Observations on the Segmentation of Earthquake Insurance in Japan*

Mahito Okura[a], Hiroyuki Nozaki[b], Kenta Iwase[c]
[a] Associate Professor, Faculty of Economics, Nagasaki University.
okura@nagasaki-u.ac.jp (corresponding author)
[b] Senior Consultant, Financial Technology Solution Division,
Nomura Research Institute, Ltd.
h2-nozaki@nri.co.jp
[c] Consultant, Social System Consulting Department,
Nomura Research Institute, Ltd.
k-iwase@nri.co.jp

ABSTRACT

This paper investigates the advantages and disadvantages of more segmented payment standards in earthquake insurance in Japan using a simple economic model. Using this analysis, we conclude that more segmented payment standards are desirable when the targeted consumers have higher incomes because these consumers tend to need insurance money at a relatively later time, whereas more segmented payment standards are not desirable when the targeted consumers have lower incomes because their need for insurance money arises relatively quickly following the earthquake.

JEL Classifications: *D80, G22*

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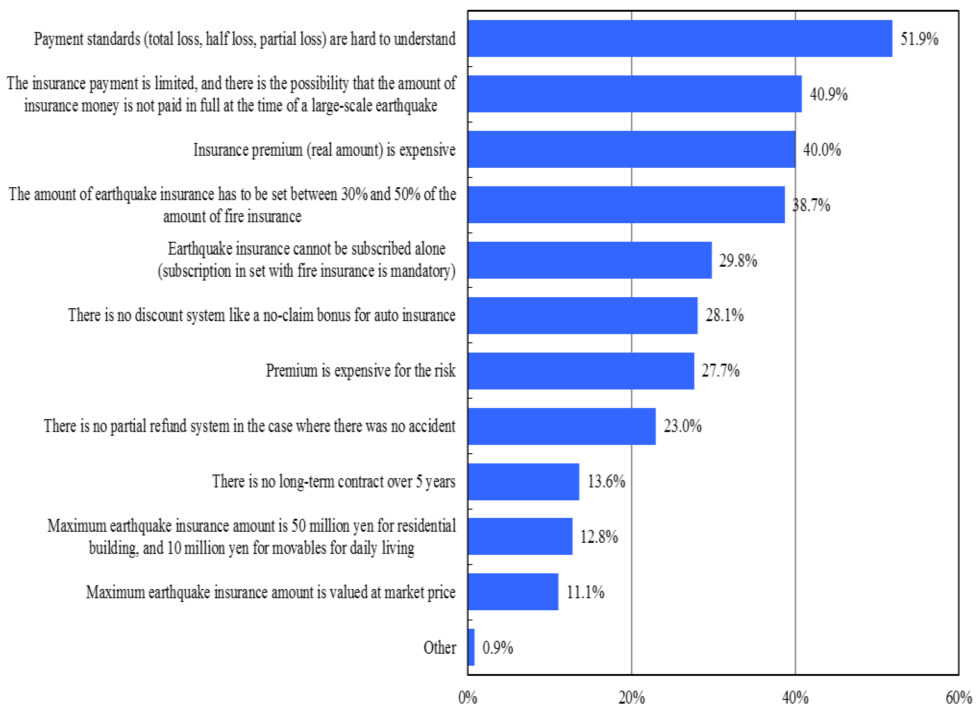
I. INTRODUCTION

Earthquake insurance in Japan is committed not only by private nonlife insurers but also by the Japanese government following devastating earthquakes such as the Hanshin–Awaji Earthquake in 1995 and the Great East Japan Earthquake in 2011. Recently, the debate about earthquake insurance promoted by the Japanese government has been extensive.[1]

In Japan, because earthquake insurance is optional for consumers who purchase fire insurance, the penetration of earthquake insurance is not high (25%).[2] Earthquake insurance in Japan is based on the Act on Earthquake Insurance established in 1966. Subsequent to Article 1 therein, the purpose of this law 'is to promote the dissemination of earthquake insurance, … thereby helping to contribute to the stability of the lives of disaster victims of an earthquake, etc.' Consequently, earthquake insurance in Japan should not be considered as compensating for damage to houses, but for providing immediate living expenses for disaster victims. In other words, although fire insurance is basically property insurance, earthquake insurance is expense insurance.[3]

However, given this distinction, consumers may have mistaken earthquake insurance for property insurance and therefore feel some confusion and dissatisfaction with earthquake insurance in Japan. As shown in Figure 1, 40.9% of consumers in a

Figure 1
What aspects of earthquake insurance are you dissatisfied with?

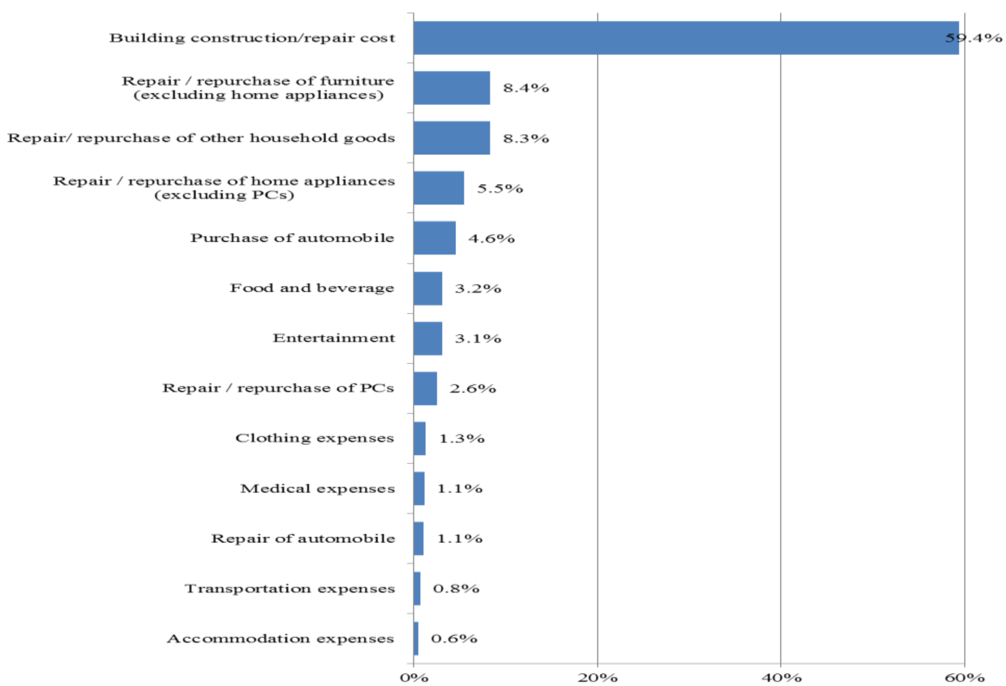


Source: Nozaki (2010).

survey responded that "The total insurance payment is limited, and there is the possibility that the amount of insurance money is not paid in full at the time of a large-scale earthquake"; 38.7% of respondents believed that "The amount of earthquake insurance has to be set between 30% and 50% of the amount of fire insurance." These responses suggest that many consumers believe the insurance money is generally insufficient to cover the rebuilding of their houses. In other words, there is a considerable discrepancy between the purpose of earthquake insurance as provided by law and that perceived by consumers. In addition, as shown in Figure 2, more than 80% of respondents listed 'Building construction/repair costs' as the main use for their insurance money.[4] The existence of such discrepancies between policies and perceptions indicates that many consumers wish to obtain additional compensation for actual losses through earthquake insurance in Japan.

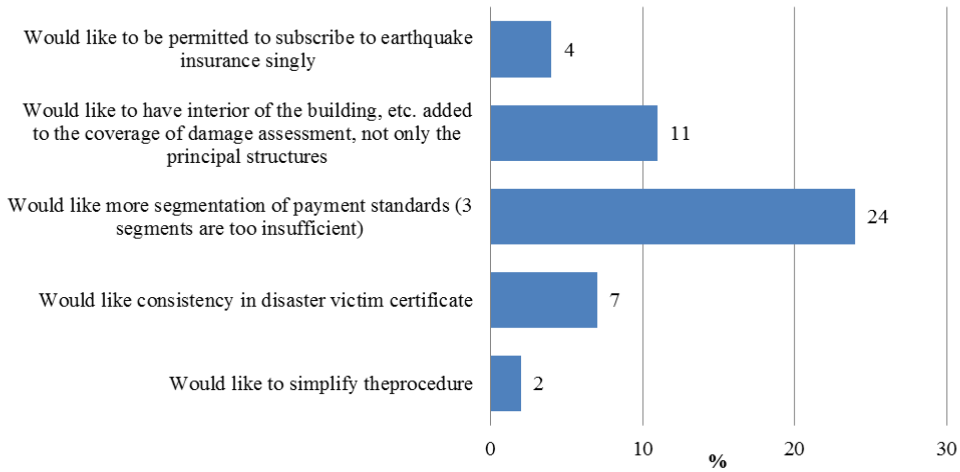
Furthermore, as shown in Figure 3, it is remarkable that 24% of consumers responded that they "Would like more segmentation of payment standards (three segments are insufficient)". For earthquake insurance in Japan, there are only three segments: "total loss", "half loss", and "partial loss" with the respective limits set at 100%, 50%, and 5% of the insurance policy.[5] From that disproportional payment about insurance money, it seems natural that some consumers who are evaluated as "partial loss" complained about that segment payment standard.[6] In response, the government and the nonlife insurance industry are now considering to change the current three-segment payment standards system into a more segmented one.[7]

Figure 2
Use of insurance proceeds



Source: Nozaki et al. (2013).

Figure 3
Requests for earthquake insurance system and products



Source: Nozaki et al. (2013).

More segmented payment standards would certainly benefit consumers by making it possible for them to obtain an amount of insurance money closer to the actual losses. However, more segmented payment standards may complicate damage estimation, and the process needed to determine which particular segment damage is included would naturally increase assessment costs.[8] Similarly, we cannot ignore the fact that more segmented payment standards would lengthen the period of time between an earthquake and the payment of insurance money once a claim is made. This means a considerable waiting cost would be imposed on disaster victims after an earthquake.

Given this background, the purpose of this article is to investigate the advantages and disadvantages of more segmented payment standards using a simple economic model. In other words, our study is focused mainly on claim adjustment after the accident. In particular, it is valuable to discuss the claim adjustment of earthquake insurance in Japan because the payment standards of earthquake insurance in Japan are regulated unlike other kinds of insurance. Even if there is no asymmetric information problem in the claim adjustment procedure, the claim adjustment problem in earthquake insurance in Japan remains.[9] Thus, we are interested in how to design optimal payment standards, which has important policy implications for the reform of earthquake insurance in Japan.

Furthermore, our study may be similar to the studies on risk classification because both claim adjustment and risk classification are focused mainly on examining problems in an insurance market.[10] However, both research themes are different in the following two ways. First, risk classification is conducted before selling insurance products, while the claim adjustment is conducted after the accident. Thus, the individuals are the policyholders in the time of claim adjustment, while they are not the policyholders in the time of risk classification. Second, risk classifications are revealed to individuals by, for example, discounted insurance premia for low-risk individuals, whereas the claim adjustment procedure is not revealed to individuals. Thus, the problems caused by asymmetric information in each study should be distinguished.

II. THE MODEL

Assume a single property-owning household that has purchased earthquake insurance and the situation where this property has been damaged by an earthquake. The household's payoff function, Π , is as follows:

$$\Pi = \delta(t)x - D + (1+m)(s - z(t)) \tag{1}$$

where t = period of time between the earthquake and the receipt of the insurance money (hereafter, the "loss adjustment period"); $\delta(t)$ = discount rate in period t; x = amount of insurance money; D = amount of damage; s = amount of savings; m = interest rate. For simplicity, the interest rates for lending and borrowing are equal; and $z(t)$ = amount of cost incurred by the delay in receiving the insurance money (hereafter, the "delay cost"). For example, a self-employed business-owning household purchases earthquake insurance for its store. When the store is damaged by an earthquake, the household cannot operate its business and therefore incurs a delay cost until it receives the insurance money

We can explain the household's payoff function in Equation (1) as follows. This household has the right to receive insurance money if the insured property is damaged by the earthquake. However, the amount of insurance money paid may not be coincident with the amount of damage suffered if the loss adjustment period is short. To represent this phenomenon, we argue that the amount of insurance money involves some uncertainty distributed on the normal distribution function $x \sim N(D, \sigma^2(t,D))$, where $\sigma^2(t,D)$ is the variance and we assume that $\partial\sigma^2(t,D)/\partial t < 0$ and $\partial^2\sigma^2(t,D)/\partial t^2 > 0$. $\partial\sigma^2(t,D)/\partial t < 0$ indicates that the longer the loss adjustment period, the smaller the difference between the amount of damage incurred and the insurance money paid. $\partial^2\sigma^2(t,D)/\partial t^2 > 0$ indicates that the decrease in the variance reduces when the loss adjustment period becomes long. Also, we assume that $\partial\sigma^2(t,D)/\partial D > 0$ and $\partial^2\sigma^2(t,D)/\partial t\partial D < 0$. The former assumption means that the larger the amount of damage, the larger the variance between amount of damage and the insurance money paid. The latter assumption means that the larger the amount of damage, the larger the reduction of variance when loss adjustment period extends.

Because the household cannot receive insurance money at the same time as the damage, the present value of the insurance money is $\delta(t)x$. As a result, the household may have to draw on its savings until it receives the insurance money. If savings remain when the household eventually receives the insurance money, the household can receive interest income $m(s - z(t))$. In contrast, if the loss adjustment period eventually becomes so long that all of the household's savings are used, the household has to borrow from a financial institution and pay interest expense $m(z(t)-s)$.

Two other variables $\delta(t)$ and $z(t)$ included in Equation (1) are characterized as follows. First, assume that $\partial\delta(t)/\partial t<0$ and $\partial^2\delta(t)/\partial t^2>0$. $\partial\delta(t)/\partial t<0$ indicates that the discount rate falls as the loss adjustment period becomes longer. $\partial^2\delta(t)/\partial t^2>0$ shows that the fall in the discount rate becomes smaller as the loss adjustment period becomes longer. Second, assume that $\partial z(t)/\partial t>0$ and $\partial^2 z(t)/\partial t^2>0$. $\partial z(t)/\partial t>0$ indicates that the delay cost becomes larger as the loss adjustment period becomes longer. $\partial^2 z(t)/\partial t^2>0$ shows that the increase in the delay cost increases as the loss adjustment period becomes longer.

The household is assumed to be weakly risk averse and the form of its utility function is specified as follows:

$$u=-\exp(-r\Pi) \tag{2}$$

where $r \geq 0$ is the degree of absolute risk aversion. We can then compute the household's certainty equivalent, CE, as

$$CE=E[\Pi]-\frac{rVar[\Pi]}{2} \tag{3}$$

where $E[\bullet]$ and $Var[\bullet]$ are the expectation and variance operators, respectively. The expectation and variance of the household's payoff can be computed as

$$E[\Pi]=E\left[\delta(t)x-D+(1+m)(s-z(t))\right]=-(1-\delta(t))D+(1+m)(s-z(t)) \tag{4}$$

$$Var[\Pi]=Var\left[\delta(t)x-D+(1+m)(s-z(t))\right]=(\delta(t))^2\sigma^2(t,D) \tag{5}$$

Substituting equations (4) and (5) into equation (3), the certainty equivalent is

$$CE=-(1-\delta(t))D+(1+m)(s-z(t))-\frac{r}{2}(\delta(t))^2\sigma^2(t,D) \tag{6}$$

Based on the above situation, we derive the optimal loss adjustment period using Equation (6). In the case of $r>0$, that optimal loss adjustment period, which is denoted by t^*, satisfies the following first-order condition.[11]

$$\frac{\partial CE}{\partial t}=\frac{\partial\delta(t^*)}{\partial t}D-(1+m)\frac{\partial z(t^*)}{\partial t}-\frac{r}{2}\left\{2\frac{\partial\delta(t^*)}{\partial t}\delta(t^*)\sigma^2(t^*,D)+(\delta(t^*))^2\frac{\partial\sigma^2(t^*,D)}{\partial t}\right\}=0 \tag{7}$$

In contrast, in the case of $r = 0$, $t^* = 0$ is satisfied because

$$\frac{\partial CE}{\partial t} = \frac{\partial \delta\left(t^*\right)}{\partial t} D - \left(1+m\right)\frac{\partial z\left(t^*\right)}{\partial t} < 0 \tag{8}$$

III. IMPLICATIONS

From Equation (7), we use comparative statics to confirm the following three results.

$$\frac{\partial t^*}{\partial r} > 0 \tag{8}$$

$$\frac{\partial t^*}{\partial D} \gtreqless 0 \tag{9}$$

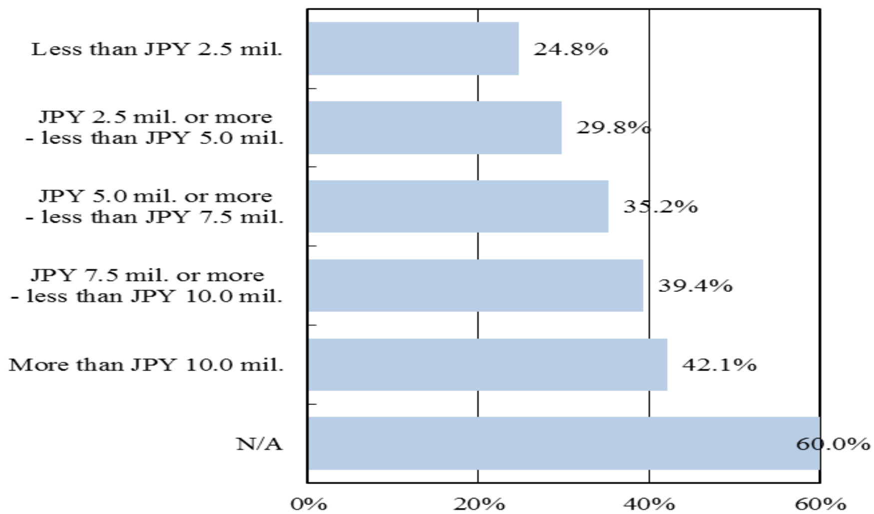
$$\frac{\partial t^*}{\partial m} < 0 \tag{10}$$

First, Equation (8) suggests that the higher the degree of absolute risk aversion, the longer the optimal loss adjustment period. This is because a household whose degree of absolute risk aversion is high will wish to extend the loss adjustment period because it is likely that it wants to avoid the difference between the amount of actual damage and the insurance money paid. In contrast, $t^*=0$ is realized in the case of $r = 0$. This means that a risk-neutral household will never wish to extend the loss adjustment period because it will be unconcerned about any difference between the amount of damage and the insurance money paid. In other words, from the viewpoint of a risk-neutral household, extending the loss adjustment period will decrease the present value of the insurance money and increase the delay cost.

Second, Equation (9) indicates that the change in the optimal loss adjustment period is ambiguous when the amount of damage increases because there are both advantages and disadvantages. When the amount of damage becomes large, reduction in variance between the amount of actual damage and the insurance money and decrease in present value of the insurance money becomes large. Households with more costly properties do not necessarily wish to extend the loss adjustment period.

Finally, Equation (10) shows that the higher the interest rate, the shorter the loss adjustment period. This is derived from the fact that the advantage in reducing the delay cost, which contributes to either an increase in interest income or a decrease in interest expense depending on the circumstances, is larger when the interest rate is higher. This appears to bear some relation to the real-world situation in that, as shown in Figure 4, high-income households are more likely to purchase earthquake insurance than low-income households.[12] In other words, high-income households are the major group of policyholders in the present Japanese earthquake insurance system. From this viewpoint, we conclude that extending the loss adjustment period is desirable for present policyholders because they generally borrow at relatively low interest rates. The reverse holds for low-income households.[13] Thus, we also conclude that extending the loss adjustment period may not be desirable if the Japanese government wishes to continue to provide earthquake insurance to low-income households. In a nutshell, whether extending the loss adjustment period is desirable depends on what kinds of households are targeted in earthquake insurance in Japan.

Figure 4
Earthquake insurance purchase by household income



Source: Nozaki (2010).

IV. CONCLUSION

The original purpose of earthquake insurance in Japan, as provided by the 1966 Act on Earthquake Insurance, is to provide stable support for earthquake disaster victims. Given this original purpose, we could argue that insurance money should be paid promptly to the victims following an earthquake. However, the primary purpose of earthquake insurance is to make payments more accurately linked to actual damage, even though policyholders may have to wait a little longer. In other words, there is a discrepancy between the characteristics of policyholders who are considered for the purpose of earthquake insurance and policyholders who have actually purchased earthquake insurance. It is impossible for a single insurance product to simultaneously satisfy both groups' needs. This situation is also closely related to the segmentation of payment standards that has recently been debated in Japan.

Against this background, this study investigated the advantages and disadvantages of the increased segmentation of payment standards using a simple economic model. Using this analysis, we concluded that more segmented payment standards are desirable when the targeted consumers have higher incomes because these consumers tend to need insurance money at a relatively later time, whereas more segmented payment standards are not desirable when the targeted consumers have lower incomes because their need for insurance money arises relatively quickly following the earthquake. In other words, given the characteristics of current policyholders, we recommend more segmented payment standards, whereas given the characteristics of policyholders who coincide with the purpose of earthquake insurance, more segmented payment standards would not be recommended.

We should note that there are several possible extensions to our model. For example, our model only considered economic aspects such as damage and delay cost. However, especially in the case of an earthquake, noneconomic damage such as psychological damage may be equally important. Furthermore, in the real world, prior to an insurance money payment, insurers usually visit the homes of victims to assess damage. We consider that the timing of this visit directly affects the degree of disruption of daily lives caused by the damage situation or the anxiety of disaster victims.

ENDNOTES

1. For example, a project team was formed in 2012 to examine the provision of earthquake insurance by the Japanese government.
2. See World Bank (2012, p. 4). Furthermore, Naoi et al. (2010) and Waldenberger (2013) discussed the reasons why the penetration of earthquake insurance is not high.
3. Because there is an exception clause in fire insurance in the case of earthquakes, fire insurance is not property insurance. Kozuka (2012a, 2012b) discussed such an exception clause.
4. This includes building construction/repair costs (59.4%), repair/repurchase of furniture (excluding home appliances) (8.4%), repair/repurchase of other household goods (8.3%), and repair/repurchase of home appliances (excluding PCs) (5.5%).
5. For details, see World Bank (2012, p. 5).
6. For example, see The Japan Times (March 18, 2012) [Online] (accessed August 7, 2014).http://www.japantimes.co.jp/news/2012/03/18/national/quake-insurance-is-but-a-token-offering/
7. One typical example is the “Report on Earthquake Insurance” issued in November 2011. This report argues for the introduction of a four-segment payment standards system. For details, see the following website (in Japanese) (accessed August 7, 2014): http://www.mof.go.jp/about_mof/councils/jisinpt/report/20121130_00.html #3-4
8. For details, see Nozaki (2013).
9. The asymmetric information problem exists in the claim adjustment procedure. The individuals have considerable information about the damaged properties; see, for example, Crocker and Tennyson (2002) and Boyer (2004). Furthermore, individuals cannot know the exact amount of damage because they do not know the damage estimation method used by the insurers; see, for example, Lee and Okura (2008).
10. For details about risk classification studies, for example, see Thomas (2007).
11. The second-order condition is always satisfied because .

$$\frac{\partial^2 CE}{\partial t^2} = \frac{\partial^2 \delta\left(t^*\right)}{\partial t^2} D - (1+m)\frac{\partial^2 z\left(t^*\right)}{\partial t^2} - \frac{r}{2}\left\{2\delta\left(t^*\right)\sigma^2\left(t^*, D\right)\frac{\partial^2 \delta\left(t^*\right)}{\partial t^2} + 2\left(\frac{\partial \delta\left(t^*\right)}{\partial t}\right)^2 \sigma^2\left(t^*, D\right)\right.$$

$$\left. + 2\delta\left(t^*\right)\frac{\partial \delta\left(t^*\right)}{\partial t}\frac{\partial \sigma^2\left(t^*, D\right)}{\partial t} + 2\delta\left(t^*\right)\frac{\partial \delta\left(t^*\right)}{\partial t}\frac{\partial \sigma^2\left(t^*, D\right)}{\partial t} + \delta^2\left(t^*\right)\frac{\partial^2 \sigma^2\left(t^*, D\right)}{\partial t^2}\right\} < 0$$

12. Athavale and Avila (2011) investigated the relationship between income and penetration of earthquake insurance using the data in the New Madrid fault zone in Missouri and found a positive relationship between them. Naoi et al. (2012) derived the same results using data from Japanese panel surveys that were conducted after the Great East Japan Earthquake in 2011.
13. Relative to income, low-income households suffered more from earthquake damage than high-income households, as indicated in, for example, Bolin and Stanford (1998) and Fothergill and Peek (2004).

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