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Research on the Principal–Agent Mechanism of Poverty Alleviation through Mandarin Popularization in Ethnic Minority Areas from the Perspective of Ability Incentive

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Abstract: In the process of poverty alleviation through Mandarin popularization in ethnic minority areas, there is a principal–agent relationship. In order to effectively stimulate the endogenous motivation of the public, it is necessary to study the principal–agent relationship between the local government and ethnic minorities in the process of poverty alleviation through Mandarin popularization from the perspective of ability incentive. Combining the traditional targeted poverty alleviation with principal–agent theory, this paper clarifies the principal–agent relationship between the local government, as principal, and the ethnic minorities, as agent, and constructs a principal–agent model based on information asymmetry scenarios. This model includes two scenarios: (1) the local government provides ability incentive; and (2) the local government does not provide ability incentive. Under the scenarios, the local government is risk-neutral, and the ethnic minorities are risk-averse. This paper focuses on analyzing the impact of ability incentives on the decision-making strategies of the local government and the public as well as on their expected revenue. Finally, the rationality and effectiveness of this model are verified through numerical simulation.

Keywords: poverty alleviation through Mandarin popularization; principal–agent; information asymmetry; incentive mechanism

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1. Introduction

The Law on the Standard Spoken and Written Chinese Language of the People's Republic of China determines that "the standard spoken and written Chinese language is Mandarin and the standardized Chinese characters. It is an act of state to popularize Mandarin and the standardized Chinese characters" [1]. As a multi-national country with a large population who speak different languages and dialects, China's workers of the spoken and written Chinese language have always shouldered the mission of upholding ethnic and national unity and made contributions to promoting the communication between regions and between ethnic groups and to the development of the country. So far, China has achieved the goal of lifting all rural residents living below the current poverty line out of poverty and made positive progress in popularizing and promoting Mandarin in minority areas, which is a measure for targeted poverty alleviation. Mandarin popularization in minority areas plays an important role in improving the economic development environment in old revolutionary base areas, minority areas, remote and border areas, and poverty-stricken areas as well as in advancing the popularization of standard spoken and written Chinese language in local areas, particularly in areas inhabited by multi-ethnic groups. Under the backdrop of the rural revitalization strategy, however, it is still an arduous task to consolidate the success in poverty alleviation through Mandarin popularization.

Since the development of human civilization, it is a basic ability for people of various countries to recognize and use the common language of their own nation. The research on languages abroad has been mostly carried out around English, and the application status of English in the context of globalization has been analyzed [2,3]. Chang Fei (2020) shows

that strengthening the cultivation of students' language ability is extremely important to the development of the English language and literature and plays an important role in cultivating students' comprehensive literacy [4]. Reyhner J et al. (2017) pointed out that language ability plays a non-negligible role in the education of American Indians and can stimulate a strong sense of identity [5]. China is a country with the most minorities in the world, with multilingualism and multiculturalism. Correspondingly, language construction has always been an important task of national cultural development. Mandarin is the national language of China and one of the treasures that distinguish the Chinese nation from the world. Xing Qianqian et al. (2021) believed that strengthening the teaching of the national common language and writing and promoting and using Mandarin can not only enhance the communication and integration between various ethnic groups but also strengthen the cohesion of various ethnic groups [6]. Wang Min (2020) understood the importance of popularization work from the national level and found that the promotion and use of language with high versatility and strong cohesion is conducive to improving the effectiveness of social communication, improving the effectiveness of national governance, and promoting economic and social development [7]. Wei Yu (2017) pointed out that the function and value of language play an increasingly prominent role in the interaction of cultures of various countries and the output of various cultural exchange strategies in China, and gradually become game elements of the comprehensive strength between countries [8]. It can be seen from this that vigorously promoting the common Mandarin language across the country is of great significance to many aspects such as economy, politics, and humanities. In this process, due to the backward economic conditions, low education levels, and many barriers to communication, the promotion of Mandarin is a job that is as difficult as infrastructure projects.

Until now, the academic community has conducted research on poverty alleviation through Mandarin popularization, mainly focusing on four aspects. The first is the policies concerning poverty alleviation through Mandarin popularization and the development process. Lei Ming et al. (2020) made a summary of the process of poverty alleviation through languages in China over the past 70 years from the perspectives of the models, mechanisms, paths, and prospects of poverty alleviation through languages in the country. They believed that the popularization of standard spoken and written Chinese language from the dimensions of "macroscopic Mandarin popularization" and "microscopic Mandarin popularization" was beneficial to achieving the goal of "targeted poverty reduction and alleviation" [1]. Based on the Outline of Poverty Alleviation and Development in China's Rural Areas (2011–2020), Wang Chunhui (2019) divided the poverty alleviation process in China over the past 70 years into two stages and analyzed the characteristics of each stage [9]. The second is qualitative research on the concepts, system structure, and policy measures of poverty alleviation through Mandarin popularization. Xiang Deping et al. (2020) studied the theoretical logic and governance effect of poverty alleviation through languages and pointed out that poverty alleviation through languages was a crucial part of and an important means for poverty governance [10]. Su Jian (2020) summarized the theoretical logic, experience support, and realization path of poverty alleviation through languages. He believed that poverty alleviation through languages was an important measure that should be combined with enhancing the capability and intelligence of impoverished populations [11]. By analyzing the theory and practice of languages and poverty, Wang Chunhui (2019) considered that poverty was a complicated phenomenon involving many factors, dimensions, and layers and that the theoretical research and practice exploration of languages and poverty was inevitably a dynamic and complex adaptive system [12]. The third is quantitative research on the effect of Mandarin popularization on poverty alleviation. Based on the perspective of language economics, Liu Chuqun (2019), Li Yuming (2019), Zhang Weiguo (2020), XieZhiju et al. (2020), and Gao W (2011) probed into the relationship between language application and poverty.They believed that language ability was an important economic indicator, and atthe micro level played a crucial role in improving income and employment [13–17]. Huang Shao'an et al. (2020), Fan Xiaoling et al.

(2020), Li Ruihua (2021), Cai Wenbo (2021), and other scholars studied the correlation between the Mandarin ability of people from severely impoverished areas or Xinjiang and their income level. They also provided strong theoretical support for poverty alleviation in severely impoverished areas or ethnic minority areas, which further indicated that it was feasible to alleviate poverty in severely impoverished areas or ethnic minority areas by popularizing Mandarin [18–27].

Additionally, the principal–agent model is an important part of the theory of institutional economics and has in recent years been widely applied to energy saving and emission reduction [28,29], governmental services [29,30], and food safety supervision [31–33]. However, only a few studies have been conducted on the application of principal–agent theory to targeted poverty alleviation. In the process of poverty alleviation through Mandarin popularization in ethnic minority areas, the information about the local government and ethnic minorities is asymmetric, the government is hard to observe, and measuring the real efforts made by the public to learn Mandarin is difficult. To this end, the principal–agent model is an important method for addressing this problem. In the principal–agent relationship, the principal provides ability incentives, that is, improves the agent's ability through organizing training, and designs a contract based on the agent's performance, which is very consistent with the characteristics of ethnic minority poverty alleviation. At the same time, most of the current studies assume that the personal ability of the agent is immutable, which does not reflect the change and role of the agent's ability in the process of principal–agent modeling, and does not consider the influence of ability as an incentive factor on the agent [34].Therefore, we conducted this research on the local government (principal) and the public (agent). The principal–agent model is based on ability incentive. This paper mainly analyzes the effect of ability incentive on decision-making strategies and expected revenue of the public and the local government under the condition of information asymmetry. Through case numerical simulation, we discussed the influence of the local government's supervision on optimal strategy selection and expected revenue, hoping to supplement the theoretical incentive mechanism for poverty alleviation through Mandarin popularization in ethnic minority areas.

Major contributions of this paper include: in the first place, the focus of poverty alleviation through Mandarin popularization in ethnic minority areas is shifted to ability incentives provided by the local government. Based on ability incentive, we studied the ways to motivate endogenous impetus of ethnic minorities with the help of the local government. As there is a lack of research in this respect, this paper may enrich studies in this field. In the second place, this paper introduces the principal–agent framework, analyzes the decision-making strategies and expected revenue of the public and the local government under the assumed condition of whether the local government has an ability incentive mechanism or not, and clarifies the internal process of poverty alleviation through Mandarin popularization in ethnic minority areas. So far, the research which has been conducted has only focused on the analysis of survey or empirical data, ignoring the studies on internal mechanisms. This paper supplements the research on internal incentive mechanisms. Finally, under the principal–agent optimal incentive framework, this paper analyzes the optimal efforts of the public when they satisfy the best incentive compatibility condition and under the situation where the local government maximizes their social benefits, achieving the optimal principal–agent goal compatibility under the ability incentive. This, as for poverty alleviation through languages, is also a new supplementation.

2. Construction of the Principal–Agent Model

2.1. Research Hypotheses

In the principal–agent relationship of Mandarin popularization in ethnic minority areas, the local government (principal) needs to provide ability incentive of improving Mandarin ability for the public. In other words, the local government may improve the Mandarin ability of the public by organizing training and designing contract mechanisms based on improving the Mandarin ability of the public. The ability incentive for improving

the Mandarin ability of the public includes two aspects: first of all, improving the Mandarin ability of the public helps to raise personal income. Related research also proves that Mandarin proficiency is positively and significantly correlated to income [1]. Secondly, the ethnic minorities who improve their Mandarin ability will be endowed with better social status and occupational reputation. Therefore, the sense of identity for their personal and social value will be enhanced, as will self-satisfaction. Relevant research shows that language ability is an important index indicating social and economic hierarchy [26]. Improving the Mandarin ability of ethnic minorities will also benefit the public for a lifetime. This means that improving Mandarin ability, in the first place, reduces poverty and exerts a profound influence on long-term career and economic revenue.

The principal–agent model of poverty alleviation through Mandarin popularization in ethnic minority areas from the perspective of ability incentive has a near-term stage and a long-term stage. In the near term, the local government (principal) provides the ethnic minorities (agent) with Mandarin training and undertakes human resource costs, financial costs and other input costs. After training, the Mandarin ability of the public may be raised, and their income will also increase. As a result, the local government will also improve its reputation and public influence.

Hypotheses of the principal–agent model:

Hypothesis 1 (H1): *Assuming that there is only one principal (the local government) and one agent (the ethnic minorities), the principal is risk-neutral, and the agent is risk-averse.*

Hypothesis 2 (H2): *Assuming that, from the perspective of ability incentive, the primary level of Mandarin ability of the agent (ethnic minorities) is F, which requires no effort. Through Mandarin training, the level is raised by f, which is related to efforts. The output function for the agent is:*

$$\pi = F + k + f + \varepsilon, F > 0, f > 0, k > 0, \varepsilon \sim N(0, \sigma^2) \quad (1)$$

In this function, ε refers to external uncontrollable factor; k ($k > 0$) refers to efforts made by the public; effort cost $c(k) = 0.5C_1k^2$ ($C_1 > 0$) refers to the effort cost coefficient of the public. This suggests that if the public make no effort to improve Mandarin ability, the primary level of their Mandarin ability is F and there is no cost generated. When the public invests greater marginal costs, their Mandarin ability will be improved less via per capita effort.

Hypothesis 3 (H3): *In the process of improving the Mandarin ability of ethnic minorities, the improvement of Mandarin ability is positively correlated to the ability of ethnic minorities. In order to better achieve the goal of poverty alleviation through Mandarin popularization, the local government proactively supports Mandarin training for the public and bears the training cost to improve the Mandarin ability of ethnic minorities. Assuming the training cost is $c(f) = m + 0.5C_2e^2$, in whichm refers to the fixed cost invested by the local government in Mandarin training, such as faculty training and teaching building; $C_2 > 0$, the cost is related to the depth and width of Mandarin training contents. The deeper and wider the depth and width, the greater the improvement of Mandarin ability and the higher the training cost. At the same time, the local government's supervision cost is $M(f) = b - \eta k$, in which η means supervision efforts made by the local government. This implies that the local government may undertake only a little supervision cost if the public work very hard in Mandarin training.*

Hypothesis 4 (H4): *Mandarin popularization can promote the construction of regional internal markets that have highly efficient communication and transactions. The local government provides incentives and subsidies for poverty alleviation through Mandarin popularization. In the meantime, the local government should also fulfill its supervision responsibility. Assuming that the contract offered by the local government to the ethnic minorities is: $s = a + d(\pi - \pi_0) + \gamma(kf + \xi)$, in which a refers to fixed economic returns granted by the local government to the public and is independent of the improvement of Mandarin ability. Such returns mainly include subsidies and technical support for poverty alleviation; d means incentive and supervision coefficient of the*

local government for better implementation of the policy of poverty alleviation through Mandarin popularization. $d \geq 0$ indicates that the local government provides incentive policy for the public and $d < 0$ suggests that the local government implements reward and punishment policies; π_0 is the benchmark output. In order to simplify the model, under the condition of not affecting the conclusion, we assume $\pi_0 = 0$. In addition to the incentive granted by the local government, $\gamma(kf + \xi), \xi \sim N(0, \delta^2)$ refers to the governmental social benefits at the ratio of γ resulting from improvement of Mandarin ability. The social benefits refer to the returns such as regional economic development due to the improvement of the Mandarin ability of the public.

Therefore, the contract offered by the local government for the ethnic minorities is:

$$s = a + d\pi + \gamma(kf + \xi) = a + d(F + k + f + \varepsilon) + \gamma(kf + \xi) \tag{2}$$

2.2. Construction of the Principal–Agent Model of Poverty Alleviation through Mandarin Popularization in Ethnic Minority Areas from the Perspective of Ability Incentive

In the process of poverty alleviation through Mandarin popularization, the agent (ethnic minorities) can, through incentives granted by the local government, improve their Mandarin ability, and thus obtain benefits. Assuming the public are averse to risks and avoid as many risks as possible, this means that the public are risk-averse. r refers to the absolute risk aversion coefficient ($r > 0$ means risk aversion). The utility function is $U = 1 - e^{r\omega}$ and ω is the effective yield of the agent. According to the Arrow–Pratt conclusion [28], the risk cost of the agent is:

$$c(r) = \frac{r(d^2\sigma^2 + \gamma^2\delta^2)}{2} \tag{3}$$

According to the assumed condition, the utility function of the agent is:

$$\omega = a + d(F + k + f + \varepsilon) + \gamma(kf + \xi) - 0.5C_1k^2 \tag{4}$$

Therefore, the agent's expected utility in the process of poverty alleviation through Mandarin popularization is:

$$E(\omega) = a + d(F + k + f) + \gamma kf - 0.5C_1k^2 \tag{5}$$

The agent's certainty equivalence ($CE(\omega)$) of improving its Mandarin ability through the local government's ability incentive is the difference between the agent's expected utility and risk cost, which is:

$$CE(\omega) = a + d(F + k + f) + \gamma kf - 0.5C_1k^2 - \frac{r(d^2\sigma^2 + \gamma^2\delta^2)}{2} \tag{6}$$

The local government is risk-neutral in the principal–agent relationship of Mandarin popularization in ethnic minority areas. The expected utility of the local government in proactively encouraging the public to improve their Mandarin ability is:

$$\begin{aligned} E(\zeta) &= E\{(1-\gamma)(kf + \xi) - [a + d(F + k + f + \varepsilon)] - (m + 0.5C_2f^2) - (b - \eta k)\} \\ &= (1-\gamma)kf - d(F + k + f) - 0.5C_2f^2 + \eta k - (a + m + b) \end{aligned} \tag{7}$$

In the principal–agent relationship of poverty alleviation through Mandarin popularization, there is information asymmetry between the local government and the public, which will surely lead to moral risks and adverse selection. The principal–agent model is used to study how the principal motivates and constrains the agent through contract design so as to ensure that, under the condition of information asymmetry and inconsistent interests, the agent's efforts conform to the principal's goals. In the principal–agent relationship of poverty alleviation through Mandarin popularization, the ability incentive mechanism should at least satisfy the following two constraints. The first is incentive

compatible (IC) constraint. This means that the local government needs to design an ability incentive mechanism and bind its interests to those of the agent. The second is participation constraint (PC). The utility of Mandarin improvement made by the agent according to the ability incentive mechanism designed by the local government is larger than the utility achieved without the mechanism. Therefore, the ability incentive model is:

$$\begin{array}{ll} \max E(\zeta) & \\ s.t. & \begin{cases} \max CE(\omega) & IC \\ CE(\omega) \geq \overline{\omega} & IR \end{cases} \end{array} \tag{8}$$

In this model, $\overline{\omega}$ is the reservation utility of the public, which is the utility when the public does not improve their Mandarin ability. Furthermore,

$$\begin{array}{ll} \max\left[(1-\gamma)kf - d(F+k+f) - 0.5C_2f^2 + \eta k - (a+m+b)\right] & \\ s.t. & \begin{cases} \max a + d(F+k+f) + \gamma kf - 0.5C_1k^2 - \frac{r(d^2\sigma^2+\gamma^2\delta^2)}{2} & IC \\ a + d(F+k+f) + \gamma kf - 0.5C_1k^2 - \frac{r(d^2\sigma^2+\gamma^2\delta^2)}{2} \geq \overline{\omega} & IR \end{cases} \end{array} \tag{9}$$

3. Optimal Results of the Principal–Agent Model of Poverty Alleviation through Mandarin Popularization in Ethnic Minority Areas from the Perspective of Ability Incentive

In order to maximize the utility, through incentive compatible constraints, the public can try their best to improve their Mandarin ability. According to Lagrange's conditioned extreme value $\frac{\partial CE(\omega)}{\partial k} = 0$:

$$\frac{\partial\left[a + d(F+k+f) + \gamma kf - 0.5C_1k^2 - \frac{r(d^2\sigma^2+\gamma^2\delta^2)}{2}\right]}{\partial k} = d + \gamma f - C_1k \tag{10}$$

$$\frac{\partial^2 CE(\omega)}{\partial^2 k} = -C_1 < 0 \tag{11}$$

The value of Equation (11) is lower than 0, which indicates that the expected revenue of the public is the concave function of their efforts. Consequently, there are optimal efforts that can maximize the expected revenue. Then we have:

$$k^* = \frac{d+\gamma f}{C_1} \tag{12}$$

Put the optimal efforts (f^*) of the gent into participation constraint and assuming that the reservation utility of the public is $\overline{\omega} = 0$, then we have:

$$a + d(F + \frac{d+\gamma f}{C_1} + f) + \frac{\gamma f(d+\gamma f)}{C_1} - 0.5C_1(d+\gamma f)^2 - \frac{r(d^2\sigma^2+\gamma^2\delta^2)}{2} \geq 0 \tag{13}$$

Put Equations (12) and (13) into Equation (9), the optimal model is:

$$\begin{array}{ll} \max\left[(1-\gamma)kf - d(F+k+f) - 0.5C_2f^2 + \eta k - (a+m+b)\right] & \\ s.t. & \begin{cases} k^* = \frac{d+\gamma f}{C_1} & IC \\ a + d(F + \frac{d+\gamma f}{C_1} + f) + \frac{\gamma f(d+\gamma f)}{C_1} - 0.5C_1(d+\gamma f)^2 - \frac{r(d^2\sigma^2+\gamma^2\delta^2)}{2} \geq 0 & IR \end{cases} \end{array}$$

Based on Equation (13), we have:

$$a \geq -d(F + \frac{d+\gamma f}{C_1} + f) - \frac{\gamma f(d+\gamma f)}{C_1} + \frac{0.5(d+\gamma f)^2}{C_1} + \frac{r(d^2\sigma^2+\gamma^2\delta^2)}{2} \geq 0 \tag{14}$$

Assuming $a = -d(F + \frac{d+\gamma f}{C_1} + f) - \frac{\gamma f(d+\gamma f)}{C_1} + \frac{0.5(d+\gamma f)^2}{C_1} + \frac{r(d^2\sigma^2+\gamma^2\delta^2)}{2} \geq 0$, the local government's expected revenue $((1-\gamma)kf - d(F+k+f) - 0.5C_2f^2 + \eta k - (a+m+b))$ can be maximized. Therefore, the optimal model is:

$$\begin{aligned} &\max\left[\frac{(1-\gamma)f(d+\gamma f)}{C_1} - d(F + \frac{d+\gamma f}{C_1} + f) - 0.5C_2f^2 + \frac{\eta(d+\gamma f)}{C_1} - (a+m+b)\right] \\ &s.t. \qquad a = -d(F + \frac{d+\gamma f}{C_1} + f) - \frac{\gamma f(d+\gamma f)}{C_1} + \frac{0.5(d+\gamma f)^2}{C_1} + \frac{r(d^2\sigma^2+\gamma^2\delta^2)}{2} \end{aligned} \tag{15}$$

Put a into $E(\zeta)$, through derivation of d, which is the local government's incentive and supervision efforts in poverty alleviation through Mandarin alleviation, and γ, which is revenue distribution coefficient, we get the local government's optimal incentive supervision effects d^* and the optimal revenue distribution coefficient γ^*:

$$d^* = \frac{(f+\eta)f\sigma^2}{\delta^2 + \sigma^2f^2 + C_1r\delta^2\sigma^2} \tag{16}$$

$$\gamma^* = \frac{(f+\eta)\delta^2}{\delta^2 + \sigma^2f^2 + C_1r\delta^2\sigma^2} \tag{17}$$

Conclusion 1: under the ability incentive equilibrium of asymmetric information, the local government's optimal reward and punishment coefficient d^* for the public is positively correlated to random factors while it is negatively correlated to random factor ξ. The optimal revenue distribution coefficient γ^* is positively related to the random factor ξ but is negatively correlated to the random factor ε.

This shows that in poverty alleviation through Mandarin popularization in ethnic minority areas, the less the public are affected by external random factors, the more likely they tend to proactively learn Mandarin, and the more likely the local government tends to give greater incentive. As the public have relatively stable positive emotions, however, a lower optimal revenue distribution coefficient can not only guarantee that the local government's social benefits constantly improve but also encourage the public to stably improve Mandarin ability.

Conclusion 2: the local government's optimal reward and punishment coefficient d^* and revenue distribution coefficient γ^* are negatively correlated to effort cost coefficient C_1 and risk aversion coefficient r of the public. However, they are positively correlated to the local government's supervision effort η in the process of Mandarin popularization.

As is shown in Figures 1 and 2, both the local government's optimal reward and punishment coefficient and revenue distribution coefficient are decreasing as the negative effects caused by the effort input of the public and the risk-bearing ability increase. This means that the higher the public effort cost coefficient and risk aversion coefficient are, the more the local government should offer a low-risk contract as incentive. The local government's optimal reward and punishment coefficient and revenue distribution coefficient are increasing as the supervision efforts increase, which indicates that the greater the supervision efforts are, the more the local government should provide a high-risk contract asan incentive. From the perspective of Mandarin popularization based on an ability incentive in ethnic minorities, the local government should raise anti-risk ability and improve effort input effect of the public by understanding the surrounding environment, personal character, and enhanced social identity of the public.

Put Equations (16) and (17) into Equation (12), we get the optimal effort level of the public in the process of poverty alleviation through Mandarin popularization in ethnic minority areas:

$$k^* = \frac{f(f+\eta)(\sigma^2+\delta^2)}{[\delta^2 + \sigma^2f^2 + C_1r\delta^2\sigma^2]C_1} \tag{18}$$

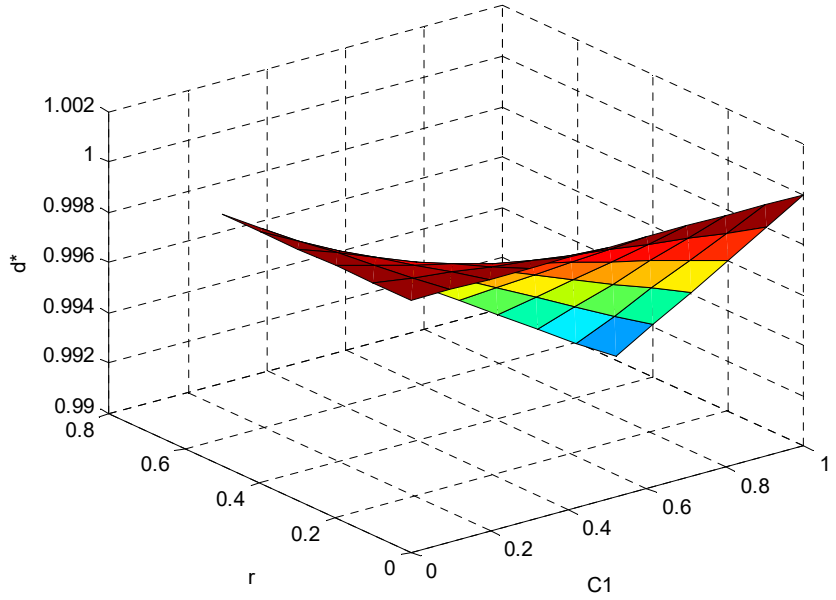

Figure 1. Relational graph of the local government's optimal reward and punishment coefficient, effort cost, and risk aversion coefficient.

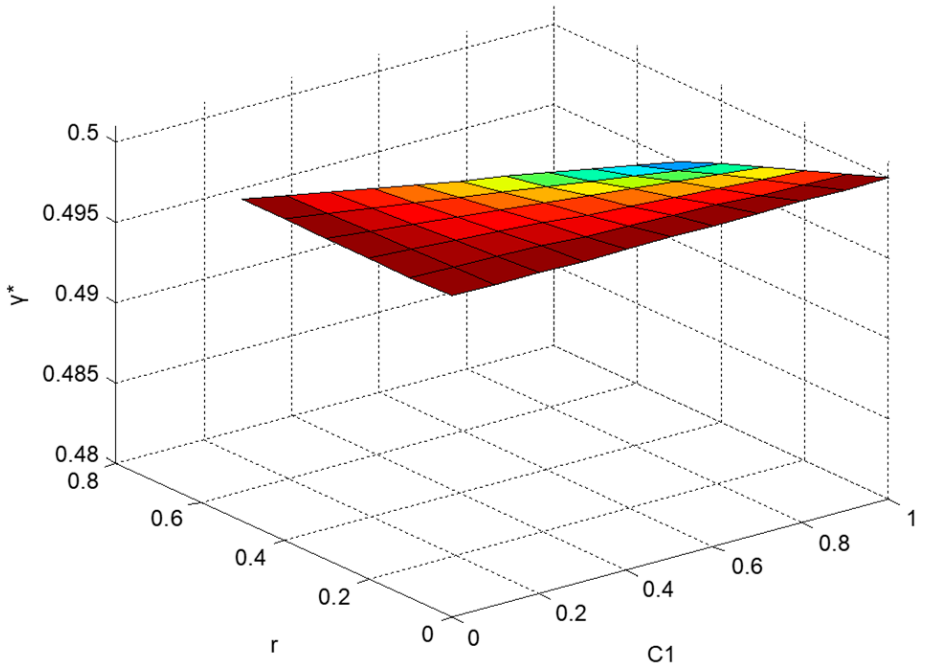

Figure 2. Relational graph of revenue distribution coefficient, effort cost, and risk aversion coefficient.

Conclusion 3: under the ability incentive equilibrium of asymmetric information, the optimal effort level (k^*) of the public in the process of poverty alleviation through Mandarin popularization in ethnic minority areas is positively correlated to the improvement (f) of Mandarin ability after training, and the local government's supervision effort (η) in the process of Mandarin popularization but is negatively correlated to the public effort cost coefficient C_1 and risk aversion coefficient r (As is shown in Figure 3).

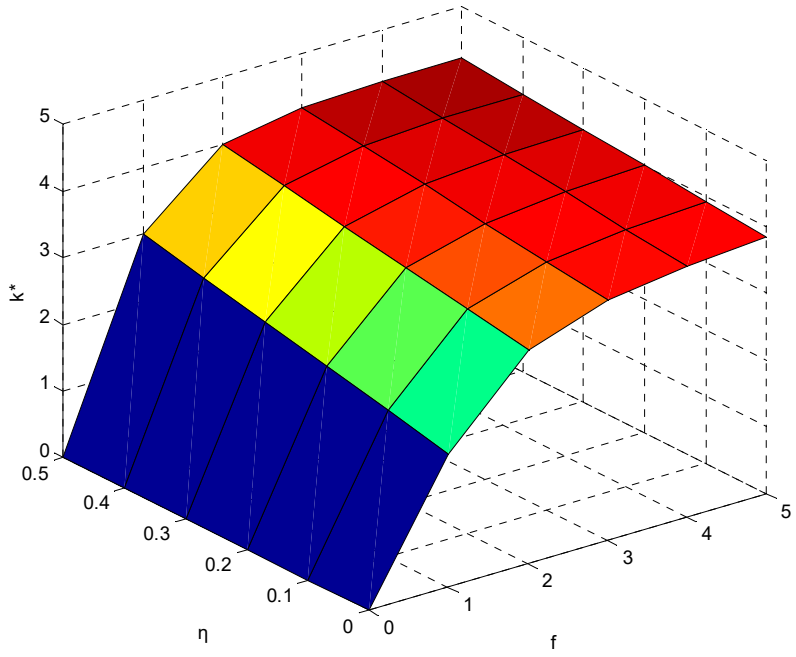

Figure 3. Relational graph of optimal effort level, improvement of Mandarin ability after training, and the local government's supervision effort.

Conclusion 3 proves that, if the public get great progress in Mandarin ability after training, they are more willing to make greater efforts to improve their Mandarin ability. Along with the improvement of Mandarin ability, the social benefits of the local government will increase and therefore the public are more likely to enjoy higher distributive revenue and they will work harder to improve their Mandarin ability. In the case that the local government imposes stricter supervision on the Mandarin improvement of the public, the public will also make greater efforts due to the supervision because they may suffer severe loss if their speculative behaviors if any, come under the observation of the local government. Consequently, the public will constantly improve their Mandarin ability. However, a larger effort cost coefficient C_1 suggests that greater efforts will lead to higher input costs. On the contrary, the higher the cost is, the more unlikely the public become to make effort. As a result, the local government has to advance the efforts of the public through supervision. In addition, a higher risk aversion coefficient r implies that the public have a weaker ability to bear external risks and that the negative effect of per capita effort will be greater. Furthermore, the public will more easily become listless in improving Mandarin ability, which further results in fewer efforts.

Conclusion 4: under the ability incentive equilibrium of asymmetric information, in the process of poverty alleviation through Mandarin popularization in ethnic minority areas, the optimal effort level k^* of the public increases along with the rise in the local government's optimal reward and punishment coefficient d^*, revenue distribution coefficient γ^* and improvement f of Mandarin ability after training. However, k^* decreases as the effort cost coefficient C_1 of the public increases.

As is shown in Figures 4 and 5, under the ability incentive equilibrium of asymmetric information, in the process of poverty alleviation through Mandarin popularization in ethnic minorities, the higher the reward and punishment coefficient is, the larger the revenue distribution coefficient is, the greater the improvement of Mandarin ability after training is, and the higher the revenue of the public is. This will further arouse the enthusiasm of the public to improve their Mandarin ability and encourage them to make greater efforts. In consequence, the local government should not only raise the reward and punishment coefficient through administrative means but also provide more revenue for

the public to a certain extent so as to improve their faculty to accelerate improvement in the Mandarin ability of the public. These will improve the learning enthusiasm of the public.

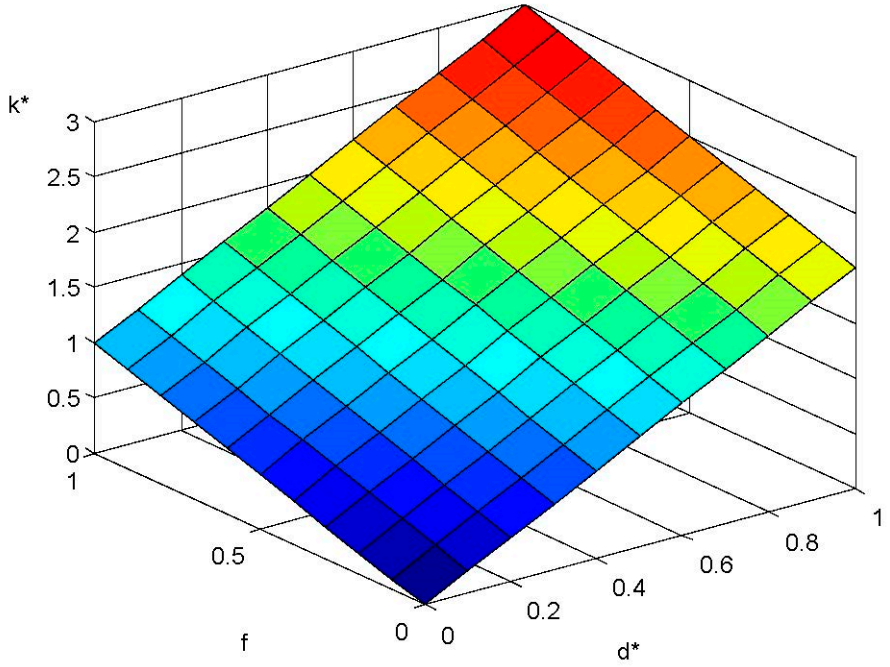

Figure 4. Relational graph of optimal effort level, improvement of Mandarin ability after training, and optimal reward and punishment coefficient.

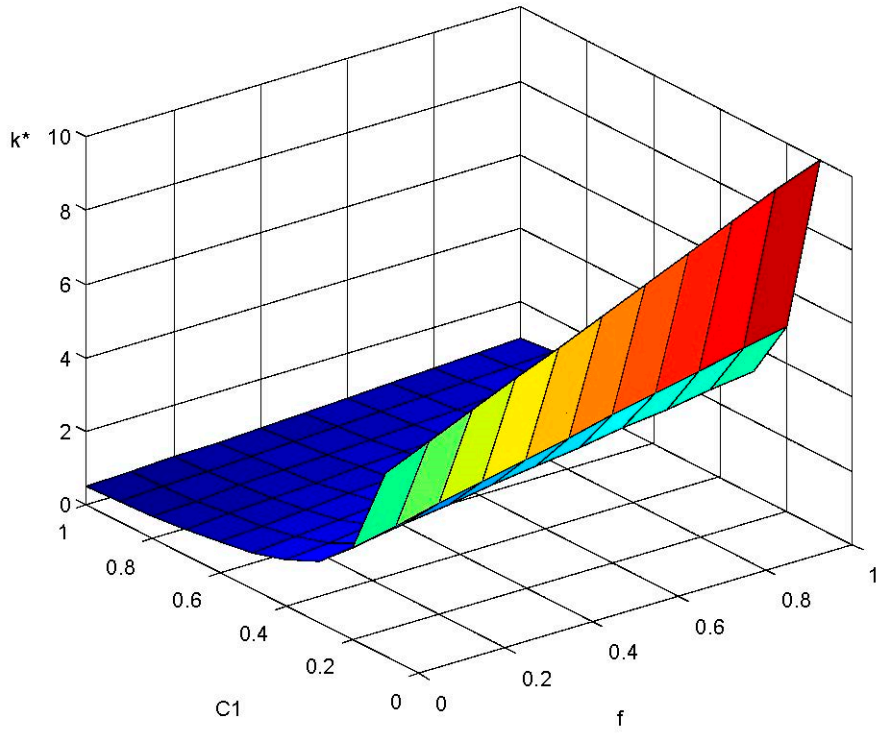

Figure 5. Relational graph of optimal effort level, improvement of Mandarin ability after training, and effort cost coefficient.

4. Analysis of Ability Incentive Effects of Poverty Alleviation through Mandarin Popularization in Ethnic Minority Areas

In this part, we constructed a principal–agent model where the local government did not provide training and calculated the expected revenue of the principal and agent. The expected revenue and major parameters were compared with those achieved through ability incentives. By doing so, we obtained the ability incentive effects and major influencing parameters of poverty alleviation through Mandarin popularization in minority areas, which provided theoretical guidance for the local government in offering ability incentives for poverty alleviation through Mandarin popularization.

4.1. Principal–Agent Model Where the Local Government Did Not Provide Training

When the local government does not provide training, the principal–agent model of Mandarin popularization in minority areas is assumed to be:

(1) Assuming that there is only one principal (the local government) and one agent (ethnic minorities) in the principal–agent relationship of Mandarin popularization in ethnic minorities. The principal is risk-neutral, and the agent is risk-averse.

(2) Assuming that the local government does not provide training, the primary Mandarin ability of the agent (ethnic minorities) is F, which remains unchanged during the principal–agent process, then the output function of the agent is:

$$\pi_1 = F + k + \varepsilon, F > 0, \varepsilon \sim N(0, \sigma^2) \tag{19}$$

In the above function, ε refers to uncontrollable factors; k ($k > 0$) refers to the effort level of the public; the effort cost is $c(k) = 0.5C_1k^2$ ($C_1 > 0$), which means the effort cost coefficient of the public.

It is assumed that other conditions are the same as those when the local government provides training. In this case, the Mandarin ability of the ethnic minorities is not improved and the local government's revenue distribution coefficient does not work. Therefore, the utility function of the ethnic minorities is:

$$\omega_1 = a + d(F + k + \varepsilon) - 0.5C_1k^2 \tag{20}$$

As a result, the agent's expected utility during the process of poverty alleviation through Mandarin popularization is:

$$E(\omega_1) = a + d(F + k) - 0.5C_1k^2 \tag{21}$$

The agent's certainty equivalence $CE(\omega)$ is the difference between the expected utility and risk cost, which is:

$$E(\omega_1) = a + d(F + k) - 0.5C_1k^2 - \frac{rd^2\sigma^2}{2} \tag{22}$$

The local government is risk-neutral in the principal–agent relationship of Mandarin popularization in ethnic minority areas. Its expected revenue is:

$$\begin{aligned} E(\zeta_1) &= E[-(a + dF + dk) - m - (b - \eta k)] \\ &= \eta k - (a + dF + dk + m + b) \end{aligned} \tag{23}$$

In the principal–agent relationship of poverty alleviation through Mandarin popularization in ethnic minority areas where no incentive is provided, the public, as the agent, own private information. In other words, there is information asymmetry between the agent and principal. Moreover, the agent's expected utility is not lower than the reservation

utility. The public, through certain efforts, will realize the goal of maximizing its own effects, which are:

$$CE(\omega_1) = a + d(F + k) - 0.5C_1k^2 - \frac{rd^2\sigma^2}{2} \geq \overline{\omega} \tag{24}$$

The optimal effort level of the public is:

$$\frac{\partial CE(\omega_1)}{\partial k} = d - C_1k \tag{25}$$

The optimal effort level of the public is:

$$k_1^* = \frac{d}{C_1} \tag{26}$$

Put Equation (23) into (20) and we have:

$$\begin{array}{l} \max E(\zeta_1) = E[-(a + dF + dk) - m - (b - \eta k)] \\ = \frac{\eta d}{C_1} + d(F + \frac{d}{C_1}) - [\frac{0.5d^2}{C_1} + \frac{rd^2\sigma^2}{2} + \overline{\omega} + dF + \frac{d^2}{C_1} + m + b] \end{array} \tag{27}$$

Supposing $\frac{\partial E(\zeta_1)}{\partial d} = \frac{\eta}{C_1} - \frac{d}{C_1} - rd\sigma^2 = 0$, then the local government's optimal reward and punishment coefficient d_1^* is:

$$d_1^* = \frac{\eta}{1 + C_1r\sigma^2} \tag{28}$$

Conclusion 5: under the condition of asymmetric information, if the local government does not provide an ability incentive (Mandarin training) during the process of poverty alleviation through Mandarin popularization, the local government's optimal reward and punishment coefficient d_1^* is negatively correlated to the random factor ε.

This suggests that, during the process of poverty alleviation through Mandarin popularization in ethnic minority areas, and under the case where the local government does not provide an ability incentive, if the public are more likely to be affected by external random factors, they become less willing to learn Mandarin. Consequently, relatively high reward and punishment set by the local government are needed to provide incentives.

Conclusion 6: under the condition of asymmetric information, if the local government does not provide an ability incentive (Mandarin training) during the process of poverty alleviation through Mandarin popularization, the local government's optimal reward and punishment coefficient d_1^* is positively correlated to the supervision efforts but negatively correlated to effort cost coefficient C_1 of the public and the risk aversion coefficient r.

As is shown in Figures 6 and 7, this conclusion is the same as the one drawn under the case where the local government provides an ability incentive. In other words, whether the government provides an ability incentive or not, as long as there are negative effects and anti-risk ability is weak, the local government needs to provide a high-risk contract incentive. At the same time, the stricter the local government's supervision is, the more likely the local government becomes to offer high-risk contract incentives. Only in this way can the public improve Mandarin ability through supervision and improvement of anti-risk ability and reduction of effort cost coefficient when the local government does not provide an ability incentive.

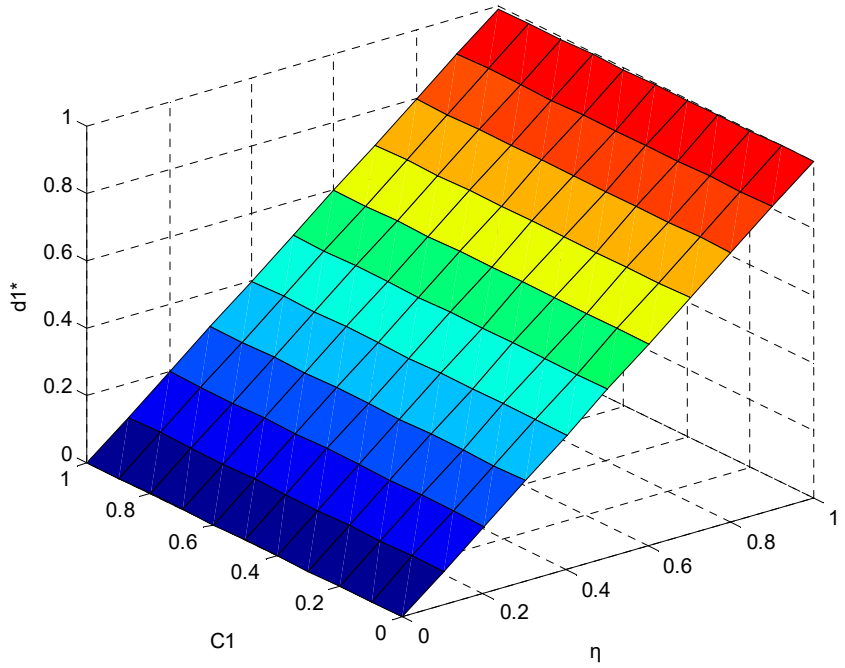

Figure 6. Relational graph of optimal reward and punishment coefficient, supervision effort, and effort cost coefficient under the condition where no ability incentive is provided.

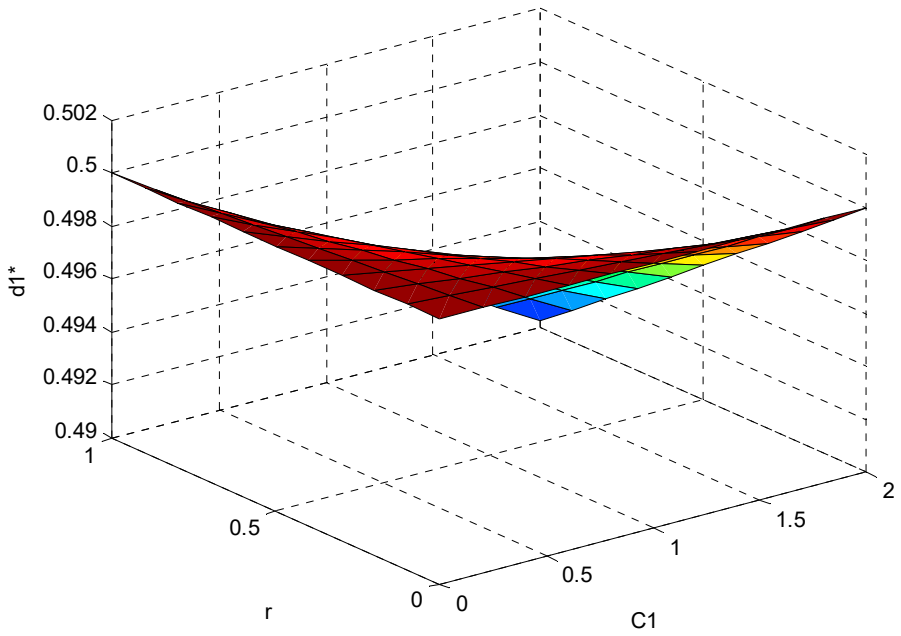

Figure 7. Relational graph of optimal reward and punishment coefficient, effort cost coefficient, and risk aversion coefficient under the condition where no ability incentive is provided.

Conclusion 7: under the condition of asymmetric information, if the local government does not provide an ability incentive (Mandarin training) during the process of poverty alleviation through Mandarin popularization, the optimal effort level k_1^* of the public rises as the local government's optimal reward and punishment coefficient d^* increases but declines as the effort cost coefficient C_1 of the public increases.

As is shown in Figure 8, this conclusion is consistent with the one drawn under the case where the local government provides an ability incentive. However, if no ability incentive is provided, the optimal effort level of the public has no connection with the

revenue distribution coefficient γ^* and improvement f of Mandarin ability after training. Because when $f = 0$, neither revenue distribution coefficient nor improvement of Mandarin ability after training works. In fact, the condition where the local government does not provide an ability incentive is a special case where the local government provides an ability incentive, but the public have no improvement in Mandarin ability.

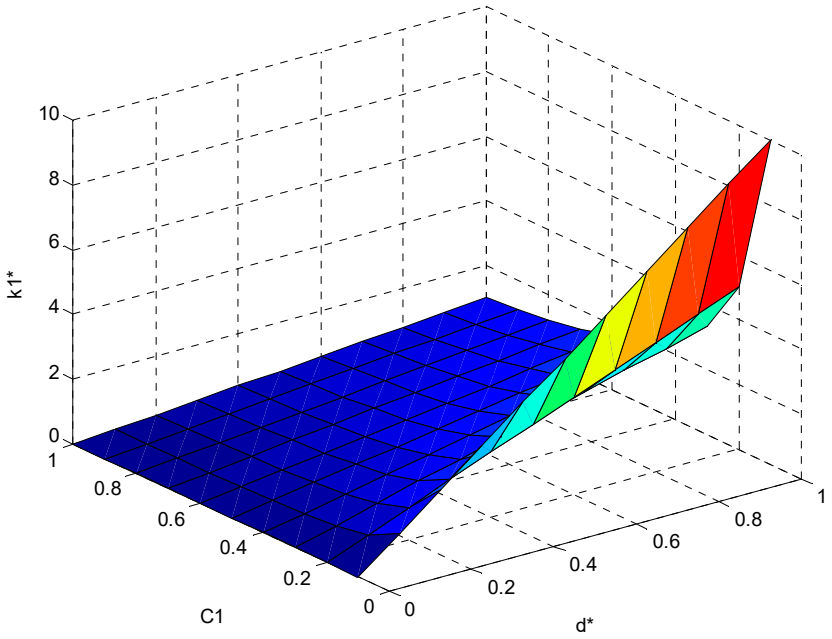

Figure 8. Relational graph of optimal effort level, reward and punishment coefficient, and effort cost coefficient under the condition where no ability incentive is provided.

4.2. Analysis of Ability Incentive Effect

In the process of poverty alleviation through Mandarin popularization in ethnic minority areas, the local government's ability incentive effect refers to free-of-charge Mandarin training provided by the local government (principal) for the ethnic minorities (agent), which can improve the Mandarin ability of the public and create more revenue for the public. Thus, the local government can also obtain greater expected revenue. The local government's ability incentive effect can be measured through the difference between the expected revenue obtained when the local government provides Mandarin training and the expected revenue when such training is not offered. Assuming $\Delta E(\zeta) = \max E(\zeta) - \max E(\zeta_1)$, according to Sections 3 and 4.1, we have $\Delta E(\zeta)$:

$$\max E(\zeta) = kf - 0.5C_2f^2 - 0.5C_1k^2 - \frac{r(d^2\sigma^2 + \gamma^2\delta^2)}{2} - m - b - \overline{\omega}$$

in which, $k^* = \frac{d+\gamma f}{C_1}$, $d^* = \frac{(f+\eta)f\sigma^2}{\delta^2+\sigma^2f^2+C_1r\delta^2\sigma^2}$, $\gamma^* = \frac{(f+\eta)\delta^2}{\delta^2+\sigma^2f^2+C_1r\delta^2\sigma^2}$.

$$\max E(\zeta_1) = \eta k - 0.5C_1k^2 - \frac{rd^2\sigma^2}{2} - \overline{\omega} - m - b$$

in which, $k_1^* = \frac{d}{C_1}$, $d_1^* = \frac{\eta}{1+C_1r\sigma^2}$.

Conclusion 8: in the process of poverty alleviation through Mandarin popularization in ethnic minority areas, the local government's ability incentive can effectively raise the local government's maximum expected revenue.

According to $\Delta E(\zeta) = \max E(\zeta) - \max E(\zeta_1)$, we know that, under the condition $\exists \eta > s$, we have $\Delta E(\zeta) > 0$. In other words, when the local government provides an ability incentive and it makes certain efforts in supervision, its maximum expected revenue is

greater than the revenue when an ability incentive is not provided. Therefore, it is necessary for the local government to provide Mandarin training for ethnic minorities to improve its benefits.

5. Numerical Simulation Analysis

The data in this article comes from the sample data of the deeply impoverished areas in southern Xinjiang, and minority areas in northern Xinjiang in August 2020. The data involves about 1000 households. In August and October 2020, the research team conducted household surveys in southern Xinjiang, including Hotan, Kashgar, Tumushuke, etc., and northern Xinjiang Urumqi, Hami, etc. The surveyed areas were all ethnic minority areas, and the areas where these areas were located were all national poverty-stricken counties. We obtained relevant data (the data has been standardized) through the collation of questionnaires:

Related parameters are shown as follows: $a = 0.1$, $F = 1$, $f = 2$, $\sigma = 0.1$, $\delta = 0.1$, $C_1 = C_2 = 1$, $r = 0.1$, $\eta = 2$, $m = 0.1$, $b = 0.1$. In poverty alleviation through Mandarin popularization in ethnic minority areas from the perspective of the ability incentive, the above parameters were put into Equations (16)–(18) to calculate the optimal effort level of the public (which was $k^* = 3.1194$), the local government's optimal reward and punishment coefficient (which was $d^* = 1.5997$), and the local government's optimal revenue distribution coefficient (which was $\gamma^* = 0.7998$). The above optimal values were put into Equations (6) and (7) and thus we obtained the optimal expected revenue of the local government and the public, which was $E^*(\omega) = 10.0154$ and $E^*(\zeta) = -4.5375$, respectively. When the local government did not provide an ability incentive, above parameters were put into Equations (26) and (28) and we calculated the optimal effort level of the public (which was $k^* = 1.998$) and the local government's optimal reward and punishment coefficient (which was $d_1^* = 1.998$). When there was an ability incentive, on the contrary, the optimal expected revenue of the local government and the public was $E_1^*(\omega) = 4.092$ and $E_1^*(\zeta) = -2.297$. As a result, the local government will surely provide an ability incentive for the public so that its expected revenue is optimized.

In poverty alleviation through Mandarin popularization in ethnic minority areas from the perspective of ability incentive, the expected revenue of the local government and the public is affected by random factors and conditions of the public but the above factors are uncontrollable. Consequently, we pay special attention to the impact of the controllable factor (the local government's supervision effort η) on the local government's optimal reward and punishment coefficient, the local government's optimal distribution coefficient, the optimal effort level of the public, and the optimal expected revenue of the local government and the public.

From Figure 9, we can see that, whether there is an ability incentive or not, the local government's optimal reward and punishment coefficient increases as the local government's supervision effort becomes greater. However, the optimal reward and punishment coefficient increases more quickly when the local government provides an ability incentive for the public. This indicates that, when the local government makes strong efforts in supervision, the speculative behaviors of the public, once they emerge, will be found by the local government and the public may face severe loss. In the case of ability incentive provided by the local government, the local government will impose severe punishment on speculative behaviors of the public. Asa consequence, the public will constantly improve their effort level, which requires more time and energy. More rewards and punishment are needed so that the public can improve their effort level.

As is shown in Figure 10, when there is an ability incentive, the local government's optimal distribution coefficient increases as the local government imposes greater supervision. In other words, when the local government provides an ability incentive for the public, the optimal effort level of the public will rise, and so does the optimal expected revenue of the local government and the public. Therefore, the local government is more willing to share partial revenue with the public to raise the enthusiasm of the public. Nevertheless, when

there is no ability incentive, the local government's supervision exerts little impact on the optimal distribution coefficient, mainly because the local government's mission does not have a positive effect on raising the expected revenue of the public and it is unnecessary to distribute revenue. Therefore, the enthusiasm of the public decreases.

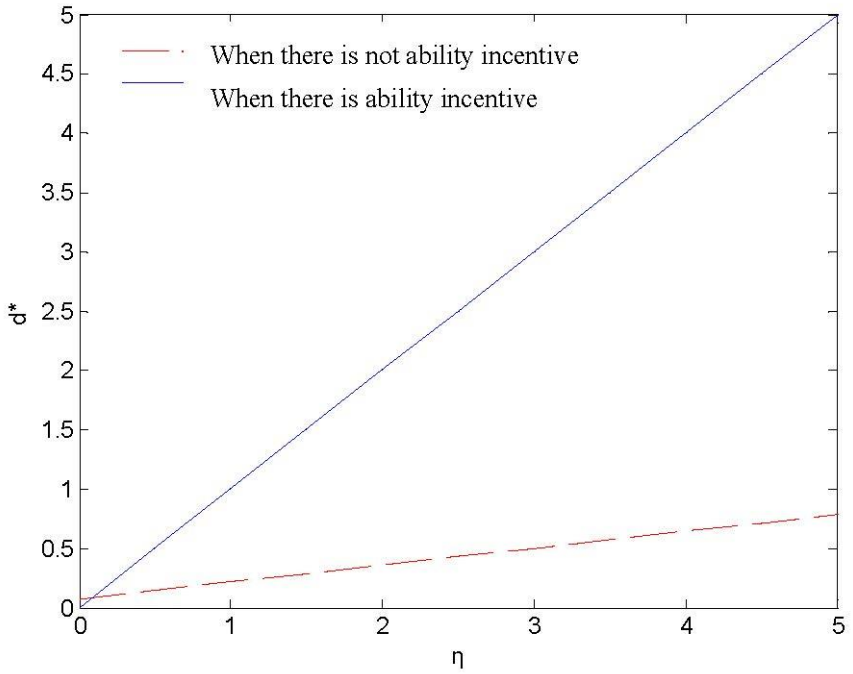

Figure 9. Influence of the local government's supervision effort (η) on the local government's optimal reward and punishment coefficient.

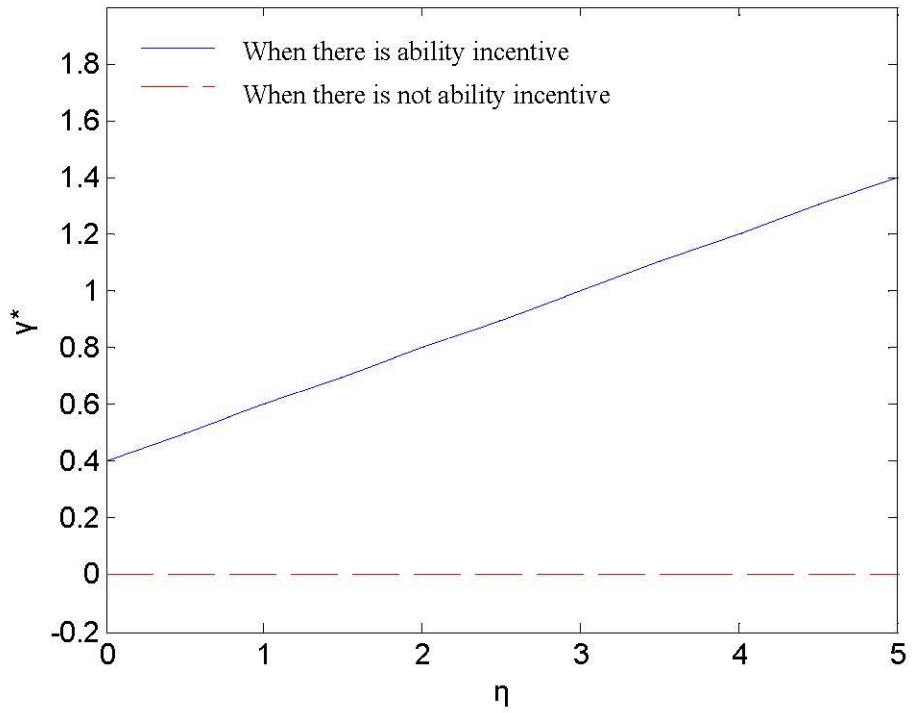

Figure 10. Influence of the local government's supervision effort (η) on the local government's optimal distribution coefficient.

According to Figure 11, the local government's optimal effort level increases as the local government has stronger supervision, whether there is an ability incentive or not. In the case of ability incentive, the optimal effort level of the public is higher than in the case where there is no ability incentive. Therefore, we can conclude that effective supervision and ability incentives can improve the optimal effort level of the public. The revenue of the local government and the public will rise as there are stronger supervision efforts. When there is no ability incentive, the optimal effort level of the public is higher than the one when there is an ability incentive. This suggests that, if the local government imposes excessive supervision and when the public receive less revenue but undertake stronger supervision, the public will be less enthusiastic to improve Mandarin ability. Therefore, the local government's supervision should remain within a reasonable range.

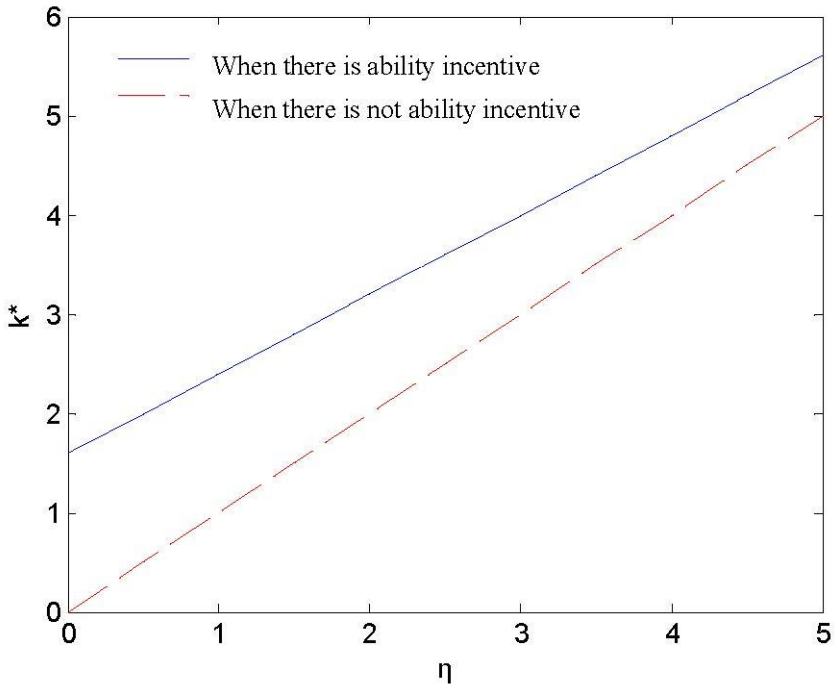

Figure 11. Influence of the local government's supervision effort (η) on the optimal effort level of the public.

Based on Figure 12, in the case of ability incentive, the optimal effort level of the public increases as the local government's supervision effort becomes stronger. Benefiting from the ability incentive provided by the local government, the public constantly improve the optimal effort level. Therefore, the revenue, in this case, is obviously higher than in the case where there is no ability incentive. In other words, the local government's ability incentive will raise the self-consciousness and initiative of the public in learning Mandarin. The rise of the local government's optimal reward and punishment coefficient and optimal distribution coefficient leads to an increase in revenue. Therefore, there is more endogenetic impetus in poverty alleviation through Mandarin popularization. If the local government provides an ability incentive, it needs to pay a certain incentive cost. If there is insufficient supervision, the effort level of the public will not be high, which leads to less expected revenue than in the case where there is no ability incentive. However, in the case of the local government's supervision effort, the expected revenue when there is an ability incentive is larger than the one when there is no ability incentive. This means that the local government should not only provide an ability incentive to raise the optimal effort level of the public but also take supervision measures to improve the expected revenue of the public and the local government.

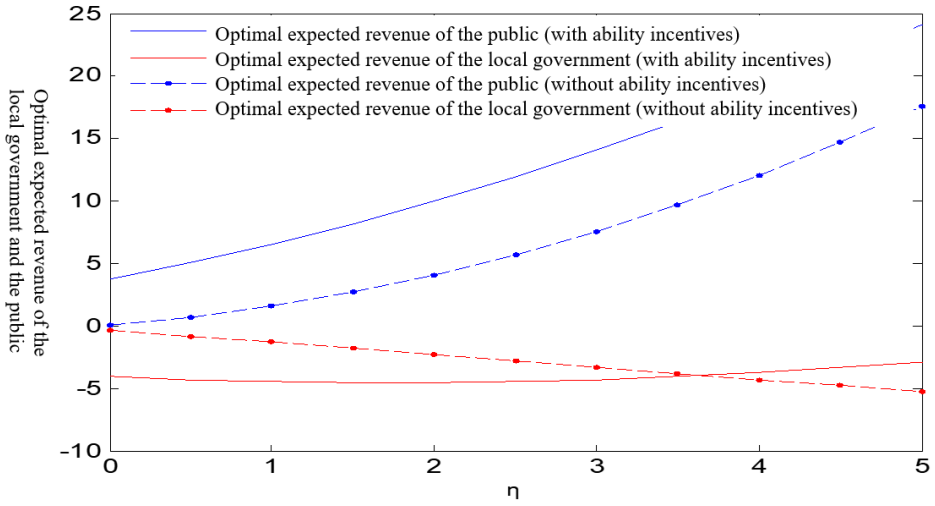

Figure 12. Influence of the local government's supervision effort (η) on the optimal expected revenue of the local government and the public.

The expected revenue of the public (agent) increases as there is stronger governmental supervision, whether there is an ability incentive or not. This shows that the local government's supervision is extremely important to motivating endogenetic impetus and raising effort levels. As there is stronger governmental supervision, the local government's expected revenue will gradually increase when there is an ability incentive. For the local government, proper supervision, and ability incentives are the keys to poverty alleviation through Mandarin popularization in ethnic minority areas. With stronger governmental supervision, however, the local government's expected revenue will gradually decrease when there is no ability incentive. This implies that the public will have a negative mentality when there is only governmental supervision but there is no ability incentive. The optimal effort level of the public will constantly decrease, resulting in less revenue for the local government. In summary, in the process of poverty alleviation through Mandarin popularization in ethnic minority areas from the perspective of ability incentive, in addition to ability incentive, the local government should also impose proper supervision to create a sound environment for Mandarin learning and training.

6. Conclusions

Based on the principal–agent relationship in the process of poverty alleviation through Mandarin popularization in ethnic minority areas, we constructed a principal–agent model and, under the condition of information asymmetry, contrasted the influence of the local government's ability incentive on decision-making strategies and expected revenue of the local government and the public. Through case numerical simulation, this paper discussed the effect of the local government's supervision effort on the optimal strategy selection and expected revenue of the local government and the public. We drew the following conclusions:

(1) Under the ability incentive equilibrium of information asymmetry, both the optimal reward and punishment coefficient and revenue distribution coefficient of the local government decrease as there is a stronger anti-risk capability and more negative effect resulting from public efforts. However, the two coefficients increase as there are stronger supervision efforts. This implies that the local government should provide high-risk contract incentives when there are stronger governmental supervision efforts. However, when the local government does not provide ability incentive, however, the local government's optimal distribution coefficient does not work. In other words, the local government does not distribute revenue to the public.

(2) Under the condition of information asymmetry, whether there is an ability incentive or not, the public become more willing to work harder to improve Mandarin ability if

they make great progress after Mandarin training; if the local government imposes greater supervision on Mandarin improvement of the public, the public will also pay more efforts due to governmental supervision. Therefore, the local government needs to raise the public enthusiasm for improving Mandarin ability through ability incentives and supervision.

(3) Under the ability incentive equilibrium of information asymmetry, whether there is an ability incentive or not, the higher the local government's reward and punishment coefficient is, the larger the revenue distribution coefficient of the public; the greater the Mandarin improvement after training is, the higher the revenue of the public is. In this case, the public become more enthusiastic about improving Mandarin ability and paying more effort.

(4) In the case of ability incentive and certain governmental supervision, the local government's maximum expected revenue is higher than in the case where there is noability incentive. In other words, it is necessary for the local government to provide Mandarin training for the ethnic minorities to maximize benefits. As there is stronger governmental supervision, however, the local government's expected revenue will gradually decrease if an ability incentive is not provided.

The principal–agent model of poverty alleviation among ethnic minorities constructed in this paper is closer to reality, provides effective guidance for improving the level of people's efforts and maximizing social benefits, and has important practical value. The limitations of the theoretical model in this paper are as follows: firstly, the principal–agent model itself also has a sensitivity to parameter selection, and in the process of system formation, in addition to policy design, it is also necessary to consider traditional path dependence, social customs, and cultural norms in ethnic minority areas, etc. Secondly, this study assumes that both the government and the public take maximizing their own profits as their decision-making goal, which is deviated from the reality to a certain extent. In addition, in the process of poverty alleviation among ethnic minorities, various types of subjects participate, such as the central government, social organizations, etc. There are two-way interactions between governments at different levels and enterprises to form a principal–agent relationship. The dual principal–agent model or the multiple principal–agent model is a problem that needs to be studied in the future.

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