THE OWNERSHIP OF FUNDS AND SYSTEMS FOR REPARATION OF VERY LARGE ACCIDENTS

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Abstract: The present system for reparation of very large oil accidents at sea neither gives incentives to take efficient care, nor allow for compensation of all damages. The reason is that the magnitudes of the accidents that we study are so big that the total assets of the injurer are not sufficient to pay for all damages. That is, strict liability for the injurer does not supply incentives enough for the liable party to take efficient care. In order to ensure that victims are compensated, in case of an accident, mandatory liability insurance has been introduced. This may have eroded the incentives to take care even further because of the moral hazard problem. Another component of the compensation system is the 1969 Brussels International Convention on Civil Liability for Oil pollution damage, CLC. The purpose of this convention is to improve the situation with the apparent inadequacy of the system to meet the compensation demands from victims. The CLC forces the states which have complied to establish a fund which has the purpose of compensate victims of an oil accident. However, the compensation coming from the fund does not have any effect on the injurer's incentives to take care. Since the amount paid from the fund in reparation will not affect the injurer's profit, there is no link induced between the level of care and the fund. A construction that would create a link between the injurer's welfare and the assets of the fund is to let the injurer own the fund, and hence earn the interest from the funded means, but place strict and unlimited liability on the fund.

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1. Introduction

During the last three decades the world has witnessed a number of accidents of catastrophic proportions. Examples are the Torrey Canyon accident in 1967 where 100 000 tons of crude oil spilled outside the coast of Brittany, the Amoco Cadiz accident in 1978 where 230 000 tons of crude oil was lost in the sea of Brittany and in 1989 Exxon Valdez spilled 38 000 tons of crude oil at the coast of Alaska.[2] Not only the oil industry has been the injurers in these very large accidents. In 1985 a Chemical plant in Bhopal released a toxic substance which killed 5000 and permanently injured 200000, and in 1986 the nuclear power plant in Tjernobyl had a breakdown and polluted large parts of Europe. The list over accidents with vast consequences could be made longer and, for example, also include the hydropower industry and the air-traffic industry.

The enormous consequences of these very large accidents bring especially two questions to the fore: the question of how victims should be compensated, and the question of creating incentives to take efficient care.[3]

We define very large accidents to be accidents distinguished from other accidents by the following: 1) The damages are in excess of the injurers assets, 2) that several countries may be involved, and 3) that the probability that the accident will occur is normally very small, which may put the question of compensation out of focus. Besides, since the number of very large accidents in the past is small, it is hard to determine the distribution of the probability that an accident will occur in the future.[4] These large accident characteristics have at least two important consequences. First, and probably most important, if the accident liability is in practice limited due to insufficient assets, the care taken will be too low and the activity level chosen will be too high. That is, the costs of taking more care and the costs of reducing the activity level will be lower than the social gains from doing so, Shavell 1996.[5]

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[2] As "only" 38 000 tons were spilled in the Exxon Valdez accident, and since the Exxon Valdez accident is unique in terms of reparation payments, it is safe to conclude that another accident in the magnitude of Amoco Cadiz could not be repaired according to the standards of reparation of the Exxon Valdez accident and the legal system of reparation.

[3] Compensation of victims includes both damage made to private property and damage made to property with public good characteristics. That is, also the environment *per se* is included in the compensation discussed here. Larsson (1997) states that the inclusion of environmental values in the compensation scheme make all existing schemes inadequate, and the state is left with the residual costs.

[4] If the distribution of the accident probability is unknown it is impossible to know the probability of an accident. This can be distinguished from the case where the probability of an accident is, for example, known to be normally distributed in which case it is possible to calculate the probability of an accident.

[5] A more comprehensive analysis should recognize that there are activities where an accident might result in damages which are distributed from small to very large due to a probability distribution. In such a setting the attitudes towards risk possessed by the actors become relevant. In such a setting it will also prove possible to

Second, victims will not be fully compensated, which may lead to worries among the population that are exposed to the risk, that an accident should have consequences that will be difficult, if not impossible, to receive compensation for.

This paper will be concerned with the reparation of accident damage of such magnitude that the liable parties' total assets are not sufficient to cover the losses. The questions that we will try to answer are if the prevailing reparation schemes - which may include strict liability, liability insurance and funds - provide strong enough incentives for hazardous industries to take efficient care and are adequate to allow for full compensation of victims, and if not, how the legal system can be changed or complemented.

The economic theory for reparation of accidental damage is well established.[6] However, the particular problems that arise with large-scale accidents have received little attention in the Law and Economics literature, Skogh (1998). [7] The existing reparation schemes for most activities are equally less developed. The combination of no, or inadequate, theoretical guidelines and the underdevelopment of juridical institutions in this area creates uncertainty for the industries to what extent they will be held liable for possible accidents in the future. The reaction to this uncertainty might be that socially desirable activities do not take place (or that the activity level is too high) or that activities are carried out without sufficient care taken. Potential future victims are also subject to this uncertainty, as the extent of any compensation cannot be estimated with certainty. Therefore, it is important to develop the theory in this area and to establish rules that are interpreted as stable by potential injurers.

As an illustrative example in our discussion we choose the oil industry and the international oil accident reparation scheme, but the discussion is also valid for other hazardous industries. The reason for our choice is the importance of the international oil accident reparation scheme as a precedent and model in international liability law, and that this reparation scheme is the most developed.[8] During the last decades, and probably as a reaction to the large oil accidents at sea, the system for compensation has improved considerably. However, as we will see, the present system is inadequate, for example in the respect of allowing for full compensation of victims to be possible.

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show that raising the limit on liability will have two effects: to increase care and to increase the probability that the injurer might not be able to pay which reduces care, i.e, the effect on care taken from raisinf the limit on liability is ambiguous. For a discussion of these matters see Cohen (1987).

[6] For an advanced treatment see Shavell (1986).

[7] Skogh (1998) starts with stating that the theoretical knowledge in Law and Economics is not developed for the purpose of analysing large scale accidents.

[8] The exception is the reparation scheme for the nuclear industry.

In the next section we begin with a brief general discussion of international liability schemes. In section 3 we discuss the importance of different liability rules. In section 4 we examine the compensation schemes for oil accidents at sea. In section 5 we discuss an alternative to the present system for compensation of oil damages at sea. Section 6 concludes.

2. International liability schemes

Accidents with environmental consequences during the 1960s and the 1970s which affected several nations, together with a growing concern for the environment, have induced global efforts to find solutions to the threat against the environment. These joint efforts by several states constitute what is called international environmental law. The United Nations Environmental Program, UNEP, has published a list with approximately 200 agreements dealing with international environmental issues.

Common to these agreements is the idea that states are both liable for remedies and have a responsibility to prevent environmental damage (Larsson, 1997). However, this idea is not generally transformed to explicit rules of liability. That is, no regime of strict liability is established in the international environmental law. An injurer may nevertheless be hold strictly liable by a specific country's domestic legislation, or by international conventions treating specific areas, e.g. oil pollution at sea.

International law makes the distinction between immovable and movable sources of pollution. The only immovable potential source of pollution that is subject to civil liability is nuclear installations. The liability scheme in this case is built up of three layers. Strict liability and liability insurance is imposed on the operator of the nuclear plant. The second layer is strict limited liability by each state. As a third layer insurance pools have been established for reinsurance purposes.

Regarding movable sources, an international regime concerning civil liability is under development (Larsson, 1997). No general rule of liability that treats all moveable sources of pollution exists; the prevailing system is built up of conventions treating particular areas. One such area is oil transports at sea. Before we study this area in some detail we have to take a look at the theoretical knowledge of Law and Economics concerning accident liability and other mechanisms for inducing care, and to provide means of compensation.

3. Accident liability in the case of large accidents

Following Shavell (1986) there are three purposes of accident liability: to create incentives to take care, to induce the efficient level of the hazardous activity and to compensate victims. The reason why liability induces care is obvious: the injurer takes care since the risk of an accident for which he will be liable is decreased by the care taken. The reason why the activity level is affected is similar: the expected losses from accident liability grows with the activity level.

The question of liability is in itself threefold. The first part of the question concerns the *conditions* under which the injurer – or someone else - can be held liable. The second part of the question concerns *who* is liable, and the third part of the question concerns *to what extent* the injurer is liable.

The answer to the question under what *conditions* someone can be held liable is: either under a liability regime or under a negligence regime and fault can be proved. The question of *who* is liable has already been somewhat addressed. One possibility is to have arrangements where the whole industry is hold liable for the damages caused by one particular firm in that industry. This channeling of liability to other firms in the industry creates incentives for each firm to monitor the safety arrangements taken by other firms. The question of to what *extent* the injurer is liable concerns the limits that any compensation claim is subject to. If the liability is limited the incentives for taking care are weakened, as damages above the limit are not internalized in the firms decisions (if this limit is not above the injurer's total assets in which case a reduction of the limit has no effect on the incentives of taking care).

Not only the magnitude of the accident but also the accident probability plays an important role in the calculations of expected liability. Using the concepts of Knight (1921), Skogh (1998) distinguished between actuarial risk that can be estimated statistically and development risk, which is a new risk induced by technological or some other change. [9] Development risks are problematic since imposing liability on the actor in such a case cannot serve the function of placing the risk on the party in the best position to avoid it. However, the actor can be seen as in the best position to acquire information about development risks through research. In between actuarial risk and development risk, Skogh (1998) defines

[9] One may make a distinction between the risk and the probability of an accident. However, following Knight (1921) we let the risk and the probability have the same meaning. For a discussion of this matter se, for example, Krier (1998).

unpredictable hazards, which is an observed danger known to exist but which is impossible to predict statistically. The reason for this is that no industry has experienced sufficiently many accidents to be able to statistically estimate the probability of an accident in the future. The statement at the outset that very large accidents occur with a probability with unknown distribution can now be reformulated: the risk (or probability) of a very large accident is either a development risk or an unpredictable risk. Thus, in the case of potentially very large accidents the deterrence motive for tort liability might not work as was intended. In order for the injurer to take efficient care he must be able to make ex ante calculations of this level of care. If the probabilities are unknown it is possible that the injurer would end up taking more (or less) care than what is efficient. That is, the scope for tort liability is reduced to compensation of victims since it is unclear if the deterrence motive can be fulfilled.

From the theory of Law and Economics we know that if strict liability is placed with the party that has the best available information concerning the activity and has the ability to affect the probability of an accident, efficient incentives are created; the efficient level of care will be taken and the efficient activity level will chosen. However, as we have seen, very large accidents have a set of distinguishing properties that make this theoretical result impossible to apply. The potential for claims in excess of the injurer's total assets, the unknown accident risk and the possible involvement of several countries make it hard to construct a reparation scheme that meet the purposes of accident liability. Neither the compensation of victims, nor the purpose of creating incentives to take efficient care or to induce the efficient activity level is accomplished within a system where the liable party has insufficient assets. Inefficient care is taken, since losses in excess of total assets will be treated as losses equal to total assets, and since the accident risk is unknown.[10] An analogous argument shows that the activity level will be too high to be efficient.

What are the alternatives to a strict liability system to induce efficient behavior? Under the negligence rule as compared to the strict liability rule, where the industry escapes liability by taking due care, the care taken may be less inefficient. That is, for very large accident it may be better, in the sense that the industry performs with greater care, to have a negligence system rather than a strict liability system (Shavell 1986). [11] More precisely, the

[10] Remember that we are discussing accidents of the magnitude that the liable parties' assets are insufficient to pay for the losses. In the case of small accidents it may be the case that both strict liability and the negligence rule lead to efficient care being taken.

[11] Given that the level of due care is set *higher* than the level of care that the liable party takes under the strict liability regime, the injurer will take more care under the negligence regime than under the strict liability regime. The explanation is that under the negligence rule the injurer escapes liability completely by taking due care, whereas under the strict liability rule the injurer only reduces the probability of liability. That is, the benefits to

injurer will choose due care if it costs less than the probability of an accident multiplied with total assets as opposed to under the strict liability rule where the injurer will choose the level of care which equates the *marginal cost* of additional care to the reduction in the probability of an accident multiplied with total assets. Consequently, the negligence rule has a potential of inducing efficient care which the strict liability rule has not. However, in order to achieve the efficient level of care, the level of due care has to be set at an efficient level, i.e. the level of care where social marginal costs of additional care equals the social marginal benefits from additional care.[12] Regarding very large accidents this problem may be particularly salient, as the probability of an accident is usually either development risks or unpredictable hazards. However, also a solvent injurer meets this problem under the strict liability rule, i.e. the negligence rule is not the source of this problem. More serious is that a negligence rule is complicated to implement because of the burden of proof. Another argument against a negligence rule is that the industry will adopt the critical level of care that it takes to escape liability, which means that victims of the accident do not get compensated.

Another possibility is that the injurer is not held liable but that the liability is channeled to a second party who is vicarious liable. If the injurer is alone liable his incentives to take care, as we have seen, may be inadequate. Channeling the liability to one party that has the ability to observe and control the injurer's level of care will induce the controlling party to compel the injurer to take efficient care.

Closely related to vicarious liability is joint liability. Here joint liability means that two or several parties that are all engaged in the same hazardous industry, mutually guarantee each other to jointly pay all claims directed to one particular company in that industry. If the industry as a whole has assets large enough to pay for damages occurring as a result of an accident, and if each company in the industry is able to monitor the conduct of all the other companies, the incentives to care will be adequate. Clearly, the total of the assets of the industry is more likely to be adequate to cover for accident damage. One problem though is that the industry might be put out of business if the claims are high enough and the liability is unlimited.

Yet another way of improving the incentives to take care is to require the injurer to hold liability insurance. If the insurer is able to determine the levels of care taken by the injurer, and if the injurer buy complete coverage, then the injurer will be induced to take

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the injurer of taking care is bigger under the negligence rule than under the strict liability rule in cases where total assets are not sufficient to pay for the costs of an accident.

[12] A riskneutral society would equate social marginal costs of additional care to the *expected* social marginal benefits.

efficient care. However, if it is impossible (or hard) for the insurer to monitor the conduct of the injurer, then the incentives to take care will be further diluted. (This is the moral hazard problem with insurance, which will be discussed below in connection with the oil transportation example). This situation is further complicated since the accident probabilities associated with very large accidents are to a large extent unknown. As efficient performance of both the policyholder and the insurer of a liability insurance are based on the accident probability being known, it is possible that neither party act in an efficient way. Shavell (1986) concludes his discussion of liability insurance by stating that it is unclear whether it is socially desirable to require liability insurance.

Further ways of sharpening the incentives to reduce risk and to ensure compensation to victims are to regulate the hazardous activities, or to require a minimum amount of assets to be granted a permission to engage in the activity. Regulation in itself does not solve the question of compensation, and it is questionable if it solves the problem of making the injurer behaving efficiently since there are monitoring costs if the regulation should be enforced. Another reason is that the authorities have no better information about the accident probabilities than the actor has. A required minimum amount of assets to engage in the activity may, if this minimum amount is high enough to cover accident damage and if the injurer is unlimited liable, induce the injurer to take efficient care. However, this approach suffers from the defect that the activity level might be too low, since some actors might be restrained from performing the activity.

The conclusion is that no system for compensation studied so far has the potential of achieving the goals of compensation and creation of incentives for behaving efficiently. Hence, a system that both compensate victims of an accident and induces the injurer to take efficient care must incorporate some other device not yet studied. The problem of creating efficient incentives is that even in a strict liability system the injurer does not face big enough losses in case of an accident. The solution must be to increase the amounts at stake for the injurer in case of an accident. One way to do this could be to establish funds that are owned jointly by the potential injurers in the industry. Before this is discussed let us examine the prevailing system for reparation of accident damages in the oil transport example.

4. Compensation schemes for oil accidents at sea

Traditionally the oil transport industry has not been strictly liable for accidents that may occur. Before 1975, when the 1969 Brussels International Convention on Civil Liability for Oil pollution damage (CLC) came into force, the claimant needed to prove fault of the owner of the ship or of the cargo.[13] That is, a negligence system ruled and the victims to an accident had to prove fault according to general rules on civil liability. There were no international (or even national) systems for reparation adopted. Moreover, ship-owners generally had a right of limitation of the liability in accordance with the 1957 Brussels International Convention Relating to the Limitation of the Liability of Owners of Seagoing Ships, which was replaced 1976 by the London Convention on Limitation for Maritime Claims.

The introduction of the CLC implies that a reparation scheme, for reparation of oil damages occurring at sea, applies which combines strict liability with compulsory insurance. The shipowner is required to hold insurance (or other financial guarantee) that covers at least up to the liability limitation limit. Operating at the market for maritime risks are the Protection & Indemnity clubs (P & I Clubs). A combination of an international pool of P & I Clubs and reinsurance cover third party damage up to $700 million (Radetzki and Radetzki, 1997).

The ship-owners liability is limited. First it should be noted that the shipowner can never be liable for more than $86 million under the CLC. Further, the CLC does not include warships and other governmental ships in non-commercial service.[14] The CLC does only include crude oil, fuel oil, heavy diesel oil, lubricating oil and whale oil which is transported by ship at the time of the accident.[15] Under the CLC the liability is strict and channeled to the registered ship-owner which merely can plead act of war, natural phenomenons, intentional acts of third party or governmental negligent maintenance of navigational aids as defense.

The CLC was complemented 1971 by the Brussels International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage (the IOPC fund convention). The IOPC came into force 1978, and a limitation fund was established.[16] The purposes of the fund are to provide compensation for oil pollution damage

[13] The CLC has been amended by Protocols 1976, 1984 and 1992. The 1992 Protocol entered into force in May 1996.
[14] Larson (1997)
[15] Larsson (1997) discusses whether or not the CLC could also cover damages caused by oil platforms.
[16] The IOPC was amended by Protocols in 1976, 1984 and 1992. The 1992 Protocol came into force 1996.

when 1) the shipowner is not liable under the CLC. 2) The sum of the shipowner's assets and insurance coverage is insufficient to cover the total claims and 3) when the damage exceeds the shipowner's liability under the CLC.

The maximum amount payable by the fund is $290 million. Put together total payable compensation from the ship-owners, the liability insurance and the fund established as a result of the IOPC is in the neighborhood of $1100 million. The inadequacy of this amount to cover for damages arising from a large oil accident at sea is obvious, as the maximum amount of payable compensation is clearly below the amounts that a large accident would trigger. For example, the cleanup bill after the Exxon Valdez's accident amount to $2200 million. Since the liability in practice is limited it can also be questioned if this system creates incentives for taking efficient care.

Both the Civil Liability Convention (CLC) and the Fund Convention (IOPC) have limited geographic application. The CLC is signed by approximately 70 states around the world and the IOPC is signed by approximately 50 of those states bounded by the CLC. Consequently, neither the CLC nor the IOPC are applicable to large parts of the seafaring world.

Awaiting the CLC and the IOPC and with the purpose of providing means of compensation in cases of oil pollution, the tanker and cargo owners reached voluntary agreements. After the 1992 Protocols to CLC and IOPC had come into force in 1996, the voluntary plans closed in 1997. Following the CLC was the Tanker Owners Voluntarily Agreement Concerning Liability for Oil Pollution, TOVALOP. The parallell to the IOPC fund convention was the Contract regarding a supplement to Tanker Liability for Oil Pollution, CRISTAL. While TOVALOP was set up by the tanker-owners the CRISTAL scheme was set up by the oil companies, i.e., the cargo owners. The combined total of compensation from TOVALOP and CRISTAL amounted to $168 million (Larsson, 1997). The future for these voluntary agreements is uncertain. The total amount of compensation is not of the magnitude that it will change the conclusion that total compensations are clearly inadequate to cover for full compensation of third party losses in case of a large accident.

The conclusion that can be drawn concerning the compensation schemes in the oil transportation industry is that it does not meet the three goals of the liability system. Due to limited liability, the total amount available for compensation is clearly inadequate. Further, limited liability and the moral hazard problems connected to insurance make it doubtful if the activity is conducted efficiently.

4. HOW CAN THE SITUATION BE IMPROVED?

The inadequacy of the present schemes for compensation

In the international discussion of the compensation scheme for oil accidents it has been recognized that the assessment of ecological damage as compensationable by the compensation schemes will make the bill unpayable by the prevailing system (Larsson, 1997).[17] We have already argued that the present system is inadequate, and the application of the system also to ecological damage reinforces our arguments. Skogh (1995) argues that the limits on the liability insurance can be raised to levels that would cover at least the same amounts that is the case for nuclear power plants. However, it is possible that the moral hazard problem with insurance for the oil transportation industry is considerably larger than the one arising in the nuclear industry. Nuclear accidents are hazardous in a much more complicated way than oil accidents. When an oil accident occurs it is certainly very unpleasant but very few would experience any direct threat against their lives, as would be the case if a nuclear accident occurs. This has forced the development of an extensive system for regulation of the activity at a nuclear power plant. It is reasonable to assume that these regulations decrease the problem with moral hazard. Consequently, it is plausible that the problem with moral hazard in the oil industry make the liability insurance a two-edged sword. On the one hand is it possible to compensate victims with liability insurance, and hence, fulfill one of the three purposes of the liability system, but on the other hand the problems with moral hazard may erode the incentives to take care. A negligence rule would possibly improve efficiency both regarding activity levels and care. But it does not guarantee compensation of all victims and values. Besides, as already argued, a negligence rule would be connected with, possibly, large transaction costs. In fact, no legal construction will induce the potential injurer to take efficient care if the construction does not at the same time increases the injurer's financial risk. That is, the injurer's assets that are at stake must increase.

Another suggestion to improve upon the present situation is to launch further fund layers on top of the IOPC fund. For example, Burrows et.al. (1974) argue that the system for reparation should be built on an extension of the TOVALOP insurance agreement. We will argue that such a system would have the potential of provide complete coverage of

[17] It has already been pointed out that the reparation scheme applied to the Exxon Valdez accident could not have been applied to the Amoco Cadiz accident, since liability would be inadequate.

damages and simultaneously create incentives to take care and to moderate the activity level, without the problems of moral hazard. It is however critical how these fund layers are owned to create a incentive mechanism. Before we go any further in the discussion of this matter let us exactly define the properties of the reparation scheme that we are looking for.

Lidgren and Skogh (1996) discuss a system, which include funds, for extended producer responsibility and recycling of used goods. Even though the problem discussed in their article is different from our problem they identify a set of legal properties that a compensation scheme should have which are also relevant for the system which we try to construct. First, it is eminent that the compensation system is robust against changes in the political and economical environment. Second, it must be unambiguous what all parties' obligations and rights are. Besides these requirements, we also want our compensation system to fulfill the goals of the liability system.

The reparation system for oil accidents at sea does not meet this set of requirements. First, as argued earlier, the present reparation system does not fulfill the requirements put on the liability system. Second, it can be argued that payments from this system are not without political uncertainty, and the political uncertainty contributes to the economical uncertainty. Third, neither part of this system has any connection to the welfare of the injurer, and hence, it cannot affect incentives to take care or to moderate the activity level. [18] The inadequacy of the present compensation system can be summarized as follows: 1) the limits to liability is too low, 2) inadequate means in the system, 3) political, legal and economical uncertainty as the system is under development and any claim is a candidate for the court.

Some of the problems encountered by the oil reparation system are similar to those shown by a pay-as-you-go pension system in a society where the demografic and economical circumstances change unpredictably. In a pay-as-you-go system the working generations are taxed and the taxes are used to give the older generations pensions. Therefore, a pay-as-you-go system is sensitive to demographic changes as well as changes in economic variables such as the growth rate. The political situation also affects the payments from a pay-as-you-go system since taxes are under the control of politicians. Hence, it is not possible for the individual to decide with certainty the value of his or hers pension rights which implies that the individual's economic decisions concerning, for example, lifecycle savings will be distorted. Similarly, in the oil reparation system, future payments are uncertain. Through

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insurances the oil industry is paying for expected damage. If the amount at stake for the oil industry is too small the level of care will be too low and the activity level will be too high.

A funded pension system, on the other hand, is a system in which each individual saves to his or her pension. The funded system overcomes some weaknesses of the pay-as-you-go system. The political uncertainty does not (in principal!) exist in a funded system. A funded pension system connects the payments to the system with the benefits from the system, which create incentives for efficient behavior. Likewise, a compensation system relying on funds potentially reduces the uncertainty connected to the ability to pay for damages and, provided that the fund's assets are big enough, strengthens the incentives to take care. Moreover, the problem with moral hazard may be mitigated given that payments from the fund for damages decrease the income of the injurer. This would be the case if the injurer owns the returns from the fund.

The present reparation system for oil accidents is built by insurances and funded means. That is, the system can be compared to a funded pension but with some of the problems known from a pay-as-you-go pension system. The key-weakness of the system is that the funded assets are not used for affecting behavior. In a funded pension system each individual owns the fund and earns the interest from the fund. In the oil compensation system the potential injurers do not directly own the funded assets. Another important weakness of the present system for reparation of oil damages is that the assets available for compensation are far too small. We will now discuss how the present compensation system for oil damages can be modified and show that it is both possible to improve the care taken compared to the prevailing situation and to create large enough resources for all damages are to be repaired.

A funded alternative

The preceding discussion showed that the negligence rule might induce the injurer to take more care than a strict liability rule would do. The main obstacles for the negligence rule to perform this good is, first, the solvency of the injurer and, second, transaction costs in deciding and implementing the efficient level of due care. However, the transaction costs connected to deciding the efficient level of care is mainly due to the difficulties in calculating the probability of an accident and therefore this problem is not unique for the negligence rule. Neither is the problem with the solvency of the injurer unique for the negligence rule. Further, we have showed that limited liability in practice mean that all damages will not be

compensated. Especially this is true if also environmental damages are included in the analysis.

Consider a system for compensation of oil damages occurring at sea, in which the resources of the system are built up by a mutual fund, owned by the injurers, and by the injurers' assets. [19] The fund receives its means from payments from the potential injurers, or by a tax on cargoes or by harbor dues. We assume that the injurers are best fitted to reduce the risk. Then, the key features of our compensation system are that the injurers earn the interest from the accumulated capital in the fund and the fund is strictly liable and injurers are operating under a negligence rule. If an accident occurs, the fund is strictly liable and the injurer will be liable with his assets if he has not exercised due care. That is, interest earned from the fund by the injurer will be reduced, which would strengthen the incentives to take care. Such a system would induce each injurer to take more care than what is the case in the prevailing system. Moreover, if the fund were large enough the care taken would be efficient. Further, this system would improve on the prevailing situation when it comes to compensation of damages. There are, however, problems with the construction of the fund.

First, there is the problem of how to divide the interest from the fund between the owners (injurers). Second, what should be the connection between the activity level and the payments to the fund? Third, how should an injurer that wishes to get out of business be compensated for his share of the fund, and similarly, how should an injurer that wishes to enter be treated?

Before we discuss these problems let us first state that membership of the fund must be compulsory. If it is not compulsory the system would not work since each potential injurer would not make payments to the fund, and hence, the system would not be able to build enough assets, which is the most important weakness of the prevailing system.

The first question concerns the incentive effects. Under the negligence rule the injurer will take due care if this costs less than the expected loss in case of an accident. The problem is that if the total assets of the injurer are small it is unlikely that he will take due care. If the injurer's potential loss is not the product of the probability of an accident and his total assets, but instead the product of the probability of an accident and the sum of his total

[19] An example of a fund that do not fulfill our requirements of a compensation system is the Swedish fund established with the purpose of providing means for the costs arising when the Swedish nuclear power plants are closed. The fund is constituted by an account that is handled by the government. The legal situation concerning whom owns and exactly how the means of the fund shall be used is unclear. The consequence of this legal uncertainty is that the incentive making connection between the fund and the actor is distorted.

assets and some share of the interest from the fund, he will take more care.[20] The interest from the fund must therefore be shared among the potential injurers in proportion to potential damage and costs of taking care. If the injurers are identical in all respects the interest from the fund should be shared equally. When the set of injurers are heterogeneous they might have different costs for taking care because they have different activity levels. In this case, sharing the interest from the fund equally may lead to some injurers taking less than due care.

The second question is connected to the first. In order to enjoy the incentive effects there must be a connection between the activity level and the payments to the fund. Higher activity level should imply higher payments and hence higher expected return from the fund.

The third question concerns entry into and exit from the fund. How should an injurer that wishes to leave the business be treated? Given that the goal is to create the strongest possible incentives to take care, it is important whether or not the money paid to the fund during activity is repaid to the exiting company. Assume that the sum of the company's assets and the return from the fund, which accrues to the company, is not big enough to induce the company to take efficient care. Then, repayment of payments to the fund will create incentives for the company to increase the level of care, and hence improve efficiency. Certainly, the incentive effect of this repayment of funded means depends on the present value of the expected amount that will be repaid. However, as long as the expected amount that will be repaid is nonnegative the effect on incentive will be to take more care. The other part of question three concerns entering into the market. In principle, there are two ways of organizing this. An entrant either starts to pay money to the fund, or buys the share of an exiting company. The first alternative means that the number of members or contributors to the fund increase, while the second alternative keeps the number of contributors constant. In order to get the market price of that specific risk and efficient risk allocation, the financial market could set the prize of a share of the fund. The financial market can also be used for

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[20] Let the total assets of the fund be F and the total assets of the injurer S, the probability of an accident $p(x, y)$, where *x* and *y* are the level of care and the activity level respectively. The cost of taking care is $c(x, y)$. The injurer will take more care in a negligence system than in a strict liability system. Consider a negligence system. The injurer will take due care if $p(x^*, y)S > c(x^*, y)$, where x^* is due care. However, for large accidents the accident probability is small, i.e., $p(x^*, y)S < c(x^*, y)$ and the injurer will take less than due care. The suggested system improves this situation if the injurer instead loses $\frac{r}{N}F + S$ in case of an

efficient risk-allocation. If the prize of fund-shares are determined at the financial market, competition among potential entrants assures that the risk is born by the company with the highest willingness to pay, i.e., the risk is allocated to the company that is most efficient in taking care.

6. Conclusions

The requirement of full compensation, which the present compensation scheme for oil damages do not fulfill, is possible to achieve by establishing a fund. The fund could, for example get its assets from small harbor dues. Even at a very small due such a fund rappidly would grow big enough to be able to fully compensate the expected losses of a very large oil accident.

The requirement that the system should give incentives to take efficient care is not fulfilled in the present compensation system. The reason is that the magnitudes of the accidents that we study are so big that the total assets of the industry are not sufficient to pay for all damages. That is, neither strict liability for the injurer nor joint liability for the industry supplies incentives enough for the liable party to take efficient care. In order to ensure that victims are compensated, in case of an accident, mandatory liability insurance has been introduced, which may have eroded the incentives to take care because of moral hazard problems. Because of the apparent inadequacy of this system to meet the compensation demands from victims an international agreement has emerged that forces the states which have complied to the CLC to establish a fund which has the purpose of compensate victims of an oil accident. However, the compensation coming from the fund does not have an effect on the injurer's incentives to take care. Since the amount paid from the fund will not affect the injurer's profit, there is no link induced between the level of care and the fund. A construction that would create a link between the injurer's welfare and the assets of the fund is to let the injurer own the fund, and hence earn the interest from the funded means, but place strict and unlimited liability on the fund.

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accident and since $\frac{r}{N}F + S > S$, where r is the interest rate and N is the number of owners. (We have assumed that the interest from the fund is shared equally between the owners)

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