solving process can be found in appendix C), we get proposition 2:

**Proposition 2:** The optimal fixed payment and commission rate of tour guides with high and low service abilities designed by the travel agency satisfies the following configurations:

\[
\beta_H^* = \frac{k_H^3}{k_H^3 + c\rho\sigma^2}, \quad \beta_L^* = \frac{k_L^3}{k_L^3 + \frac{q}{1-q}(k_H^3 - k_L^3) + c\rho\sigma^2},
\]

\[
\alpha_L^* = \pi_0 - \beta_L p \cdot \frac{1}{2c} \left( \beta_L p \right) (k_L^3 - c\rho\sigma^2), \quad \alpha_H^* = \pi_0 - \beta_H p \cdot \frac{1}{2c} \left( \beta_H p \right) (k_H^3 - c\rho\sigma^2) - \beta_H^*(k_H^3 - k_L^3)
\]

where \( \beta_H^* \in (0,1), \beta_L^* \in (0,1), \frac{\partial \beta_H^*}{\partial k_H} \neq 0 \) and \( \frac{\partial \beta_L^*}{\partial k_L} = 0 \). And \( (k_H^3 - k_L^3) \) increases as \( \beta_L^* \) decreases. The economic meaning is: under the menu contract, the higher the service
abilities of the tour guides are, the stronger the travel agency’s incentive is. The commission rate of the senior tour guides is only affected by their service ability, and the junior ones will get smaller commission rate when the gap of the service ability is increasing.

From the above-mentioned formulas, we can also know that \( \frac{\partial \beta_H^*}{\partial q} = 0, \frac{\partial \alpha_H^*}{\partial q} < 0 \) and \( \frac{\partial \beta_L^*}{\partial q} = 0 \). The economic meaning is: the increasing proportion of the tour guides with high service ability will weaken the incentive to the junior ones, and decrease the fixed payment of the senior ones at the same time.

**Lemma 2:** The specific effect of the tour guides’ risk aversion on the menu contract is as follows:

(1): If the tour guides tend to be risk neutral (\( \rho \to 0 \)), then \( \lim_{\rho \to 0} \beta_H^* = 1 \). Therefore, the senior tour guides will get all the residual claims and the tour guides’ incentives from the travel agency reach the maximum. However, as \( \lim_{\rho \to 0} \beta_L^* = \frac{k_H^3}{k_L^3 + \frac{q}{1-q}(k_H^3 - k_L^3)} < 1 (q \neq 0) \), the junior tour guides will only get a part of residual claims.

(2): If the tour guides tend to be risk aversion (\( \rho > 0 \)), then \( \beta_L^*, \beta_H^* \in (0,1) \). By \( \frac{\partial \beta_H^*}{\partial \rho} < 0 \) and \( \frac{\partial \beta_L^*}{\partial \rho} < 0 \), the travel agency will weaken the incentives to tour guides when their risk aversion increases.

(3): If the tour guides tend to be full risk aversion (\( \rho \to +\infty \)), then \( \lim_{\rho \to +\infty} \beta_H^* = \lim_{\rho \to +\infty} \beta_L^* = 0 \) and \( \lim_{\rho \to +\infty} \alpha_L^* = \lim_{\rho \to +\infty} \alpha_H^* = \pi_0 \). So the travel agency will full insure the tour guides and the tour guides will get only the reservation utility.

**Lemma 3:** Under the menu contract, the junior tour guides can only get \( \pi_0 \) and the
senior tour guides can get not only \( \pi_0 \) but also the **real information rent** (Laffont, 2002; Zhang, 2009), what’s more, the larger the gap of service abilities is, the more the information rent is.

Proof: Put the optimal parameters function of the contracts into the utility function of the tour guides, the utilities of the senior and junior tour guides are respectively as follows:

\[
\pi_{HL} = \pi_0 + \frac{1}{2c} (\beta_L p)^3 (k_H^3 - k_L^3) \quad \text{and} \quad \pi_{LL} = \pi_0 .
\]

Let \( \Delta \pi = \pi_{HL} - \pi_{LL} = \frac{1}{2c} (\beta_L p)^3 (k_H^3 - k_L^3) \). When \((k_H - k_L)\) increases, the \( \Delta \pi \) will increase also.

And with \( \frac{\partial \Delta \pi}{\partial q} = \frac{\partial \Delta \pi}{\partial \beta_L} . \frac{\partial \beta_L}{\partial q} \), we can know when \( p \) increases in tourism market, the travel agency will believe strongly that the tour guides that they hire are high service ability, which will weaken the advantage of obtaining information rent by the private information of high service ability.

**5.3 Comparative Analysis**

By analyzing the optimal parameters function of these kinds of contracts, we can draw the following propositions.

**Proposition 4**: Regardless of incentive contracts of the tour guides offered by the travel agency, the tour guides will get less \( a_i^* (i = L, H; ) \) and \( \alpha^{SB} \) decreases as \( \theta \) increases. \( a_i^* (i = L, H; ) \) and \( \alpha^{SB} \) will be negative in both the menu contract and the pooling contract.

Proof: \( \frac{\partial a_L^*}{\partial \theta} < 0 , \frac{\partial a_H^*}{\partial \theta} < 0 \) and \( \frac{\partial \alpha^{SB}}{\partial \theta} < 0 . \) And when \( \theta \) is large enough, \( a_L^* \) and \( a_H^* \) will be negative.

This proposition’s economic meaning is that once the commission rate is fixed, the
travel agency won’t change it whatever the contracts and the tourism market conditions are changing. And whatever the contracts the travel agency offers, the capitation fees or the quality deposit will happen in some cases.

**Proposition 5:** $\beta^i (i = L, H;)$ and $\beta^{SB}$ are independent of $\theta$, and dependent on $\sigma$.

Proof: $\frac{\partial \beta^{SB}}{\partial \theta} = \frac{\partial \beta^L}{\partial \theta} = \frac{\partial \beta^H}{\partial \theta} = 0$, $\frac{\partial \beta^{SB}}{\partial \sigma} < 0$, $\frac{\partial \beta^L}{\partial \sigma} < 0$ and $\frac{\partial \beta^H}{\partial \sigma} < 0$.

The economic meaning is that the market conditions of tourism do not affect on the commission rate of the tour guides. But the market uncertainty is related with the commission rate, and the increasing uncertainty of the tourism market will weaken the commission rate, which decrease the market risk that the tour guides can undertake.

**Proposition 6:** The optimal commission rates of two kinds of contracts satisfy $\beta^*_H > \beta^{SB} > \beta^*_L$.

Proof: With the formula (15), (17) and (18),

$$
\beta^*_H - \beta^*_L = \frac{(k^3_H - k^3_L)}{(k^3_H + c\rho\sigma^2)} \left[ k^3_H + \frac{1}{q} (k^3_H + c\rho\sigma^2) \right] > 0 \tag{21}
$$

$$
\beta^{SB} - \beta^*_L = \frac{(\beta^*_H - \beta^{SB})(k^3_H + c\rho\sigma^2)}{k^3_H + c\rho\sigma^2 + \left(\frac{1}{q} - 2\right)(k^3_L + c\rho\sigma^2)} > 0 \tag{22}
$$

With proposition 6, the menu contract can well distinguish service abilities of tour guides.

The senior tour guides prefer to the menu contract and the junior tour guides prefer to the pooling contract. To improve the pooling contract, the travel agency let the senior tour guides work harder and compensate them with higher salary. So the travel agency must offer a higher motivation to the senior tour guides to distinguish difference of service abilities.

**Lemma 4:** Compared with the pooling contract, the menu contract strengthens the
incentive to the senior tour guides when the number of them is small; otherwise, they will weaken the motivation to the junior tour guides.

Proof: If \( 0 < q < \frac{1}{2} \), then \( \beta_{\text{SN}} - \beta_{\text{L}} > \beta_{\text{H}} - \beta_{\text{SN}} \).

If \( \frac{1}{2} < q < 1 \), then \( \beta_{\text{SN}} - \beta_{\text{L}} < \beta_{\text{H}} - \beta_{\text{SN}} \).

In menu contract, if there are a few senior tour guides, then they have strong competitive advantage and the travel agency tends to employ them with higher commission rates. However, if there are many senior tour guides, then the travel agency tends to weaken the commission rates of the junior tour guides.

**Proposition 7:** if there are \( G(0) > 0, G(1) < 0 \) and \( H(0) > 0, H(1) < 0 \), the travel agency may reject to cooperate with the junior tour guides under both contracts. The exclusion phenomenon of the market is similar to lemon market (Tian, 2011).

Proof: Under the menu contract, the utility of the travel agency that hires the junior tour guides is

\[
\pi^*_{\text{AL}} = \frac{p^2k^3_i[k^3_i + c \rho \sigma^2 + \frac{2q}{1-q}(k^3_{\text{H}} - k^3_i)]}{2c[k^3_i + c \rho \sigma^2 + \frac{q}{1-q}(k^3_{\text{H}} - k^3_i)]} + p\theta - \pi_0
\]

(23)

It’s clear that the function of \( \pi^*_{\text{AL}} \) is continuous and \( \partial \pi_{\text{AL}} / \partial q < 0 \). According to L’Hospital rule, when \( G(0) = \lim_{q \to 0} \pi^*_{\text{AL}} = \frac{1}{2c} p^2k^3_i + p\theta - \pi_0 > 0 \) and \( G(1) = \lim_{q \to 1} \pi^*_{\text{AL}} = p\theta - \pi_0 < 0 \), there must be a point \( \xi \) that satisfies \( G(\xi) = 0 \) by Mean Value theorem. This shows that when the proportion of the senior tour guides gradually increases to a critical point, the travel agency will become unprofitable when they employ the junior tour guides. So the travel agency will only cooperate with the senior tour guides and exclude the junior tour guides.
Under the pooling contract, the utility of the travel agency that hires the junior tour guides is

$$\pi_{AL}^{SB} = \frac{p^2[k_i^3 + q(k_i^3 - k_i^2)][3k_i^3 + q(3k_i^3 - c \rho \sigma^2) + k_i^3 c \rho \sigma^2]}{2c[k_i^3 + 2q(k_i^3 - k_i^2) + c \rho \sigma^2]^2} + p\theta - \pi_0$$ \hspace{1cm} (24)

In the same way, if \( H(0) = \lim_{q \to 0} \pi_{AL}^{SB} > 0 \) and \( H(1) = \lim_{q \to 1} \pi_{AL}^{SB} < 0 \), there exist the same situation that the travel agency rejects to cooperate with the junior tour guides.

**Lemma 5:** The coming tour off-season decreases the demand for the tour guides. So the travel agency will dismiss the junior tour guides and keep only a few senior tour guides.

### 6. Numerical Simulation

This section mainly analyzes the effect of the contracts’ parameters on the utility of the travel agency through the numerical simulation. Table 1 is the initial values of each parameter. The utilities of the travel agency with the pooling contract and the menu contract are shown in figures 3 - 6.

**Table 1: parameters of contracts**

<table>
<thead>
<tr>
<th>parameter</th>
<th>( c )</th>
<th>( \rho )</th>
<th>( \sigma )</th>
<th>( \theta )</th>
<th>( p )</th>
<th>( q )</th>
<th>( k_L )</th>
<th>( k_H )</th>
<th>( \pi_0 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>value</td>
<td>0.5</td>
<td>1.5</td>
<td>2.0</td>
<td>1.0</td>
<td>10.0</td>
<td>0.5</td>
<td>0.1</td>
<td>0.7</td>
<td>0</td>
</tr>
</tbody>
</table>
Several observations are gained from Figure 3 and figure 4. Firstly, the utility of the travel agency will increases when the service ability and proportion of the senior tour guides increase; Secondly, the utility of the travel agency will get remarkable promotion through improving the service ability of the tour guides, which means that the travel agency more prefer to cooperate with the senior tour guides.

**Proposition 8:** Because the utility of the menu contract is strictly better than that of the pooling contract, the exclusion rate of the menu contract is lower than that of the pooling contract.

Proof: Suppose the utility of the travel agency is $\pi_1$ in figure 3, then the exclusion rate of the menu contract and the pooling contract are $q_1$ and $q_2$, respectively. It’s obvious that $q_1 < q_2$.

Figure 5 shows that the travel agency can gain more utilities by improving the conditions of the tourism market and there is a certain linear relationship between the utilities and the conditions. Figure 6 shows the utilities of the travel agency are affected by
the risk aversion of the tour guides. The reason of the phenomenon is that the more the tour
guides are afraid of risk, the weaker the incentives by the travel agency are. And this
behavior affects the service performance of the tour guides and therefore causes the
revenue’s volatility of the travel agency.

7. Concluding discussions

It is an important way to improve the service quality and efficiency of the tourism supply
chain that the travel agency motivates the tour guides effectively. In this paper, the service
effort and service ability of the tour guides are asymmetric information that can’t be
observed by the travel agency. The pooling contract with one-dimension asymmetric
information about the service effort are designed, as well as the menu contract with
two-dimension asymmetric information about the service effort and the service ability. By
analyzing the parameters of two kinds of contracts, we can draw the following conclusions:

This research has highlighted several managerial implications from the research findings.
(1) in both the pooling contract and menu contract, the travel agency may charge the
capitation fees or the quality deposit from the tour guides. Therefore, the phenomenon of
zero or negative membership fees cannot be improved by either the travel agency or the tour
guides. The government should impose a relevant policy to forbid the zero or negative
membership fees.

(2) tour guides can motivate the travel agency to increase the commission rate by
improving the service ability. But the total service ability of the tour guides can affect the
commission rate. As the service ability decreases, the commission rate will reduce. In order
to get the higher commission rate, the tour guides must offer higher service abilities than the average service ability.

(3) the travel agency should classify the tour guides on management according to their service ability, promise different commission rates and implement differentiated wages, which can motivate all the tour guides to further improve their service ability, and shorten the gap between the junior tour guides and the senior tour guides.

(4) once behaviors and distributions of interests of both sides have been defined explicitly by the contracts before the travel agency and the tour guides cooperate, the travel agency won’t reset the commission rates of the tour guides and adjust the incentive of the tour guides when the contracts’ type or the market conditions of tourism changes. At the same time, when the uncertainty of tourism market increases, the tour guides like higher fixed payment than higher commission rate.

(5) the full time tour guides are more professional and loyal than the part time tour guides. The travel agency has a longer cooperation with the full time tour guides than that with the part time tour guides. And some travel agencies will fire part time tour guides and retain only a few full time tour guides when the off-season of tourism is coming.

(6) the travel agency can improve his utility by promoting the service ability of the tour guides. So the travel agency should train the tour guides regularly. In the menu contract, the tour guides will select the different fixed payment and the commission rate automatically. Therefore, the menu contract will offer strictly better utility, more honesty employees and higher employment rate than the pooling contract.

(7) because improving the tourism market conditions can increase the benefit of travel
agencies obviously, travel agencies should actively help the government improve the tourism market, such as strengthening propaganda, improving the tourism infrastructure, etc.

(8) the utility of the travel agency is affected by the risk aversion of the tour guides. The more the risk the tour guides are afraid of, the lower commission rates are. And this behavior affects the service performance of the tour guides and therefore causes the revenue's volatility of the travel agency.

The analysis results show that the menu contracts allow the travel agency to screen and motivate the tour guides effectively to improve the service quality, and increase revenue of the travel agency and enhance the structural stability of the tourism supply chain.

However, this paper only considers designing the incentive contract with a single cycle game between the travel agency and the tour guides. In reality, their relationship is long-term and the payment of the tour guides from the travel agency is dynamic. The service effort and service ability of the tour guides in the first cycle game will affect their fixed payment and commission rates in the following cycle game. Therefore, it is theoretical and practical to design the incentive contract with multi-cycle game. In addition, this paper only considers designing the incentive contract between the travel agency and the tour guides and ignoring tourists as important participants. Although tour guides can meet travel agencies' requirements, the tourists may be unsatisfied with the service ability and service efforts of the tour guides. In the future research, it will be a direction that designs the incentive contract with the tourists' requirements, tour guides' service ability and service efforts.
8. Appendix

A. Solution of the Pooling Contract Model

Using the first order optimality conditions on the formula (6) and (7), we can get
\[ e_i = \frac{1}{c} \beta p k_i^2, \quad i \in \{H, L\}. \]
By the method of reduction to absurdity on the formula (8) and (9), formula (8) is a loose constraint and formula (9) is a tight constraint. Assign \( e_i \) and \( \alpha \) to the formula (5), we can get
\[ \pi_A = \frac{\beta^2}{2c} [ (1 - \beta) q k_i^3 + (1 + q k_i^2 - \beta (q - \sigma^2) ) ] \theta. \]
It’s obvious that \( \frac{\partial^2 \pi_A}{\partial \beta^2} < 0 \). \( \beta^{SE} \) can be solved with the first order optimality conditions. \( \alpha^{SE} \) can be solved by assigning \( \beta^{SE} \) to \( \alpha \).

B. Proof of Lemma 1

From formula (15),
\[ \frac{\partial \beta^{SE}}{\partial q} = \frac{(k_h^3 - k_i^3)(c \rho \sigma^2 - k_i^3)}{(k_i^3 + 2q(k_h^3 - k_i^3) + c \rho \sigma^2)^2}. \]
If \( k_h^3 > c \rho \sigma^2 \), \( \beta^{SE} \) decreases as \( q \) increases.
If \( k_h^3 < c \rho \sigma^2 \), \( \beta^{SE} \) increases as \( q \) decreases.

C. Solution of the Menu Contract Model

Using the first order of optimality conditions on the incentive compatible constraints, if the tour guides with the ability of type \( i \) choose the contract \((\alpha_i, \beta_i)\), their optimal service effort level is \( e_i^* = \frac{1}{c} \beta_i p k_i^2 \); and if they choose the contract \((\alpha_j, \beta_j)\), their optimal effort level is \( e_j^* = \frac{1}{c} \beta_j p k_j^2 \), \( i, j \in \{H, L\}, i \neq j \).

Assign \( e_i^* \) and \( e_j^* \) to the object function and constraint function, the model of the menu contract is equal to the following forms.
\[ \max \pi_A = q[p(1 - \beta_H)(\frac{1}{c} \beta_H p k_H^2 + \theta) - \alpha_H] + (1 - q)[p(1 - \beta_L)(\frac{1}{c} \beta_L p k_L^2 + \theta) - \alpha_L], \quad (C.1) \]
\[ \pi_{1H} = \alpha_H + \beta_H p\theta + \frac{1}{2c}(\beta_H p)^2(k_H^3 - c\rho\sigma^2) \geq \pi_{1L} = \alpha_L + \beta_L p\theta + \frac{1}{2c}(\beta_L p)^2(k_L^3 - c\rho\sigma^2), \quad (C.2) \]
\[ \pi_{LL} = \alpha_L + \beta_L p\theta + \frac{1}{2c}(\beta_L p)^2(k_L^3 - c\rho\sigma^2) \geq \pi_{1H} = \alpha_H + \beta_H p\theta + \frac{1}{2c}(\beta_H p)^2(k_H^3 - c\rho\sigma^2), \quad (C.3) \]
\[ \pi_{1H} = \alpha_H + \beta_H p\theta + \frac{1}{2c}(\beta_H p)^2(k_H^3 - c\rho\sigma^2) \geq \pi_0 \quad \text{(C.4)} \]
\[ \pi_{LL} = \alpha_L + \beta_L p\theta + \frac{1}{2c}(\beta_L p)^2(k_L^3 - c\rho\sigma^2) \geq \pi_0 \quad \text{(C.5)} \]

With formulas (C.2) and (C.5), we can get \( \pi_{1H} \geq \pi_{1L} = \pi_{1L} + \frac{1}{2c}(\beta_L p)^2(k_H^3 - k_L^3) \). So, the formula (C.4) can be omitted. As \( \pi_{1H} > \pi_{1L} \), the rational travel agency will increase the revenue to \( \pi_A \) through decreasing the fixed payment \( \alpha_H \) without affecting the formula (C.2), till the formula (C.2) becomes a tight constraint. With the method of the reduction to absurdity, formula (C.3) is a loose constraint. Moreover, without affecting the two incentive constraints, \( \pi_A \) can be increased through decreasing the same amount of \( \alpha_L \) and \( \alpha_H \), until the formula (C.5) becomes a tight constraint. So
\[ \alpha_L = \pi_0 - \beta_L p\theta - \frac{1}{2c}(\beta_L p)^2(k_L^3 - c\rho\sigma^2) \]

Assign \( \alpha_L \) to the formula (C.2) that is a tight constraint, we can get
\[ \alpha_H = \pi_0 - \beta_L p\theta - \frac{1}{2c} \left[ \beta_H^2 (k_H^3 - c\rho\sigma^2) - \beta_L^2 (k_H^3 - k_L^3) \right] \]

Assign \( \alpha_L \) and \( \alpha_H \) to the formula (B.1) that is the objection function, we can get
\[ \max_{(\beta_H, \beta_L)} \pi_A = \frac{p}{2c} \left\{ q \left[ 2(\beta_H p k_H^3 + c\theta) - p \beta_H^2 (k_H^3 + c\rho\sigma^2) - p \beta_L^2 (k_H^3 - k_L^3) \right] \right. \\
+ \left. (1-q) \left[ 2(\beta_L p k_L^3 + c\theta) - p \beta_H^2 (k_L^3 + c\rho\sigma^2) \right] \right\} - \pi_0 \quad \text{(C.6)} \]

Using the first order optimality conditions on the formula (C.6), the solution of \( \beta_L^* \) and \( \beta_H^* \) is obtained. At the same time, the solution of \( \alpha_L^* \) and \( \alpha_H^* \) is gained.
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