Commentary

Research on economy and social exclusion: China dolls and rare diseases

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Summary	The second workshop on "Research on Economy And Social Exclusion (REASE)" was held in the University of Tokyo on January 26, 2013. Focusing on rare diseases and disorders in China, three speakers from China introduced the current status of rare diseases and the challenge of support organizations for patients with rare disease and disorders in China, and especially pointed out some important issues associated with rare diseases and disorders in China. From the viewpoint of economics, this paper discusses some of the important issues of rare diseases and disorders in China raised in this workshop, especially from the aspects of economy of scale and orphan drugs, and the emergence of stigma from discrimination. It was shown that international coordination and cooperation are called for in order to give a proper incentive to the drug industries to create new drugs for rare diseases, and suggested that an important step toward inclusion is to reduce stigma by making rare diseases visible as much as possible.

Keywords: Disability, complementarity, discrimination, prejudice

1. Introduction

On January 26, 2013, the second workshop on "Research on Economy And Social Exclusion (REASE)" was held in the University of Tokyo. In this workshop, focusing on rare diseases and disorders in China, we invited three speakers from China, Rufang Huang, Lei Xiao, and Yitong Jiang. Huang and Xiao are the core members of China-Dolls Center for Rare Disorders (*http:// www.chinadolls.org.cn*), which is a non-government organization that assists people with rare diseases and disorders, with particular strength in assisting children suffering from osteogenesis imperfecta (OI) and osteomalacia. They introduced the current status of rare diseases and the challenge of support organizations for patients with rare disease and disorders in China, and especially pointed out some important issues associated with rare diseases and disorders in China, including a lack of specialized medical doctors, a lack of medicine and huge cost, an insufficient social security system, poverty due to these factors, and discrimination and

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prejudice against patients and their families.

These issues may be regarded as social problems as well as medical ones. Some of the issues cannot be understood and resolved without understanding their economic aspects. This is precisely the reason that social sciences including economics have to be involved in the research of intractable and rare diseases, and this is why it is related to a project called "Research on Economy And Social Exclusion (REASE)" launched by our group. REASE is a research project funded by the grants-in-aid for scientific research, focusing on the economic aspects of barriers and obstacles of people with long-standing health problem or disability, children who need social care, and those who suffer from the east Japan earthquake in 2011.

As pointed out by Tang and Makuuchi (*1*), it is estimated, that there are 5,000-7,000 distinct rare diseases in the world. While each disease is small in terms of the number of patients (0.065-0.1%) as defined by the World Health Organization (WHO), the total number of patients suffering from rare diseases amounts to 6-8% of the total EU population and 10% of the total US population. Therefore, rare diseases have a significant impact on our society.

From the viewpoint of economics, I want to discuss some of the above concerns raised by Rufang Huang, especially from the aspects of economy of scale and

orphan drugs, and the emergence of stigma from discrimination.

2. Economy of scale and orphan drugs

The first two issues raised by Rufang Huang, the lack of medical doctors and that of medicines for rare diseases, are understood by using economy of scale, a classical concept of economics (see, *e.g.*, a textbook by Mankiw (*2*)). Although there are a couple of versions of the concept, let us focus on the most relevant one here, that is, a decreasing average cost of production. Let us, for the sake of simplicity, take the case of drugs as an example instead of that of medical doctors.

In order to create a drug, a drug company needs an investment. Ignore uncertainty for the moment and suppose that this research and development (R&D) investment costs $F > 0$. The drug, after development for use, costs $c > 0$ per person. Suppose further that there are n patients potentially using this drug. Then the price p of the drug has to be at least (*i*) $\bar{p} = c + F/n$ in order for the company to break even. The less the number of patients is, the higher the break even price $\bar{p}$ becomes. In the presence of economy of scale, market may not function well. To see this point, suppose that the demand curve for this drug is (*ii*) $d = n - ap$, $a > 0$ where d is the demand as counted by the number of patients. The property that the demand decreases as p increases reflects the fact that the higher the price becomes, the more patients have to give it up. Assume $n/a > c$ for relevancy. If the price is $p < n/a$, then the demand is $n-ap$, and the consumer surplus, the surplus that the patients get in total, is (*iii*) $(1/2)(n/a-p)(n-ap)$. Thus, from the viewpoint of total welfare, which is obtained by subtracting the cost from the sum of the consumer surplus and the company's profit, the drug has to be developed if (*iv*) $(1/2)(n/a-p)(n-ap)+p(n-ap)-c(n-ap)-F > 0$ holds. On the other hand, this drug is provided if and only if the company can raise profit, *i.e.*, (*v*) $p(n-ap)-c(n-ap)-F > 0$ holds for some $p > c$. A simple calculation shows that this drug is not provided despite that its provision would increase the total welfare if (*vi*) $(p-c)(n-ap) < F < (1/2)(n/a-p)(n-ap)+(p-c)(n-ap)$ holds. In this case, some subsidy is called for in order to properly provide the drug.

Now, to highlight the issue of drug demand in the context of world economy, suppose that there are K countries. Assume that the kth country has n_k patients of this disease. For the sake of simplicity, each country has two strategies, to approve the drug at a small but positive cost if developed, which is denoted by A, and not to approve it, denoted by N. Assume that $n = n_1 + ... + n_K$ is sufficiently large so that (*v*) holds. The benefit from taking A depends on the number of countries that take A: the more countries approve the drug, the higher the benefit from A becomes. Suppose that there is a threshold $\bar{k}$, the number of countries, beyond which taking A induces a higher payoff than taking N. This property

that the more countries take A, the more attractive action A becomes is called strategic complementarity in economics (Bulow *et al*. (*3*)).

In this game, there are two types of equilibria. To begin with, let us see the incentive of each country. There are two important cases. First, each country has an incentive to approve the drug if all the other countries are expected to approve it. Second, no country has an incentive to approve the drug if no other country is expected to approve it. Given the behavior of the countries, there are essentially two possibilities of the company's investment decision. On one hand, if the company expects the first case to occur, then it has an incentive to invest in R&D. On the other hand, if it expects the second case, then it has no incentive to invest in R&D. Hence, there are two qualitatively different equilibria, the one in which the drug is developed and provided and the other in which it's not. Note that this is true even if (*v*) holds so that it is beneficial for the entire world to have the drug.

Thus, we need international coordination and cooperation to obtain the second type of equilibrium where the needs of people with rare diseases are properly accommodated.

3. The emergence of stigma from discrimination

In his presentation, Lei Xiao showed pictures of a boy with OI who is denied entrance to an elementary school because the school said they cannot be responsible for a possible broken bone of the boy. This way, OI patients, and people with rare diseases/disorders become invisible in the society. This section, taken from Matsui (*4*), argues that such a discriminatory action may lead to prejudice or stigma.

While stigma has been a key concept in sociology since Goffman (*5*), it has never been a key concept in economics. One reason for this is that stigma is a mental attachment, and there has been little attempt to relate it to economic variables (*Note*: one exception is Becker (*6*), but his analysis assumes stigma at the outset, while the purpose of our analysis is to endogenize it). Kaneko and Matsui (*7*) studied stigma in a game theoretic context, constructing a two-stage game called the festival game. In the first stage of this game, a population, which is divided into two ethnic groups, A and B, simultaneously choose a location, 1 or 2, to visit. Let group A be the majority and group B be the minority. In the second stage, upon observing the ethnic composition of the participants at one's own location, each person decides whether he/she will play in a friendly or an unfriendly manner. If a person takes unfriendly action, then his/her level of satisfaction (payoff, henceforth) is at the default level of zero. On the other hand, if the person takes friendly action, then – since this is a "festival" – his/her payoff depends upon the number of friendly people in the same location. The greater the number of friendly people, the higher the

payoff to the person who takes friendly action. In other words, the festival game exhibits complementarity. If no other people take friendly action, the payoff from taking friendly action is less than that from taking unfriendly action. Here, we assume that even the smaller ethnic group is so large that the group by itself can reach a critical mass beyond which people taking friendly action receive a positive payoff. In order to obtain a clear result, it is assumed that their payoffs do not depend, among other things, upon the demographic composition.

Kaneko and Matsui decomposed the analysis of this game into two parts, the standard equilibrium analysis and a new analysis, called inductive game theory. First, the simplest equilibrium is the one in which everyone goes to the same location and takes friendly action. This is a unification equilibrium. Another simple equilibrium is the one in which people choose a location randomly, and wherever they may go, they take unfriendly action. These are equilibria since people would like to take friendly action if many others do, and vice versa.

Yet, there is another equilibrium, which may be called a segregation equilibrium. In this equilibrium, the two groups of people go to different locations: group *A* people go to, say, location 1, while group *B* people go to location 2. They take friendly action as long as they observe only people from their own ethnic group. In order for this situation to be an equilibrium, each individual in group *B* must have no incentive to deviate to location 1, which is physically more attractive than location 2 since more people gather there and a higher payoff is obtained there than at location 2. This is made possible if group *A* people discriminate against group *B* people. Technically, this can be done if when group *A* people see a group *B* person they suddenly take unfriendly action. This way, segregation is maintained through discrimination.

Kaneko and Matsui continued on to the development of inductive game theory. In this theory, people try to "explain" their experiences by constructing a model. Suppose, for this purpose, that people do not know the actual structure of the game, or in particular, how their payoffs are determined. Suppose further that they play the game according to the segregation equilibrium described above.

In this equilibrium, people who wish to "explain" the discriminatory behavior may come up with the following story. For some reason, group *A* people are happy in general, but they become unhappy from time to time. When one closely monitors what happens when their payoff drops, one may realize that a decrease in payoff is observed whenever there is a group *B* person in location 1. Thus, this group *A* observer may conclude that group *A* people become unhappy when a group *B* person joins them. This is a false model since the objective game says that what matters is the number of friendly people. However, this prejudicial model may well explain one's

experiences, and prejudices emerge.

How can such a prejudicial model be falsified and thus an inclusive mind be cultivated? The above prejudicial model would be falsified if two groups interact in a friendly manner, which is perhaps the easiest way of eliminating prejudices in the mind of the people in the main stream.

4. Conclusion

We have shown, by way of economics/game theory, that in an industry for orphan drugs, economy of scale induces market failure in a single country and coordination failure in an international economy, and therefore, international coordination and cooperation are called for in order to give proper incentive to the drug industries to create new drugs for rare diseases. Another concern related to rare diseases is discrimination and prejudice. We have shown that invisibility caused by discrimination enhances prejudice. It is, therefore, an important step toward inclusion is to make rare diseases visible as much as possible.

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