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On the economic efficiency of liquidated damages

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Abstract

Recently, Aghion and Bolton (*American Economic Review*, 1987, 77, 388–401) have shown that liquidated damages can serve as a barrier to entry and may therefore be socially harmful. In this paper I show that liquidated damages remain excessive and continue to serve as a barrier to entry even in the presence of relationship-specific investment, but may nevertheless have an overall positive effect on welfare.

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1. Introduction

In a recent thought-provoking paper, Aghion and Bolton (1987) show that liquidated damages can be used as a barrier to entry and may therefore be socially harmful. [1] In their model, a buyer and a seller sign a contract that requires the seller to produce one unit of a good for the buyer. Anticipating that a more efficient seller (an entrant) may show up, the parties stipulate in the contract damages for breaching the agreement (liquidated damages). These stipulated damages force the entrant to lower his bid for providing the good to the buyer, thereby shifting some of the surplus generated by the entrant to the original parties. Socially, this creates a loss since the entrant may find that in order to supply the good he has to bid below his cost, in which case he will not enter. Aghion and Bolton conclude that liquidated damages may be socially harmful.

An important aspect of contractual relationships that is not considered by Aghion and Bolton is the presence of relationship-specific investments. When such investments are non-contractible (e.g. they are non-verifiable to a court), the parties will have an incentive to behave opportunistically ex post and attempt to hold-up their partners. This hold-up in turn creates an underinvestment problem [Klein et al. (1978), Williamson (1979, 1985)]. However, as Williamson (1983) shows, properly stipulated liquidated damages can mitigate ex post opportunism, and can therefore solve the underinvestment problem. Such liquidated damages are therefore socially desirable.

The objective of this paper is to reconcile the two conflicting results. To this end, I introduce a relationship-specific investment by the seller into the Aghion and Bolton model. I show that in this setting, privately stipulated liquidated damages remain excessive, in the sense that they still serve as a barrier to entry, but may nevertheless have a positive overall effect on welfare. The

[1] A similar result is shown in Diamond and Maskin (1979).

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conclusion is that in the presence of potential entry, some restrictions by courts on privately stipulated liquidated damages may be justified on economic efficiency grounds.

2. The model

The basic features of the model are as in Aghion and Bolton (1987). There are two periods. In the first period, a buyer procures one unit of a good from a seller. The buyer's valuation of the good is 1, while the seller's cost of producing it is C. In the second period, the seller faces a threat of entry by a rival seller whose cost, C_e, is distributed uniformly over the unit interval. If entry occurs, the buyer trades with the entrant. Otherwise, the buyer trades with the incumbent seller.

The point of departure from Aghion and Bolton is that while in their model $C = 1/2$, I assume that $C = C(k) = \max\{1/2 - k, 0\}$, where k is a relationship-specific cost-reducing investment that the seller makes at the end of the first period, after an initial contract has been signed but before C_e is realized. The cost of investment is given by $g(k)$, where $g'(k) \geq 0$, $g''(k) > 0$. To ensure an interior solution for k, I assume in addition that $g'(0) = 0$ and $g'(1/2) > 1$. Investment is assumed to be non-contractible, either because it is not observable to third parties or because its cost cannot be measured objectively. For example, k may represent the effort exerted by the seller in lowering the cost of production, in which case $g(k)$ is the seller's disutility from effort.

Before proceeding, it is useful to establish the first-best outcome as a benchmark. This outcome is obtained when investment is chosen to maximize the social surplus given by

$$W(k) = \int_0^{C(k)} [1 - C_e]\,\mathrm{d}C_e + \int_{C(k)}^{1} [1 - C(k)]\,\mathrm{d}C_e - g(k)$$

$$= \frac{1}{2} + \frac{(1 - C(k))^2}{2} - g(k)\,. \tag{1}$$

Let k^{fb} be the maximizer of $W(k)$. Substituting for $C(k)$ and differentiating, the first-order condition for k^{fb} is given by

$$1 - (\tfrac{1}{2} - k^{fb}) = g'(k^{fb})\,, \tag{2}$$

where superscripts denote partial derivatives. The existence of a unique interior solution is ensured by the assumptions that $g'(0) = 0$, $g'(1/2) > 1$, and $g''(k) > 0$. To understand Eq. (2), note that the probability that the incumbent seller actually produces the good is $1 - C(k) = 1 - (1/2 - k)$, and that the marginal cost reduction due to investment is equal to 1. Thus, the left-hand side of the equation is the expected marginal benefit of investment, which at the first-best solution is equal to the expected marginal cost of investment given by $g'(k)$.

3. Analysis

First, consider the case where the parties do not sign an initial contract. Aghion and Bolton assume that in this case entry occurs if and only if $C_e \leq C(k)$, and the entrant competes in prices with the incumbent seller. The resulting equilibrium price is $C(k)$. On the other hand, they assume that whenever $C_e > C(k)$, the entrant stays out of the market, leaving the incumbent as a monopolist who in turn sets a price equal to 1 which is the maximum amount that the buyer is willing to pay for the good. However, this assumption raises the question: Why has the incumbent all the bargaining power when the potential entrant stays out? After all, the buyer can always approach the potential entrant and offer to buy from him at a cost of C_e plus a penny. Hence, I assume instead that the more efficient seller produces for the buyer, but receives a price equal to his cost plus a fraction, γ, of the difference between his cost and his (less efficient) rival's cost. Given this assumption, the incumbent seller's expected payoff absent an initial contract is

$$I^{nc}(k) = \int_{C(k)}^{1} \gamma[C_e - C(k)]\, dC_e - g(k)$$
$$= \frac{\gamma}{2}(1 - C(k))^2 - g(k)\,. \quad (3)$$

Whenever $C_e \leqslant C(k)$, the entrant is more efficient than the incumbent, in which case the incumbent does not sell the good and gets a payoff of 0. Otherwise, the incumbent is the more efficient seller, in which case he gets a fraction, γ, of the difference between his cost and the entrant's cost. Let k^{nc} be the level of investment that maximizes $I^{nc}(k)$. Substituting for $C(k)$ and differentiating, the first-order condition for k^{nc} is

$$\gamma(1 - (\tfrac{1}{2} - k^{nc})) = g'(k^{nc})\,. \quad (4)$$

Again, the assumptions that $g'(0) = 0$, $g'(1/2) > 1$, and $g''(k) > 0$ ensure the existence of a unique interior solution. A comparison of Eqs. (4) and (2) reveals that the incumbent invests optimally when $\gamma = 1$, but underinvests otherwise. The intuition for this result is that while the incumbent bears the entire cost of investment, he captures only a fraction, γ, of the benefits. Thus, absent an initial contract, the incumbent seller underinvests, so the social surplus is below its first-best level.

Next, assume as in Aghion and Bolton that the parties write a simple initial contract of the form $\{P, P_0\}$. According to this contract the buyer pays the incumbent seller P if he buys the good from him, and P_0 if he decides to buy from the entrant. Thus, P_0 represents liquidated damages. It is useful to think of the initial contract as requiring the buyer to pay the incumbent P_0 regardless of whether they trade and to add the amount $m \equiv P - P_0$ if they do trade. Given this contract, the buyer buys from the incumbent provided that the entrant cannot profitably offer the good for less than m. This happens if and only if $C_e \leqslant m$. Since C_e is distributed uniformly over the unit interval, the probability that the entrant provides the good is m. Thus, the incumbent's expected payoff under the initial contract is

$$I^{c}(k) = \int_{0}^{m} P_0\, dC_e + \int_{m}^{1} [P - C(k)]\, dC_e - g(k)$$
$$= P - (1 - m)C(k) - m^2 - g(k)\,. \quad (5)$$

Let k^c be the level of investment that maximizes this expression. Substituting for $C(k)$ and differentiating, the first-order condition for k^c is

$$1 - m = g'(k^c)\,. \quad (6)$$

Since $g'(0) = 0$, $g'(1/2) > 1$, and $g''(k) > 0$, Eq. (6) has a unique interior solution. Since the incumbent produces with probability $1 - m$, the left-hand side of Eq. (6) is the expected marginal benefit of investment from the incumbent seller's point of view. At the optimum, this expected marginal benefit is equal to the marginal cost of investment. A comparison of Eq. (6) with Eqs. (2) and (4) reveals that the incumbent chooses the first-best level of investment if and only if

$m = 1/2 - k^{fb}$. Thus, the first best is attained if the initial contract sets the difference between P and P_0 equal to the incumbent seller's cost of production under optimal investment.[2]

Now consider the initial contract, $\{P, P_0\}$, that the buyer and the incumbent seller write at the beginning of period 1. When writing this contract, the parties take into account its effects on the incumbent seller's investment and on the probability of entry. Obviously, the parties will design the initial contract so as to maximize their expected joint payoff. To find this payoff, let $B^c(k)$ be the buyer's expected payoff under the initial contract. When $C_e \geqslant m$, the buyer buys from the incumbent and pays P. Otherwise, the buyer buys from the entrant and pays him $C_e + \gamma(m - C_e)$. Thus,

$$B^c(k) = \int_0^m [1 - C_e - \gamma(m - C_e) - P_0]\, dC_e + \int_m^1 [1 - P]\, dC_e$$
$$= 1 - (1+\gamma)\frac{m^2}{2} + m^2 - P . \tag{7}$$

Evaluating $I^c(k)$ and $B^c(k)$ at $k = k^c$ and adding, the expected joint payoff of the two parties is

$$I^c(k^c) + B^c(k^c) = \int_0^m [1 - C_e - \gamma(m - C_e)]\, dC_e + \int_m^1 [1 - C(k^c)]\, dC_e - g(k)$$
$$= 1 - (1-m)C(k^c) - (1+\gamma)\frac{m^2}{2} - g(k) . \tag{8}$$

Since this expression is independent of P and P_0, the problem of designing the initial contract becomes one of choosing an optimal m. The prices P and P_0 are then chosen to divide the expected joint payoff between the two parties. Substituting for $C(k)$ into (8) and using the envelope theorem, the optimal m, denoted by m^c, is defined by the following first-order condition:

$$\tfrac{1}{2} - k^c = (1+\gamma)m^c . \tag{9}$$

Substituting for m^c from (9) into (6) reveals that, in equilibrium, k^c is implicitly defined by the equation

$$1 - \left(\frac{1/2 - k^c}{1+\gamma}\right) = g'(k^c) . \tag{10}$$

Since the left-hand side of this equation exceeds the left-hand side of (2) for all $k < 1/2$, while the right-hand sides of the two equations are the same increasing function of k, it follows that $k^c > k^{fb}$. Thus, the initial contract induces the incumbent to overinvest relative to the first best.

To examine the implications of overinvestment for entry, recall that the probability of entry is m. Moreover, recall that the first best can be achieved if $m = m^{fb} \equiv 1/2 - k^{fb}$. But, since $k^{fb} < k^c$, it follows that $m^{fb} > 1/2 - k^c > (1/2 - k^c)/(1+\gamma) \equiv m^c$, implying that under the initial contract, the probability of entry is too low. Thus,

Proposition. When the buyer and the incumbent seller write the initial contract with the objective of maximizing their expected joint payoff, the result is that the incumbent seller overinvests and there is too little entry relative to the first best.

[2] A similar result is derived by Chung (1992), although in his model the roles of the buyer and the sellers are reversed, so that $P - P_0$ equals the incumbent buyer's valuation evaluated at the first-best level of investment.

Table 1
The change in welfare due to liquidated damages as a percent of the welfare level absent an initial contract

b, γ	0	0.25	0.5	0.75	1
1.1	200.00	104.31	54.72	9.61	−37.5
1.2	100.00	66.89	38.30	9.44	−16.32
1.5	40.00	29.35	17.78	6.05	−1.78
2	20.00	13.95	8.00	2.74	0.00
2.5	13.33	8.85	4.71	1.37	−0.18
5	5.00	2.95	1.23	0.01	−0.53
10	2.22	1.23	0.42	−0.13	−0.38

The proposition shows that, as in Aghion and Bolton (1987), the initial contract serves as a barrier to entry. Now, since low m is associated with a high P_0 (otherwise the incumbent seller does not receive a fraction, γ, of the surplus), the proposition implies that, in equilibrium, liquidated damages are excessive. The conclusion is that some legal restrictions on privately stipulated liquidated damages may be justified on economic efficiency grounds.

Finally, to examine the welfare implications of the contract, let $g(k) = bk^2/2$, where $b > 1$. A straightforward calculation establishes that $k^{nc} = \gamma/(2b - 2\gamma)$, and $k^c = (1 + 2\gamma)/(2(b + \gamma b - 1))$. Substituting these expressions in (1) yields, $W(k^{nc}) = (b(5b - 8\gamma) + (4 - b)\gamma^2)/(8(b - \gamma)^2)$, and $W(k^c) = (b(5b - 8\gamma) + 4 - 9b + 10\gamma b^2 + (4 + 5b^2)\gamma^2)/(8(b + \gamma b - 1)^2)$. Table 1 shows, for different combinations of b and γ, the change in welfare due to liquidated damages, measured as a percentage of the level of welfare absent an initial contract. That is, each entry in Table 1 was computed as $100(W(k^c) - W(k^{nc}))/W(k^{nc})$. The table shows that liquidated damages are welfare-improving when the incumbent seller's bargaining power is sufficiently low (i.e. γ is sufficiently less than 1). The improvement in welfare is especially significant when the cost of investment is small. On the other hand, when the seller has a relatively large bargaining power (i.e. γ is close to 1), liquidated damages may harm welfare, especially when the cost of investment is small. Intuitively, when γ is small the underinvestment problem is severe, so the overall effect of liquidated damages on welfare is positive. On the other hand, as γ gets closer to 1, the underinvestment problem disappears, so liquidated damages become socially harmful.

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