

## **Policies increasing the number of disaster medical volunteers with a sense of mission**

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*Received: 15 December 2017*

*Revised: 5 March 2018*

*Accepted: 5 March 2018*

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### **Abstract**

This study presents an economic analysis of policies designed to increase the number of healthcare workers with a sense of mission as disaster medical volunteers, who play critically important roles during or immediately after natural disasters. I apply a cultural transmission model to ascertain how changes occur in the ratios of healthcare workers motivated by a sense of mission and those motivated by economic incentives. As a result, increasing subsidies to hospitals that deploy medical volunteers to disasters increases the number of healthcare workers motivated by economic incentives. Therefore, I show that increasing the ethical standards of healthcare workers while decreasing subsidies to hospitals could increase the number of healthcare workers motivated by a sense of mission.

*Keywords:* disaster medical volunteers; sense of mission, cultural transmission model

*JEL Classification Codes:* H0, Z1

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### **1. Introduction**

The role played by volunteers in times of a devastating disaster is crucially important. The Japanese government created Disaster Medical Assistance Teams (DMATs) that operate in disaster areas to reduce damage from natural disasters. After the Great East Japan Earthquake in 2011, 1,426 teams and 9,328 healthcare workers were registered as DMATs. Healthcare workers in DMATs, namely, disaster medical volunteers, are dispatched to disaster medical fields from their employing hospitals, which are certified as core disaster hospitals. They are regularly paid rewards for normal medical activities from their employing hospital, but they work without compensation as disaster medical volunteers in times of disaster<sup>1</sup>. Therefore, they must have a

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Citation: Fukuyama, H. (2017) Policies increasing the number of disaster medical volunteers with a sense of mission, *Economics and Business Letters*, 6(4), 125-132.

<sup>1</sup> Disaster volunteers are classifiable as those without specialized capabilities and those with them. The former help operate disaster shelters and cook, or engage in general volunteer work such as cleanup, whereas specialized volunteers include disaster medical volunteers who have obtained government certification for advanced work

strong sense of mission. On the other hand, healthcare workers without a sense of mission are not registered in DMATs, and do not provide medical services in disaster areas. Therefore, in recent years, national certification examinations for healthcare workers have included questions related to professional ethics, such as “medical ethics” and “human rights of patients,” in order to increase the number of healthcare workers with a sense of mission (Ministry of Health, Labour and Welfare, 2003).

The main purpose of this paper is policies that could increase the number of disaster medical volunteers.

This study specifically examines healthcare workers with a sense of mission. Heyes (2005) analyzed why nurses’ wages do not rise despite a shortage of nurses; one reason was that a rise in wages causes a decrease in the proportion of nurses who have a sense of mission. Although it is necessary for hospital administrators to pay high wages in order to create high levels of effort in workers motivated by economic incentives, working in the public not-for-profit sector for workers with a sense of mission engenders a rise in their payoff, despite low wages. Much economic research has been conducted on workers with a sense of mission (Barigozzi & Burani, 2016; Besley & Ghatak, 2005; Brekke & Nyborg, 2010; Delfgaauw & Dur, 2008, 2010; Francois, 2000). Like these works, this study constructs a model that incorporates not only healthcare workers motivated by economic incentives as wages, but also those motivated by the social contributions of their medical work.

A contribution of this study is that it is endogenously determined whether workers become motivated by a sense of mission or by economic incentives, using a cultural transmission model. This is an extension of previous studies, which have investigated exogenous determination of workers’ motivation (economic incentives or a sense of mission). Bisin and Verdier (2001) conducted a representative study of the cultural transmission model, which they developed to ascertain whether cultural characteristics of individuals are set by direct vertical socialization (in families) or through oblique socialization outside the home (society or companions). This model is helpful in analyzing the effects of policies for increasing the number of healthcare workers with a sense of mission.

Moreover, this study examines two methods to achieve its objective. The first is the use of policies to increase ethical standards; that is, levels of sense of mission for healthcare workers in national certification examinations. These policies might decrease the probability of attracting individuals without a particular sense of mission. The second is the use of subsidies for medical institutions that deploy healthcare workers as disaster medical volunteers and are certified as core disaster hospitals. To support the medical care functions of core disaster hospitals in times of disaster, the Japanese government offers them the subsidies<sup>2</sup>. These policies might give incentives for hospital administrators to aggressively employ healthcare workers with a sense of mission.

## 2. Model

### 2.1. Payoff of Individual

I consider an economy consisting of an individual living during two periods and a hospital administrator. The first period of the individual represents childhood, while the second represents adulthood. The individual in the childhood period has no preference: he or she is naïve. The individual in the adulthood period either has a preference motivated by a sense of

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such as providing healthcare, caregiving, and health examinations. In this paper, I consider disaster medical volunteer activities by medical workers regularly employed by a hospital.

<sup>2</sup> Possession of DMATs is one of certification requirements for a hospital to be certified as a core disaster hospital. The core disaster hospital can receive a subsidy for core disaster hospital facility maintenance costs from each administrative division.

mission, namely, altruism (referred to as Type A in this study) or some economic (financial) incentive, namely, selfishness (Type S). Types A and S have different payoffs. The payoff of type A is

$$u_A = \gamma + \alpha w. \quad (1)$$

The payoff of type S is

$$u_S = w. \quad (2)$$

In equations (1) and (2),  $\gamma$  stands for a feeling of satisfaction derived from serving others through medical practice—the “warm glow” described by Andreoni (1990)—and  $w$  denotes the wage. Type A cares about altruism and, partly, wages.  $\alpha(0 < \alpha < 1)$  denotes the degree of the selfishness of Type A. Type S is interested only in the monetary value of work. An individual has one child. The population of a generation is normalized to 1. The share of Type A is denoted as  $q$  and that of Type S is denoted as  $1 - q$ .

Individuals become either Type A or Type S in the adulthood period, and seek jobs. Thus, two types of workers exist: healthcare workers and unemployed workers. To become healthcare workers, individuals should pass the national certification examination for medical practitioners. The probability of passing examinations differs between Type A and Type S. Type A can pass the examination with a probability of 1. Type S cannot pass the examination with probability  $p(0 < p < 1)$ . Therefore, because Type A, motivated by a sense of mission, satisfies professional ethics and cooperative personality requirements for healthcare workers, he or she can pass the examination with a probability of 1. By contrast, because Type S, who is motivated by an economic incentive, does not satisfy the condition, he or she cannot pass the examination with probability  $p$ . I interpret the probability  $p$  of examination failure as representing the required ethical standard for healthcare workers.

Next, individuals who pass the examination can become healthcare workers if employed by the hospital administrator. Healthcare workers can produce benefits of 2 for the employing hospital through their work providing medical services. Moreover, healthcare workers who register with a DMAT work as volunteers providing medical services in disaster areas if, for example, a major earthquake occurs. At such times, a Type A individual registers with a DMAT and works as a volunteer, but a Type S individual does not because the volunteer does not receive rewards. A hospital that sends a volunteer to a disaster area is recognized as a “core disaster hospital” and obtains a subsidy  $b(> 2)$  from the government. Therefore, Type A produces benefit  $b(> 2)$  for the hospital if a large earthquake occurs. Type S produces only benefit 2 by working at the hospital even if a large earthquake occurs. I assume  $b > 2$  because it is necessary to guarantee the hospital the opportunity cost of sending a DMAT volunteer to a disaster area, which is 2 at least.

Individuals of Type S who failed the examination and individuals who were not employed at the hospital become unemployed workers. For simplicity, I assume that an unemployed worker produces a benefit of 0.

## 2.2. Signal and Labor Market

Next, I consider the healthcare worker labor market. A sufficient number of hospitals are homogeneous. A hospital hires a healthcare worker. The hospital administrator cannot observe the type of individual, but knows the population ratio  $(q, 1 - q)$  of Types A and S.

The prior belief  $(q, 1 - q)$  of the hospital administrator is updated by the signal that an individual passed the examination. Let  $\theta$  denote the posterior belief that the individual is Type A. In addition, let  $1 - \theta$  denote the posterior probability that the individual is Type S when the

hospital administrator receives the signal. When the hospital administrator observes the signal,  $\theta$  and  $1-\theta$  are obtained as

$$\theta = \frac{q}{q + (1-q)(1-p)}, \quad 1-\theta = \frac{(1-q)(1-p)}{q + (1-q)(1-p)}. \quad (3)$$

Here, the hospital administrator's expected benefits  $E\pi$  generated using a healthcare worker are given as

$$E\pi = (1-\varepsilon) \times 2 + \varepsilon \times [\theta \times b + (1-\theta) \times 2] = 2 \left\{ 1 + \varepsilon \theta \left[ \frac{b}{2} - 1 \right] \right\}, \quad (4)$$

where  $\varepsilon (0 < \varepsilon < 1)$  represents the occurrence probability of a disaster, such as a major earthquake, that is, an incidence of disasters. The first term of equation (4) represents benefits produced by a healthcare worker during regular work. The second term of equation (4) represents the expected benefits produced by a healthcare worker when a disaster occurs. At the time of a disaster, Type A works as a volunteer and produces benefit  $b (> 2)$  for the hospital. Type S produces a benefit of 2 through regular work. I assume that the expected benefits  $E\pi$  of equation (4) are halved between the hospital administrator and the healthcare worker. Therefore, the healthcare worker wage is given as

$$w = 1 + \varepsilon \theta \left[ \frac{b}{2} - 1 \right], \quad (5)$$

where the wage is the same irrespective of whether the healthcare worker participates as a volunteer, because it is determined at the labor contract stage.

The payoff of type A is equivalent to equation (1) because Type A is employed by the hospital administrator without fail. From equations (2) and (5), the expected payoff  $Eu_M$  of Type S is expressed as shown as follows:

$$Eu_S = (1-p)w = (1-p) \left\{ 1 + \varepsilon \theta \left[ \frac{b}{2} - 1 \right] \right\}. \quad (6)$$

Type S obtains wage  $w$  when he or she passes the examination with probability  $1-p$ . Otherwise, he or she would become an unemployed worker and obtain wage 0.

### 2.3. Cultural Transmission Process

I assume that individuals in the adulthood period take account not only of their own payoff (equations [1] or [6]), but also a child's payoff, as explained by Bisin and Verdier (2001). Therefore, individuals choose a level of education investment to maximize the sum of their own payoff and the present value of the discounted childhood payoff.

An individual of Type A recognizes his or her child's payoff in the future as  $V^{AA}$  if the child becomes the same Type A:

$$V^{AA} = \gamma + \alpha w = \gamma + \alpha \left\{ 1 + \varepsilon \theta \left[ \frac{b}{2} - 1 \right] \right\}. \quad (7)$$

Moreover, an individual of Type A will recognize his or her child's payoff in the future as  $V^{AS}$  if the child becomes a different type (i.e., Type S):

$$V^{AS} = (1-p)w = (1-p) \left\{ 1 + \varepsilon \theta \left[ \frac{b}{2} - 1 \right] \right\}. \quad (8)$$

I assume that the Type A individual hopes his or her child has the same preference as his or her own in the future, that is,  $\gamma$  is sufficiently large to satisfy the following:

$$\gamma > (1 - \alpha - p) \left\{ 1 + \varepsilon \theta \left[ \frac{b}{2} - 1 \right] \right\}. \tag{9}$$

An individual of Type S will recognize his or her child’s payoff in the future as  $V^{SS}$  if the child becomes the same Type S:

$$V^{SS} = (1 - p)w = (1 - p) \left\{ 1 + \varepsilon \theta \left[ \frac{b}{2} - 1 \right] \right\}. \tag{10}$$

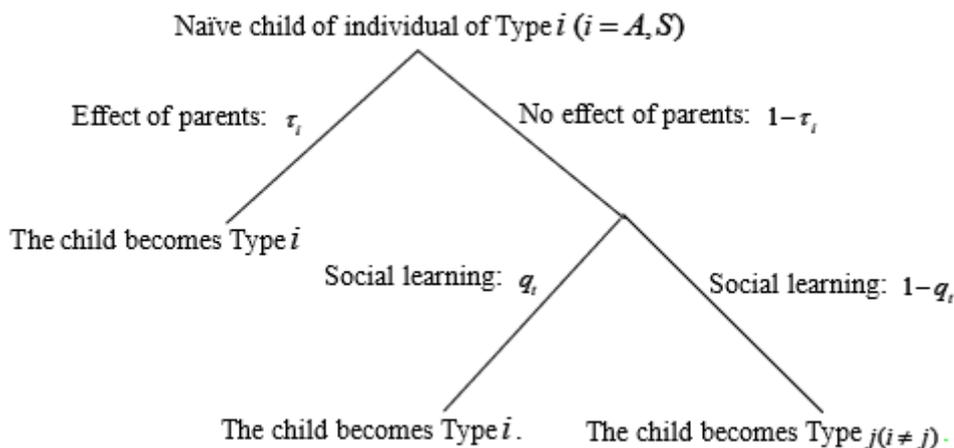
Moreover, an individual of Type S will recognize his or her child’s payoff in the future as  $V^{SA}$  if the child becomes a different type (i.e., Type A).

$$V^{SA} = 0. \tag{11}$$

In fact, equation (11) means that a Type S individual cannot accurately predict the payoff of his or her child in the future because a Type S individual, who is motivated by an economic incentive, cannot understand the satisfaction generated by a social contribution, such as medical activities. The parent has “imperfect empathy” (Bisin & Verdier, 2001). In addition, from equations (10) and (11), a Type S individual hopes his or her child has the same preference as himself or herself in the future.

Here,  $\tau_i (i = A, S)$  represents the probability that the child will have the same preference as the parent in the future. The child has the same preference as the parent with probability  $\tau_i$  through educational investment by the parent, but this investment does not influence the child with probability  $1 - \tau_i$ . The child who is not influenced by the parent’s educational investment becomes Type A or Type S through social environment effects, that is, social learning. When the share of Type A individuals is denoted as  $q_t$  and that of Type S individuals as  $1 - q_t$  at period  $t$ , a child who is not influenced by the parent’s educational investment becomes Type A with probability  $q_t$  or Type S with probability  $1 - q_t$  by social learning (Figure 1).

Figure 1. Cultural transmission of an individual of Type  $i$ .



I make the following assumptions for the analyses:  $z_t^{ij}$  denotes the probability that the child of a Type  $i$  individual becomes Type  $j$  at period  $t$ , where  $i, j = A, S$ . The equations expressing these probabilities are presented as follows:

$$z_t^{AA} = \tau_A + (1 - \tau_A)q_t, \quad (12)$$

$$z_t^{AS} = (1 - \tau_A)(1 - q_t), \quad (13)$$

$$z_t^{SS} = \tau_S + (1 - \tau_S)(1 - q_t), \quad (14)$$

$$z_t^{SA} = (1 - \tau_S)q_t. \quad (15)$$

Assuming that  $H(\tau_A)$  ( $H'(\cdot) > 0, H''(\cdot) > 0, H'(0) = 0$ ) denotes the costs associated with the educational investment by the Type A individual, that is, it increases as the level  $\tau_A$  of educational investment (i.e., the probability that the child becomes the same Type A as his or her parent) increases. Therefore, from equations (7), (8), (12), and (13), the decision problem related to the level of educational investment by a Type A individual at period  $t$  is given as follows:

$$\text{Max}_{\tau_A} \lambda \left[ z_t^{AA} V^{AA} + z_t^{AS} V^{AS} \right] - H(\tau_A) = \lambda \left[ (\tau_A + (1 - \tau_A)q_t)(\gamma + \alpha w) + (1 - \tau_A)(1 - q_t)(1 - p)w \right] - H(\tau_A). \quad (16)$$

Here, the discount rate is  $\lambda$  ( $0 < \lambda < 1$ ). The first term of equation (16) represents the expected payoff that the child of a Type A individual will obtain in the subsequent period ( $t+1$ ). This expected payoff signifies that the child of a Type A individual becomes Type A with probability  $z_t^{AA}$  and obtains payoff  $V^{AA}$ ; alternatively, he or she becomes Type S with probability  $z_t^{AS}$  and obtains payoff  $V^{AS}$ . The individual's own payoff is omitted from equation (16) because  $\tau_A$  does not affect his or her own payoff. The second term of equation (16) represents the educational investment cost. The Type A individual decides  $\tau_A$  to maximize this object function. Therefore, by substituting equation (5) for (16), the first-order condition of maximization is given as follows:

$$\lambda(1 - q_t) \left[ \gamma - (1 - \alpha - p) \left\{ 1 + \varepsilon \theta \left( \frac{b}{2} - 1 \right) \right\} \right] = H'(\tau_A). \quad (17)$$

Similarly, letting  $G(\tau_S)$  ( $G'(\cdot) > 0, G''(\cdot) > 0, G'(0) = 0$ ) denote the costs associated with the educational investment by the Type S individual, from equations (10), (11), (14), and (15), the decision problem related to the level of educational investment by a Type S individual at period  $t$  is given as follows.

$$\text{Max}_{\tau_S} \lambda \left[ z_t^{SS} V^{SS} + z_t^{SA} V^{SA} \right] - G(\tau_S) = \lambda \left[ (\tau_S + (1 - \tau_S)(1 - q_t))(1 - p)w \right] - G(\tau_S). \quad (18)$$

The first-order condition of maximization is obtained as follows by substituting equation (5) for (18).

$$\lambda q_t (1 - p) \left[ 1 + \varepsilon \theta \left( \frac{b}{2} - 1 \right) \right] = G'(\tau_S). \quad (19)$$

By using the implicit function theorem for equations (17) and (19), the following Lemma 1 holds.

#### Lemma 1

- (a) Educational investment of a Type A individual decreases and that of a Type S individual increases as the share  $q_t$  of Type A individuals increases.

- (b) Educational investment of a Type A individual decreases and that of a Type S individual increases as the subsidy  $b$  to the hospital that sends disaster volunteers increases.
- (c) Educational investment of a Type A individual increases and that of a Type S individual decreases as ethical standards  $p$  increase.
- (d) Educational investment of a Type A individual increases and that of a Type S individual decreases as the degree of selfishness of Type A  $\alpha$  increase.

### 3. Dynamics

In this section, I consider the dynamics of the population ratio  $(q_t, 1 - q_t)$  of Types A and S. The share  $q_{t+1}$  of Type A at period  $t + 1$  equals the sum of the probability that the child of a Type A individual becomes the same Type A as his or her parent and the probability that the child of a Type S individual becomes a different type (i.e., Type A) from his or her parent at period  $t$ . This share  $q_{t+1}$  is computed from equations (12) and (15) as follows:

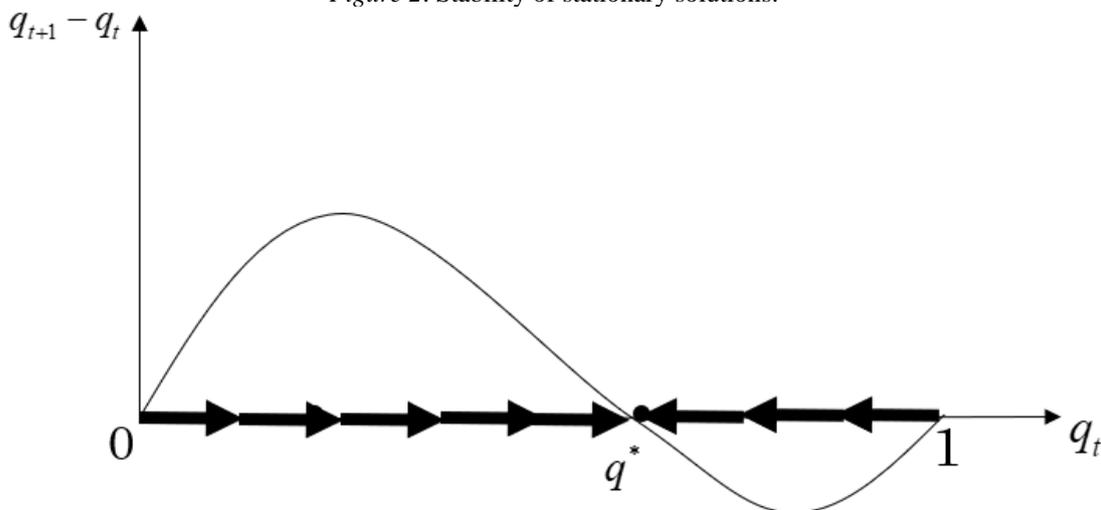
$$q_{t+1} = q_t z_t^{AA} + (1 - q_t) z_t^{SA} = q_t + q_t(1 - q_t)(\tau_A - \tau_S). \tag{20}$$

Because a steady state is  $q_{t+1} = q_t$ , a stationary solution  $q^* (= q_{t+1} = q_t)$  satisfies:

$$q^*(1 - q^*)[\tau_A(q^*) - \tau_S(q^*)] = 0. \tag{21}$$

From equation (21), the stationary solution  $q^*$  is  $q^* = 0$ ,  $q^* = 1$ , or  $q^* (0 < q^* < 1)$ , which satisfies  $\tau_A(q^*) - \tau_S(q^*) = 0$ .  $q^* = 0$  and  $q^* = 1$  represent a homogeneous society in which all individuals are only Type A or only Type S.  $q^* (0 < q^* < 1)$ , which satisfies  $\tau_A(q^*) - \tau_S(q^*) = 0$ , represents a heterogeneous society that includes Type A and Type S individuals. I confirm that  $q^* (0 < q^* < 1)$  is a stable stationary solution and that  $q^* = 0$  and  $q^* = 1$  are unstable stationary solutions from Figure 2.

Figure 2. Stability of stationary solutions.



I investigate how a stable stationary solution  $q^* (0 < q^* < 1)$  varies with policy parameters  $b, p$ . Considering disaster medical volunteers using the comparative statics of  $b, p$  enables me to make policy recommendations. By differentiating equation (21) for  $b$  and  $p$ , the following holds from Lemma 1.

$$\frac{dq^*}{db} = -\frac{\frac{d\tau_A}{db} - \frac{d\tau_S}{db}}{\frac{d\tau_A}{dq^*} - \frac{d\tau_S}{dq^*}} < 0, \quad \frac{dq^*}{dp} = -\frac{\frac{d\tau_A}{dp} - \frac{d\tau_S}{dp}}{\frac{d\tau_A}{dq^*} - \frac{d\tau_S}{dq^*}} > 0. \quad (22)$$

From equation (22), the policy that increases the share of Type A individuals motivated by a sense of mission is summarized in the following Proposition 1.

*Proposition 1*

*To increase the share of Type A individuals, the government should decrease the amount of subsidy to hospitals within the limits of  $b > 2$  and should increase ethical standards.*

#### 4. Concluding remarks

The important limitations of this study are as follows. First, this study did not address the decision problem of investment in human capital by healthcare workers. This is an important aspect in order to examine the difference of level of human capital investment between Types A and S. Second, this study assumed hospital administrators are homogeneous. However, it should be considered that hospital administrators, like healthcare workers, could be motivated by a sense of mission or an economic incentive. Doing so would enable comparisons of different roles of public versus private hospitals.

#### Acknowledgements

This work was supported by JSPS KAKENHI Grant Number 16K12374.

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