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Optimal Combination of International and Inter-temporal Diversification of Disaster Risk: Role of Government

Tao YE*, Muneta YOKOMATSU and Norio OKADA

* Graduate School of Engineering, Kyoto University

Synopsis

This paper aims at recalling the role of the government in the financial management of disaster risk, instead of emphasizing on the importance of insurance industry. It tries to check whether a combined approach of inter-generational and international disaster risk diversification would help to optimize social welfare. In this study, a one-goods, two-country and two-period-overlapping-generations model is set up to make comparative analysis on this combined instrument and traditional instruments. In the model, the disaster risk could be diversified by the open capital market, the private insurance contract or the combined instrument, disaster reserve fund plus international loan. The result shows that the intervention from the government could successfully diversify disaster risk among generations and then increase the expected utility of the households.

Keywords: disaster risk diversification, disaster reserve fund, overlapping-generations model, role of government

1. Introduction

There has been growing evidence that in the coming years there would be a rise in both the frequency and severity of natural disasters (Mahul and Gurenko, 2006). Meanwhile, the concentration of the world's population and wealth to urban areas leads to much higher exposure to natural disasters. Moreover, social vulnerability also increases due to sub-standard construction and false regional land-use planning, etc. As a matter of fact, the potential damage induced by disasters would definitely increase.

The increasing potential damage claimed by disaster coincide with the weak financial management of disaster risk would definitely cause large economic losses. In comparison to the decade of 1960s, the direct economic losses have increased by a factor of nine, as described by Munich Re (1998a, 1998b). A few years ago, it was realized that how important insurance and re-insurance is in financing disaster risk (Kunreuther and Roth, 1998; Kleindorfer, and Kunreuther, 1999), which promotes the rapid development of disaster insurance and reinsurance in past decades. Particularly, the difference of insurance coverage between developed and developing countries has taught us some lessons about the effectiveness of insurance market (Gurenko, 2004). However, the experience of major natural catastrophes in the 1990s - e.g. Hurricane Andrew in 1992, Northridge California earthquake in 1994, and earthquake in Kobe in 1995 - resulted in a widespread concern among insurance and reinsurance companies that there might not be enough allocated capital to meet their underwriting goals (Mürmann, 2000). Meanwhile, on the contrast to developed countries, the developing and economy-emerging countries feel even bitterer, as they have only very limited insurance coverage provided by the local market.

The fear on the capacity of insurance and re-insurance leads to the demand of larger pools for diversifying disaster risk. One method is to develop the financial market as the backup for insurance industry. In USA, the capital pool of the option market reaches to thousands of billions, which is approximately 100 times of $100 billion catastrophe event. It could be a valid support for insurance industry. Another choice is to enhance the role of government in the financial management of disaster risk. The government should not rely too much on insurance but establish its own national disaster financing system. Appropriate disaster financing strategy should be designed and adopted, in which existing financing instruments are re-grouped and combined.

In this paper, the authors want to specify the discussion on the combined instrument of inter-temporal and international instruments. Since present instruments mainly diversify disaster risk to larger population who lives in different places around the world but contemporarily, one could consider enlarging the pool inter-temporally. The government, which is regarded as the wise central planner in economics, can do so by adjusting and balancing the welfare among different generations. This paper aims at developing a model to describe the financing process of such combined instruments and check how households' welfare would change with respect to it. Other instruments for disaster risk diversification would also be discussed as the comparative case.

2. Research Framework

2.1 Environment of the model

The model is based on a one-goods, two-country and two-period-overlapping-generations model. The basic assumptions for the model are as following:

[1] There are only one goods for consumers to consume.

[2] Only two countries are considered in this model. One faces disaster risk, which is called hazardous country. The other does not face disaster risk, which is then called hazard-free country. They have open capital market but closed labor market between them. There is no transaction cost in the capital market.

[3] Two-period-overlapping-generation indicates that individuals live for only two periods, the young and the old. At each period *t*, there would be two generations live contemporarily. For simplicity, the model assumes that the population is constant, which means that at each time *t*, there would be only one young people and one old people in each country. People work only when they are young, gaining wage and saving it in the bank, either in his country or in the other country, and consume when he is old.

[4] The probability of disaster faced by the hazardous country is μ. Physical capitals in hazardous country would be damaged at the rate of $1-\varepsilon$ when disaster happens.

2.2 Instruments to model

In this model, there are three instruments for diversifying disaster risk to model (fig. 1). Case A indicates that the disaster risk is shared via the open capital market through the process of investment of both kinds of households. In case B the insurance contract would be introduced into the equilibrium of case A. Case C is the combined inter-temporal and international disaster risk diversification: the government diversifies disaster risk among generations by raising disaster reserve fund and making international loan.

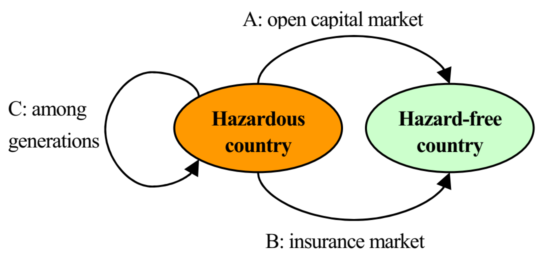

Fig. 1 Instruments to model

3. Description of the model

In order to make description convenient, here we give the list of symbols which is going to be used in the following texts.

s_t and s_{0t} are the savings of the hazardous household in hazardous and hazard-free country, respectively. s_t^0 and s_{0t}^0 are the savings of the hazard-free household in hazardous and hazard-free country, respectively.

w_t and w_0 are the wages of hazardous and hazard-free households, respectively.

c_{t+1}^{n} and c_{t+1}^{d} are the consumptions of the hazardous households when disaster occurs or not occurs, respectively. c_{t+1}^{0n} and c_{t+1}^{0d} are the consumptions of the hazard-free households when disaster occurs or not occurs, respectively.

r_{t+1}^{n} and r_{t+1}^{d} are the net interest rates in hazardous country when disaster occurs or not occurs, respectively. r_{t+1}^{0} is the net interest rate in hazard-free country.

k_{t+1} and k_{t+1}^{0} are the physical capital in hazardous and hazard-free countries, respectively.

ε is the undamaged proportion of physical assets.

μ is the probability of disaster.

ν is the insurance premium rate.

m and m^{0} are the demand and supply of insurance coverage, respectively.

Z_{t} is the total disaster reserve fund raised by the hazardous government for diversifying disaster risk.

τ is the annual tax imposed on the hazardous households to raise disaster reserve fund.

η is the mean annual repayment from the disaster reserve fund to the hazard-free household.

σ is the subsidy to the hazardous household after the arrival of disaster happens.

ζ is the loan made from the hazard-free household to subsidy the victims by the hazardous government.

3.1 Transfer disaster risk via the open capital market

From the basic assumption of two-period overlapping generation model, we could derive the lifetime budget constraint of the households like

$$\begin{aligned} & s_t + s_{0t} = w_t \\ & c_{t+1}^{n} = \left(1+r_{t+1}^{n}\right)s_t + \left(1+r_{t+1}^{0}\right)s_{0t} \\ & c_{t+1}^{d} = \left(1+r_{t+1}^{d}\right)\varepsilon s_t + \left(1+r_{t+1}^{0}\right)s_{0t} \end{aligned} \qquad (1)$$

$$\begin{aligned} & s_t^{0} + s_{0t}^{0} = w_t^{0} \\ & c_{t+1}^{0n} = \left(1+r_{t+1}^{n}\right)s_t^{0} + \left(1+r_{t+1}^{0}\right)s_{0t}^{0} \\ & c_{t+1}^{0d} = \left(1+r_{t+1}^{d}\right)\varepsilon s_t^{0} + \left(1+r_{t+1}^{0}\right)s_{0t}^{0} \end{aligned} \qquad (2)$$

Obviously, the setting in the model would enable disaster risk transfer via the open capital market. This is because once the hazard-free households save in the hazardous country, they are taking the risk: their savings could possibly be affected by disaster. One could argue that why people would save in the hazardous country and exposes to the disaster risk. However, that is not the truth. Since everyone wants to save in the hazard-free country, the interest rate in the hazardous country would be much higher than the hazard-free country. Hence it will gain a higher rate of return to save in the hazardous country.

The equilibrium conditions in the capital market are

$$\begin{aligned} & k_{t+1} = s_t + s_t^{0} \\ & r_{t+1}^{n} = f'\left(k_{t+1}\right) \\ & r_{t+1}^{d} = f'\left(\varepsilon k_{t+1}\right) \end{aligned} \qquad (3)$$

$$\begin{aligned} & k_{t+1}^{0} = s_{0t} + s_{0t}^{0} \\ & r_{t+1}^{0} = f'\left(k_{t+1}^{0}\right) \end{aligned} \qquad (4)$$

The equilibrium in labor markets are

$$\begin{aligned} & w_t = f\left(k_t\right) - r_t k_t \\ & w_{t+1}^{n} = f\left(k_{t+1}\right) - r_{t+1}^{n} k_{t+1} \\ & w_{t+1}^{d} = f\left(\varepsilon k_{t+1}\right) - r_{t+1}^{d}\varepsilon k_{t+1} \end{aligned} \qquad (5)$$

$$w_t^{0} = f\left(k_t^{0}\right) - r_t^{0} k_t^{0} \qquad (6)$$

Since the capital market is completely open and there is no transaction cost, the households can save in either country as it likes. Because of the existence of disaster risk, surely each household would choose his own optimum investment behavior to maximize his expected utility. The object function can be denoted as

$$\max_{\mathbf{s}} E\left[u\left(c\right)\right] = \left(1-\mu\right)u\left(c^{n}\right) + \mu u\left(c^{d}\right) \qquad (7)$$

which is subjected to equation (1) and (2). Then the first order condition for maximization would be

$$\frac{\partial E\left[u\left(c\right)\right]}{\partial \mathbf{s}} = \left(1-\mu\right)u'\left(c^{n}\right)\frac{\partial c^{n}}{\partial \mathbf{s}} + \mu u'\left(c^{d}\right)\frac{\partial c^{d}}{\partial \mathbf{s}} = 0 \qquad (8)$$

From the first order condition the optimum choice for the hazardous households could be derived as:

$$s_t^* = s_t(w_t),\ s_{0t}^* = s_{0t}(w_t)$$

And the optimum choice for the hazard-free households could be denoted as

$$s_t^{0*} = s_t^0(w_0),\ s_{0t}^{0\,*} = s_{0t}^0(w_0)$$

3.2 Function of the insurance market

Now we are going to introduce insurance contract into the equilibrium system of the open capital market to check the existence of insurance market and whether it can help both households get better off. Suppose that hazard-free households decide to provide private insurance contract to the hazardous households. One needs to pay the premium of νm to cover a physical capital of *m*. In this case, the lifetime budget constraints of both kinds of households would change to

$$\begin{aligned} & s_t + s_{0t} = w_t - \nu m \\ & c_{t+1}^n = \left(1+r_{t+1}^n\right)s_t + \left(1+r_{t+1}^0\right)s_{0t} \\ & c_{t+1}^d = \left(1+r_{t+1}^d\right)\varepsilon s_t + \left(1+r_{t+1}^0\right)s_{0t} + \left(1+r_{t+1}^0\right)m \end{aligned} \tag{9}$$

$$\begin{aligned} & s_t^0 + s_{0t}^0 = w_t^0 + \nu m^0 \\ & c_{t+1}^{0n} = \left(1+r_{t+1}^n\right)s_t^0 + \left(1+r_{t+1}^0\right)s_{0t}^0 \\ & c_{t+1}^{0d} = \left(1+r_{t+1}^d\right)\varepsilon s_t^0 + \left(1+r_{t+1}^0\right)s_{0t}^0 - \left(1+r_{t+1}^0\right)m^0 \end{aligned} \tag{10}$$

The equilibrium in the insurance market is

$$m\left(\nu^*\right) = m^0\left(\nu^*\right) \tag{11}$$

Note that the insurance contract could come into truth only when the demand and supply of the insurance coverage are larger than 0 and equal to each other.

3.3 Diversifying disaster risk among generations

Now let us consider the market equilibrium with the intervention from the government. Of course, the government of the hazardous country intends to maximize the social welfare other than households' welfare, but not some specific generation. It would discount the utility of future generations at the rate of θ. Thus, the objective function of the government is

$$\max E(U) = \sum_{i=0}(1+\theta)^{-i} E(u_i) \tag{12}$$

Alternatively, we can use the object function of some reprehensive generation instead of the overall object function. In this case, the government would try to adopt some measures to let its households better off. It would be a good idea to set up some funds to diversify the disaster risk among generations. One typical fund is disaster reserve fund (DRF). The government imposes taxes on generations to accumulate DRF. When disaster happens, the government then subsidy the victims use the funds from DRF.

However, the accumulation of DRF is very slow and generally it is not enough to cover the damage of disaster, especially if the disaster occurs shortly after the fund is created (Kunreuther and Linnerooth-Bayer, 2003). The government should find other funding sources to fill the gap, e.g. making international loan from the foreign household. Note that the loan must be and can only be made by the hazardous government from the young hazard-free households! On the one hand, this is because in this overlapping generation model, the government does not have money. Thus, the money can only be borrowed from the foreign households. On the other hand, since in the current setting of this model, it is the old generation whose saving is damaged and who needs the loan. They must not be in debt in their latter period of life – otherwise, no one would repay the loan! Hence, the private loan is not possible. The funding process of the disaster reserve fund could be denoted as

$$dZ_t = r_{t+1}^0 Z_t dt + \tau dt - \eta dt - (\sigma - \zeta)\, dN(t) \tag{13}$$

Where the tax revenue is income and international repayment plus disaster subsidy is the outgo. In equation (13), the subsidy σ consists of two parts: $\sigma - \zeta$ from the disaster reserve fund and ζ from the international loan. The sign of σ is given as (+). Once the subsidy includes foreign loans, the following generations will have to pay back the loan, which means that the annual repayment $\eta > 0$. $dN(t)$ denotes the standard Poisson process, which represents the arrival of

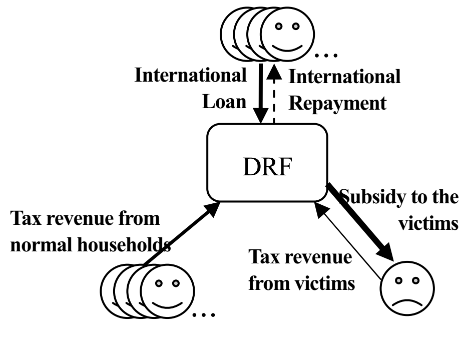

Fig. 2 Balancing of the Disaster Reserve Fund (DRF)

natural disaster. We could know from the property of Poisson process that $dN(t) \sim \mu dt$, whose expectation is just the intensity of this process, μ. Fig. 2 illustrates the functioning of the total government funding, in which the income and outgo are balanced.

The process of the repayment is a bit complex, because the loan should be repaid within the lifetime of the hazard-free households. In order to illustrate the process, suppose at some time t_0 the government borrowed ζ from the hazard-free young generation $G(1, t_0)$, and this loan is supposed to be fully repaid in the period of *T*. Of course, *T* should be larger than ζ/τ, since annual payment should be no larger than annual tax revenue. In general condition, the present value of annual average repayment is simply ζ/T. However, since the people live only for two-period in this model, the loan must be fully repaid within hazard-free households' lifetime! Nevertheless, the government does not have enough fund to do so, hence it needs to borrow again at time t_0+1 from the young $G(1, t_0+1)$ and repay the money to the old $G(2, t_0+1)$. The present value of the new loan from $G(1, t_0+1)$ then would be $\zeta(T-1)/T$. The government then has to repeatedly borrow from the foreign young generation and use the new loan plus domestic tax revenue to repay the previous loan to the foreign old generation, until all loans are completely repaid. The essences of this case and the general case are the same: both the present values of actual mean annual repayments are $\eta = \zeta/T$, but processes are different. In order to discuss the relationship between total loan and annual repayment, we should take into consideration the balance condition of the loan, denoted as

$$dL_t = rL_t dt + \eta dt - \zeta dN(t) \quad (14)$$

By No-Ponzi-Game condition, the sustainability constraints of the disaster reserve fund and the balancing condition of the international loan could be given as

$$\begin{aligned} &\lim_{t\to\infty} E[Z_t]e^{-rt} = 0 \\ &\lim_{t\to\infty} E[L_t]e^{-rt} = 0 \end{aligned} \quad (15)$$

Note that here we use *r* instead of r_{t+1}^0 for simplicity. Solving for $E[Z_t]$ and $E[L_t]$ (for detailed approach of solving, please turn to appendix 1) we know that

$$\begin{aligned} E[Z_t] &= \left(\frac{\tau-\eta-(\sigma-\zeta)\mu}{r}\left(1-e^{-rt}\right)+Z_0\right)e^{rt} \\ E[L_t] &= \left(\frac{\eta-\zeta\mu}{r}\left(1-e^{-rt}\right)+L_0\right)e^{rt} \end{aligned} \quad (16)$$

Hence, the sustainability constraints of DRF and balancing condition for international loan change to

$$\begin{aligned} &\frac{\tau-\eta-(\sigma-\zeta)\mu}{r} + Z_0 = 0 \\ &\frac{\eta-\zeta\mu}{r} + L_0 = 0 \end{aligned} \quad (17)$$

For simplicity, by letting the initial amount of DRF and loan both equal to 0, we get the equilibrium condition in DRF and international loan

$$\begin{aligned} &\eta = \mu\zeta \\ &\tau(\sigma) = \mu\sigma \end{aligned} \quad (18)$$

In this setting, the households' lifetime budget constraints change to

$$\begin{aligned} &s_t + s_{0t} = w_t - \tau \\ &c_{t+1}^n = \left(1+r_{t+1}^n\right)s_t + \left(1+r_{t+1}^0\right)s_{0t} \\ &c_{t+1}^d = \left(1+r_{t+1}^d\right)\varepsilon s_t + \left(1+r_{t+1}^0\right)s_{0t} + \sigma(\tau) \end{aligned} \quad (19)$$

$$\begin{aligned} &s_t + s_{0t} = w_t - \zeta \\ &c_{t+1}^n = \left(1+r_{t+1}^n\right)s_t + \left(1+r_{t+1}^0\right)\left(s_{0t}+\zeta\right) \\ &c_{t+1}^d = \left(1+r_{t+1}^d\right)\varepsilon s_t + \left(1+r_{t+1}^0\right)\left(s_{0t}+\zeta\right) \end{aligned} \quad (20)$$

Note that the hazard-free country is actually not affected by this change.

4. Numerical Examples

We specify the instantaneous utility function to be a Cobb-Douglas utility function in order to derive the value function explicitly.

$$u(c) = \ln c \tag{21}$$

For the hazardous country, we suppose that its production function is in the form of

$$f(k_t) = \ln k_t \tag{22}$$

While for the hazardous country, we suppose its production function is

$$f^0(k_t) = \omega + \gamma k_t \tag{23}$$

Then we could derive the equilibriums of three cases.

4.1 Equilibrium in the open capital market

As the equilibrium could not be solved analytically, some explicit relationship could be derived as $r_{t+1}^d > r_{t+1}^n > \gamma$, $c_{t+1}^n > c_{t+1}^d$, and $\frac{s_t^*}{s_{0t}^*} = \frac{s_t^{0*}}{s_{0t}^{0*}}$. We could go further by using numbers to show the equilibrium. By giving the value of parameters ω=30, γ=0.02, μ=0.05, and ε=0.5, we can calculate the value of variables interactively until it reaches some stable point. For some given initial endowment $w_{t=0}$=20, when it comes to equilibrium, we have r_{t+1}^{n*}=0.0540, k_{t+1}^*=18.5140, w_t^* =1.9185, s_t^*=1.1128, and s_{0t}^*=0.8057.

4.2 Equilibrium in the insurance market

By equation (9) and (10), we could derive the first order condition for maximization as

$$\frac{dE\left[u\left(c_{t+1}\right)\right]}{dm} = \frac{dE\left[u\left(c_{t+1}^0\right)\right]}{dm^0} = 0 \tag{24}$$

By solving the insurance market equilibrium in equation (11), we know that

$$\frac{v^* m}{m\left(1+r_{t+1}^0\right)} = \frac{\mu p^n}{(1-\mu)p^d + \mu p^n} \cdot \frac{1}{1+r_{t+1}^0}$$

$$\therefore v^* = \frac{\mu p^n}{(1-\mu)p^d + \mu p^n}$$

Where $p^n = \left(1+r_{t+1}^n\right)\left(s_t + s_t^0\right) + (1+\gamma)\left(s_{0t} + s_{0t}^0\right)$, and $p^d = \varepsilon\left(1+r_{t+1}^d\right)\left(s_t + s_t^0\right) + (1+\gamma)\left(s_{0t} + s_{0t}^0\right)$.

Since $\varepsilon\left(1+r_{t+1}^d\right) < 1+r_{t+1}^n$, we have $p^d < p^n$ and $v^* > \mu$, which indicates that the equilibrium insurance premium rate is larger than the fair premium rate. Moreover, when the insurance market reaches to its equilibrium, both the demand and the supply of the insurance coverage are 0, $m(v^*) = m^0(v^*)$ =0. It means the insurance market would actually not work.

4.3 Possibility of inter-temporal diversification

Insert equation (18) into the budget constraints of (19) and (20), and solve for the market equilibrium. Then do comparative statics of the maximized expected utility V with respect to parameter τ to check the effectiveness of raising the disaster reserve fund. Similarly, the analytical solution cannot be derived here. So we use some numerical example to show the relationship between τ and maximized expected utility V. Using the stable equilibrium condition in case A as the initial condition, we increase τ from 0 with the interval of 0.001 until either $w_t - \tau$ or s_{0t} becomes negative. Then calculate the relevant stable point and the value of V of each τ. The result is shown in fig. 3.

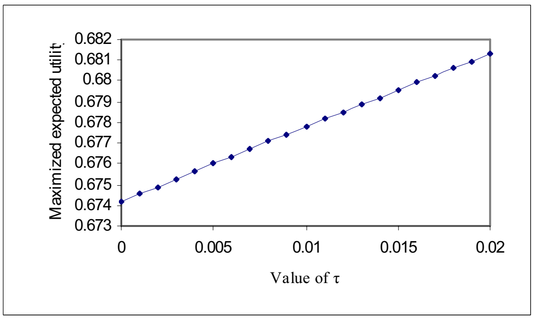

Fig. 3 change of V on the change of τ

From the first glance we could know that the optimized expected utility rises on the increase of τ. However, the figure is a bit misunderstanding that one might think their relationship is linear. Actually the marginal effect is decreasing, which means that $\frac{dV}{d\tau} > 0, \frac{d^2V}{d\tau^2} < 0$ (fig. 4). One could easily check in appendix 2 which gives the detailed simulating results.

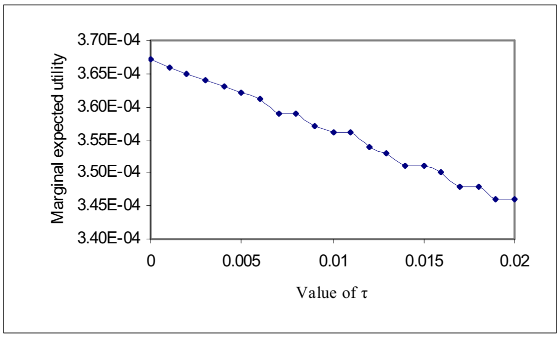

Fig. 4 change of Marginal expected utility ($dV/d\tau$)

5. Conclusions and Discussion

This study developed a model based on one-goods, two-country and two-period-overlapping-generation economy. Three cases are introduced into the study to demonstrate the effects of different disaster financing instruments. Case A shows that the open capital market would reach to an equilibrium and transfer disaster risk automatically. Households would adjust their optimum investment behavior due to the frequency and severity of natural disaster. Disaster risk is then shared by the households in the hazard-free country. Case B indicates that in the current setting of the model, insurance contract is not realized because both kinds of households have the same level of disaster risk aversion: they are all Constant Relative Risk Aversion (CRRA). Case C shows that the government of the hazardous country could get better off by both raising disaster reserve fund and budget deficit. Obviously in this model, the solution of the government intervened approach would be a better choice. This result also implicates that the government should be more active in the financial management of disaster risk and not relay too much on the insurance market. Market approach is efficient, but it also has its own limitation. Command approach is less efficient to some extent, but it is powerful and sometimes very effective.

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Appendix 1

Solving the differential equations in following form

$$dy - rydt = mdt + ndN(t) \qquad \text{(i)}$$

First let the right hand side of the equation equals to 0,

$$d\bar{y} = r\bar{y}dt \qquad \text{(ii)}$$

Integral both side of the equation we get

$$\bar{y} = Ce^{rt} \qquad \text{(iii)}$$

Let some $u(t) = C$ and insert it into the equation (iii), then the solution for the linear differential equation (i) is actually $y = u(t)e^{rt}$. Differentiate it,

$$dy = u'(t)e^{rt}dt + u(t)re^{rt}dt \qquad \text{(iv)}$$

We could know from the property of Poisson process that $dN(t) \sim \mu dt$. Thus, equation (i) is equivalent to

$$dy - rydt = mdt + n\mu dt \qquad \text{(v)}$$

By comparing equation (iv) and (v) we could get the solution for the differential equation. As μdt is actually the expectation of $dN(t)$, the solution is also an expected value.

$$u(t) = -(m + n\mu)e^{-rt}/r \qquad \text{(vi)}$$

$$E[y] = \left(-\frac{(m+n\mu)}{r}e^{-rt} + C\right)e^{rt} \qquad \text{(vii)}$$

By giving the initial condition $y|_{t=0} = y_0$, we can solve for the constant C and get the final solution for the differential equation (i).

$$E[y] = \left(-\frac{(m+n\mu)}{r}\left(1-e^{-rt}\right) + y_0\right)e^{rt} \qquad \text{(viii)}$$

Appendix 2 Result of numerical simulation

τ	s_t^*	w_t^*	V
0.000	1.112821	1.918527	0.674166
0.001	1.151263	1.918920	0.674533
0.002	1.189693	1.919315	0.674899
0.003	1.228120	1.919710	0.675264
0.004	1.266544	1.920105	0.675628
0.005	1.304965	1.920499	0.675991
0.006	1.343384	1.920893	0.676353
0.007	1.381801	1.921286	0.676714
0.008	1.420215	1.921680	0.677073
0.009	1.458626	1.922073	0.677432
0.010	1.497035	1.922465	0.677789
0.011	1.535441	1.922858	0.678145
0.012	1.573844	1.923250	0.678501
0.013	1.612245	1.923642	0.678855
0.014	1.650643	1.924033	0.679208
0.015	1.689039	1.924425	0.679559
0.016	1.727433	1.924816	0.679910
0.017	1.765823	1.925206	0.680260
0.018	1.804212	1.925597	0.680608
0.019	1.842597	1.925987	0.680956
0.020	1.880981	1.926377	0.681302
0.021	1.919361	1.926766	0.681648

災害リスクの国際的・世代間分散の最適組み合わせ：政府の役割

叶　涛*・横松　宗太・岡田　憲夫

*京都大学大学院工学研究科

要　旨

近年，中国では災害保険の重要性が増している．しかし保険市場は横断的にリスクを配分するシステムであり，一定の限界をもっている．本研究では2国・2期間生存・世代重複モデルを定式化し，はじめに資本市場におけるリスク配分，2国間の保険契約による災害リスクの分散効果について分析する．次いで政府が災害基金システムを用いて災害リスクを世代間で分散することによって，家計の期待効用を高めることができることを示す．

キーワード: 災害リスク分散，災害基金，世代重複モデル，政府の役割