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Industry equilibrium with outside financing and moral hazard: Implications for market integration

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Abstract

In this paper, we study industry equilibrium under the assumptions that (1) firms need outside financing and (2) they have a moral hazard problem in taking potentially excessive risks. We characterize an industry equilibrium with credit rationing, where firms choose not to take risks, and compare this to the industry equilibrium in the absence of credit rationing. In both cases, we show that competition increases and prices decline as markets integrate. However, in markets with credit rationing there is typically more exit, a smaller decline in prices and, most strikingly, the market value of the industry increases rather than decreases.

JEL classification: L11; L13; G39

Keywords: Industry equilibrium; Credit rationing; Risk-taking behavior; Market integration

1. Introduction

As markets integrate, due to globalization or the creation of regional common markets, conventional wisdom predicts that competition increases, output prices and profits decline, and a net transfer of wealth from shareholders to consumers occurs. In this paper, we show that introducing a simple "risk-shifting" moral hazard problem can, in fact, dramatically alter this understanding, and that market integration can lead to an increase in profits for individual incumbent firms and for the industry as a whole.

We consider a model of monopolistic competition where entrepreneurs seek to finance their production costs by borrowing from the financial markets. Those entrepreneurs who are successful in obtaining credit have access to two possible production technologies: one safe and one risky. The expected costs of production are higher

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for the risky technology than for the safe technology. The problem is that the convexity in the entrepreneurs' payoffs, due to their limited liability, may, nevertheless, give them an incentive to choose the risky one. We show that, depending on the severity of the moral hazard problem, equilibria, in which all firms use either the safe or the risky technology can exist. As in Stiglitz and Weiss (1981), there is credit rationing in the equilibrium with the safe technology. In our model, this means that only a limited number of firms obtain credit, competition is imperfect, and firms make positive profits. In the equilibrium with the risky technology, entry continues until firms' profits equal zero.

As one would expect, in both types of equilibria, the number of firms increases in the market size and competition is more intense in larger markets. More surprisingly, in the equilibrium with the safe technology, firms' profits increase in the market size, despite the increased number of entrepreneurs. The reason for this is that in larger markets, firms produce larger quantities and have greater potential gains from taking risks, in relation to their costs of production. Therefore, to prevent these firms from taking risks, the equilibrium profits must also increase in the market size. Casual empiricism suggests that in many industries industry profits (not necessarily profitability) increase with the market size, in contrast to predictions of traditional models in Industrial Organization, such as Novshek (1980).

Next, we study the industry equilibrium when m markets of equal size are integrated into a single market. Even though there are more firms in the integrated market than there were in any one separate market beforehand, some firms must exit as markets integrate. We show that in large markets, there is relatively more exit from markets with credit rationing than from markets without. In fact, in the case of credit rationing, in the limit, as the market size goes to infinity, the number of firms in integrated markets equals the number of firms that existed in any separate market before integration. We also show that in markets with credit rationing, the drop in output prices is smaller, and the total market value of the industry increases rather than decreases. These results may partially explain recent trends in corporate merger activity, competition and equity valuation. For instance, at the end of last decade, large part of mergers and acquisitions in Europe took place in just three sectors: banking, insurance and high-tech industries. It may not be a coincidence that these are all examples of industries where risk-shifting problems are potentially important.

This paper is organized as follows: Section 2 lays out the basic model. Section 3 studies the conditions for equilibria with and without credit rationing, while Section 4 studies the comparative statics of these equilibria with respect to market size. In Section 5, the effects of market integration are considered and Section 6 concludes the paper. [1]

2. The basic model

There is a single period and there are three types of agents: lenders, potential entrepreneurs and consumers. Lenders and potential entrepreneurs are risk neutral and

[1] There are, of course, many other implications to globalization besides those presented in this paper. For instance, the implications of capital market integration are not discussed.

derive utility from their end-of-period wealth. The utilities of consumers will be described shortly.

Entrepreneurs, indexed in the interval $[0, \infty)$, are endowed with a production technology but no initial wealth. Lenders, on the other hand, are each endowed with one unit of cash, but no production technology. Production precedes sales, so in order to produce, an entrepreneur must borrow his production costs from the lenders. Other entrepreneurs and lenders observe the total number of firms that are given credit, i.e., the number of firms that produce, but do not observe the total amount of borrowing by any one firm (each firm borrows from several lenders). We assume that entrepreneurs have limited liability, so their payoffs cannot be negative. The credit market operates competitively and lenders have access to a storage technology that offers zero returns.

Firms' production, sales and profits are unobservable to lenders. There exists, however, a costly monitoring technology that allows a lender to observe a firm's profit. As in Diamond (1989), the cost of using this monitoring technology is that it destroys the firm's revenues if used.[2] We assume that borrowers and lenders can ex ante commit to the use of this costly monitoring technology. Under these assumptions, the literature on optimal contracts (see, e.g., Townsend, 1979; Gale and Hellwig, 1985; Freixas and Rochet, 1998) implies that a standard debt contract is optimal. Given this result, we only consider standard debt contracts. In a standard debt contract, a lender lends one unit of cash to an entrepreneur i in exchange for a fixed scheduled terminal repayment of $R_i = (1 + r_i)$ units of cash, where r_i is the interest rate. It is ex ante agreed that the lender monitors the entrepreneur's profits if and only if the entrepreneur's payment falls short of the scheduled payment.

Having borrowed a sufficient amount of cash, all n entrepreneurs who have been issued credit have access to two different production technologies $T \in \{s, r\}$, where s stands for safe and r for risky. The cost of producing q units of output with technology T is initially:

$$C_T(q) = F + c_T q,$$

where $0 \leqslant c_r < c_s$. Depending on the technology chosen, there may later be an additional (repair) cost $\gamma_T c_T q$. Here $\gamma_r = \gamma \in (0, 1)$ with probability $\phi \in (0, 1)$ and $\gamma_T = 0$ otherwise. The safe technology dominates the risky technology in expectation, i.e., $(1 + \phi\gamma)c_r > c_s$.[3]

After producing $\{q_i\}_{i=1}^n$ units of output, with either technology, firms sell their output in the market to a group of G homogenous, price-taking consumers at market clearing prices $\{p_i\}_{i=1}^n$. G can be interpreted as the market size. Denoting the profit (after

[2] More generally, at the cost of simplicity, we could assume that monitoring destroys a fraction $0 < \lambda \leqslant 1$ of the firm's revenues without qualitatively changing our results.

[3] There are many ways we can imagine a firm selecting a risky cost structure rather than a safe one. For instance, a bank can reduce its cost of lending by not screening its loan applicants. At the same time, however, the loan portfolio becomes risky and the bank is likely to incur some credit losses. Similarly, if an entrepreneur chooses to use low quality inputs, unskilled labor for instance, the marginal costs are lower. This, however, may increase the risk of problems arising and other additional costs being incurred.

interest) of an entrepreneur i by π_i, the maximization problem for an entrepreneur i is

$$\max_{T\in\{s,r\},q_i} E_{\gamma_T} \max\{\pi_i; 0\}$$

$$= \max_{T\in\{s,r\},q_i} E_{\gamma_T} \max\{(p_i - c_T R_i - \gamma_T c_T)q_i - FR_i; 0\}. \tag{2.1}$$

A representative consumer has a utility function which is separable in the numerare good, so that his utility from consuming $\{x_i\}_{i=0}^{n}$ units of the n firms' output is

$$U = x_0 + u(x_i : i \in (0, n]),$$

where

$$u(x_i : i \in (0, n]) = \alpha \int_0^n x_i \, di - \frac{1}{2}\left[(1-\beta)\int_0^n x_i^2 \, di + \beta \int_0^n \int_0^n x_i x_j \, di \, dj\right].$$

Here $\alpha > c_s$ and $0 < \beta < 1$. This utility function was used, for instance, in Vives (1990) to provide microeconomic foundations for a monopolistic competition model. As in Vives (1990), we make the assumption that firms are infinitely small and treat n as a continuous variable. If $\beta < 1/2$, the demand function exhibits a taste for variety, as defined in Bénessy (1996).

A representative consumer's maximization problem is

$$\max_{x_i} U(x_i : i \in (0, n]) - \int_0^n p_i x_i \, di. \tag{2.2}$$

The first order condition implies that the market clearing price for good i is

$$p_i = \alpha - \frac{q_i + \beta(\tilde{q} - q_i)}{G}, \tag{2.3}$$

where $\tilde{q}$ is the aggregate production of all goods, $\tilde{q} = \int_0^n q_j \, dj$.[4]

The timing of events is as follows:

(1) The entrepreneurs enter the loan market sequentially. Each entrepreneur i, that arrives, attempts to borrow M_i units of cash from M_i lenders. When an entrepreneur has obtained a sufficient amount of cash, he chooses his production technology $T \in \{s, r\}$ and produces q_i units of output, subject to his budget constraint $C_T(q_i) \leqslant M_i$. Once an entrepreneur i has produced, this event, but not the quantity produced, becomes public information, and the next entrepreneur can enter the loan market. The loan market closes when an entrepreneur is denied credit by two lenders who have not yet lent to an entrepreneur.

(2) The goods are sold to consumers at market-clearing prices (relative to the numerare good) $p_i : i \in (0, n]$.[5]

[4] We assume that the representative consumer is endowed with a sufficient amount of the numerare good so that his budget constraint for the non-numerare goods does not bind.

[5] In this setup, a firm takes the representative consumer's consumption of other firms' goods as given, and acts as a monopolist on the residual demand curve. Given this, it does not matter whether a firm chooses its quantity or price first.

(3) If an entrepreneur chose the risky technology, the final level of his marginal cost is realized, i.e., with probability ϕ an additional cost $\gamma c_r q_i$ occurs.
(4) The entrepreneurs pay back or default on their loans to the lenders. Depending on an entrepreneur's repayment, his lenders may monitor the firm's profit.
(5) Lenders and entrepreneurs consume their wealth.

An equilibrium exists when the strategies of entrepreneurs maximize 2.1, those of consumers maximize 2.2, given the strategies of other players, lenders earn zero expected profits and no additional lending, where lenders earn non-negative profits, can occur.

We show below that, depending on the cost parameters and the probability of high marginal costs under the risky technology, two types of equilibria with active production can exist. First, there is an equilibrium with credit rationing in which all firms that succeed in obtaining credit use the safe technology. Second, there are equilibria in which some or all firms use the risky technology. The first (second) type of equilibrium is likely to prevail when the probability of high marginal costs is high (low). We focus our attention on the two polar equilibria in which all entrepreneurs produce with either the safe or the risky technology.

Before characterizing the equilibrium conditions, let us look at the determination of the interest rate. Let $P_i(R_i, \pi_i)$ denote the equilibrium repayment by firm i per dollar lent, as a function of firm i's profit π_i and the scheduled repayment R_i. A lender's zero profit constraint is

$$E_{\gamma_T} P_i(R_i, \pi_i(\gamma_T)) = 1. \tag{2.4}$$

In an equilibrium where firm i uses the safe technology, $\pi_i(\gamma_s)$ is non-random, and therefore it must follow that $P_i(R_i, \pi_i) = R_i = R^s = 1$. On the other hand, in an equilibrium where firm i uses the risky technology, $T = r$, the profits, when $\gamma_r = \gamma$, must be negative, i.e., $\pi_i(\gamma_r = \gamma) < 0$, as otherwise the there would be no moral hazard problem and the entrepreneur would choose the safe technology. Given this, and the use of a standard debt contract, Eq. (2.4) implies that $(1 - \phi)P_i(R_i, \pi_i(\gamma_r = 0)) = 1$, and that $R_i = R^r = 1/(1 - \phi)$. [6]

3. Equilibrium

3.1. Equilibrium with safe technology and credit rationing

Proposition 1. *Define* $\bar{G}_s \equiv 4(1-\beta)F/(\alpha - c_s)^2$. $\forall G > \bar{G}_s, \exists \hat{\phi}_s(G) < 1$ *and* $0 < \tilde{\phi}_s(G) < 1$, *such that when* $\phi > \hat{\phi}_s(G)$ *and* $\phi \geqslant \tilde{\phi}_s(G)$, *there exists an equilibrium in the overall game, where* $n^s(G) > 0$ *firms obtain credit and produce using the safe technology. In this equilibrium, firms earn profits of* $\pi^s(G) > 0$.

[6] To be able to produce q_i units of output with technology $T \in \{s, r\}$, each firm needs to borrow $M_i = F + q_i c_T$ units of cash from the lenders. As the choice of M_i is trivial, given the quantity produced, throughout the paper we focus only on the determination of the latter.

The proposition states that if G, the market size, is sufficiently large, to enable a positive number of firms to recover their fixed costs, there exists an equilibrium where firms use the safe technology, as long as ϕ, the probability that marginal costs are high with the risky technology, is high enough. This probability ϕ must be high to avoid an incentive to take risks and to prevent the entry of firms producing with the risky technology.

As in Stiglitz and Weiss (1981), there is credit rationing in this equilibrium: Firms that obtain credit earn positive profits and are strictly better off than firms that are denied credit. The positive profits, i.e., monopoly rents, are necessary to induce firms not to take risks: In equilibrium, firms choose the safe technology because they do not want to jeopardize their positive profits by choosing the inefficient risky technology.

Proof. Under the assumption that all firms use the safe technology, substituting for $p_i(\{q_i\}_{i=1}^n)$ and $R_i = 1$, the first order condition to a firm's maximization problem gives

$$q(n,G) = \frac{G(\alpha - c_s)}{2(1-\beta) + n\beta}, \tag{3.1}$$

and

$$\pi(n,G) = \frac{(1-\beta)q(n)^2}{G} - F. \tag{3.2}$$

To check whether firms have an incentive to deviate from using the safe technology, we must calculate the profits of a firm who successfully deviates to the risky technology, $\pi^d(n, G, \gamma_r = 0)$, i.e., when γ_r turns out to be zero. Assuming that $\pi^d(n, G, \gamma_r = \gamma)$ is negative (otherwise there would be no moral hazard problem, and some additional firms producing with the safe technology could enter), substituting for p_i and $R_i = 1$, and taking the first order condition gives

$$\pi^d(n, G, \gamma_r = 0) = G(1-\beta)\left[\frac{(\alpha - c_s)}{2(1-\beta) + n\beta} + \frac{(c_s - c_r)}{2(1-\beta)}\right]^2 - F. \tag{3.3}$$

The incentive compatibility constraint can now be stated as

$$\pi(n,G) \geqslant (1-\phi)\pi^d(n, G, \gamma_r = 0). \tag{3.4}$$

To prevent entry of firms using the safe technology, either the incentive compatibility constraint or the zero profit constraint must be binding. Given that $\pi^d(n, G, \gamma_r = 0) > \pi(n,G) \geqslant 0$, in equilibrium, given 3.4, $\pi(n,G) > 0$, and thus 3.4 must be binding. Substituting for $\pi(n,G)$ and $\pi^d(n, G, \gamma_r = 0)$ and requiring that (3.4) holds as an equality gives

$$n^s(G) = \frac{2(1-\beta)}{\beta} \times \left(\frac{(\alpha - c_s)}{(1-\phi)(c_s - c_r)/\phi + \sqrt{(1-\phi)(c_s - c_r)^2/\phi^2 + 4F(1-\beta)/G}} - 1\right), \tag{3.5}$$

$$q^s(G) = \frac{G(1-\phi)(c_s - c_r)}{2\phi(1-\beta)}\left[1 + \sqrt{\frac{1}{(1-\phi)} + \frac{4\phi^2 F(1-\beta)}{G(1-\phi)^2(c_s-c_r)^2}}\right], \tag{3.6}$$

and

$$\pi^s(G) = \frac{(1-\beta)q^s(G)^2}{G} - F. \tag{3.7}$$

From the expression for $n^s(G)$, note that if and only if $G > \bar{G}_s \equiv 4(1-\beta)F/(\alpha - c_s)^2$, there exists $\hat{\phi}_s(G) < 1$ such that $n^s(G) > 0$ if and only if $\phi > \hat{\phi}_s$.

Second, there should be no entry of firms producing with the risky technology. The first order condition to the maximization problem for such a new entrant, after substituting for p_i and $R_i = 1/(1-\phi)$, implies that its profits would equal

$$\pi^e(n^s, G, \gamma_r = 0) = \frac{G(\alpha - (\beta n^s q^s/G) - (c_r/(1-\phi)))^2}{4(1-\beta)} - \frac{F}{1-\phi}, \tag{3.8}$$

when $\gamma_r = 0$. Now, to prevent entry of such firms, it must be the case that $\pi^e(n^s, G, \gamma_r = 0) \leqslant 0$. Given the expressions for n^s and q^s, we can write this condition as

$$\sqrt{\frac{4F(1-\beta)}{G(1-\phi)}} + \frac{\phi c_r}{(1-\phi)} \geqslant \frac{(c_s - c_r)}{\phi} + \sqrt{\frac{(1-\phi)(c_s-c_r)^2}{\phi^2} + \frac{4F(1-\beta)}{G}}. \tag{3.9}$$

It is now easy to see that there exists $0 < \tilde{\phi}_s(G) < 1$ such that (3.9) holds when $\phi \geqslant \tilde{\phi}_s(G)$. □

3.2. Equilibrium with risky technology

Proposition 2. *Define* $\bar{G}_r \equiv 4(1-\beta)F/(\alpha - c_r)^2$. $\forall\ G > \bar{G}_r$, $\exists \hat{\phi}_r(G) > 0$, *such that when* $\phi < \hat{\phi}_r(G)$ *and* $\phi \leqslant \tilde{\phi}_s(G)$, *there exists an equilibrium in the overall game, where* $n^r(G) > 0$ *firms obtain credit and produce using the risky technology. In this equilibrium, each firm's profits equal zero if their marginal costs are low, and they default on their loans otherwise.*

Proof. In any equilibrium where firms produce with the risky technology, the firms must default on their debt when $\gamma_r = \gamma$ (otherwise they would choose the safe technology). Assuming this is the case, the first order condition to the maximization problem for entrepreneurs, substituting for $R_i = 1/(1-\phi)$, implies that all firms produce

$$q(n^r) = \frac{G(\alpha - (c_r/(1-\phi)))}{2(1-\beta) + n^r\beta} \tag{3.10}$$

units of output and earn profits

$$\pi(n^r, G, \gamma_r = 0) = \frac{(1-\beta)q^r(n^r)^2}{G} - \frac{F}{1-\phi}, \tag{3.11}$$

when $\gamma_r = 0$.

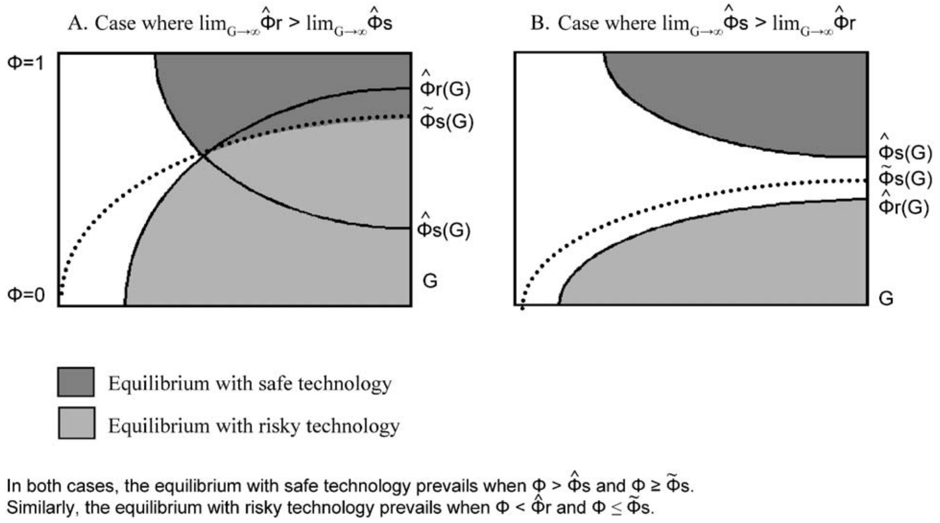

Fig. 1. Regions in $\phi - G$ space for the existence of the two equilibria.

In equilibrium, to prevent additional entry of firms producing with the risky technology, these profits $\pi(n^r, G, \gamma_r = 0)$ must equal zero. This implies that

$$n^r = \frac{2(1-\beta)}{\beta}\left(\frac{\alpha - (c_r/(1-\phi))}{2}\sqrt{\frac{G(1-\phi)}{(1-\beta)F}} - 1\right) \tag{3.12}$$

and

$$q^r = \sqrt{\frac{GF}{(1-\beta)(1-\phi)}}.$$

Note that n^r monotonically decreases in ϕ, it is negative for high values of ϕ, and equal to zero if $G = \bar{G}_r$ and $\phi = 0$. This, and the fact that n^r monotonically increases in G, implies that for $G > \bar{G}_r, \exists \hat{\phi}_r > 0$ such that $n^r > 0$ if and only if $\phi < \hat{\phi}_r$.

Note also that when n equals n^r, the incentive compatibility condition for using the risky technology is satisfied. Unilateral deviation to safe technology, with higher marginal costs, must yield negative profits. Also, confirming our earlier assumption, if $\gamma_r = \gamma$, firms default on their debt.

The only equilibrium condition that remains to be checked is whether there can be additional entry of firms who produce, and who are expected to produce, with the safe technology. To prevent entry of such firms, given that for any firm's maximization problem, only the other producers' aggregate production matters, given (2.3), it is sufficient that $n^r q^r \geqslant n^s q^s$. This condition is equivalent to requiring that $\phi \leqslant \tilde{\phi}_s(G)$. □

Fig. 1 shows in $\phi - G$ space the regions where the equilibria with the safe and the risky technology exist. Since $\lim_{G\to\infty} \hat{\phi}_r$ may be larger or smaller than $\lim_{G\to\infty} \hat{\phi}_s$, and $\hat{\phi}_r(\hat{\phi}_s)$ increases (decreases) in G, two different situations can arise as depicted in

Fig. 1.[7] The two equilibria are mutually exclusive, when $\phi \neq \tilde{\phi}_s(G)$. Furthermore, as for each firm's maximization, only the other producers' aggregate production matters, given (2.3), also equilibria, where different firms use different technologies, cannot exist when $\phi \neq \tilde{\phi}_s(G)$.

4. Comparative statics with respect to market size

Proposition 3. *In the equilibrium with the safe technology, as G increases, the number of firms, $n^s(G)$, increases, but approaches a constant, $\lim_{G\to\infty} n^s(G) \equiv \bar{n}^s_\infty < \infty$, from below. The quantity produced, $q^s(G)$, and profit, $\pi^s(G) > 0$, also increase in G, and become linear in G in the limit. The price–cost margin, $(p - c_s R^s)$, approaches a strictly positive constant from above. In the equilibrium with the risky technology, on the other hand, firms' profits, π^r, are always negative or equal to zero, the number of firms, n^r, increases in G and approaches infinity in the limit. Each firm's market share q^r/G and the price–cost margin $(p - c_r R^r)$ approach zero from above.*

The proof follows directly from the expressions for n, q, π and the price–cost margin:

$$(p - c_T R^T) = \frac{(1-\beta)q^T}{G},$$

where $T \in \{s, r\}$, and is omitted.

Thus, in the equilibrium with the safe technology, as the market size increases, new firms enter the market, competition and each individual firm's production increase, and prices decline. This is similar to traditional models in Industrial Organization. It is surprising, however, that firms' profits, $\pi^s(G)$, increase despite lower output prices and higher competition. This result can be understood as follows: In the equilibrium with the safe technology, the potential benefits from switching to the risky technology are greater in larger markets because of larger production. Because of this, the reward for behaving prudently, or, in other words, the equilibrium profit, must also increase in the market size. It is also interesting that in the safe technology equilibrium, in contrast to the risky one, firms' market shares and price–cost margins remain strictly positive even in the limit.

The contrast is even larger when the safe technology equilibrium is compared to traditional models in Industrial Organization, without credit rationing, which have a finite number of firms, as in Novshek (1980). These models make similar predictions regarding the comparative statics of the number of firms and price–cost margins, as does our model without credit rationing. They also predict, however, that firms' profits decrease due to higher competition as the market size increases.[8]

[7] Recall that $\tilde{\phi}_s$ satisfies $q^s n^s = q^r n^r$. This implies, given that both q^s and q^r are positive, that, for all G, $\tilde{\phi}_s$ lies in a region where n^s and n^r have the same sign. In Fig. 1, this shows as $\tilde{\phi}_s$ always lying between $\hat{\phi}_s$ and $\hat{\phi}_r$, which define the positive regions for n^s and n^r.

[8] Our model without credit rationing gives similar results if we require the number of firms to be an integer.

Fig. 1 shows that there is also a third possibility when G increases: that the equilibrium changes from one with safe to one with risky technology. The reason such a switch between equilibria is possible is that firms' after-interest fixed costs are higher in a risky than in a safe technology equilibrium, due to higher financing costs. Therefore, if the after-interest marginal cost with the risky technology is lower than the limit of the safe technology equilibrium price, $\lim_{G\to\infty} p(n^s, G)$, although the safe technology equilibrium may initially dominate, due to lower fixed costs, the risky technology equilibrium eventually prevails as G increases. In such a situation, the profits, although having initially increased in market size, immediately drop to zero as the market size goes beyond the critical point. A switch from safe to risky technology equilibrium is thus characterized by a significant drop in profits, a dramatic rise in credit spread, i.e., the interest rate, and an increase in the bankruptcy rate. [9]

5. Market integration

Let us now consider what happens to the number of firms, price–cost margins and total industry profits if we merge m markets of equal size, G (a situation somewhat similar to the case of the Common Market in Europe). In contrast to the previous analysis, we now keep the total number of consumers (mG) constant and increase the market size for each individual firm by merging several previously segregated markets. As before, there are three possible situations: (1) The equilibrium was and remains an equilibrium with safe technology, (2) the equilibrium was and remains an equilibrium with risky technology and (3) there is a change of equilibrium from one with safe to one with risky technology. We focus our analysis on the first two situations, since many of our results concern integration of large economies, and because we have the following result:

Proposition 4. *The range of values of ϕ, for which the integration of m identical markets causes a regime switch from a safe to a risky technology equilibrium, is either zero or goes to zero as the market size increases.*

The proof, along with all the remaining proofs, is given in the appendix. The proof follows from the observation that $\lim_{G\to\infty} \tilde{\phi}_s$ exists.

Let us now look at the first two situations, i.e., cases where the equilibrium remains of the same type. Our previous results show that the number of firms in the integrated market is either $n^s(mG)$ or $n^r(mG)$, depending on whether or not there is credit rationing. As in both cases, $n(mG)$ is greater than $n(G)$, the competition in integrated market is more intense insofar as there are now more firms operating in the single market than there were in any individual market before integration, and prices are lower

[9] Note that there need not be a dramatic change in the number of firms, quantity produced, or the price–cost margin when we move beyond the critical point defined by $\tilde{\phi}_s(G)$, since for $\phi = \tilde{\phi}_s$, $n^s q^s = n^r q^r$.

in integrated markets. Nevertheless, in both cases, some firms must exit as markets integrate.

Proposition 5. *As m identical markets integrate, when there is no credit rationing, the proportion of firms that exit is less than* $1 - 1/\sqrt{m}$. *In contrast, in markets with credit rationing, the proportion of firms that exit approaches* $1 - 1/m$ *as* $G \to \infty$.

The proposition shows that, at least when large markets integrate, there is proportionally more exit from markets with credit rationing than from markets without. Our results also imply a smaller proportional drop in the price–cost margin in markets with credit rationing than in markets without.

Proposition 6. *As m identical markets integrate, when there is no credit rationing, the percentage drop in the price–cost margin is* $1 - 1/\sqrt{m}$. *In contrast, in markets with credit rationing, the percentage drop in the price–cost margin approaches zero as* $G \to \infty$.

So, when there is credit rationing, the market integration of large economies will have no effect on the price–cost margins, which remain strictly positive, and the number of firms in the new integrated market will be reduced to the number of firms that prevailed in any one of the single markets before integration.

In large markets, industries facing moral hazard and credit rationing will have a natural absolute ceiling to the number of firms that will operate in that market. When several markets are merged, the same natural absolute ceiling will exist, and so a large "shake-out" of firms from the industry will occur. The firms lucky enough to survive will be rewarded with even higher profits than before emanating from maintained margins on a greatly expanded consumer base. Gains in industry efficiency from the reduced duplication of fixed costs are also appropriated by the surviving firms. In this way, the total profits of the unified industry are even greater than the combined sum of profits made in the smaller unintegrated markets.

Proposition 7. *In the presence of credit rationing, when m identical markets integrate, total industry profits increase. That is,* $n^s(mG)\pi^s(mG) - mn^s(G)\pi^s(G) > 0$.

This result is much stronger than our previous result, that, under credit rationing, both individual firms' profits and total industry profits are greater in larger markets. The above result suggests that, in the case of credit rationing, industry profits in integrated markets are more than m times the profits in the smaller, unintegrated markets.

Compare this result to the case of competitive markets with no credit rationing where individual firms' profits, as well as the industry profits, are always negative or equal to zero. This result also contradicts the conventional wisdom of Industrial Organization based on models with a finite number of firms, which would predict that the individual firms' profits and the total industry profits decline, due to increased competition, when m markets of equal size are integrated into a common market. So our result, that industry profits increase in industries with credit rationing when markets integrate, is fundamentally different from the traditional understanding in the field of Industrial Organization. [10,11]

Our last result, also proven in the appendix, is that the market integration increases the total output, but the increase in output goes to zero as the market size of the merging markets, G, increases.

6. Conclusion

We studied industry structure in a setting where firms rely on outside financing and have a moral hazard to select a risky over a safe technology that stochastically dominates the former. Our results show that, depending on the severity of the moral hazard problem, equilibria exist where all firms use either the safe or the risky technology. In the equilibrium with the risky technology, entry continues until firms' profits equal zero. In the equilibrium with the safe technology, on the other hand, there is credit rationing and firms make positive profits. In this equilibrium, firms' profits increase with the market size. This occurs because in larger markets, firms produce more and have greater potential gains from taking risks related to their cost of production. To prevent firms from taking risks, the equilibrium profits must increase with the market size.

We studied the effects of market integration on industry structure. Our results suggest that a Common Market in industries with credit rationing will result in a large shakeout, only slightly declining prices and an increase in the total value of the industry due to cost savings. Examples of industries with a potentially severe moral hazard problem in risk-taking are for instance, banking, insurance and high-tech industries, where it is difficult for investors to be informed of the risks in R&D. It may not be a coincidence that these industries are currently undergoing major consolidation in Europe through mergers and acquisitions. In industries without credit rationing, on the other hand, market integration does not affect profits, and, at least in the case of large markets, it results in a smaller shakeout and larger decline in prices, as compared to industries with credit rationing. [12]

The "simple" argument that "a Common Market increases competition and leads to an improved consumer surplus" may not be quite so simple after all. As our model shows, the mere presence of a moral hazard problem may dramatically reduce the

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[10] The conventional wisdom, based on Novshek (1980), can be understood by considering our model in the absence of credit rationing, but requiring that the number of firms be an integer. In such a model, when $\beta \leqslant 1/2$, so that there is taste for variety, as defined in Bénessy (1996), the total industry profits are positive, due to an integer problem, but are bounded above by $2F$ (the proof is available upon request). The Novshek (1980) argument is reflected in the observation that if we merge m such markets, each with industry profits of, say, F, the total industry profit decreases from mF to something less than or equal to $2F$.

[11] An important exception to the conventional wisdom are the "natural oligopoly" models, e.g., Shaked and Sutton (1983). Similar to ours, these models predict that there can be an absolute ceiling to the number of firms in a market. Such "natural oligopolies" can arise, e.g., if the marginal cost function is decreasing or if firms compete for market share with endogenously determined fixed costs. See, e.g., Sutton (1991) and Vives (1999).

[12] These results also suggest that the so-called "new economy," i.e., the economic conditions of the past decade, most prevalent in the US, where prices were declining in goods markets, aggregate output increasing and share prices rising, could have partially reflected increased market integration.

strength of this argument. Policy makers might do well to consider what mechanisms (market or regulatory) could be encouraged in order to mitigate moral hazard problems and to reap the maximum benefits from a Common Market.

One must, however, also recognize the limits of the above analysis, which focuses solely on product market integration. Capital market integration may have entirely different consequences and policy implications, which should be studied in future research. Extending the current analysis to include multinational and multiproduct firms would also be interesting. Another extension could be to examine the effects of market integration on industry equilibrium in the presence of different moral hazard problems such as the quality choice.

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Appendix A

Proof of Proposition 4. From Eq. (3.9), which defines $\tilde{\phi}_s$, we have that $\lim_{G\to\infty} \tilde{\phi}_s$ satisfies

$$\frac{\phi^2}{(1-\phi)(1+\sqrt{(1-\phi)})} = \frac{(c_s - c_r)}{c_r},$$

implying that $\lim_{G\to\infty} \tilde{\phi}_s \in (0,1)$. If $\lim_{G\to\infty} \hat{\phi}_r = (\alpha - c_r)/\alpha > \lim_{G\to\infty} \hat{\phi}_s = (2\alpha(c_s - c_r) - c_s^2 - c_r^2)/(\alpha - c_r)^2$, the range of values of ϕ, for which there is a change in the type of equilibrium are such that $\tilde{\phi}_s(mG) > \phi > \tilde{\phi}_s(G) \geqslant \hat{\phi}_s(G)$. As $\tilde{\phi}_s$ converges, this range goes to zero as $G \to \infty$. If $\lim_{G\to\infty} \hat{\phi}_s > \lim_{G\to\infty} \hat{\phi}_r$, there cannot be a change in the type of equilibrium. This result follows since, given that $\partial\hat{\phi}_s(G)/\partial G < 0$ and $\partial\hat{\phi}_r(G)/\partial G > 0, \hat{\phi}_s > \hat{\phi}_r$ for all $G > \bar{G}_s$, implying that for the same value of ϕ, only one type of equilibrium can exist.

Proof of Proposition 5. In the absence of credit rationing, the exit ratio, due to the integration of m markets, is

$$Exit\% \equiv 1 - \frac{n^r(mG)}{mn^r(G)}$$

$$= 1 - \frac{((\alpha - (c_r/(1-\phi))/2)\sqrt{(G(1-\phi)/(1-\beta)F)} - 1/\sqrt{m})}{\sqrt{m}((\alpha - (c_r/(1-\phi))/2)\sqrt{(G(1-\phi)/(1-\beta)F)} - 1)}$$

$$< 1 - \frac{1}{\sqrt{m}},$$

as $m > 1$. The exit ratio approaches $1 - 1/\sqrt{m}$ as $G \to \infty$. By contrast, in the presence of credit rationing, given that $n^s(G) \to \bar{n}^s_\infty$, as $G \to \infty$,

$$Exit\% \equiv 1 - \frac{n^s(mG)}{mn^s(G)} \to 1 - \frac{1}{m} \text{ as } G \to \infty.$$

Proof of Proposition 6. In markets without credit rationing, the percentage drop in the price–cost margin is

$$\Delta(p^r - c_r R^r)\% = 1 - \frac{p^r(mG) - (c_r/(1-\phi))}{p^r(G) - (c_r/(1-\phi))} = 1 - \frac{q^r(mG)/mG}{q^r(G)/G} = 1 - \frac{1}{\sqrt{m}}.$$

By contrast, in the presence of credit rationing, using the result that $\pi^s = (1-\beta)q^{s2}/G$ increases in G, we have

$$\Delta(p^s - c_s R^s)\% = 1 - \frac{q^s(mG)/mG}{q^s(G)/G} < 1 - \frac{1}{\sqrt{m}},$$

and, given that q^s/G converges to a constant as $G \to \infty$, the drop in the price–cost margin goes to zero as $G \to \infty$.

Proof of Proposition 7. First note that

$$\Delta\Pi = n^s(mG)\pi^s(mG) - mn^s(G)\pi^s(G) = mG\left[\frac{n^s(mG)\pi^s(mG)}{mG} - \frac{n^s(G)\pi^s(G)}{G}\right].$$

To show that this is positive, it is sufficient to show that $(n^s(G)\pi^s(G)/G)$ increases in G. First, write (3.4), using (3.1) in (3.3) and rearranging, as

$$\frac{q^s(G)^2}{G^2}\left(1 - (1-\phi)\left(1 + \frac{G(c_s - c_r)}{2q^s(G)(1-\beta)}\right)^2\right) = \frac{\phi F}{G(1-\beta)}. \tag{A.1}$$

Now, using first Eqs. (3.1) and (3.2), and later (A.1), we have

$$\frac{\phi}{(1-\beta)}\frac{n^s(G)\pi^s(G)}{G}$$

$$= \left[\frac{G(\alpha - c_s)}{q^s(G)\beta} - \frac{2(1-\beta)}{\beta}\right]\left[\phi\frac{q^s(G)^2}{G^2} - \frac{\phi F}{G(1-\beta)}\right]$$

$$= \left[\frac{G(\alpha - c_s)}{q^s(G)\beta} - \frac{2(1-\beta)}{\beta}\right]\left[\frac{(1-\phi)(c_s - c_r)}{G(1-\beta)}q^s(G) + \frac{(1-\phi)(c_s - c_r)^2}{4(1-\beta)^2}\right]$$

$$= \frac{(1-\phi)(c_s - c_r)}{\beta}\left[\frac{(\alpha - c_s)}{(1-\beta)} - \frac{2q^s(G)}{G} + \frac{G(c_s - c_r)(\alpha - c_s)}{4(1-\beta)^2 q^s(G)} - \frac{(c_s - c_r)}{2(1-\beta)}\right],$$

which increases in G given that per capita production $q^s(G)/G$ decreases in G.

Proof that total output increases as markets integrate. The change in total industry output is

$$\Delta Q\% = \frac{n(mG)q(mG)}{mn(G)q(G)} - 1,$$

which, using (3.1) and (3.10), can be written as

$$\Delta Q\% = \frac{[q^s(G)/G - q^s(mG)/mG]}{[((a - c_s)/2(1-\beta)) - q^s(G)/G]}$$

and

$$\Delta Q\% = \frac{[q^r(G)/G - q^r(mG)/mG]}{[\frac{a-(c_r/(1-\phi))}{2(1-\beta)} - q^r(G)/G]},$$

respectively. In both cases, the change in total output is positive, but goes to zero as $G \to \infty$.

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