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Limited Liability and Market Power

TERESA A. JOHN
Stern School of Business, New York University, 40 West Fourth Street, New York, NY 10012, Tel: (212)998-0025
E-mail: tjohn@stern.nyu.edu

LEMMA W. SENBET
Robert H. Smith School of Business, University of Maryland

ANANT K. SUNDARAM
Thunderbird, The American Graduate School of International Management

PETER A. WOODWARD
Antitrust Division, US Department of Justice

Abstract. This paper evaluates the welfare effects of limited liability on firm behavior when market power is present. A risk-neutral monopolist facing uncertain demand (with constant returns to scale technology) produces higher output, yielding higher expected profits when costless exit is induced by limited liability. The higher output may increase social welfare (monopolist profit plus consumer surplus) even though the monopolist may overproduce relative to the quantity that maximizes social welfare. When no market power is present, the overproduction resulting from the provision of limited liability results in loss of social welfare. Appropriate use of liability limitation laws can thus provide policy makers an additional policy instrument with which to mitigate the effects of market power.

Key words: limited liability, market power, social welfare, monopoly

JEL Classification: D24, D41, D42, G32, G38

1. Introduction

This paper examines product market choices made by a firm that is organized as a limited liability firm. Specifically, it examines how the limited liability organizational form and the resulting incentives affect price, quantity and welfare in the context of a quantity-setting demand.[1] We show that limited liability gives the monopolist a payoff structure that is convex in market demand. More precisely, the pay-off structure is that of a call option on market demand, with an exercise price equal to the total costs incurred in production.[2] If total revenue resulting from realized market demand exceeds total costs, then the monopolist is able to pay the factors of production and keep the difference as monopoly profits; on the other hand, if total revenue from realized market demand falls below total cost, the monopolist has the option to declare bankruptcy and walk away from her liability.[3]

In this context, the provision of limited liability to a monopolist results in an increase in output yielding lower prices, higher expected profits and higher social welfare, relative

to the case of unlimited liability.[4] In other words, the incentives provided by the limited liability feature, allowing exit at zero profits, leads to higher social welfare when the firm has market power. However, when no market power is present the provision of limited liability results in loss of social welfare. Under certain conditions, when the firm has market power the limited liability organizational form constitutes a socially optimal one. Judicious use of liability laws may provide a welfare-maximizing social planner an alternative policy instrument to deconcentration.

The intuition behind the results is as follows. Limitation of liability transforms the loss from low demand realizations to zero. The firm will, therefore, place zero weight on those realizations in which profits will be negative, since it no longer carries the risk of losses from low demand realizations. This creates the incentive for the firm to produce a higher output, even though expected price will be lower. The higher output not only increases profits for high demand realizations, but it may also equal the output level that maximizes social welfare, by eliminating the familiar deadweight loss from monopoly. When demand is linear and uniformly distributed, we show that welfare is necessarily increased. If no market power is present, then risk-neutral competitive firms will already be producing at the social optimum, and the provision of limited liability worsens social welfare by inducing overproduction.

The next section provides a brief motivation for the paper, and reviews literature related to the ideas developed here. Section 3 sets out the model of the monopolist with and without limited liability, in the context of demand uncertainty. Here, we also examine the price, quantity and welfare implications resulting from the provision of limited liability. Section 4 examines additional interesting features induced by the option-like characteristic of limited liability, and concludes with a discussion of some of the more surprising implications of our results and directions for further research.

2. Limited liability organizational form

The corporate form of organization—as opposed to proprietorship or partnership—pervades economic activity in most industrialized nations.[5] A distinguishing feature of the corporate form is limitation of liability—that is, the personal assets of the owners of the corporation are not used to meet the obligations of various claimants in the event that corporate assets are insufficient to meet those claims (Clarke, 1988). The modern corporation would perhaps be unthinkable without limited liability, yet this feature was not commonly granted to business until the mid-1800s.[6]

The institutional arrangements by which the monopolist firm can declare bankruptcy and walk away from her liability to suppliers, employees and debt holders are governed by the Bankruptcy Reform Act of 1978 and settled by the same reorganization process (Chapter 11 process). For a levered firm, inability to make the required payments (the coupon or principal payments that have come due) puts the firm in default. As Fama (1990) pointed out, even an all-equity financed firm has fixed claims issued to agents other than debt holders, for example, employees, managers, and suppliers. These short term fixed promised—payment contracts account for 90% of the financial flows of US corporations compared to debt and equity securities that account for only 10% of financial flows.[7]

In the context of this paper, where we do not explicitly model debt financing for the firm, evoking limited liability is represented by the firm seeking bankruptcy protection from trade creditors and suppliers. In the event where the cash flows of the firm are insufficient to make the payments owed to suppliers and other trade creditors, the firm would be in default. As in the case with conventional debt, the firm may first attempt to redress the default through negotiations with the relevant impaired claimants (suppliers, other trade creditors, or employees) without going through the formal court-adjudicated Chapter 11 reorganization process. In the event these informal debt workouts are unsuccessful, the firm goes through a formal chapter 11 reorganization process. The role and strategies of trade creditors in the reorganization process could be important (see Gilson, John and Lang, 1991) for a discussion of their role in debt renegotiations). John (1993) and Senbet and Seward (1995) survey the literature on formal/informal debt renegotiation inside and outside the bankruptcy process.

In the past few years, there has been a growing body of literature that addresses the implications of limited liability in specific settings. Examples include applications to employment contracts in a principal-agent setting (Sappington, 1983; Kahn and Scheinkman, 1985), managerial compensation in a corporate finance setting, (John, 1987; John and John, 1993); and effort and output choices in the context of debt versus equity in firms' capital structure (Brander and Lewis, 1986; Maksimovic, 1988; Brander and Spencer, 1989). In Sappington (1983), the emphasis is on incentive-compatible contract design between the principal and agent in the context of limited liability; it is shown that it might be in the interest of the principal to forego socially efficient behavior. Kahn and Scheinkman (1985) examine optimal employment contracts with risk-averse, informationally disadvantaged employees when the employer has limited liability; underemployment is likely relative to the full information case.

John (1987) analyzes the risk-shifting incentives of equity-aligned managers in the presence of risky debt and limited liability; John and John (1993) characterize the features of an optimally designed managerial compensation contract in a corporation with limited liability. Brander and Lewis (1986) and Brander and Spencer (1989) focus their attention on the interaction between output and financial structure, through the limited liability for equity holders induced by taking on debt into the capital structure; when debt holders are "captive" in the sense of leverage decisions being made prior to output decisions, then limited liability may commit a firm to more aggressive output choices when more debt is taken on.

Another interesting framework that has been used to analyze the interaction between production and financial decisions is exemplified by Dotan and Ravid (1985). In their model the firm makes endogenous decisions about production capacity and debt capacity simultaneously. Both decisions give rise to tax shelters. With uncertain prices and hence uncertain revenues, the model allows for the possibility that the firm loses its tax shields in states when there is insufficient income. Since debt-related and capacity-related tax shields are substitutes, higher productive capacity is optimally financed with less debt. See Ravid (1985) for an excellent survey of this literature on the interaction of production and financial decisions. For recent empirical work in the area, see Chevalier (1995a, b) and Phillips (1995).

Limited liability of the corporate form represents a sharing rule between the private corporation and the society at large as does the taxation of the corporate entity. John and

Senbet (1989), John, Senbet and Sundaram (1990a, 1990b, 1991) and John, Nair and Senbet (2005) argue that the provision of limited liability results in an agency problem between the corporate form and society, because of the incentive it creates for over investment in risky technologies relative to socially optimal levels of investment. Consequently, a "social planner" may attempt to equate private and social values through particular features of the tax code and other policies. Based on the potential conflicts between the corporate form and society, or a "social agency problem" John and Senbet (1989) and John, Senbet and Sundaram (1990a) rationalizes features of the tax codes including deductibility of interest, but not dividend, payments for tax purposes. John, Senbet and Sundaram (1990b, 1991), and John, Nair and Senbet (2005) study the potential for conflicts between multinational enterprises and host governments, whereas Winton (1993) examines the effect of limited liability on the ownership structure of the firm.

Our paper is closest in spirit to Polinsky and Rogerson (1983), though their focus is on the impact of product liability laws on welfare, when firms make decisions about both output and quality. They show that, in the presence of large enough market power, the use of "no product liability" laws (equivalent to our limited liability case) may result in larger output, even though it may lead to loss in consumer welfare through decreased product quality.

This paper characterizes the behavior of the monopolist and its attendant welfare implications, when society has allowed costless exit through limitation of liability. Our analysis abstracts from consideration of risk-aversion, information asymmetries or precommitment. They are not necessary for our central result that welfare is increased by the provision of limited liability to firms with market power. Further, though our focus is not on optimal contract design, we are also able to demonstrate, as a corollary, that the commonly observed form of the social contract that allows exit at zero profits may be the optimal contract.

3. Firms with and without limited liability

Consider two risk-neutral, quantity-setting monopolies, one with unlimited liability and the other with limited liability, subscripted by 1 and 2, respectively. For $i = 1, 2$, the (concave)[8] demand function is given by

$$P_i(A, Q_i) = A - f(Q_i) \geq 0 \tag{1}$$

where A, the common demand intercept, is a random variable distributed in the interval $[d, u]$, $d < u$, with density $g(A)$. It is assumed that the expected value of A, $E(A)$, exists. We assume that $f(Q_i)$ is twice continuously differentiable. The cost function, given by $c(Q_i) = cQ_i$, is assumed to represent a constant returns to scale technology that is common to both firms. $E(A)$ is assumed to be greater than c, and fixed costs are zero (or at least sufficiently small) so that each monopolist has the incentive to produce.

Ensuring non-negativity of prices in (1) will require a restriction on the support of A. Let $Q^{\max}$ denote the quantity at which price equals or exceeds marginal cost for $A = u$; that is $Q^{\max}$ satisfies $u - f(Q^{\max}) \geq c$. $Q^{\max}$ is thus the upper bound for the monopolist's quantity. We impose the restriction that price is positive for all $Q \leq Q^{\max}$. So we will require that

$d \geq f(Q^{\max})$ Combining these will require that $d \geq u - c$. We assume throughout that these restrictions are met.

3.1. *Unlimited liability*

Let us first consider the firm with unlimited liability. It chooses an output level to maximize expected profits:

$$\text{M1} \qquad \arg\max_{Q_1} \quad E[\pi_1(A, Q_1)] = \left(\int_d^u Ag(A)\, dA - f(Q_1) - c \right) Q_1$$

The unlimited liability firm makes the following (implied) sequence of decisions: It first solves (M1) for the optimal quantity Q_1^* that maximizes expected profit, where the expectation is given by the integral in (M1). It then hires the factor of production at total cost cQ_1^*, produces Q_1^*, and given that it has unlimited liability, it has an implicit commitment to pay the factor of production what it is owed (i.e., cQ_1^*). Demand is then realized, and the firm sells all its output at the price implied by Q_1^*. Demand could be sufficiently low that this price is lower than marginal cost, causing a loss for the firm.[9] The important point in this implied sequence of decisions is that, because of unlimited liability, firm 1 does not have the option to walk away from its payment commitment, since its owners are bound by law or social contract to make good the difference from their personal assets. Thus, the firm with unlimited liability can make negative realized profits with positive probability in sufficiently adverse states of nature.

Under this interpretation, firm 1 solves (M1) to obtain

$$\frac{\partial[E(\pi_1)]}{\partial Q_1} = \int_d^u Ag(A)\, dA - [f(Q_1) + c + Q_1 f'(Q_1)] = 0 \tag{2}$$

where f' is the partial derivative with respect to quantity. Concavity of $f(Q_1)$ assures that the Q_1^* satisfying (2) is a maximum.

In deriving the optimal output of the unlimited liability firm, an essential condition has been that the firm has a commitment to pay the factor of production what it is owed (i.e., cQ_1^*). Even if the demand is so low that the product price is less than the marginal cost, because of unlimited liability, Firm 1 does not have the option to walk away from its payment commitment. It has to make good on the payment from the personal assets of the owners of the unlimited liability firm. This is a prevalent legal form for organizing business in the U.S. and abroad. In the U.S., sole proprietorships and general partnerships are both organizational forms with unlimited liability for business debts and obligations; as such, no distinction is made between business assets and the personal assets of the owners. Some firms in the U.S. (e.g., in the law and real estate businesses) are organized as unlimited liability firms. See Ross, Westerfield and Jaffe (2005) for a concise description of organizational forms with unlimited liability.

3.2. *Limited liability*

Now consider firm 2, the firm with limited liability. Here too, in the first stage, the firm selects its optimal output Q_2^*, but using a different expected profit function. It is different because, in the next stage, the firm has limited liability, and therefore does not have a commitment to pay its factor of production, as the social contract permits owners to protect their personal assets. If the realized revenue is greater than the total cost, then the firm makes full payment to its input factor, but if the realized revenue is lower then the total cost, then the firm goes into bankruptcy, and it (or a bankruptcy court) can only pay the factors the realized revenue.[10] At some realized (demand) intercept A^r, if $A^r \leq c + f(Q_2)$, then firm 2 makes a profit; instead, if $A^r > c + f(Q_2)$, then it walks away from the commitments to its claimants. The firm with limited liability always makes non-negative realized profits.

Firm 2 chooses an output level to maximize expected profits:

$$\text{M2} \qquad \arg\max_{Q_2} \quad E(\pi_2(A, Q_2) \mid \pi_2(A, Q_2) > 0)$$

or equivalently,

$$\arg\max_{Q_2} \quad \left[\int_{\theta(Q_2)}^{u} Ag(A)\, dA - f(Q_2) - c \right] Q_2,$$

where

$$\theta(Q_2) = c + f(Q_2) \tag{3}$$

or equivalently,

$$\arg\max_{Q_2} \quad \left[\int_{\theta(Q_2)}^{u} Ag(A)\, dA - (f(Q_2) + c) \int_{\theta(Q_2)}^{u} g(A)\, dA \right] Q_2$$

$$\arg\max_{Q_2} \quad \left[\frac{\int_{\theta(Q_2)}^{u} Ag(A)\, dA}{\int_{\theta(Q_2)}^{u} Ag(A)\, dA} - f(Q_2) - c \right] Q_2$$

Note that the denominator of the first term in brackets reflects the conditional expectation of A, given that low realizations of A will cause exit. We first state the following useful lemma, which will then be used to prove Proposition 1.

Lemma 1.

$$H(Q_2) = \left[\frac{\int_{\theta(Q_2)}^{u} Ag(A)\, A}{\int_{\theta(Q_2)}^{u} g(A)\, dA} \right] \quad \text{is increasing in } Q_2.$$

Proof: See Appendix. □

It is clear that

$$H(Q_2) \geq \int_d^u Ag(A)\,dA, \quad \text{for all } Q_2 \tag{4}$$

that is, the conditional expectation of A in the states of nature in which expected profits are positive is greater than the unconditional expectation of A. We now state and prove the main results of the paper.

Proposition 1 *(Quantity, price and profit under limited liability).* *The limited liability monopolist produces higher quantity, yielding lower expected prices and greater expected profits, compared to the unlimited liability monopolist.*

Proof: The first order condition to (M2) is

$$\partial E(\pi_2)/\partial Q_2 = H(Q_2) - f(Q_2) - c + H'(Q_2)Q_2 - f'(Q_2)Q_2 = 0 \tag{5}$$

We have that $f'(Q_2) > 0$, and $H'(Q_2) > 0$, by Lemma 1.

We first show that $\frac{\partial \pi_1(Q_1)}{\partial Q_1} < \frac{\partial \pi_2(Q_1)}{\partial Q_1}$. The first order condition for (M1) (unlimited liability) implies that

$$\int_d^u A(g(A)\,dA - f(Q_1) - c - f'(Q_1)Q_1) = 0 \tag{6}$$

The first derivative for (M2) (limited liability), evaluated at Q_1, gives us

$$H(Q_1) - f(Q_1) - c + H'(Q_1)Q_1 - f'(Q_1)Q_1 \tag{7}$$

so that, subtracting (7) from (6), we have

$$\int_d^u Ag(A)\,dA - H(Q_1) - H'(Q_1)Q_1 < 0 \tag{8}$$

from (4), and Lemma 1.

For the quantity level ${Q_1}^*$ solving (M1), where $\partial \pi_1/{Q_1}^* = 0$, it must be true that $\partial \pi_2/\partial Q_2 > 0$, and therefore, the monopolist with limited liability cannot be at its profit maximizing point compared to the monopolist with unlimited liability, which implies that ${Q_2}^* > {Q_1}^*$.

Next we can compare (2) to (5) to see that $\pi_1(Q_1^*) < \pi_2(Q_1^*)$ This follows since

$$\begin{aligned} \pi_1(Q_1) - \pi_2(Q_1) &= \left[\int_d^u Ag(A)\,dA - f(Q_1) - c\right]Q_1 \\ &\quad - [[H(Q_1) - f(Q_1) - c]Q_1] \\ &= \int_d^u Ag(A)\,dA - H(Q_1) < 0 \end{aligned} \tag{9}$$

That is, at Q_1^*, the limited liability monopolist has larger expected profits compared to the unlimited liability monopolist. At Q_2^*, the limited liability monopolist must have at least as high a profit as $\pi_2(Q_1^*)$ for otherwise, it will have no incentive to produce a larger output. That expected price must be lower follows from larger expected output. □

Remark. It should be pointed out that the input suppliers would rationally anticipate that a limited liability firm would default on its promised payment with a positive probability, and incorporate that in the factor price "c" charged to them. The factor price c_L charged to a limited liability firm would be higher than the factor price c_U charged to an unlimited liability firm.[11] However, the limited liability firm takes the promised payment as a given and the incentives to over-produce continues to obtain as discussed in Proposition 1.

3.3. *Welfare effects of limited liability*

Let S represent social welfare to be maximized by a policy maker by her choice of quantity Q_s. Then, regardless of the liability laws, the problem of maximizing S is

$$\text{M3} \qquad \arg\max_{Q_s} \quad S = \int_0^{Q_s} \int_d^u (A - f(Q_s) - c) g(A)\, dA\, dQ_s$$

The first order condition for (M3) is

$$\partial S/\partial Q_s = \int_d^u A g(A)\, dA - f(Q_s) - c = 0 \tag{10}$$

which implies that the solution Q_s^* satisfies

$$f(Q_s) = \int_d^u A g(A)\, dA - c \tag{11}$$

Optimal quantity Q_s^* is set so that the expected benefit of the last unit is just equal to that unit's marginal cost. Since only $f(Q_s)$ depends on quantity in (11), we see that S is increasing in Q_s up to Q_s^*, that is, as long as

$$f(Q_s) < \int_d^u A g(A)\, dA - c \tag{12}$$

From the solutions to (M2) and (M3) above, we see that if $Q_2^* < Q_s^*$, then welfare is higher under limited liability than unlimited liability, since $Q_2^* > Q_1^*$ (by Proposition1).

Proposition 1 does not, however, rule out the possibility that Q_2^* exceeds Q_s^* by an amount sufficiently large that welfare is actually *lower* at Q_2^* than at Q_1^*. In the general formulation that we have adopted thus far, it is difficult to derive the precise conditions under which this will not happen. We now show that for specialization to the case of linear demand, where $f(Q) = bQ$, $b > 0$, and A is uniformly distributed, social welfare is higher at Q_2^* than Q_1^*.

Proposition 2 *(Consumer and producer surplus with limited liability).* *Assume that A is distributed uniformly in the interval* $[d,u]$ *and* $P = A - bQ$. *The provision of limited liability increases welfare* (*i.e.*, *the sum of expected monopoly profit and consumer surplus*). *The monopolist may produce an output greater than that which maximizes social welfare.*

Proof: From equation (2), it is easy to see that

$$Q_1^* = (u + d - 2c)/4b \tag{13}$$

where $g(A) = \text{unif}\,[d, u]$ and $f(Q) = bQ$.

It is straightforward to show that

$$H(Q_2^*) = \left(u + c + bQ_2^*\right)/2 \tag{14}$$

so that

$$H'\left(Q_2^*\right) = b/2 \tag{15}$$

Substitution of these into (5) yields

$$Q_2^* = (u - c)/2b \tag{16}$$

while the solution to (12) gives us

$$Q_s^* = (u + d - 2c)/2b \tag{17}$$

By comparing (16) and (17), we see immediately that the limited liability monopolist will produce more than the social optimum whenever $c > d$. If $c = d$, then the provision of limited liability induces the monopolist to produce at the social optimum.

We now show that expected social welfare is higher at Q_2^* regardless of whether Q_2^* exceeds Q_s^*. Substituting Q_1^* and Q_2^* successively into (M3) and simplifying yields

$$S\left(Q_1^*\right) = \frac{3(u + d - 2c)^2}{32b} \tag{18}$$

$$S\left(Q_2^*\right) = \frac{(u - c)(u + 2d - 3c)}{8b} \tag{19}$$

so that

$$S\left(Q_2^*\right) - S\left(Q_1^*\right) = u^2 + 2du + 4cd - 3d^2 > 0 \tag{20}$$

since u, d and c are all >0, and $u > d$. **QED**. □

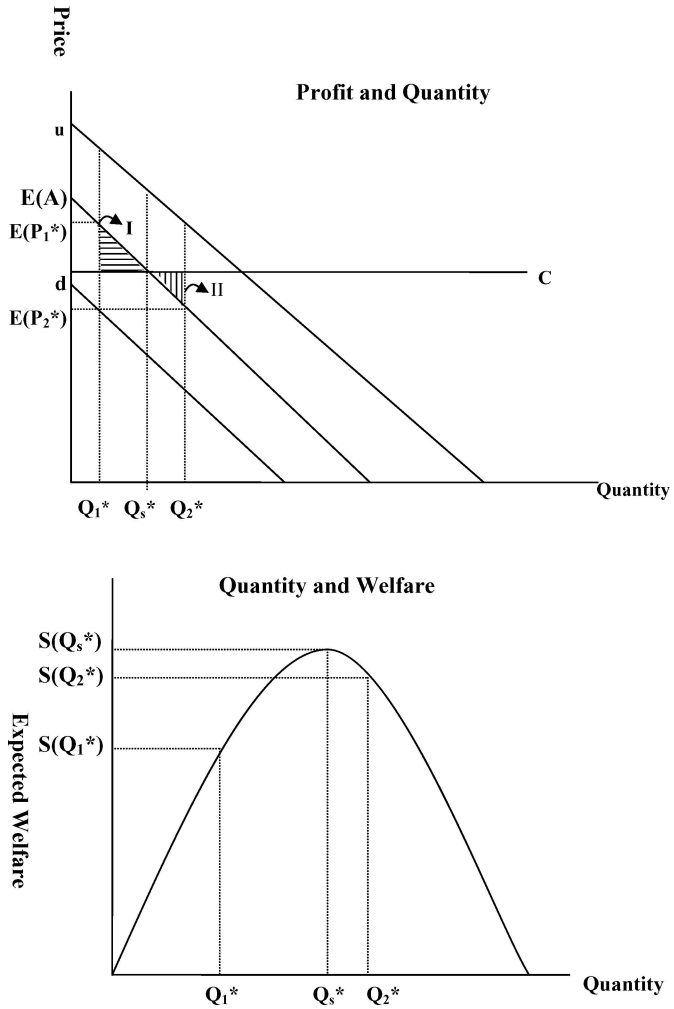

Figure 1. Profit and quantity.

Under linear uniformly distributed demand, welfare is increased by the provision of limited liability (relative to unlimited liability) even if the monopolist produces more than the social optimum. The results of Proposition 2 are graphically depicted in Figure 1. In this example, $Q_1^* < Q_s^* < Q_2^*$, so that the monopolist overproduces relative to the social optimum. The welfare improvement from limited liability results from the trade-off between the welfare triangle that would have been lost with the unlimited liability monopolist (shaded area I in Figure 1) and the expected loss of welfare resulting from overproduction by the limited liability monopolist (shaded area II in Figure 1).

It is important to note from Proposition 2 (also see Figure 1), however, that there is the potential for overproduction relative to the socially optimal level. This potential for overproduction suggests that, from the socially optimal level to set the limitation of liability may be *less than zero*—that is, the monopolist is permitted to exit only if losses exceed a certain amount. Such liability levels that would induce the monopolist to scale output back to the socially optimal level would be likely to be industry-specific, being determined by the nature of demand uncertainty and the technology.

Corollary 1 *(Limited liability and no market power)***.** *Limited liability can be welfare improving only if market power is present.*

Proof: Under perfect competition, firms will enter until expected profits are zero, which corresponds to the condition that expected price equals marginal costs, and the industry output must be at Q_s^* (the social optimum) already, see Figure 1. The provision of limited liability will lead to overproduction, i.e., $Q_2^* > Q_s^*$ resulting in the welfare loss triangle shown in shaded area II. With market power, the production without limited liability is below Q_s^*, such that with limited liability the production level goes towards Q_s^*. □

Corollary 1 will imply, *inter alia*, that when firms have no market power, liability limitation laws are perhaps best designed such that exit is induced at some level of profits less than zero. An alternative (and somewhat controversial) interpretation is that, if uniform liability limitation laws are present in a society, then the allowance of some form of market power is likely to be desirable, from the social standpoint.

For the case in which the limited liability monopolist produces an amount lower than the socially optimal level, i.e., $Q_2^* < Q_s^*$, we derive the following corollary that is consistent with commonly observed features in relation to liability limitation laws for corporations in most countries:

Corollary 2 (*Limitation of liability at zero profit when* $Q_2^* < Q_s^*$**.** *For* $Q_2^* < Q_s^*$*, in the absence of a social subsidy to monopolists, liability limitation laws that allow exit at zero profit will maximize social welfare* (*the sum of expected profits and consumer surplus).*

Proof: That liability will not be limited at *less* than zero profit is evident from Propositions 1 and 2, since expected profits to monopolists and consumer surplus can both be increased by the additional output resulting from raising the level of liability limitation. On the other hand, the monopolist will produce a larger output than is implied by liability limitation at zero profit *only* if he can be assured of a subsidy in states of nature in which his profits would have been greater than zero when evaluated at the output level implied by liability limitation at zero profit. This is so since larger output, and consequently lower expected prices, will mean lower expected profits relative to the expected profits implied by liability limitation at zero profit. If we rule out such a subsidy, then the monopolist will have no incentive to produce at a level greater than would be implied by liability limitation at zero profit. □

4. Conclusions and extensions

Corporate limited liability is a pervasive feature of modern industrial economies. The results in Section 3 provide one rationale why the limited liability corporation is a viable organizational form. This rationale does not require the consideration of risk aversion or asymmetric information (see, e.g. Easterbrook and Fischel, 1985). In the presence of market power and demand uncertainty, the provision of limited liability results in greater output, yielding lower prices, larger expected monopoly profits, and greater welfare, relative to the case of unlimited liability. When no market power is present, the provision of limited liability results in a loss of social welfare (Corollary 1). Of course adding consideration of risk aversion and asymmetric information may give rise to additional benefits to limited liability that can potentially offset this loss in social welfare. Such benefits may include risk-sharing by entrepreneurs with the society-at-large by undertaking risky technologies only in limited liability organizational forms as well as widely dispersed holding of ownership shares.

Corollary 2 may justify another institutional feature in most economies: the fact that corporate liability is limited at the level of zero profits, rather than at the level of some profits less than zero.[12] This is true, however, only if the optimal quantity for the limited liability monopolist is lower than the social optimum. Otherwise, under this rule, there is the possibility for overproduction relative to the socially optimal of output. One way to mitigate the incentive for overproduction would be to alter the liability limitation laws such that exit is allowed only at some level of profits less than zero. The results of our paper can be summarized broadly as in Figure 2.

In the analysis above, we have assumed constant returns to scale technology. However, it should be easy to see that the welfare effects of limited liability are likely to be increased by increasing returns to scale technology and decreased by decreasing returns to scale

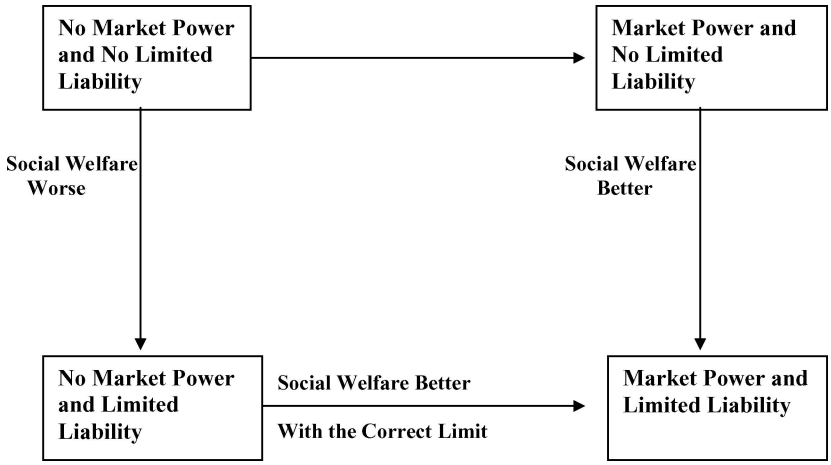

Figure 2. A schematic summary of the main results.

technology. With increasing returns to scale, there are greater benefits to be had from increased output (Proposition 1),[13] the reverse being true for decreasing returns to scale. The factor of production, rationally anticipating the risk transference resulting from limited liability, may require from the limited liability monopolist a higher payment than from the unlimited liability monopolist, i.e., $c_1 < c_2$. This will reduce the welfare gain from limited liability. Note, however, that if labor were the factor of production and if unemployment insurance were available, this issue would be moot.[14]

Since both limited liability and unlimited liability organizational forms co-exist, sometimes in the same industry, e.g. real estate, it would be incorrect to interpret the results here to suggest that the provision of limited liability leads to an unambiguous increase in social welfare, in the context of a simultaneous increase in expected monopoly profits. Moreover, it appears that firms with limited liability (corporations) are treated differently from firms without limited liability (proprietary firms and many partnerships) on matters such as taxation, raising equity and debt capital and reporting requirements. A rationalization of these public policy differences between firms with and without limited liability as arising from a "social agency" problem induced by the provision of limited liability has been addressed in detail in John and Senbet (1989), John, Senbet and Sundaram (1991) and more recently in John, Nair and Senbet (2005). Further research into the relationship between organizational form, entity level taxation, and limitation of liability seems to be a fruitful research agenda. Another interesting implication of our result is that the provision of limited liability and the evolution of market power are closely related phenomena.[15]

If we accept limited liability as an institutional feature of our economy, many issues are raised with respect to whether market power has some of the traditionally postulated implications for social welfare. For example, the policy maker may be able to use liability limitation laws as substitutes for active anti-monopoly, deconcentration or regulatory policies. Alternatively, in the context of limited liability, traditionally postulated policies to counteract the negative social welfare consequences of market power may be less desirable than is often assumed. This observation also lends an additional dimension to the views of the Chicago School (see, for example, Demsetz (1968)) that have advocated that auctions of initial franchise may overcome the negative social welfare effects of unregulated monopolies. Judicious use of liability limitation laws may obviate the need for these auctions to achieve social welfare equivalents of competitive markets.

Finally, the option-like characteristic of limited liability can be exploited further to examine some of the risk-shifting implications (for an analysis of risk-shifting behavior induced by option-like features in financial contracts, see, for example, John (1987), and John and John (1993). The option analogy should imply, *ceteris paribus*, that firms with limited liability will benefit from mean preserving spreads in demand shocks: that is, the "riskier" the demand, the greater the expected monopoly profits under limited liability. Consequently, we expect the provision of limited liability to result in the monopolist shifting to products of greater demand risk. All of these issues suggest many interesting avenues for further research.

Appendix: Proof of Lemma 1

To see this, we differentiate

$$\frac{\partial H(Q_2)}{\partial Q_2}$$
$$= \frac{\left[\int_{\theta(Q_2)}^{u} g(A)\,dA\right]\left[-\theta(Q_2)g(\theta(Q_2))f'(Q_2)\right] - \left[\int_{\theta(Q_2)}^{u} Ag(A)dA\right]\left[g(\theta(Q_2))f'(Q_s)\right]}{\left[\int_{\theta(Q_2)}^{u} g(A)\,dA\right]^2}$$
$$= \left[g(\theta(Q_2))f'(Q_2)\right]\left[\frac{\int_{\theta(Q_2)}^{u} Ag(A)dA - \theta(Q_2)\int_{\theta(Q_2)}^{u} g(A)dA}{\left[\int_{\theta(Q_2)}^{u} g(A)dA\right]^2}\right] > 0$$

since this is the product of two positive terms. The second term is positive because, by definition, $A > \theta(Q_2)$. **QED**.

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Notes

1. Demand uncertainty in models of various types of competition has been addressed by several researchers (see, for example, Klemperer and Meyer (1986, 1989)). The convex payoff structure of limited liability interacts with uncertainty producing interesting incentive effects, see, for example, John (1987), and John and John (1993). These effects of limited liability do not obtain under certainty.
2. A call option gives the holder a right, but not an obligation, to buy an asset at a pre-specified "exercise" price on or before a particular maturity date. If the value of the underlying asset exceeds the exercise price, then the owner of the option will exercise it, making a profit; if the value of the underlying asset falls below the exercise price, then the owner of the option will leave it unexercised. The relationship between limited liability and call options has been well known in the financial economics literature at least, as early as the classic articles of Black and Scholes (1973) and Merton (1973).
3. The institutional features that allow the firm to evoke limited liability under the U.S. bankruptcy code are discussed in section II.
4. In our setting, social welfare is measured by the sum of producer and consumer surplus. In the specific context of the monopoly problem analyzed, the sum of expected monopoly profit and consumer surplus measures social welfare. Thus at the socially optimal production level, the sum of expected monopoly profit and consumer surplus is maximized.
5. For example, in the US, sales of corporations (firms with the limited liability organizational form) account for over 88% of total business sales, and profits of corporations account for over 72% of total business profits. The importance of the corporate form of organization is particularly strong in the manufacturing and transportation/utilities sectors of the economy, where they account for over 96 and 92% respectively of total business sales (data are for 1997, from US Census Bureau (2000); "business" includes corporations (including S-form corporations), proprietorships and partnerships).

6. The history of limited liability in the US and in the UK has been addressed in John, Senbet and Sundaram (1991), and we will not go into it here. Though in occasional existence in various forms since the Roman empire, the concept of limited liability was formally introduced through the English Companies Act in 1862. For a good summary of the debate and a large volume of both legislative and media inquiry that preceded the provision of limited liability in the UK, see Hunt (1936), especially chapters 4 to 7; for the text of and commentary on the original Limited Liability Act in the UK, see Gibbons (1858-59); for an examination of evolution of corporations in the US, see Myers (1970); the importance of limited liability for the development of the corporate form and equity markets has been addressed by various authors—see, for example, Shannon (1933), Payne (1967), King (1977) (especially chapters 1 to 3) and Baskin (1988).
7. In addition to the importance of the amount of these claims, their short maturity also gives them a priority structure that often exceeds that of conventional long-term debt. See, Fama (1990).
8. Under strictly concave demand and additive demand shocks (see below), a monopolist always prefers quantity-setting strategies to price setting strategies; with linear demand, the monopolist is indifferent between the two (see Klemperer and Meyer (1986), page 637).
9. We could complicate the model a bit further and assume, perhaps more realistically, that the firm has a two-stage decision. After the demand is realized, in stage 2, the firm solves a new problem to maximize total revenue at the realized demand, since it has paid the factor of production already and cQ_1^* is a sunk cost. This complication, however, is unnecessary since our objective is to make a comparison *between* the behaviors of firms with and without limited liability. If we considered this case for the limited liability firm, it would be equivalent to an interpretation that a revenue-maximizing "bankruptcy court" would adopt the same decision as firm 1, in stage 2.
10. Thus, the firm with limited liability has the equivalent of a call option on market demand, with an exercise price equal to total factor cost. The claimants then get whatever is the total revenue, at a price implied by the realized demand.
11. We do not explicitly model the endogenous determination of c_L as a function of the output level. As is familiar from models of risky debt in a limited liability corporation, the rational pricing of debt by the bondholders does not eliminate the risk-shifting incentives of debt. Similarly, the incentives for over-production obtain even with the rational pricing of input factors. We believe that explicit modeling of the endogenous determination of factor prices would only encumber the model without providing additional insights.
12. In the early part of the evolution of the corporate form in the US, it was common to limit equity owner' liability to *twice* par value of shares: that is, owner of the corporation could be liable for up to two times the par value of shares outstanding, in meeting the obligations of the corporation under bankruptcy. This feature has all but disappeared in the twentieth century.
13. We would, however, require the additional assumption that marginal costs are decreasing at a slower rate than marginal revenues.
14. There may, thus, be a relationship between the evolution of limited liability and the provision of unemployment insurance.
15. In the case of the UK, an examination of the historical evolution of limited liability suggests that it began to be commonly provided—albeit not by mere registration until a couple of centuries later—for state-chartered monopolies such as the East India Company and the Africa Company, in the early-to-mid 1600s. Scott (1912) (especially pages 270–271), for example, examines the relationship between the provision of liability limitation and the need to provide inducements to the Africa Company to continue with their slave trade in the face of "... violent fluctuations in prices" (p. 272). That is, the coming of general limited liability, at least in the case of the UK, is historically consistent with the allowance by the state of large corporate monopolies.

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