Vicarious liability rule and apportioning damages for multiple tortfeasors

Jae-Cheol Kim, Byungtae Lee and Se-Hak Chun
Korea Advanced Institute of Science and Technology

September 10, 2008

Abstract

In this article, we study the liability rule and apportioning damages between an employer and employee in a vicarious liability perspective. We also analyze how the vicarious liability could be efficient rule in a relation of principal and agent. We focus on liability rule when there are multiple tortfeasors and how compensate victim's damages in a equitable perspective. We combine optimal vicarious liability rule and joint and several liability rule. One dimension is how allocate liability between employer and employee and other dimension about how compensate victim's damages using joint and several liability rule or several liability in a multiple tortfeasor situation. This study contributes on conflict decision making between joint & several liability and nonjoint (several only) choice with efficiency view and between vicarious liability or not with negligence based liability rule. Also it gives a business guideline for opitmal payoff decsion in a pricipal and agent relation. In managerial perspective, this study gives an implication on giving instruction when he give instructions to his employee (or bear some precaution effort) and the optimal payoff considering all situation that employer gives instruction or when he does not give instruction by analyzing optimal liability rule and court's equitable compensation scheme.

1 Introduction

Vicarious liability is defined as when one person is liable for the negligent actions of another person, even though the first person was not directly responsible for the injury. For instance, a parent sometimes can be vicariously liable for the harmful acts of a child and an employer sometimes can be vicariously liable for the acts of a worker (http://www.lectlaw.com/def2/u035.htm). The law of vicarious liability exists to cope with the problem of judgment-proof agent which the victim of an agent's tortious conduct cannot recover full compensation directly from the agent (Sayke, 1981). Sayke(1981) identified the circumstances under which vicarious liablity is and efficient rule using a formal economic model of the principal-agent relationship. He focused on principal's monitoring effort and vicarious liability's efficiency. He says that if precautionary behavior is unaffected by the financial incentives created by alternative liability rules, then vicarious liability is generally an efficient rule and if the pricipal can monitor the adequacy of the agent's precautions, then vicarious liability again is generally an efficient rule. Under vicarious liability, the principal and the agent are jointly liable for damages, and the optimal judgment-proof contract is unavailable to the enterprise. If the enterprise's total assets are sufficient to cover its potential tort liability, tort victims will be fully compensated. Vicarious liability results in full compensation to the tort victim.

Compensation issue is related to multiple tortfeasors' problem especially by joint and several liability rule. It is defined as two or more defendants are together held financially responsible for a plaintiffs injury and each defendant individually may be held financially responsible for the full value of the harm (Schmit, Anderson and Oleszczuk, 1991). Its rationale developed that the burden of insolvency or some other barrier to recovery against one defendant ought to be borne by the other culpable parties rather than the innocent plaintiff (Keeton, 1984). This provokes an issue on who should bear the risk of insolvent or unidentifiable defendants. McNichols(1979) says that there are two distinct but often conflicting goals. One aspect is about by adoption of joint and several liability, the court can ensuring fairnes but adequate compensation to victims. The other aspect is about providing equitable allocation of responsibility among wrongdoers. This is related to abolition of joint and several liability. Joint and several liability can distort that allocation process by placing full monetary responsibility on a single party. Landes and Posner (1980) says that the critical element in achieving optimal deterrence is appropriate allocation of expected cost ex ante rather than allocation of actual costs ex post. Although by imposing joint and several liability fully compensation is obtained and the court shift the burden of proving to defendants in a perspective of cost of administration system, but deterrence goal may not obtained. Today most states permit joint and several liability in a number of situations (Schmit, Anderson and Oleszczuk, 1991), however the overall number of joint and several liability cases is quite small (0.41 percent in 1988) at the federal level, but joint and several cases showed an exponential increase from 1963 through 1988. In a proponents of joint and several liability, defendant will be better able to absorb the loss and spread the cost among society than would be the injured plainfiff. And in a opponents of joint and several liability, when the plaintiff is contributorily negligent, the joint and several liability may be most strained. For example, the plaintiff's negligence has caused harm to the plaintiff alone, while the defendant's negligence has caused harm to another person. Therefore the plaintiff should be able to recover the full amount of his or her damage less any percentage which he or she wase negligent. The plaintiffs take their defendants as they find them–consistent with the law holding defendants liable for differing amounts depending on the age and income staturs of the plaintiffs. When there is only one defendants involved in a cases, and that defendant is insolvent, the plaintiff has no recourse and cannot recover.

For contribution issue, Anderson(1985) shows that 44 states and the District of Columbia recognize some right of contribution among joint tortfeasors. The primary roadblock to such recovery may be the solvency of joint defendants rather than legal rationales.

In this article, we study the liability rule and apportioning damages between an employer and employee in a vicarious liability perspective. We also analyze how the vicarious liability could be efficient rule in a relation of principal and agent. We focus on liability rule when there are multiple tortfeasors and how compensate victim's damages in a equitable perspective. We combine optimal vicarious liability rule and joint and several liability rule. One dimension is how allocate liability between employer and employee and other dimension about how compensate victim's damages using joint and several liability rule or several liability in a multiple tortfeasor situation.

This study contributes to conflict decision making between joint & several liability and nonjoint (several only) choice with efficiency view and between vicarious liability or not with negligence based liability rule. Also it gives a business guideline for opitmal payoff decsion in a pricipal and agent relation. In managerial perspective, this study gives an implication on giving instruction when he give instructions to his employee (or bear some precaution effort) and the optimal payoff considering all situation that employer gives instruction or when he does not give instruction by analyzing optimal liability rule and court's equitable compensation scheme.

This study aims to find optimal principal's decision when vicarious liability may be imposed and its optimal payoff for agent considering accident situation in a principal's perspective. In a court perspective, this study provides some guideline for allocation of liability and apportioning damages in a situation when the victim may not be fully compensated. We especially consider both situation when the agent is insolvent or solvent and generalize compensation rule in an agent's judgment proof situation with discusing its efficiency issue.

The court is primarily concerned with maximizing efficiency. In other words, the court chooses liability rule and compensation scheme that leads the employer to behave in an efficient manner. Once the efficiency consideration is fulfilled, the court is also concerned with distributional equity, especially on welfare of the victim.If there are a number of ways to obtain the social optimum, the court chooses the one that perfectly compensates the victim.

Our model generalizes and extends vicarious liability to negligence based liability even in situation of vicarious liability aiming to practically apply in a situation which there exists tort victim's may not be fully compensated. Also we analyze when vicarious liability rule is the best solution based on negligence based liability rule and how apportionate victim's damages when the agent is insolvency and partly negligent principal. As Sayke(1981) commented, although vicarious liability is very widely in force, its theories are not well developed. In this study, we investigate vicarious liability and compensation rule by interwining these two concepts. First, when joint and several liability or not — full compensation or not, Second, strict vicarious liability or negligence based liability, Third, when vicarious liability is efficient? Fourth, what is optimal effective wage for employee?

2 The Model

Consider an employment contract in which one party (principal or employer) hires another party (agent or employee) and delegates a risky task. Hereafter we consider the relationship of employer and employee. In order to concentrate on liability questions, we assume away risk sharing issues by considering risk neutral employer and employee (Bisso and Choi, 2006). When the task is done properly, the employer receives a positive monetary payoff u_2 and then pays a wage v_2 to the employee. The task may end up in an accident, which causes some harm a to a victim. In the event of the accident, the employer receives u_1, out of which he pays v_1 to the employee. The employee possesses some wealth, not sufficient for damages (or harm), that is, of $e < a$.[1]

The probability of the accident occurring depends on precautionary efforts of both parties. The employer may give detailed instructions to his employee about what and how to do. If the employee conforms to instructions, the accident occurs with probability p. If the employer dose not give any instructions, the accident probability goes up to $q > p$. The employer gives instructions but the employee may find conformity not worth. Then, the instructions are in vain and the accident probability is q. The employer cannot observe nor monitor perfectly whether the employee acts as instructed. As a result, there is room for moral hazard on the part of the employee. Giving instructions is costly, incurring w_r. Similarly, it costs the employee w_e to conform.

When an accident occurs, the court is assumed to be able to verify whether the employer instructed or not. If the employer is found to have been negligent to give instructions, the court declares him at fault and holds the employer strictly liable.[2 3] When instructions were given and the accident occurs, both the employer and the employee are held liable.[4] The court allocates liability in two steps. First, the employee is 100θ % at fault and the employer $100(1-\theta)$ % at fault where $0 \leq \theta \leq 1$.[5] Thus, θ represents the size of personal liability and $1-\theta$ that of vicarious liability of the employer. Second, noting that if $\theta a > v_1 + e$, the employee becomes insolvent, we define s to be an amount with which the employee can get away with, especially when the employee becomes insolvent.

$$s = s(\theta, v_1, a) = \max\{0, \theta a - v_1 - e\}$$

[1] This assumption is based on the doctrine of vicarious liability under which a deep-pocket principal is held responsible for a judgment-proof agent's tortious conduct (Bisso and Choi, 2006).

[2] The court adopts the rule of negligence for the employer's misconduct.

[3] As will be explained below, by observing the compensation to the employee for his performance, the court can infer whether the employer gave instructions or not.

[4] We may consider a case where a negligent liablity rule is imposed on the employee. Even when the employer cannot monitor the employee's action, it is still possible to infer whether or not the employee conformed by observing some relevant variables available. Yet, we dismiss this case for the reason to follow in section ##.

[5] θ depends on many factors such as legal theories, plaintiff's behavior, legislation.

If $s > 0$, s is de facto (involuntary) subsidy to the employee provided by the employer and/or the victim. The employer bears additional liability, γs where $\gamma = 0$ or 1. If $\gamma = 1$, both parties are jointly and severally liable and if $\gamma = 0$, they are severally liable. Note that when $s = 0$ or the employee is solvent, γ is irrelevant.[6] This liability rule, although appearing awkward, is general enough to comprise various liability rules. For example, if $\theta = 0$, the employer is strictly vicariously liabile (irregardless of γ) (Newman and Wright, 1990; Arlen) while if $\theta < 1$ and $\gamma = 1$, the employer is (partially) vicariously liable and a victim is fully compensated by the joint and several liability. If $\theta = 1$ and $\gamma = 0$, no vicarious liability is imposed and a victim cannot be compensated with amout of s. We assume that the employer is never insolvent. Finally, a victim suffers uncompensated damages, $(1-\gamma)s$. Thus, $(1-\gamma)s = 0$ means that a victim is compensated fully while $(1-\gamma)s > 0$ means a victim is partialy compensated by a deep-pocket principal employer with partial vicarious liability (Bisso and Choi, 2006). Table 1 shows parties' liability and compensation allocation rule based on whether negligence liability (θ) and joint and several liability(γ) are imposed or not.

Table1. Notations

	$\theta = 0$	$0 < \theta < 1$	$\theta = 1$
$\gamma = 0$	SVL	Partial vicarious liabillity Imperfect compensation	Personal liability Imperfect compensation
$\gamma = 1$	SVL	Partial vicarious liabillity Perfect compensation	Personal liability Perfect compensation

($\gamma = 0$: Several liability, $\gamma = 1$:Joint and several liability, SVL:Strict vicarious liability)

To keep the employment relation, the employer has to guarantee the employee the reservation wage, v_0. The court is primarily concerned with maximizing efficiency. In other words, the court chooses θ and γ that leads the employer to behave in an efficient manner. Once the efficiency consideration is fulfilled, the court is also concerned with distributional equity, especially on welfare of the victim. If there are a number of ways to obtain the social optimum, the court chooses the one that perfectly compensates the victim.

2.1 Optimal Wage Contract and Liability

We have potentially three outcomes. When the employer instructs and the employee conforms, outcome I is obtained. If the employee does not conform, outcome II is obtained. If the employer fails to instruct, outcome III is realized. We will calculate payoffs of both parties for each outcome. Suppose that the employer gives instructions so that either outcome I or outcome II is realized.

[6] In reality, the victim pursues the employer, the 'deep pocket', for the full damages and the employer makes a separate action against the employee.

If no accident occurs, payoffs of the employer and the employee are $u_2 - v_2$ and v_2, respectively. When the accident occurs, the employer and the employee receive $u_1 - v_1 - (1-\theta)a - \gamma s$ and $v_1 - \theta a + s$, respectively. Define

$$\begin{aligned} v_a &= v_1 - \theta a + s \\ &= \max\{v_1 - \theta a, -e\}, \end{aligned}$$

net wage after damages in the event of the accident. Net wealth of the employee is then $v_a + e$. We similarly define

$$\underline{v}_a = \max\{-\theta a, -e\} \leq 0,$$

the lowest effective wage the employee can expect in the event of an accident. When insolvency is allowed, v_a cannot be less than $-e$ or $-\theta a$.

The employer's payoff $u_1 - v_1 - (1-\theta)a - \gamma s$ can be rewritten as $u_1 - v_a - a + (1-\gamma)s$. It is like the employer and the employee making a contract that the former bears entire damages and pays v_a to the latter, who then gives s in return for cleared liability. The sum of payoffs of the employer and the employee is $u_1 - a + (1-\gamma)s$, which means that the victim is imperfectly compensated by the amount of $(1-\gamma)s$. When the employer does not give instructions, then he receives $(1-q)(u_2 - v_2) + q(u_1 - v_1 - a)$ while the employee receives $(1-q)v_2 + qv_1$. By inspection, any v_2 and v_1 for which $(1-q)v_2 + qv_1 = v_0$ maximize the employer's payoff.

Let Π_r^k, Π_e^k, Π_v^k and $\Pi_c^k = \Pi_r^k + \Pi_e^k + \Pi_v^k$ be payoffs of the employer, the employee, the victim and the court associated with outcome $k = I, II, III$, respectively. Then,

$$\begin{aligned} \Pi_e^I &= (1-p)v_2 + pv_a - w_e && \text{(1a)} \\ \Pi_r^I &= (1-p)(u_2 - v_2) + p(u_1 - v_a - a + (1-\gamma)s) - w_r && \text{(1b)} \\ &= (1-p)u_2 + p(u_1 - a + (1-\gamma)s) - \Pi_e^I - w_e - w_r && \\ \Pi_v^I &= -p(1-\gamma)s && \text{(1c)} \\ \Pi_c^I &= (1-p)u_2 + p(u_1 - a) - w_e - w_r && \text{(1d)} \end{aligned}$$

$$\begin{aligned} \Pi_e^{II} &= (1-q)v_2 + qv_a && \text{(2a)} \\ \Pi_r^{II} &= (1-q)(u_2 - v_2) + q(u_1 - v_a - a + (1-\gamma)s) - w_r && \text{(2b)} \\ &= (1-q)u_2 + q(u_1 - a + (1-\gamma)s) - \Pi_e^{II} - w_r && \\ \Pi_v^{II} &= -q(1-\gamma)s && \text{(2c)} \\ \Pi_c^{II} &= (1-q)u_2 + q(u_1 - a) - w_r && \text{(2d)} \end{aligned}$$

$$\begin{aligned} \Pi_e^{III} &= v_0 && \text{(3a)} \\ \Pi_r^{III} &= (1-q)u_2 + q(u_1 - a) - v_0 && \text{(3b)} \\ \Pi_v^{III} &= 0 && \text{(3c)} \\ \Pi_c^{III} &= (1-q)u_2 + q(u_1 - a). && \text{(3d)} \end{aligned}$$

By inspection, outcome III is socially preferred to outcome II ($\Pi_c^{III} > \Pi_c^{II}$). Let $\Delta c = \Pi_c^I - \Pi_c^{III} = (q-p)(u_2 - u_1 + a) - w_e - w_r$, an increase in the court's payoff or social welfare when both the employer and the employee make precautionary efforts compared to that when they fail to do. Assume that $\Delta c > 0$ so that it is socially optimal that the employer gives instructions and the employee conform to them.

Lemma 1 *Suppose that the employer gives instructions. If* $\underline{v}_a = -e$ *or* $\theta a \geq e$, *then* $v_1 = 0$ *and* $s = \theta a - e$. *On the other hand, if* $\underline{v}_a > -e$ *or* $\theta a < e$, *then* $v_1 \geq 0$ *and* $s = 0$.

Proof. Suppose that $\theta a \geq e$. Consider a pair of $v_1 \geq 0$ and $v_2 \geq 0$ that outcome I is realized. We first note that if the employer changes v_1 and/or v_2 in such a way that Π_e^I remains the same, the employee has no incentive to deviate from his original choice. There are two cases to consider. First, if $\theta a \geq v_1 + e$, then $s = \theta a - v_1 - e$ and $v_1 - \theta a + s = -e$. Then, by inspection, given v_2, Π_r^I is maximized when $v_1 = 0$ if $\gamma < 1$.[7] Next, if $\theta a < v_1 + e$, $s = 0$ and $\Pi_r^I = (1-p)u_2 + p(u_1 - a) - \Pi_e^I - w_r$. Π_e^I and therefore Π_r^I remain the same if the employer adjusts the wage contract such that $v_1' = \theta a - e$ and $v_2' = v_2 + \frac{q(v_1 - \theta a + e)}{1-q}$. As noted above, the employer is better off by choosing $v_1'' = 0$ and v_2'. The same argument can be made for outcome II. Now, $\theta a < e$. Then, $-e < v_1 - \theta a$ so that $v_a = v_1 - \theta a$, which means $s = 0$. ■ ■

Table 2 summarizes the above lemma 1 result. It says that if the personal liability is rather small ($\theta < \frac{e}{a}$), the employee is solvent so that no subsidization occurs ($s = 0$). However, if the personal liability is large or the employee is insufficiently endowed relative to his liability ($\frac{e}{a} \leq \theta$), the employer has an incentive to intentionally makes the employee insolvent in the event of the accident, by which he can absorb the victim's loss into his payoff ($s = \theta a - e$) (Sykes, 1981). The court can make compensation perfect ($(1-\gamma)s = 0$) basically in two ways: either by making both parties jointly and severally liable ($\gamma = 1$) or by making them only severally liable but the employer vicariously liable heavily ($\gamma = 0$ and $\theta < \frac{e}{a}$). Thus, it means that if joint and several liability is not imposed (or both parties are severally liable) when the personal liability is rather large, the employer will purposely make the employee insolvent.

Table 2. Lemma 1.

	$0 \leq \theta < \frac{e}{a}$	$\frac{e}{a} \leq \theta \leq 1$
$\underline{v}_a$	$\underline{v}_a > -e$	$\underline{v}_a = -e$
v_1	$v_1 \geq 0$	$v_1 = 0$
s	0	$\theta a - e$
γ	$\theta^* = 0$	1

Now, we will investigate the behavior of the employer, the employee and the

[7] If $\gamma = 1$, Π_r^{II} is invariant with any $v_1 \leq \theta a - e$, especially $v_1 = 0$.

court. Suppose that the employer gives instructions. He may wish to obtain outcome I or outcome II. To obtain outcome I, he must offer v_2 and v_a such that $\Pi_e^I \geq \Pi_e^{II}$ and $\Pi_e^I \geq 0$ or

$$\begin{aligned} IC(v_a, v_2) &= (q-p)(v_2 - v_a) - w_e \geq 0 \\ IR^I(v_a, v_2) &= (1-p)v_2 + pv_a - w_e - v_0 \geq 0. \end{aligned}$$

In the above, $IC \geq 0$ and $IR^I \geq 0$ are the incentive compatibility and the individual rationality constraints, respectively for outcome I. Note that the first condition implies that $v_2 > v_a$.

On the other hand, if he wishes to obtain outcome II, it must be that

$$\begin{aligned} IC(v_a, v_2) &= (q-p)(v_2 - v_a) - w_e \leq 0 \\ IR^{II}(v_a, v_2) &= (1-q)v_2 + qv_a - v_0 \geq 0. \end{aligned}$$

Again $IC \leq 0$ and $IR^{II} \geq 0$ are the incentive compatibility and the individual rationality constraints, respectively for outcome II.

Fig. 1 depicts a typical situation.

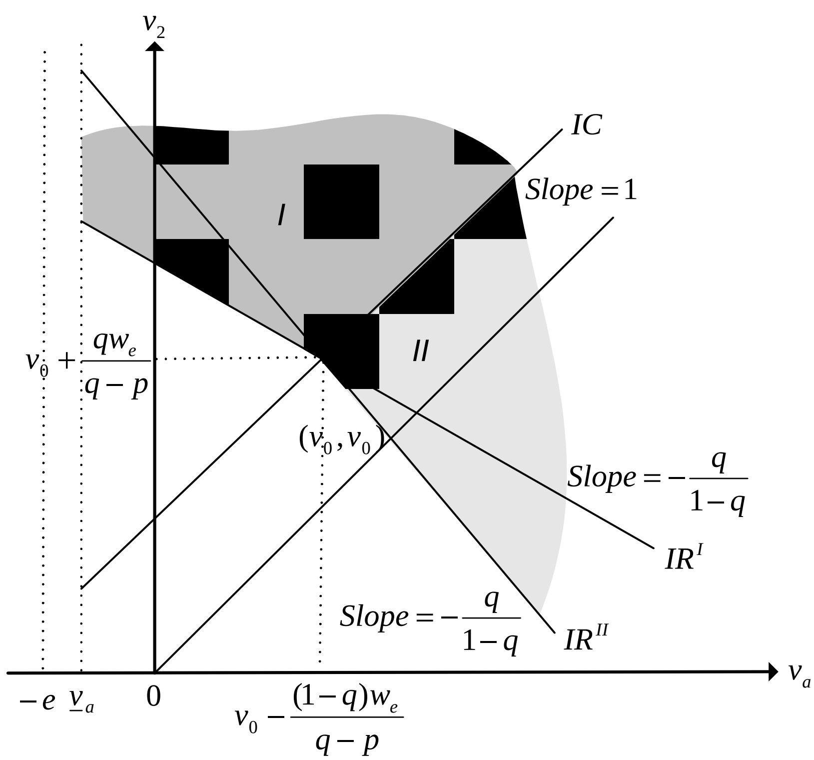

Fig. 1. $w_e < \frac{q-p}{1-q}(v_0 + e)$

Some explanations about the figure are in order. IC represents a collection of (v_a, v_2) for which $IC(v_a, v_2) = 0$. IR^I and IR^{II} are similarly defined. Then, we have $\frac{dv_2}{dv_a}_{|IC=0} = 1 > 0$, $\frac{dv_2}{dv_a}_{|IR^I=0} = -\frac{p}{(1-p)} < 0$, $\frac{dv_2}{dv_a}_{|IR^{II}=0} = -\frac{q}{(1-q)} < 0$ and $\frac{dv_2}{dv_a}_{|IR^{II}=0} < \frac{dv_2}{dv_a}_{|IR^I=0}$. Also, IR^I, IR^{II} and IC intersect with each other at the same point

$$(\widehat{v}_a, \widehat{v}_2) = (v_0 - \frac{1-q}{q-p} w_e, v_0 + \frac{q}{q-p} w_e).$$

The corresponding $\widehat{v}_1 = \widehat{v}_a + \theta a$. Finally, area k $(k = I, II)$ represents a set of (v_a, v_2) for which outcome k is realized.

In general, it costs more the employer to achieve outcome I than outcome II. Define $v_2^{IC} = v_2^{IC}(v_a)$ and $v_2^{IR^k} = v_2^{IR^k}(v_a)$ $(k = I, II)$ such that $IC(v_a, v_2^{IC}) = 0$ and $IR^k(v_a, v_2^{IR^k}) = 0$.[8] The additional (expected) wage given $v_a \geq \underline{v}_a$ needed is

$$\begin{aligned} \Delta v &= \max\{0, (1-p)(v_2^{IC} - v_2^{IR^I}) = (1-q)(v_2^{IC} - v_2^{IR^{II}})\} \\ &= \max\{0, \frac{(1-q)w_e}{q-p} - v_0 + v_a\} \geq 0. \end{aligned}$$

2.1.1 Case 1. $\Delta v = 0$ for some $v_a \geq \underline{v}_a$ and θ.

In this case, we have the following result:

Lemma 2 *The social optimum outcome I with perfect compensation can be achieved.*

Proof. Consider v_a and θ for which $\Delta v = 0$. Let the corresponding v_2 be $v_2^{IR^I}$. By definition, $IR^I(v_a, v_2^{IR^I}) = 0$ and $v_2^{IC} \leq v_2^{IR^I}$ so that $IC(v_a, v_2^{IR^I}) \geq 0$. Therefore, the employee chooses to conform. Next, suppose that the court chooses γ such that $(1-\gamma)s = 0$, that is, if $s > 0, \gamma = 1$ while if $s = 0$, any γ will do. Then, $\Pi_r^I = (1-p)u_2 + p(u_1 - a) - v_0 - w_e - w_r$ so that the court's and the employer's interests are aligned. Therefore, the employer will prefer outcome I.■ ■

Fig. 1 depicts this situation. By inspection, $\Delta v = 0$ is equivalent to $\widehat{v}_a \geq \underline{v}_a$. In fact, we have a slightly stronger result.

Proposition 3 *Suppose that $\widehat{v}_a \geq -e$ or $w_e \leq \frac{q-p}{1-q}(v_0 + e)$. Then, the social optimum outcome I with perfect compensation can be achieved.*

[8] It is easy to see that $v_2^{IC} = \frac{w_e}{q-p} + v_a$, $v_2^{IR^I} = \frac{w_e+v_0}{1-p} - \frac{p}{1-p} v_a$ and $v_2^{IR^{II}} = \frac{v_0}{1-q} - \frac{q}{1-q} v_a$.

Proof. If $-e \leq \widehat{v}_a < \underline{v}_a$, then the court can choose $\theta \geq \frac{e}{a}$ so that $\underline{v}_a = -e$. ■ ■

Table 3. Proposition 3.

$$\begin{array}{rcl}
 & & \quad\quad -e \leq \widehat{v}_a \quad -\theta a = \underline{v}_a \leq \widehat{v}_a \\
 & & \underline{v}_a \quad -e \quad\quad\quad\quad -\theta a \\
\Delta v & = & 0 \\
\widehat{v}_a & \geq & -e <==> \dfrac{(1-q)}{q-p} w_e \leq v_0 + e \\
 & & \text{Outcome I} \\
 & & \text{Perfect compensation for any } \theta \\
\text{when } \theta & \geq & \dfrac{e}{a}, \gamma = 1 : \text{perfect compensation with } \gamma = 1 \\
\text{when } \theta & < & \dfrac{e}{a}, \text{perfect compensation with } \theta^* = 0
\end{array}$$

The proposition says that if the employee's effort costs of conforming are rather small (relative to his financial soundness), there are several liability rules to realize the social optimum with perfect compensation. One example is that $\theta \geq \frac{e}{a}$ and $\gamma = 1$: The court holds the employee largely liable and both parties jointly and severally liable. Another example is when $\widehat{v}_a \geq \underline{v}_a = -\theta a$ for some $\theta \leq \frac{e}{a}$. In this case, any such θ is sufficient. If, say, the reservation wage is large enough ($v_0 > \frac{1-q}{q-p} w_e$), the court holds the employer strictly and vicariously liable ($\theta = 0$).

2.1.2 Case 2. $\Delta v > 0$ for any v_a and $\theta : w_e > \frac{q-p}{1-q}(v_0 + e)$

This case is depicted in Fig. 2. In fact, this is the case when $\widehat{v}_a < -e$ or $\frac{1-q}{q-p} w_e > v_0 + e$.

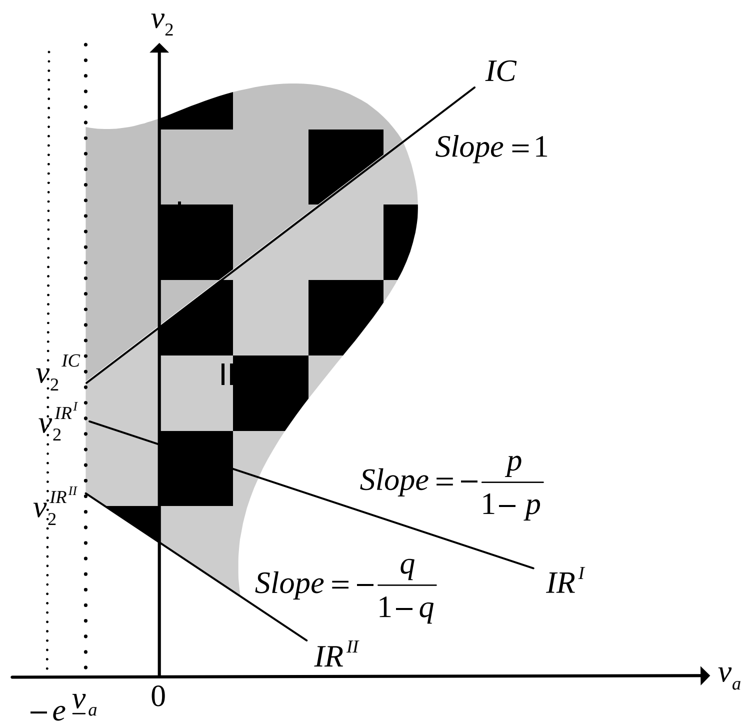

Fig. 2

In this case, the employee's effort cost is relatively large so that he is less inclined to conform. This implies that the employer needs to pay more to induce the employee to conform. Since the slope of iso-payoff lines of the employer is negative[9] and the lower an iso-payoff line, the higher the payoff, the optimal wage in area I is $(\underline{v}_a, v_2^{IC})$ while that in area II is $(\underline{v}_a, v_2^{IR^{II}})$. Therefore,

$$\Delta v = \frac{(1-q)w_e}{q-p} - v_0 + \underline{v}_a.$$

Substituting v_2^{IC} and $v_2^{IR^{II}}$ gives

$$\begin{aligned} \Pi_r^I &= (1-p)(u_2 - v_2^{IC}) + p(u_1 - \underline{v}_a - a + (1-\gamma)s) - w_r \\ \Pi_r^{II} &= (1-q)u_2 + q(u_1 - a + (1-\gamma)s) - v_0 - w_r. \end{aligned}$$

[9] In area I, as long as $\underline{v}_a > -e$ so that $s = 0$,the slope of them is $-\frac{p}{1-p} = \frac{dv}{dv'}_{|IR^I} < 0$. If $\underline{v}_a = -e, s = \theta a - e \geq 0$, there is a discontinuity in the downward direction at $v_a = -e$ if $\theta > \frac{e}{a}$. Similarly, the slope of iso-payoff lines in area II is $-\frac{q}{1-q} = \frac{dv}{dv'}_{|IR^{II}} < 0$.

As mentioned above, the employer needs to pay more than what is needed to have the employee willingly work for him, which is $v_0 + w_e$ for outcome II and v_0 for outcome III. Therefore, outcome I is not necessarily preferred to other outcomes.

We first compare Π_r^I and Π_r^{III}. $\Pi_r^I - \Pi_r^{III} = p(1-\gamma)s - (\Delta v - \Delta s)$. Its interpretation is straightforward. By achieving outcome I instead of outcome III, the employer can expect to receive benefits of subsidy $(p(1-\gamma)s)$ and welfare gains (Δc) at the cost of additional wages (Δv). Then, the necessary and sufficient condition for the employer to prefer outcome I to outcome III is that

$$p(1-\gamma)s \geq \Delta v - \Delta c. \tag{4}$$

Next, $\Pi_r^I - \Pi_r^{II} = (q-p)(u_2 - u_1 + a - (1-\gamma)s) - w_e - \Delta v = -(q-p)(1-\gamma)s - \Delta v + \Delta c + w_r \geq 0$. When achieving outcome I instead of outcome II, the employer suffers reduced subsidy equal to $((q-p)(1-\gamma)s)$ and additional wage cost while receives welfare gains, which is in this case $(q-p)(u_2 - u_1 + a) - w_e = \Delta c + w_r$. The relevant condition for outcome I to be preferred to outcome II is then

$$(q-p)(1-\gamma)s \leq -\Delta v + \Delta c + w_r. \tag{5}$$

Note that Δv is decreasing for $\theta \leq \frac{e}{a}$ and is constant thereafter while s is constant for $\theta \leq \frac{e}{a}$ and increasing thereafter.

Proposition 4 *Suppose that* $\widehat{v}_a < -e$ *or* $\frac{(1-q)w_e}{q-p} > v_0 + e$. *If* $w_e > \frac{q-p}{(1-q)}(v_0 + e)$,*then, (i) social optimum can be achieved if and only if* $\Delta v \leq \frac{p}{q} w_r + \Delta c$ *for some* θ. *(ii) Social optimum with perfect compensation can be achieved if and only if* $\Delta v \leq \Delta c$ *for some* θ.[10] *(iii) Social optimum with imperfect compensation can be achieved if and only if* $\Delta c < \Delta v$ *for all* θ *but* $\Delta v \leq \frac{p}{q} w_r + \Delta c$ *for some* θ.[11]

Proof. (i) For both (4) and (5) to be satisfied, it must be that $\frac{-\Delta v + w_r + \Delta c}{q-p} \geq \frac{\Delta v - \Delta c}{p}$ or $\Delta v \leq \frac{p}{q} w_r + \Delta c$ for some (γ, θ). The converse is also true. (ii) For perfect compensation, that is, for $(1-\gamma)s = 0$, (4) implies $\Delta v \leq \Delta c$. Conversely, if $\Delta v \leq \Delta c$, $\frac{-\Delta v + w_r + \Delta c}{q-p} > 0$ and therefore, there exists some γ and θ such that $(1-\gamma)s = 0$ satisfying (4) and (5). (iii) Obvious.■

Even when effort cost is relatively large, if welfare gains are sufficiently large to offset additional wage cost, social optimum and perfect competition can be simultaneously achieved. If not, social optimum can be still achieved unless additional wage cost is not too large. But in this case, compensation becomes necessarily imperfect.

We consider these two cases, which are depicted in Figs. 3 and 4. In Fig. 3, the case when $\Delta v \leq \Delta c$ for some θ is drawn.

[10] We already have seen that outcome I with perfect compensation can be achieved in the previous case, in which $\Omega = -\Delta < 0$.

[11] We already have seen that outcome I with perfect compensation can be achieved in the previous case, in which $\Omega = -\Delta < 0$.

Case 2.1 $0 < \Delta v \leq \Delta c$.**(ii-1)** $\Delta v > 0$ (*or* $\widehat{v}_a < -e$) **and** $\Delta v \leq \Delta c$ **for some** θ $(\underline{\theta}_0 \leq \theta)$: **outcome I with perfect compensation for** $\underline{\theta}_0 \leq \theta$

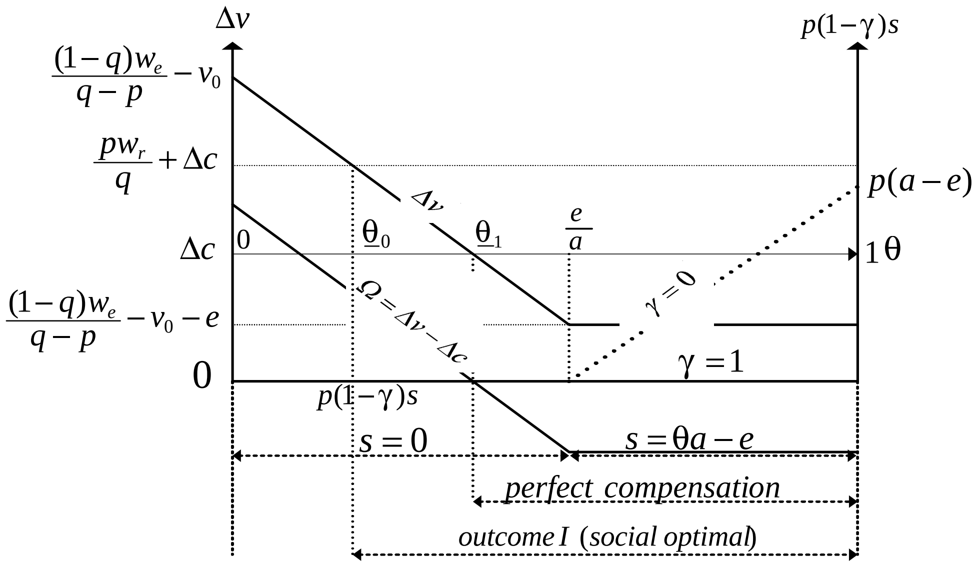

Fig. 3

Proposition 5 *Proposition . If* $w_e > \frac{q-p}{1-q}(v_0 + e)$,*social optimum can be obtained only when if the employer subsidizes the additional wage* (Δv) *to the employee within the amout of social welfare gains* (Δc).

Proof. The figure 3 depicts this case when $\Delta v \leq \Delta c$ some θ. $\Delta v \leq \Delta c$

means that perfect compensation because $(1-\gamma)s = 0$.from (4). This case also satisfies the condition of the outcome I, $\Delta v \leq \Delta c + \frac{p}{q}w_r$ automatically for some θ(*especially* $\underline{\theta}_0 \leq \theta$).(it means there is some area when $\Delta v > \Delta c + \frac{p}{q}w_r$ for some $\theta(< \underline{\theta}_0$) from (5). Shown in the figure 3, outcome I condition is necessary condition for the perfection compensation, not sufficient condition. ■

Even when the employee's effort cost is relatively large $(w_e > \frac{q-p}{1-q}(v_0+e))$, if the additional wage cost to achieve outcome I is not greater than social welfare gains $(\Delta v \leq \Delta c)$ (in this case $\underline{\theta}_0 \leq \theta$), efficiency with perfect compensation is always possible (outcome I for $\underline{\theta}_0 \leq \theta$). If the employer subsidizes the additional wage (Δv) to the employee within the amout of social welfare gains (Δc), then the social optimal outcome I can be achieved with perfect compensation for $\underline{\theta}_0 \leq \theta$. There are a number of ways to achieve outcome I with perfect compensation: $\gamma = 1$ and $\theta \geq \underline{\theta}_0$ or $\gamma = 0$ and $\underline{\theta}_0 \leq \theta \leq \frac{e}{a}$.

If $\theta \geq \frac{e}{a}, \gamma = 1$ because $s = \theta a - e > 0$ (joint and severally liability when $\theta \geq \frac{e}{a}$). If $\underline{\theta}_0 \leq \theta \leq \frac{e}{a}$, no meaning of $\gamma = 1$ or 0 because always $s = 0$ (several liability or JS liability for p.c).

$$
\begin{aligned}
& & &\text{Summary for case 2.1} \\
0 &< & &\Delta v \leq \Delta c \\
0 &< & &\Delta v <==> \widehat{v}_a < -e \\
& < & &==> w_e > \frac{(q-p)}{(1-q)}(v_0 + e) \\
& & &\text{Outcome I} \\
& & &\text{Perfect compensation for some } \theta \ (\underline{\theta}_1 \leq \theta) \\
\text{if } \frac{e}{a} &\leq & &\theta\text{, then joint and several liability for perfect compensation} \\
\text{if } \underline{\theta}_1 &\leq & &\theta \leq \frac{e}{a}\text{, several liability or JS liability for p.c}
\end{aligned}
$$

	$0 \leq \theta < \underline{\theta}_1$	$\underline{\theta}_1 \leq \theta < \frac{e}{a}$	$\frac{e}{a} \leq \theta < 1$	$\theta = 1$
$\gamma = 0$	No equilibrium	Outcome I $s = 0$: victim's loss perfect compensation several liablity	No equilibrium	No equilibrium
$\gamma = 1$	No equilibrium	Outcome I $s = 0$: victim's loss perfect compensation joint and several liablity	Outcome I $s = \theta a - e$: victim's loss, *but*, it is compensated by JSL joint and several liablity	No equilibrium

Note that θ should be set above a certain minimum level. Otherwise, the employee has little incentive to conform, in which case the employer may find it not worthwhile pursuing outcome I because it requires him to pay too much additional wage to the employee.

Case 2.2 $0 < \Delta c < \Delta v \leq \Delta c + \frac{p}{q} w_r$. **(ii-2)** $\Delta v > 0$ (*or* $\widehat{v}_a < -e$) **and** $\frac{p}{q} w_r + \Delta c > \Delta v > \Delta c$ **: outcome I with imperfect compensation and severally liable :for** $\theta > \frac{e}{a}$ when additional wage cost is greater than social gain(Δc).

As seen in the proposition 4-(iii), if $\Delta v < \Delta c$, then social optimum can be obtained with perfect compensation, however, if $\Delta c < \Delta v$(which means additional wage cost is greater than social gain(Δc)),then, even though social optimum can be obatained, but the victim cannot be compensated perfectly.

In Fig. 4, the case when $\Delta c < \Delta v$ for all θ is drawn.

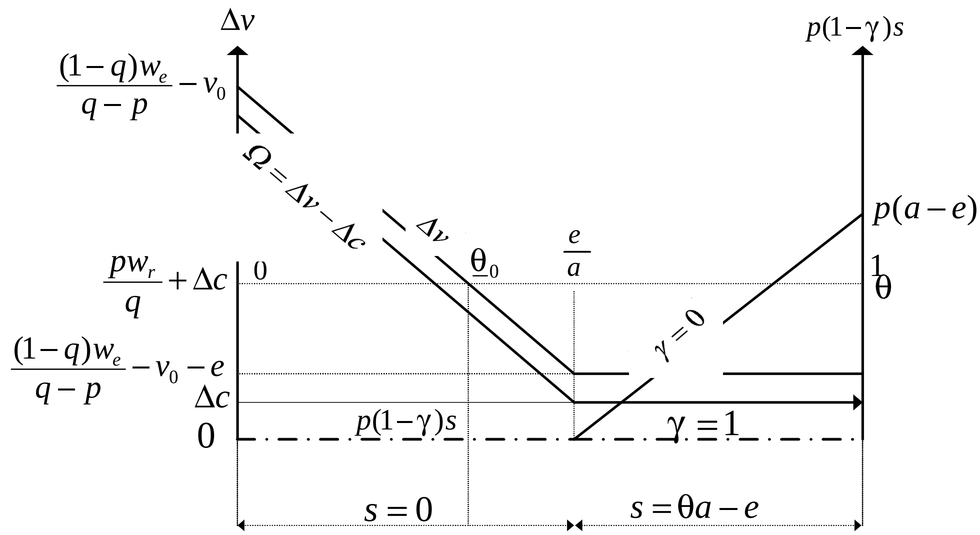

Fig. 4

Proposition 6 *When $0 < \Delta c < \Delta v \leq \Delta c + \frac{p}{q} w_r$, outcome I can be achieved (or attained) for $\theta > \frac{e}{a}$ with imperfect compensation. To minimize victim's loss, the court sets $\theta = \frac{e}{a}$, which is minimum θ.*

Proof. Outcome I can not be achieved for $\frac{e}{a} > \theta > \underline{\theta}_1$. From (4) $p(1-\gamma)s \geq \Delta v - \Delta c$ should be satisfied to achieve outcome I. However, if $\frac{e}{a} > \theta > \underline{\theta}_1$, $s = 0$, and then $0 = p(1-\gamma)s \geq \Delta v - \Delta c$,which contradicts the condition to achieve outcome I. If $\theta > \frac{e}{a}$, $s = \theta a - e$. Then, as noted above, the employer prefers outcome I if the court sets $\theta \geq \frac{e}{a}$. (4) 4) implies that $\gamma = 0$. Perfect compensation is not possible because $s = \theta a - e$ and $\gamma = 0$. To minimize the victim's loss, the court sets $\gamma = 0$ and $\theta = \frac{e}{a}$. ■

To minimize victim's loss, the court sets $\theta = \frac{e}{a}$, which is minimum θ. :vicarious liability is maximized. This type is when $\Delta c < \Delta v$ for all θ and $\Delta c < \Delta v$ means that $(1-\gamma)s \neq 0$ (imperfect compensation). This type also is when $\Delta v \leq \Delta c + \frac{p}{q} w_r$ for some θ (outcome I condition. there is some area when $\Delta v > \Delta c + \frac{p}{q} w_r$ for some θ)

$$
\begin{array}{rcl}
 & & \text{Summary for case 2.2} \\
0 & < & \Delta c < \Delta v \leq \Delta c + \dfrac{p}{q} w_r \\
0 & < & \Delta v <==> \widehat{v}_a < -e \\
 & < & ==> w_e > \dfrac{q-p}{(1-q)}(v_0 + e) \\
\gamma^* & = & 0 \\
\theta^* & = & \dfrac{e}{a} \text{ (mimimize victim's loss)} \\
 & & \text{Outcome I} \\
 & & \text{Partial Compensation} \\
 & & \text{Several Liablity}
\end{array}
$$

	$0 \leq \theta < \underline{\theta}_1$	$\underline{\theta}_1 \leq \theta < \frac{e}{a}$	$\frac{e}{a} \leq \theta < 1$	$\theta = 1$
$\gamma = 0$	*none*	*none*	Outcome I $s = \theta a - e$: victim's loss $\theta^* = \frac{e}{a}$($mimizes$ victim's loss) partial compensation several liablity	*none*
$\gamma = 1$	*none*	*none*	*none*	*none*

Case 2.3. $0 < \Delta c + \frac{p}{q} w_r < \Delta v$ This case is when the additon wage cost, $\Delta v, is$ extremely high, then, $\Delta v > \Delta c + \frac{p}{q} w_r$.

Finally, if $\Delta v > \frac{p}{q} w_r + \Delta c$,outcome I cannot be achieved for all θ.Instead, outcome III is achieved with perfect compensation.

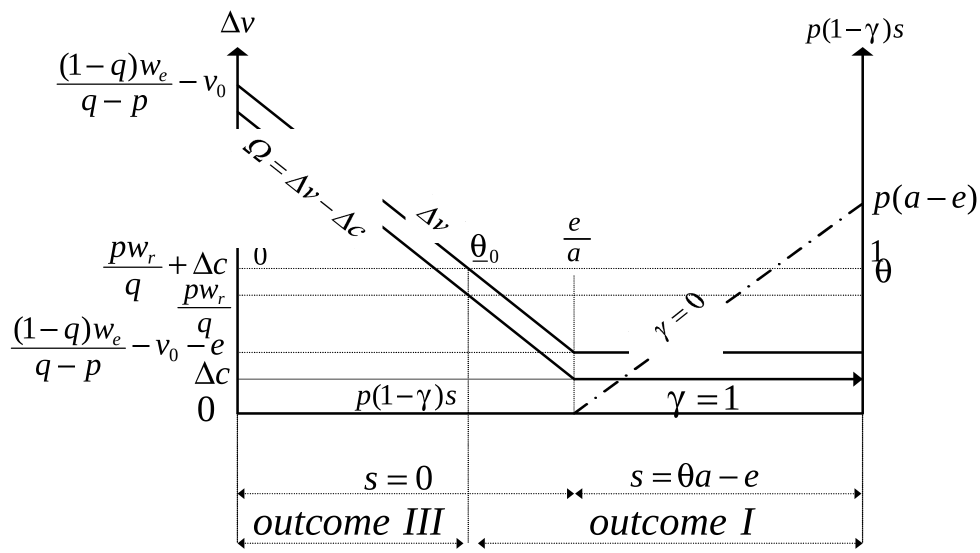

Fig. 5

Proposition 7 *Outcome III is the second-best and perfect compensation can be achieved when $\Delta v > \frac{p}{q}w_r + \Delta c$ for $\theta < \underline{\theta}_1$.*

Proof. $\Pi_r^{III} > \Pi_r^I$ because $0 = p(1-\gamma)s < \Delta v - \Delta c$.(1) $\Pi_r^{III} - \Pi_r^{II} = (\Pi_r^I - \Pi_r^{II}) - (\Pi_r^I - \Pi_r^{III}) = (eq.5) - (eq.4) = ((-\Delta v + \Delta c + w_r) - (q-p)(1-\gamma)s) - (p(1-\gamma)s - (\Delta v - \Delta c)) = (qs\gamma - qs + w_r) = -q(1-\gamma)s + w_r > 0$. If $(1-\gamma)s < \frac{w_r}{q}$, then outcome II is prefered to outcome III.(2)

From (1) and (2), if $\frac{p}{q}w_r < \Delta v - \Delta c$, $\Pi_r^{III} > \Pi_r^I$, which means (2) area of θ. The court can set $\gamma = 1$ or $\gamma = 0$. This is because in this area of $\theta < \underline{\theta}_1 (< \frac{e}{a}), s = 0$. $\gamma = 1$ has no meaning because of s=0. Thus, the court will set $\gamma = 0$, which makes severally liability and outcome III is achieved with perfect compensation. In this case, the court will set any $\theta < \underline{\theta}_1$.■ ■

$$
\begin{aligned}
0 &< \Delta c + \frac{p}{q} w_r < \Delta v \\
0 &< \Delta v <==> \widehat{v}_a < -e \\
\gamma^* &= 0 \text{ or } \gamma^* = 1 \\
&\quad \text{No meaning of } \gamma^* \\
\textit{any } \theta^* &< \underline{\theta}_1 \\
\text{Outcome III} &: \text{secon best solution} \\
&\quad \text{Perfect Compensation} \\
&\quad \text{Several Liablity}
\end{aligned}
$$

	$0 \leq \theta < \underline{\theta}_1$	$\underline{\theta}_1 \leq \theta < \frac{e}{a}$	$\frac{e}{a} \leq \theta < 1$	$\theta = 1$
$\gamma = 0$	Outcome III $s = 0$ perfect compensation *several liablity*	*none*	*none*	*none*
$\gamma = 1$	Outcome III $s = 0$ perfect compensation *JSL*	*none*	*none*	*none*

This type is when $\Delta c < \Delta v$ for all θ. And $\Delta c < \Delta v$ means that $(1-\gamma)s \neq 0$ for outcome I which cannot be attained. Thus, $\Delta c < \Delta v$ and $(1-\gamma)s = 0$ for outcome III. from condition (4). This type also when $\Delta v > \Delta c + \frac{p}{q} w_r$ for some θ which means outcome III.

(Need comparative statics.)

(For example, Fig. 3: If a increases, $\frac{e}{a}$ decreases and Δc increases so that the minimal personal liability ($\underline{\theta}_0$) can be lowered.)

(Fig. 4: If a increases, $\frac{e}{a}$ decreases so that the personal liability ($\overline{\theta}$) can be lowered. Δc increases, $\overline{\theta}$ can be lowered. If e increases, $\overline{\theta}$ can be lowered. v_0 increases, $\overline{\theta}$ can be lowered

Lemma 8 *1. (Principle liability rule). If $\theta a \geq e$, then $\underline{v}_a = -e$, $v_1 = 0, s = \theta a - e$. On the other hand, if $\theta a < e$, $\underline{v}_a > -e, v_1 > 0$ and $s = 0$.*

If θa is larger than e, the employee is insolvent, thus $v_1 = 0$ and employer receive endowment, e, from employee. Thus, employee receives the subsidy, $s = \theta a - e$,eventually. The court can set $\gamma = 1$ for perfect compensation to the victim by making $(1-\gamma)s = 0$.This case is joint and several liability.

If $\theta a < e$, several liability. The court can set $\gamma = 0$ or 1. Perfect compensation occurs irrespective of court's decision of γ.Don't need joint and several liability by making vicarious liability larger.

2.1.3 Case 1. $\Delta v = 0$ (or$\widehat{v}_a \geq -e$) (for any θ).

Proposition 9 *If $\frac{1-q}{q-p} w_e \leq v_0 + e$ ($\widehat{v}_a \geq -e$), then, the social optimum (outcome I) with perfect compensation can be achieved (for any θ).*

Proof. If $-e \leq \widehat{v}_a < \underline{v}_a$, then the court can choose $\theta \geq \frac{e}{a}$ so that $\underline{v}_a = -e$. ■

One example is that $\theta \geq \frac{e}{a}$ and $\gamma = 1$: The court holds the employer largely liable(?) and both parties jointly and severally liable.

Another example is when $\widehat{v}_a \geq \underline{v}_a = -\theta a$ for some $\theta \leq \frac{e}{a}$. In this case, any such θ is sufficient. If, say, the reservation wage is large enough ($v_0 > \frac{1-q}{q-p} w_e$), the court holds the employer strictly and vicariously liable ($\theta = 0$).

2.1.4 Case 2-1. $\Delta v > 0$ (or $\widehat{v}_a < -e$) and $\Delta v \leq \Delta c$ for some θ ($\underline{\theta}_0 \leq \theta$) : outcome I with perfect compensation for $\underline{\theta}_0 \leq \theta$

2.1.5 Case 2.2. $\Delta v > 0$ (or $\widehat{v}_a < -e$) and $\frac{p}{q} w_r + \Delta c > \Delta v > \Delta c$: outcome I with imperfect compensation and severally liable :for $\theta > \frac{e}{a}$

2.1.6 Case 2.3. $\Delta v > 0$ (or $\widehat{v}_a < -e$) and $\Delta v > \frac{p}{q} w_r + \Delta c$ for $\theta \leq \frac{e}{a}$: Outcome III with Severally liability and perfect compensation

[redacted], [redacted].

if $\Delta v > \frac{p}{q} w_r + \Delta c$,
when $\theta \leq \frac{e}{a}$
outcome III–no precaution in employer and employee (default or minimum precaution)
employer – full compensation