

The Research on Prisoner's Dilemma in Prenatal Sex Determination

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Abstract: Inequality in the sex ratio is a significant issue in China. Some illegal sex determination mechanisms that give parents of young children gender information significantly contribute to the sex ratio imbalance. As a result, some parents make prejudiced decisions to abort girls. Regulation of prenatal sex determination by governmental and medical institutions will be challenging due to the high degree of information asymmetry. A few of the government's initiatives have yet to show obvious results. Medical institutions and women of childbearing age automatically cooperate in spite of information asymmetry. The "prenatal sex determination" regulation model is given a new interpretation in this paper using the game theory analysis method. Additionally, the paper explains the causes of the regulation's difficulty and proposes ideas, countermeasures, and solutions. The idea of cooperation contained in game theory is of great significance in resolving interest conflicts and achieving social harmony under the condition of interest differentiation.

Keywords: Prenatal Sex Determination, Prisoner Dilemma, Game Analysis, Inequality

1. Introduction

In recent years, the problem of controlling the high sex ratio at birth has been put on the government's work agenda. The main debate about why our country's infant sex ratio is higher began in 1982, following the third population census data. According to the results of a 10% sample data from our country's fourth population census in 1990, the sex ratio calculated by children at birth in 1989 was 111.3, and that reported by mothers was 113.8. 111.3 and 113.8 both exceed the expected normal value of 106. That is, for every 100 male girls born in 111 or 114, five or eight babies should be born as a result of abnormal influences [1]. Since the 1980s, some direct and indirect measures have been taken to control the non-medical "prenatal sex determination" to curb the upward trend of the sex ratio at birth. In 2000, the Central Committee of the Communist Party of China and The State Council listed "the normalization of the sex ratio of babies at birth as one of the goals of population and family planning work in the next ten years." Some parents may have a preference for sons, so when they find out the sex of the child through unofficial means, they will abandon the child. This proves that unofficial prenatal sex determination directly contributes to the gender imbalance. Therefore, it is of great social significance to study this problem.

In order to explain the development of cooperative behavior and the preservation mechanisms of cooperative institutions, Jiang proposes that biologists, sociologists, and economists need to work together to try to solve this important challenge [2]. Banister & Johnson suggests that fetal sex

determination and selective abortion induction are the direct causes of the continuous high sex ratio of the Chinese birth population, which has become the consensus of the theoretical community at home and abroad since the mid-1990s [3]. Chu using kinship network in the central province of birth population sex ratio in field investigation, the survey results show that due to the “boy preference”, the proportion of prenatal sex determination and selective flow induced labor is very high, which is the main cause of the high birth sex [4]. However, statistical data and the survey results of some researchers show that due to the blockage of information access by government regulatory authorities and the cost of some reasons. Zhong & Zhu found it difficult to ban “prenatal sex identification” conditions that are not medically necessary, and prenatal sex identification has encountered regulatory difficulties [5].

So far, most experts have studied the prisoner’s dilemma of game theory or investigated prenatal sex determination institutions. Only a few scholars have connected the two. In contrast, the government, medical institutions, and maternal there are both some games. This paper first investigates the dilemma of prenatal supervision of illegal sex determination in China. At the same time, it constructs the supervision model of “prenatal sex identification”. It tries to analyze the game process and results among the supervision agencies, medical institutions, and couples of childbearing age by combining the prisoner’s dilemma. This paper also uses the twp payoff matrix to analyze each perspective’s payoff. Finally, this paper hopes to provide a new way of thinking about the causes of the regulatory dilemma and, on this basis, provide some ideas and more realistic suggestions for solving the regulatory dilemma.

2. Case Description

The gender imbalance has long been a problem in China. According to the Statistical Yearbook, in rural areas, the sex ratio of males to females (female =100) in 31 provinces is greater than 100. That is, there are more males than females in all rural areas in 31 provinces. Among them, 14 provinces are greater than 110, namely Beijing, Shanxi, Inner Mongolia, Shanghai, Zhejiang, Fujian, Jiangxi, Hubei, Guangdong, Guangxi, Hainan, Chongqing, Yunnan and Ningxia [6]. The root cause of this phenomenon is rural China’s backward economy and ideology. First, giving birth to boys has great economic value in rural areas, where men can go to the farm while women can only care for their husbands and children at home. At the same time, the traditional family-oriented concept of male preference and the male-oriented concept of carrying on the family line lead to a strong desire to bear boys. It is to prevent this gender imbalance that the hospital chooses not to tell parents the gender of the child. However, due to the progress of current science and technology, the technical conditions of fetal sex identification and artificial termination of pregnancy by selecting the sex, as well as the lack of supervision, the sex ratio of China’s population is still on the high side despite the economic progress in recent years.

In addition, statistics and the findings of some researchers show that prenatal sex testing has encountered regulatory difficulties because government regulators have limited access to information and high costs, making it difficult to prohibit non-medically necessary prenatal sex testing.

This conclusion is based on the following understandings: First, government departments have formulated laws and regulations and have designated special supervision and management agencies. Second, medical institutions at all levels are familiar with this law, but some medical institutions are driven by interests to know the law, break the law, and secretly conduct underground transactions. Third, due to the concealment of prenatal sex identification, it is difficult for government management departments to determine who has violated laws and regulations. Fourthly, the abnormal market of “prenatal sex identification” has been formed between the medical institutions of prenatal sex identification and couples of childbearing age due to their common interests. They are easy to form a

“confidential alliance”, which makes it difficult to detect and punish this violation of laws and regulations, and increases the difficulty of supervision and management [7].

3. Analysis on the Problem

The Prisoner’s dilemma game is one of the theoretical models that presents the social dilemma situation in which individual and collective interests’ conflict. In the traditional two-strategy game with only cooperators and defectors, both under evolutionary game theory and natural selection, the defector is superior to the cooperator.

3.1. The Game between Medical Institutions and Parents

Before the game analysis, it is assumed that the couples of childbearing age have the rationality of economic man and maximize their interests under certain constraints. In fact, this assumption is reasonable. After the mid-20th century, with the introduction of microeconomics analysis methods into the family field, fertility began to be considered a behavior based on the rational decision-making of families [8]. It can be said that the fertility behavior of couples of childbearing age reflects the utility maximization of the family on the basis of the trade-off between costs and benefits.

Table 1: The payoff matrix between medical institutions and parents

| Parents | | Medical institutions | |
|----------------------|---------|----------------------|--------|
| | | Conceal | Admit |
| Medical institutions | Conceal | 10; 10 | 5; 0 |
| | Admit | 0; 5 | -5; -5 |

According to Table 1, assume that two participants, medical institutions and couples of reproductive age, are suppliers and demanders of prenatal sex determination technology, respectively. In the face of government inspection, both players face the strategic choice of keeping secret or coming clean. If security, medical institutions, and parents payoff [10, 10], respectively, if adopt to confess the benefits [- 5, 5], respectively, representative frank medical institutions will be forced to accept the punishment, therefore, will be far less than frank when medical institutions, such as the short-term direct income because of confidentiality. Then, the strategic choice of secrecy or confession between the medical institution and the couple of reproductive age constitutes a complete information game problem with a payoff matrix shown in Table 1.

It can be seen from Table 1 that confidentiality strategies are all the dominant strategies of medical institutions and couples of childbearing age. The balanced result means that even if there are no external force constraints, medical institutions and it is easy to reach a cooperation agreement between couples of childbearing age, abide by the conditions of the agreement and given each other, no one has the motivation to deviate from their behavior rules outlined in the agreement, is said that the agreement can be automatically carried out.

The analysis of this game fully reveals a practical problem: driven by rationality, medical institutions pursue the maximization of economic benefits, and couples of childbearing age pursue the maximization of family utility brought by “boys,” forming an abnormal market of “prenatal sex identification” technical services, and the cooperation agreement between the supply and demand sides is complied with, which aggravates the information asymmetry in the supervision process This also shows that although the government and all sectors of society deeply dislike the behavior of

prenatal sex identification and have taken many measures, the phenomenon of illegal prenatal sex identification has been repeatedly banned and defeated.

3.2. Incomplete Information Game between Regulators and the Medical Institutions

This paper assumes that there are two players a medical institution and a regulatory institution. They are all “rational economic men,” whose behavior is characterized by pursuing the maximization of their interests under constraints. As the government’s representative, the regulatory agency maximizes social interests. On the other hand, there is information asymmetry between medical institutions and regulators. Set by the government laws and regulations and regulatory inspection information is common knowledge, medical institutions may provide prenatal sex determination or may not provide, for this information, their mastery of medical institutions. However, faced with many medical units, regulatory agencies understand the situation of each medical institution, and there is obvious information asymmetry among medical institutions.

Table 2: The payoff matrix between regulators and the medical institution

| | | Medical institutions | |
|-----------|--------------|----------------------|--------------|
| | | Offer | Not to offer |
| Regulator | Check | -1; -5 | -5; 0 |
| | Not to check | -10; 0 | 0; 0 |

According to Table 2, the plight of prenatal sex determination regulation results from information asymmetry. Obviously, the higher the regulatory agency’s information about the medical institution, the lower the likelihood that the medical institution will illegally conduct prenatal sex identification. However, the cooperative solution formed through the game between medical institutions and couples of childbearing age is the key to causing information asymmetry.

4. Suggestions

The dilemma of prenatal sex determination regulation is actually a conflict of interest between the government and medical institutions. A stable game equilibrium process is formed under asymmetric information. The Nash equilibrium between medical institutions and couples in the pursuit of maximizing their respective interests is the key factor leading to information asymmetry, further aggravating the regulatory dilemma. The following are several possible solutions to the problem.

4.1. Establish policies of Punishment and Incentive

Wang & Ma proposed that an appropriate amount of punishment is the key to facilitating the realization of equilibrium [9]. When fines are applied to regulation, and the penalties are large enough, the costs of prenatal sex determination outweigh the opportunity benefits. Because the medical institution is rational, its behavior will be unmotivated in the absence of profit drive. In addition, the government can establish a credit system for life for medical institutions that have broken the law in the past. Medical institutions that violate regulations should be punished accordingly. At the same time, they need to show the strength of this punishment to society to play the role of killing chickens. Moreover, punishment can also include the advanced medical institutions in the assessment evaluation and leadership promotion activities to increase medical institutions because of irregularities and bear the cost of credit losses. If there is only blind punishment, it may produce rebellious psychology in medical institutions. Therefore, it is necessary to establish a long-term and

effective incentive mechanism, change the past mechanism of only punishing but not rewarding, and combine the incentive mechanism with the punishment mechanism to transfer the equilibrium solution. For instance, those who report illegal prenatal sex determination agencies can be rewarded with cash.

4.2. Eliminate the Son Preference Idea

In general, raising children can be viewed as an investment process. Since it can be assumed that raising men and women costs about the same, the difference is in the payoff: if raising a boy has a significantly higher future payoff than raising a girl, then both parents will prefer to raise a male. In order to address son preference, it is necessary to equalize the benefits of rearing males and women. In reality, the government's pension insurance might also be helpful because it lowers parents' expectations of return from relying heavily on their kids, which might partially reduce son preference.

The network information supervision department shall be responsible for strengthening the daily management of news websites, commercial websites, medical and drug information service websites, pharmaceutical enterprises and self-established websites of medical institutions; Strengthen the review of website advertising, guide and urge websites to strictly implement the relevant provisions on advertising review, and prohibit the release of non-medical fetal sex identification advertising information; Strengthen the management of search engine websites, urge search engine websites to block online advertising information involving fetal sex identification through the establishment of filter keywords and other technical means, and resolutely block the online transmission channels of related advertisements; Timely clean up blogs, forums, instant messaging tools and other interactive links and illegal intermediary websites involving blood collection to identify fetal sex advertising information; Strengthen the investigation and punishment of violations according to law, and punish websites that illegally publish advertisements for blood collection to identify the gender of the fetus according to law.

4.3. Government Support

According to the analysis above, the government can play a limited role in addressing the high sex ratio of the population at birth through the methods mentioned above, which may lessen the incentive for some medical institutions to break the law when people's psychology of "boy preference" and gender inequality are difficult to change significantly. The cost or marginal cost of such supervision, on the other hand, is quite high [10]. So, while the government maintains a high-pressure situation in "prenatal sex determination," measures should be taken to eliminate gender inequality in reality so that, on the one hand, couples of childbearing age demand prenatal sex determination technology, cost prenatal sex determination technology market; on the other hand, it can reverse the fertility concept of "boy preference," thereby promoting the fundamental solution of the long-term problem. The most effective way to address this issue is to eliminate Chinese gender preferences. The government must improve education and rural development so that Chinese people have a proper understanding of gender.

5. Conclusion

This paper focuses on the relationship between prenatal sex identification and the prisoner's dilemma and analyzes the phenomenon of gender inequality in China and the direct relationship between prenatal sex identification and the imbalance of male to female ratio. The text uses a payoff matrix to analyze the payoff of regulators, medical institutions, and parents, aiming to solve this social problem in China from the game theory perspective. The idea of cooperation contained in game theory is of

great significance in resolving interest conflicts and achieving social harmony under the condition of interest differentiation.

This paper still has some limitations. First and foremost, the article relies heavily on secondary rather than primary data. Second, due to the scarcity of literature linking prenatal sex identification and game theory, articles can only draw on a limited amount of prior literature. At the same time, due to the limited number of authoritative literature, some points of view cannot be compared, and thus errors may occur. In the future, primary data can be obtained through surveys, interviews, conducting experiments, or researching official databases.

References

- [1] Li, Y. P. (1993). *The Effect of Abortion induced by fetal sex determination on THE SEX ratio of born infants. Population studies (05), 21-25 + 13.*
- [2] Jiang, H., Jiang, Y. L. & Huang, Q. Z.(2022). *Observe the influence of the level of cooperation mechanism of the prisoner's dilemma game. Control and decision making. Doi: 10.13195 /j.k. zyc.0666.*
- [3] Banister .(2002). *Recent Population Trends and Issues in China. Paper presented at the 11th Biennial Conference of the Australian Population Association, Sydney, 2-4.*
- [4] Chu, J. (2001). *Determinants OF Prenatal Sex Selection in rural China. The population of China science (01).*
- [5] Zhong, Q. C. & Zhu, X. J. (2006). *"prenatal sex determination" regulators, game analysis. The south population (03), 4-10 + 25.*
- [6] Zi, C. (2021). *Latest announcement of male/female ratio in 31 provinces. Branch Construction (36),54.*
- [7] Li, Q. S. (2023). *The perspective of game theory in our country third party payment regulation studies (master's degree thesis, northeast university of finance and economics). <https://kns.cnki.net/kcms2/article/abstract?v=ncFPfLIMdGaCBPpUoaSwzTWg9qm>*
- [8] Cheng, W. (2002). *Gender preference and fertility behavior. Chinese women population research, (02): 14 to 22.*
- [9] Wang, Y. F. & Ma, X. M. (2023). *Ecological compensation and government supervision in the context of polluting industry transfer: a signal game based on compensation application. Resources and industry. Doi: 10.13776 / j.carol carroll nki resourcesindustries. 0710.001.*
- [10] Chen, W. (2002). *Gender preference and productive behavior of Chinese women. Population Research (02),14-22.*