Mergers with Product Market Risk

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This paper studies the causes and the consequences of horizontal mergers among risk-averse firms. The amount of diversification depends on the allocation of shares among the merging firms, with a direct risk-sharing effect and an indirect strategic effect. If firms compete in quantities, consolidation makes firms more aggressive. Mergers involving few firms are then profitable with a relatively low level of risk aversion. With strong enough risk aversion, mergers reduce prices and improve social welfare. If firms instead compete in prices, consumers do not benefit from mergers in markets with demand uncertainty, but can easily benefit with cost uncertainty.

1. Introduction

Mergers allow firms to diversify and share their risks, or at least, this is the claim often made by the merging firms. As there are typically limited cost synergies or demand interdependencies among firms operating in different sectors, diversification is often cited as a prominent motive for conglomerate mergers. This desire to diversify at the firm level is compatible with the reluctance in many companies to take risks, as

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witnessed by the large amount of corporate hedging activity and the executive obsession with risk management.

Risk sharing is also cited as a reason for merging by firms competing in the same market, as in the landmark Airtours/First Choice merger case.[1] As recognized by the EU Competition Commission (1999), package tour operators face considerable demand-side risk when signing contracts with airlines and hoteliers.[2] Demand at a particular location may fall short of expectations due to unforeseen events, such as unrest in the area or change in consumers' interest. Operators are then unable to sell all their capacity or are forced to sell it at heavily discounted prices.[3] As a consequence, the industry has experienced severe losses and bankruptcies in the UK in some of the years (e.g., in 1995) preceding the proposed merger. In fact, the EU Competition Commission report recognized that "the large operators take a cautious approach to capacity planning" in response to the risk faced.[4]

Inspired by this merger case, this paper investigates the causes and the consequences of horizontal mergers among firms operating in uncertain markets. Departing from a conventional assumption in oligopoly theory, we allow firms to be risk averse, for example because they are owned by a single risk-averse owner. We rule out the possibility of (full) insurance or the use of alternative financial instruments to diversify risk. As discussed in Section 1.1, risk-averse behavior can originate more generally from the presence of nondiversified owners, liquidity constraints, delegation of control to risk-averse managers, or stochastic production. In these circumstances, the amount of hedging is often limited by transaction costs and the presence of moral hazard.

We focus on the effects of risk-averse behavior on horizontal mergers, because these transactions are greatly affected by risk considerations

1. This merger had been halted by a decision of the EU Competition Commission (1999) that was subsequently appealed and overturned by the European Court of First Instance in 2002.

2. "But suppliers of package holidays are severely hampered in precisely aligning capacity and demand. They need to 'produce' (i.e., contract for the necessary flights, accommodation etc.) virtually the whole of what they expect to sell a long time before it is 'consumed' (i.e., when the consumer departs for the holiday destination, or at the earliest, when the consumer pays the bulk of the price—usually around 8 weeks before departure)" (EU Competition Commission, 1999).

3. "The tour operator, accordingly, bears almost all of the risk of any contracted capacity remaining unsold. . . . Matching capacity and demand is therefore critical to profitability, especially since package holidays are perishable goods—a given package loses all its value unless it is sold before its departure date" (EU Competition Commission, 1999).

4. Similar issues arise in markets for perishable goods, such as newspapers. "Each night publishers despatch over 12 million copies for distribution within a few hours through wholesalers to retailers in England and Wales. By mid-morning most copies have either been home delivered or sold over the counter and by the end of the day those left are no longer in demand" (UK Competition Commission, 1993).

and raise important concerns for competition authorities. We formulate a simple and tractable model, in which firms have mean variance preferences, compete either in prices or quantities, and sell differentiated products to a market characterized by a linear demand system with uncertainty about cost or demand. Before the competition stage, we allow a number of firms to merge as in the model of Salant et al. (1983). Our model is designed to address the following questions:

- How should the payment for the merger be arranged, in cash or shares?
- Under which conditions are mergers more likely to take place?
- Could competition be more effective after a merger and could this benefit consumers?
- In which situations can risk sharing be a valid "efficiency defense?"

Our analysis is based on results recently obtained by Asplund (2002) on the effect of risk aversion on the outcome of competition. Extending the monopoly models of Baron (1971) and Leland (1972), Asplund has shown that more risk-averse firms set lower quantities or higher prices, except when they set prices facing uncertain demand. Intuitively, risk aversion increases the firms' concern about low-profit states (that result when demand is low or costs are high), and so induces a desire to perform well in these scenarios at the cost of sacrificing profits in good times. Quantity-competing firms reply with lower quantities for both lower demands or higher costs. Tour operators, therefore, should be expected to set lower capacities the more risk averse they are. If firms instead compete in prices, the best response is higher prices to higher costs and lower prices to lower demand.

In the presence of risk aversion, we find a novel distinction between types of mergers depending on how the claims to uncertain profits are split. In a *takeover*, the acquiring firm alone bears all the uncertainty of the new entity. In a *merger of equals*, this risk is evenly split among the constituent firms. More generally, the higher the fraction of payments made in cash relative to shares, the more risk the acquiring owners have to face when in control.

The contractual split of profits has two effects. First, it directly affects the payoff of the acquiring firm, and in turn, the amount the firm can pay to the acquired firms and thus the viability of the transaction. Second, by determining the risk bearing attitude of the controlling stakeholder, it affects the strategic behavior in the product market and thus the level of *ex post* expected profits.[5] Merging firms determine

5. The sharing rule can be seen as a *credible* commitment affecting behavior in the product market. Note the similarity with strategic delegation of decisionmaking to managers (Fershtman and Judd, 1987).

the optimal contractual split of profits by taking into account both the diversification and the strategic effects.

To illustrate our results, consider first a merger of a group of *ex ante* symmetric firms competing in quantities, as in the package tours operators example. In this case, the best consolidation agreement is a merger of equals. By holding equal shares in the merged firm, the constituent firms achieve the best possible risk diversification and commit to the most aggressive behavior in the product market.[6] Responding to a tougher competitor, the rivals will reduce production, leaving a higher market share and thus more profits for the merged firm. Whereas in the absence of risk aversion total production by the merging firms decreases as a result of the merger, with risk aversion production tends to decrease by less or can even increase. The number of profitable mergers increases with the level of risk aversion. If the firms are sufficiently risk averse, competition becomes so much tougher as a result of the merger that consumers and society are made better off.

Price-competing firms would not always agree to merge as equals. With cost uncertainty, firms face a trade-off between diversification and strategic commitment. Merging as equal maximizes risk diversification, but the increased risk bearing potential toughens competition. Because price-competing firms profit from committing to be soft, they have an incentive to increase their level of risk aversion. We show that the merging firms choose an asymmetric sharing rule (intermediate between takeover and merger of equals) and that mergers are always profitable. If the level of risk aversion is high enough, the merging firms as well as the outsiders end up setting lower prices, so that consumer and social welfare increase as a result of the merger. With demand uncertainty, diversification results instead in softer behavior, so that mergers are clearly profitable but unambiguously reduce consumer surplus.

The paper proceeds as follows. Section 1.1 discusses our assumption that firms are risk averse. Section 2 introduces the model. Section 3 derives the effect of the contractual arrangements among the merging firms on risk sharing and downstream competition. Section 4 analyzes the case of Cournot competition and demand uncertainty, whereas Section 5 considers Bertrand competition with cost uncertainty. Section 6 concludes. Appendix A extends the results to the cases of Cournot competition with cost uncertainty and Bertrand competition with demand uncertainty. Appendix B collects the proofs of the results presented in the body of the paper.

6. Quantity competing firms want to commit to tough behavior in the product market whereas price competing firms prefer to commit to soft behavior (Fudenberg and Tirole, 1984).

1.1 Risk Aversion

It is a hotly debated issue whether diversification through mergers can be beneficial to shareholders. With perfect capital and insurance markets, these shareholders should hold perfectly diversified portfolios (Levy and Sarnat, 1970). Firms should then be concerned only about aggregate risk, whereas diversification of idiosyncratic risk is best left to shareholders. However, in reality most firms are controlled by single (or family) owners or large shareholders.[7] Our model directly applies to firms fully controlled by undiversified risk-averse entrepreneurs, once the firm's objective function is identified with the owner's utility.

In this section, we discuss a number of reasons why firms might be risk averse or act as if they are risk averse. These observations point to the relevance of risk in decisionmaking by firms, as also stressed in the management literature (see, e.g., Wright et al., 1996).

1.1.1 Concentrated Ownership

It is empirically well documented that portfolios held by households tend to be largely undiversified (see, e.g., Goyal and Santa Clara, 2003). Firms with undiversified shareholders should then care about the variability of their profits. As confirmed by La Porta et al. (1999), in most large companies, some shareholders typically hold control rights well in excess of their cash flow rights (largely through the use of pyramids) and have an active role in management.[8] The firm's payoff should then be constructed to take into account the level of risk aversion of the undiversified shareholders.[9]

1.1.2 Limited Hedging

Even if ownership is concentrated and the firm is concerned about risk, hedging markets can help insure against profit variability. Transaction costs and moral hazard problems limit the insurability of risk, especially when the firm's payoff crucially depends on the actions taken in the product market as well as on the realization of uncertainty.[10]

7. According to Burkart et al. (2003): "Most firms in the world are controlled by their founders, or by the founders' families and heirs. Such family ownership is nearly universal among privately held firms, but also dominant among publicly traded firms." Even large corporations can have concentrated ownership, especially in countries with undeveloped financial markets.

8. Large shareholders might be willing to bear the cost of monitoring and the risk of an undiversified portfolio, in exchange for private benefits of control, as also suggested by La Porta et al. (1999).

9. Note that as controlling shareholders actively participate in management, they might be willing to take less risk than would be optimal for the totality of shareholders. Our welfare analysis could be extended to account for this divergence between the controlling shareholder's and the firm's objective function.

10. To illustrate this, consider a quantity setting firm operating in a market with demand uncertainty. Suppose that insurance contracts can be made contingent on the

1.1.3 Managerial Control

In modern widely held corporations, ownership is often dispersed and decisionmaking is delegated to professional managers.[11] Managers are often given incentives contingent on realized profits, and so must bear some of the firm's risk.[12] Managerial moral hazard problems create the well-known trade-off between risk sharing and incentives, as in the case of hedging discussed above. When risk averse managers are in control and are remunerated on the basis of the firm's profitability, they will sacrifice expected profits in order to reduce variability. As a result of managerial incentive problems, the firm will behave as if it is risk averse.[13]

1.1.4 Limited Debt Capacity and Liquidity Constraints

Liquidity constraints and costs of financial distress can make the firms' payoff functions concave in profits and so generate risk-averse-like behavior.[14] When the cost of financing via external sources is higher than via internally generated funds, the firm's value of additional profits decreases with the level of profits. This concavity can be generated in models with informational asymmetries between managers and outside investors, along the lines of Bolton and Scharfstein (1990).[15]

1.1.5 Stochastic Production

Competition between risk-neutral firms with stochastic production is also equivalent to competition between risk-averse firms. To illustrate this, suppose that in a market for a homogeneous good only a random fraction of each firm's production reaches the market, so that a firm i sells $s_i x_i^s$ when producing x_i^s. Profits are then given by $\pi_i^s = (a - s_i x_i^s - \sum_{j \neq i} s_j x_j^s) s_i x_i^s$. Assume that s_i are independently identically distributed across firms, with support [0, 1], expectation $\bar{s}$, and variance

firm's verifiable revenues, but not on the output set by the firm, its cost or the realization of demand. In this moral hazard environment, the firm will have to bear some risk, as otherwise it would have no incentive to produce a positive output.

11. See Amihud and Lev (1981) for an empirical investigation of the managerial risk reduction motive of conglomerate mergers.

12. The sensitivity of managerial compensation to firm performance has indeed increased drastically since 1980, as documented by Hall and Liebman (1998).

13. With this interpretation, the firm's payoff will typically differ from the manager's payoff, invalidating our welfare analysis. The effect of mergers on consumers would be clearly unchanged, but the welfare analysis would need to be extended to account for the divergence of firm and managerial objectives.

14. See Froot et al. (1993) for a comprehensive discussion of situations leading firms to hedge risk.

15. Lewellen (1971) has argued that mergers allow firms to reduce the bankruptcy risk and therefore borrow more. In his setting, firms can borrow a limited amount of funds because lenders are worried about bankruptcy arising when cash flows fall below a solvency threshold. If two firms merge, there are instances in which the excess cash flow of one can be used to avoid bankruptcy by the other firm. Unless the cask flows are perfectly correlated, the total debt capacity of the combined entity is increased.

σ_s^2. Identifying $\bar{s}x_i^s$ with x_i and $\frac{\sigma_s^2}{\bar{s}^2}$ with $\frac{R}{2}\sigma^2$, the expectation of π_i^s results in the mean variance preferences specified in the quantity competition version of our model. Due to the concavity of profits in the quantity sold, profits decrease in the variance of the stochastic loss in production.

2. Model

Following the tour operator example, we consider an oligopolistic industry with n (*ex ante* symmetric) risk-averse firms that produce differentiated goods. For simplicity, we assume that they have identical mean variance preferences over their (random) profits, $U(\cdot) = E(\cdot) - \frac{R}{2}\text{Var}(\cdot)$, where R is the coefficient of risk aversion.[16]

We analyze horizontal mergers using the following three-stage game. In the first stage, firms make long-term merger decisions. In the second stage, the existing firms compete in the product market, either in quantities or in prices, facing either demand or cost uncertainty. For example, in the tour operator market, capacity planning is made under significant demand uncertainty. The uncertainty is realized between the second and the third stage, when consumers either discover their tastes or firms find out their exact production costs. In the third and final stage, consumers make their purchasing decisions.[17]

In the first stage, a group of k firms (denoted by $t = 1, \ldots, k$) decide whether to merge, by joining their plants into a single firm. Following the approach of Salant et al. (1983), each firm compares the expected utility of merging with that of remaining independent, and agrees to merge if the former exceeds the latter. The merger takes place if and only if all the merging firms unanimously agree.[18] Before taking this decision, the merging firms anticipate the terms of the agreement, which specifies the allocation of fixed cash payments (F_t) and shares of the profits of the new entity (τ_t), with the constraint that shares cannot be negative and the scheme is balanced ($\tau_t \geq 0$, $\Sigma_{t=1}^k \tau_t = 1$, and $\Sigma_{t=1}^k F_t = 0$). Given that all insiders are (*ex ante*) symmetric, we assume that they cooperatively agree on a sharing rule that benefits all of them equally. This means

16. Mean-variance preferences can be obtained through a constant absolute risk aversion (CARA) utility function with normal random shocks. We disregard problems arising from negative values.

17. Our setup for the case of Cournot competition is similar to that considered by Brown and Chiang (2002). Whereas their focus is on endogenous coalition formation, we are interested in comparing private and social incentives for exogenous mergers.

18. We therefore check whether merging is a subgame perfect Nash equilibrium outcome. Note that two (or more) firms deciding to stay independent is always an equilibrium, regardless of the utility of merging. However, this equilibrium involves weakly dominated strategies if the utility of merging is lower than that of staying independent.

that the allocation of shares and the mutual cash transfers should grant them the same expected utility. [19] The payoff structure (fixed fee and percentage of joint profits), however, affects the strategic behavior in the product market—the next stage of the game.

In the second stage, the existing firms compete in either quantities or prices and face either demand or cost uncertainty.[20] In the case of *demand uncertainty*, firms (or plants) produce with constant marginal costs, normalized to 0 for simplicity, and face demands characterized by idiosyncratic consumer tastes for the n goods, $(\theta_1, \ldots, \theta_n)$. At this point, firms consider these tastes to be identically distributed with mean 0, variance σ^2 and $\mathrm{Cov}(\theta_i, \theta_j) = \rho\sigma^2$ for $i \neq j$. In the case of *cost uncertainty* instead, we normalize $\theta_i \equiv 0$ so that the known demand for each product is the same and firms have random and constant marginal costs υ_i. For notational simplicity, we assume that the marginal costs have the same distribution as the one specified above for the demand parameters.

The shocks are positively, independently or negatively correlated depending on whether $\rho \gtreqless 0$. Because $\mathrm{Var}(\Sigma_{i=1}^n \theta_i) = \sigma^2 n(1 + \rho(n-1)) \geq 0$ we have that $\rho \geq -\frac{1}{n-1}(\geq -\frac{1}{k-1})$. In order to clarify the main effects, we further assume that the merged firm cannot achieve full market diversification by itself $(\rho > -\frac{1}{k-1})$, either because it is not possible $(\rho > -\frac{1}{n-1} \geq -\frac{1}{k-1})$ or because the merger is not to monopoly ($\rho \geq -\frac{1}{n-1} > -\frac{1}{k-1}$).[21]

For simplicity, we assume that the product market decisions of the merged firm are delegated to the new company's largest shareholder, firm $l = \arg\max_{t \in \{1,\ldots,k\}} \tau_t$.[22] At this stage, firm l effectively runs the merged company by taking output or price decisions for all products.[23]

In the third stage, consumers know their tastes and make their choices. We assume that the representative consumer has preferences over the n goods represented by the utility function

19. Our results would not qualitatively change if instead we had assumed that one firm made a take-it-or-leave-it sharing proposal to the other $(k-1)$ firms, which sequentially accept or reject the proposal. In this case, the proposing firm would retain all the surplus from merging, but this is inessential for our results.

20. Firms are therefore assumed to commit to their choice of quantity or price before the realization of market uncertainty (in stage three), and are not allowed to change their price or quantity after the uncertainty is resolved. See Klemperer and Meyer (1986) for a similar approach to modeling competition under uncertainty in a context with risk-neutral firms.

21. In the text, we explain what happens when $\rho = -\frac{1}{n-1} = -\frac{1}{k-1}$.

22. Note that $\tau_l \in [1/k, 1]$.

23. Our results hold also if the new firm is managed by a decisionmaker that takes into account the preferences of all the shareholders, provided that the preferences of the largest shareholder are weighted positively.

$$V(x_1, \ldots, x_n) = \sum_{i=1}^{n}(a - \theta_i)x_i - \frac{1}{2}\left(\sum_{i=1}^{n} bx_i^2 + \sum_{j=1,\, j\neq i}^{n} dx_i x_j\right),$$

where $b > 0, b > d, a - \theta_i > 0$, and $b + (n - 1)d > 0$;[24] and, in the case of cost uncertainty $\theta_i = 0$ for all $i = 1, \ldots, n$. The goods are substitutes, independent, or complements depending on whether $d \gtreqless 0$. The goods are perfect substitutes when $b = d$. Solution of the consumer's maximization problem gives rise to the linear inverse demand system

$$p_i = a - \theta_i - bx_i - dX_{-i},$$

where the sum of the production of goods other than i is denoted by $X_{-i} = \Sigma_{j=1,j\neq i}^{n} x_j$. Analogously, denoting by $p_{-i} = \Sigma_{j=1,j\neq i}^{n} p_j$ the sum of the prices of goods other than i, direct demands functions are

$$x_i = \alpha - \mu_i - \beta p_i + \gamma p_{-i},$$

where $\alpha = \frac{a}{b+(n-1)d}$, $\mu_i = \frac{\theta_i}{b+(n-1)d}$, $\beta = \frac{b+(n-2)d}{(b+(n-1)d)(b-d)}$, $\gamma = \frac{d}{(b+(n-1)d)(b-d)}$ and therefore $\beta + \gamma > 0$ and $\beta - (n - 1)\gamma > 0$. For expositional convenience, we denote the distribution of μ_i as those of the other random parameters. In part of the analysis, we focus on the special cases with homogeneous goods (i.e., perfect substitutes $b = d$) and independent shocks (i.e., $\rho = 0$).

We now proceed to the analysis of the subgame perfect Nash equilibrium of this exogenous merger game, treating the number k of merging firms as a parameter of the model.

3. Optimal Contract: Cash and Shares

In this section we show that the allocation of shares of the new company affects the amount of diversification. In particular, we distinguish two effects on the payoff of the merging firms, a direct risk-sharing effect and an indirect strategic effect. We show that these effects have an impact on the incentives of financing the merger with cash and/or shares. By analyzing how these two effects act depending on the nature of the competition and the type of market uncertainty, this section also previews the paper's main results.

Our diversification explanation of the financing method used in mergers complements other factors that have been identified in the corporate finance literature, such as taxes, asymmetric information, and

24. These assumptions ensure that V is strictly concave (see, e.g., Vives, 1999).

agency considerations. [25] Risk sharing and the strategic implications for product market competition appear to have been overlooked.[26]

In order to concentrate on the direct effect of risk sharing, let us fix the strategies in the product market and denote the uncertain profits of the merged firm by Π^M. Because the merging firms are symmetric, we assume that they reach an agreement in which they all obtain the same expected utility. Firms cooperatively allocate the shares of the new company $(\tau_1, \ldots, \tau_k)$ and set up cash transfers among them $(F_1, \ldots, F_k)$ so that the surplus of merging is equally split $U(\tau_i \Pi^M + F_i) = U(\tau_j \Pi^M + F_j)$ for all $i, j = 1, \ldots, k$.

There are many agreements compatible with our restrictions that the shares be nonnegative and add up to 1 and that the cash transfers be balanced. For example, the merging firms may split evenly the shares of the new company in a "merger of equals," in which case

$$\tau_t = \frac{1}{k} \text{ and } F_t = 0 \text{ for } t = 1, \ldots, k. \tag{1}$$

Alternatively, they may opt for a "pure takeover" by assigning all the shares to one of the merging firms, say firm l, and imposing a cash transfer from this firm to the former shareholders of the other merging firms, that is,

$$\tau_l = 1 \text{ and } F_l = -\frac{k-1}{k}\left[E(\Pi^M) - \frac{R}{2}\text{Var}(\Pi^M)\right]$$

$$\tau_j = 0 \text{ and } F_j = \frac{1}{k}\left[E(\Pi^M) - \frac{R}{2}\text{Var}(\Pi^M)\right] \text{ for } \quad j = 1, \ldots, k,\ j \neq l.$$

More generally, because all firms obtain the same expected utility level, $U(\tau_i \Pi^M + F_i) = U(\tau_j \Pi^M + F_j) \equiv U^*$ for all $i, j = 1, \ldots, k$, and $\Sigma_{t=1}^k \tau_t = 1$ and $\Sigma_{t=1}^k F_t = 0$, we have that,

$$U^* = \frac{1}{k}\left[E(\Pi^M) - \left(\sum_{t=1}^{k} \tau_t^2\right) \frac{R}{2}\text{Var}(\Pi^M)\right] \tag{2}$$

25. At least since Carleton et al. (1983), the finance literature has studied empirically the determinants and effects of the method of payment used in mergers. A number of studies document the different impact of stock and cash deals on the stock returns of bidding firms (see, e.g., Travlos, 1987; Chang, 1998).

26. See Rappaport and Sirower (1999) for a discussion of the effect of the method of payment on risk bearing. Although that paper focuses on the risk associated with the magnitude of the synergy created by the merger, the effects discussed are similar to those that arise in our case in which the risk is inherently present in downstream market competition.

and

$$F_j = \frac{k\sum_{i\neq j}\tau_i - (k-1)}{k}E(\Pi^M) - \frac{\sum_{i\neq j}\tau_i^2 - (k-1)\left(1-\sum_{i\neq j}\tau_i\right)^2}{k}\frac{R}{2}\mathrm{Var}(\Pi^M) \qquad (3)$$

for all j. As the fixed payments must satisfy (3), the optimal contract is completely determined by the distribution of shares of the new company.

From (2), we can see the first *direct effect* of the contractual agreement on the level of risk *diversification* implied by the merger. In a takeover, the risk is not diversified because the uncertain profits of the new firm are retained fully by the acquiring firm, whereas the other firms obtain a fixed fee without any risk. Consequently, (2) is lowest. Clearly, the optimal way to diversify any given amount of risk is to share the profits of the new firm equally. A merger of equals then maximize (2), holding Π^M constant.

In addition, there is a second *indirect effect* of the distribution of shares on the firms' *strategic* incentives and in turn on Π^M. The largest shareholder of the merged firm maximizes $U(\tau_l\Pi^M + F_l) = E(\tau_l\Pi^M + F_l) - \frac{R}{2}\mathrm{Var}(\tau_l\Pi^M + F_l)$, or equivalently

$$\max E(\Pi^M) - \tau_l\frac{R}{2}\mathrm{Var}(\Pi^M). \qquad (4)$$

Hence, the merged firm can be interpreted as a firm with risk aversion level $\tau_l R$. Intuitively, giving more shares to the largest shareholder results in an increase of the level of risk aversion of the merged firm.[27]

Whether firms prefer to be more or less risk averse depends on the nature of the competition and the type of the uncertainty. As shown by Asplund (2002), higher levels of risk aversion induce quantity competing firms to set lower quantities in the presence of either cost or demand uncertainty, becoming thus softer competitors in the product market. Because a quantity competing firm prefers to behave aggressively (Fudenberg and Tirole, 1984), insiders prefer to induce their firm to be less risk averse and therefore they should give less shares to the largest shareholder.

27. There are a number of special cases in which both effects are absent and the contractual agreement is irrelevant, so that any sharing rule is optimal. First, in the absence of risk aversion by the firms ($R = 0$), U^* in (2) is independent of $(\tau_1, \ldots, \tau_k)$ and the objective function in (4) is also independent of τ_l. Second, the contractual arrangement is irrelevant if the profits of the merged firm are certain, i.e., Var $(\Pi^M) = 0$. This may occur either in the complete absence of uncertainty in the market ($\sigma^2 = 0$) or whenever the merger allows for complete diversification ($\rho = -\frac{1}{k-1}$).

An increase in the level of risk aversion would induce price competing firms, instead, to set lower prices in the presence of demand uncertainty (or higher prices in the presence of cost uncertainty), becoming thus more aggressive (or respectively softer) competitors in the product market. Given that a price competing firm prefers to be soft, insiders would induce their firm to be less risk averse by giving less shares to the largest shareholder only in the presence of demand uncertainty. If the market is characterized by cost uncertainty instead, insiders would give more shares to the largest shareholder and make their firm more risk averse.

Summarizing, the direct diversification effect always pushes merging firms to merge as equals. The indirect strategic effect also induces merging firms to merge as equals, except in the case of price competition with cost uncertainty. In the remainder of the paper, we spell out these effects for the different cases and show that firms would merge as equals in all cases except price competition with cost uncertainty. In that case, the arrangement that arises is a hybrid between a merger of equals and a pure takeover.

4. Cournot Competition with Demand Uncertainty

Following the tour operator example, this section analyzes quantity competition with demand uncertainty. Appendix A shows that the results of this section apply for the case in which quantity setting firms compete under cost uncertainty.

4.1 Production

For a given realization of the uncertainty, θ_i, the profits of an independent firm i are

$$\Pi^i_{q,d} = (a - \theta_i - bx_i - dX_{-i})x_i,$$

and therefore $E(\Pi^i_{q,d}) = (a - bx_i - dX_{-i})x_i$ and $\mathrm{Var}(\Pi^i_{q,d}) = \sigma^2 x_i^2$. Therefore, in the benchmark case in which no merger has taken place in the first stage, each firm in the second stage solves

$$\max_{x_i}(a - bx_i - dX_{-i})x_i - \frac{R}{2}\sigma^2 x_i^2. \tag{5}$$

In the unique equilibrium, production is identical for all firms $i = 1, \ldots, n$, with

$$x_i \equiv x = \frac{a}{2b + d(n-1) + R\sigma^2}. \tag{6}$$

Intuitively, risk-averse firms limit exposure to low-profit realizations by restricting output. A higher level of risk aversion relaxes competition, resulting in a reduction in the quantity produced by all firms (Asplund, 2002).

Suppose that k firms decide to merge. The profits of the merged firm are

$$\Pi^M_{q,d} = \sum_{t=1}^{k}(a - \theta_t - bx_t - dX_{-t})x_t,$$

and therefore $E(\Pi^M_{q,d}) = \Sigma_{t=1}^k(a - bx_t - dX_{-t})x_t$ and $\mathrm{Var}(\Pi^M_{q,d}) = \sigma^2(\Sigma_{t=1}^k x_t^2 + \rho\Sigma_{t,j,t\neq j}x_t x_j)$. Denoting by $\tau \equiv \tau_l$ the share of profits of the largest shareholder of the new entity and recalling the assumption that the largest shareholder controls all the insiders' production decisions, the merged entity solves (4), or

$$\max_{x_1,\ldots,x_k} \sum_{t=1}^{k}(a - bx_t - dX_{-t})x_t - \frac{R}{2}\sigma^2\tau\left(\sum_{t=1}^{k}x_t^2 + \rho\sum_{t,j,t\neq j}x_t x_j\right). \tag{7}$$

The outsiders ($o = k + 1, \ldots, n$) maximize (5) as before. Equilibrium outputs are

$$x_t = \frac{a(S - d(n-k))}{SP - d^2(n-k)k} \quad \text{for} \quad t = 1, \ldots, k \tag{8}$$

and

$$x_o = \frac{a(P - dk)}{SP - d^2(n-k)k} \quad \text{for} \quad o = k+1, \ldots, n \tag{9}$$

where $S = 2b + (n - k - 1)d + R\sigma^2$ and $P = 2b + (k-1)2d + \tau R\sigma^2(1 + \rho(k-1))$.[28] Note that a reduction in the stake of the largest shareholder effectively makes the merged firm less risk averse and therefore more aggressive. Merging firms' production is larger whereas, as a response, the outsiders' production is lower.

Comparing (6) and (8), the insiders increase their production after the merger whenever

$$(1 - \tau(1 + \rho(k-1)))R\sigma^2 \geq d(k-1). \tag{10}$$

To interpret this condition, consider the case with substitute goods ($d > 0$). In the standard case with risk neutrality ($R = 0$) or without risk ($\sigma^2 = 0$), the insiders reduce production and so are better able to exploit their increased market power. According to the right-hand

28. Because $S - (n-k)d > 0$, $P - kd > 0$, and $SP - d^2(n-k)k > 0$ all firms produce a positive amount.

side of (10), the output reduction induced by the merger increases in the number of insiders and the substitutability of the goods. In the presence of risk and risk aversion ($R\sigma^2 > 0$), a merger results in an increase in the risk-bearing potential of the insiders, unless the shocks are perfectly positively correlated ($\rho = 1$). As the correlation in the shocks (ρ) decreases, it becomes more likely that a positive shock in one of the markets served by the merged entity is offset by a negative shock in one of its other markets. Because of this diversification effect, the merged entity is more willing to take on risk by selling a higher output. Similarly, a reduction in the fraction of risk borne by the firm with decision power (τ) increases risk bearing and so results in an increase in the insiders' output. When instead the goods are complements ($d < 0$), the insiders produce more as long as the level of risk averse-like behavior does not increase so much that it overcomes the strategic increase in production.

Comparing (6) and (9), the outsiders increase their production after the merger whenever

$$d(1 - \tau(1 + \rho(k - 1)))R\sigma^2 \leq d^2(k - 1). \tag{11}$$

Contrasting this condition with (10), note that the outsiders' shift in production is in the opposite direction of that of the insiders when the goods are substitutes, and in the same direction when they are complements. The outsiders' reaction, however, is never strong enough to compensate for the change in production by the insiders. The total production then increases whenever condition (10) is satisfied.

Note that when firms are risk neutral, outsiders always increase production, whereas the insiders' (and total) production is only increased when the goods are complements.

4.2 Private Incentives

In this section we study the incentives to merge and evaluate the consequences of a merger for consumers and society. We study first whether a merger is an equilibrium of our game.[29]

Proposition 1: *Under Cournot competition, the optimal sharing rule is equal sharing (merger of equals).*

In the case of Cournot competition, the direct diversification and the indirect strategic effects operate in the same direction. Holding fixed

29. Like in simultaneous voting models, in this exogenous merger model weakly dominated strategies can be part of an equilibrium. For example, even if two firms can achieve a higher payoff by merging, there is an equilibrium in which they both decline the merger, each based on the fulfilled expectation that the other is declining. However, these degenerate equilibria do not survive if the payoffs are perturbed.

the strategies of the outsiders, an equal division of shares increases diversification and leads to more aggressive behavior in the product market. In turn the outsiders reply to the insiders' increased quantity by reducing their quantity, shifting upward the insiders' residual demand. As this indirect strategic effect is also to the advantage of the insiders, the insiders' total utility is maximized with an egalitarian division of the shares.

In the absence of uncertainty, Salant et al. (1983) have shown that firms producing homogeneous goods and constant marginal costs have limited incentives to merge. To understand this "merger paradox," note that as a result of the merger the insiders become less aggressive and the outsiders free ride on the insiders' attempts to raise market prices by increasing production. As shown by Perry and Porter (1985), merger profitability is restored when firms produce with (linearly) increasing marginal costs. In that setting, the marginal cost of the merged company is less steep than the marginal cost of each of the constituent firms. The merger then makes the insider behave more aggressively. As a result, mergers are more profitable the steeper the marginal cost curves. Note that Perry and Porter's model can also be applied to markets where firms produce differentiated goods with constant marginal costs.[30] As goods become more differentiated, mergers become more profitable.

In uncertain markets, risk-neutral firms decide to produce and merge exactly as in these models without uncertainty, with the only difference that variables are replaced by their expected values. The presence of risk aversion makes merging firms more aggressive following the merger, even if goods are homogeneous and marginal costs are constant:

Proposition 2: *Under Cournot competition with homogeneous goods and independent shocks, mergers occur in a larger set of industry configurations for higher levels of risk aversion.*

The risk-bearing potential of merged firms is higher for any type of contract the merging firms agree upon. In a takeover, for example, the merged firm does not obtain any direct benefit from diversification but is nevertheless more aggressive in the product market, exactly in the same way as in Perry and Porter's model with increasing marginal costs.[31] By dividing the shares of the new firm equally, the merging firms

30. The profits of a single-plant firm i with linearly increasing marginal costs in a homogeneous good market are $\pi_i = (a - x_i - X_{-i})x_i - (c_1 + c_2 x_i)x_i$, which can be rewritten as $\pi_i = (a - (1 + c_2)x_i - X_{-i})x_i - c_1 x_i$. Note that these profits can be re-interpreted as those of a firm selling differentiated products with constant marginal cost.

31. To see this, substitute $\tau = 1$, $\rho = 0$, and $b = d = 1$ into (7) to obtain $(a - \Sigma_{t=1}^{k} x_t)\Sigma_{t=1}^{k} x_t - \frac{R}{2}\sigma^2 \Sigma_{t=1}^{k} x_t^2$. This can be thought as the payoff resulting from a merger of k firms that produce a homogeneous good with linear increasing marginal cost, $C(x_t) = \frac{R}{2}\sigma^2 x_t$, in an industry without uncertainty.

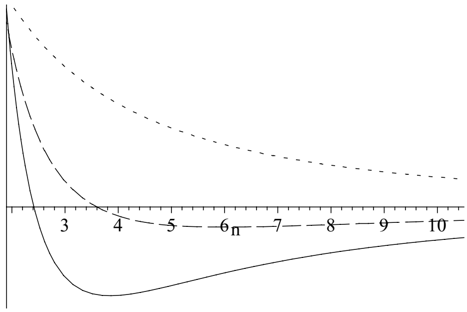

FIGURE 1. PRIVATE INCENTIVES TO MERGE IN A COURNOT MARKET

perform even better, as if they had a superior production function. Note that this effect is different from the reallocation of quantities across firms with given production functions. Because the merging firms are able to better diversify risk, they behave in an even more aggressive way in the product market. This advantage is amplified by the strategic effect on competitors, who become more reluctant to take risk.

Figure 1 depicts the change in expected utility for an insider firm as a result of a merger involving $k = 2$ firms, as a function of n ($\geq$2), the number of firms originally present in the market. Each curve corresponds to a market with different levels of risk aversion. As shown by Salant et al. (1983), risk-neutral firms ($R = 0$, thin curve) find the merger profitable only when they represent a large part of the market. The reduction of the combined production of the merging firms is compensated by an increase in the expected price only if there are few free-riding outsiders. In this benchmark case with risk-neutral firms, a two-firm merger is profitable only if the two firms merge to become a monopoly ($n = 2$), but is unprofitable otherwise. If firms exhibit low risk aversion ($R\sigma^2 = 0.5$, dashed curve), a merger in an industry with three firms is also profitable. If there are four or more firms in the market, the merger is not profitable because of the free-riding effect identified by Salant et al. (1983).[32] For high levels of risk aversion ($R\sigma^2 = 2$, dotted curve), a two-firm merger is profitable.[33]

32. In this case, condition (8) is not satisfied and therefore insiders face the same trade-off as in the risk-neutral case. Their combined production is lower but the market price is higher.

33. In this case condition (8) is satisfied and therefore insiders face a different trade-off. Their combined production is larger but the market price is lower. In this case a larger number of outsiders may reduce the negative impact of the merger on the price because their production increases following the merger. We show in the proof of Proposition 2 that a given merger is profitable in any industry if the level of risk aversion is higher than a given threshold.

If consumers do not perceive the goods produced by this industry as imperfect substitutes, mergers are even more profitable. As argued above, differentiation increases the incentives to merge, by adding the effect present in Perry and Porter's model.[34] Additional incentives arise when shocks are not independent but negatively correlated. As argued above, if shocks are less correlated, a low demand realization in one division is more likely to be compensated by high demand in another division.

Even if firms have more incentive to merge, a more concentrated market structure need not result in the presence of more risk or risk aversion. In fact, the opposite may well occur, as Brown and Chiang (2002) show using a coalition formation approach. To see this, suppose that there are three (*ex ante* symmetric) firms and the market structure is determined according to the sequential formation approach of Bloch (1996) and Ray and Vohra (1999).[35] With risk neutrality (or certainty), monopoly would result because two firms in a three-firm industry would prefer not to merge and, anticipating that, the first firm proposes a monopoly. With a sufficiently high level of risk aversion a merger between two firms in a three-firm market is profitable, but it is better to remain as an outsider in a duopoly than joining the other two firms to form a monopoly. The final market structure is a duopoly because the first firm decides to stay alone, given that it predicts that the other two firms will later merge. In this example, the final market structure is less concentrated when firms are more risk averse. Indeed, an important insight of the literature on endogenous coalition formation is that less concentrated outcomes may result when larger coalitions have higher payoffs.

4.3 Consumer and Social Welfare

As explained in the previous section, efficiencies in our model are not derived merely from output rationalization as in Perry and Porter (1985). Mergers bring about additional diversification gains that would not be feasible otherwise. Efficiencies gains from risk sharing are equivalent to cost synergies, as defined by Farrell and Shapiro (1990). As a result of these diversification synergies, consumers might end up gaining from mergers.

34. The analysis of Cournot competition with complementary goods parallels that of Bertrand competition with substitute goods, covered in the next section.

35. In the game of coalition sizes, Bloch (1996) and Ray and Vohra (1999) show that if the payoffs of the *ex ante* symmetric players are decreasing in the order in which the coalitions are formed, then the stationary symmetric subgame perfect equilibrium coalition structures of the infinite-horizon sequential game coincide with the partitions generated by the choice-of-sizes game. This condition is satisfied in our example.

Note that consumer welfare is deterministic in this setting. Even though prices fluctuate to meet demand, consumers' preferences are also uncertain. In our linear-quadratic framework, the two uncertain parameters exactly cancel out in the computation of the consumer surplus. We have that

$$CS = V - \sum_{i=1}^{n} p_i x_i = \frac{1}{2}\left(\sum_{i=1}^{n} b x_i^2 + \sum_{j \neq i} d x_i x_j\right), \tag{12}$$

and because production is certain, consumer surplus is also certain. In particular, for homogenous goods ($b = d$), we have that,

$$CS = \frac{d}{2}\left(\sum_{i=1}^{n} x_i\right)^2, \tag{13}$$

and therefore consumers are better off when more output is produced. From condition (10), a merger increases consumer welfare whenever $(1 - \rho)R\sigma^2 \geq kd$. If the shocks are perfectly positively correlated, risk sharing has clearly no effect, so that mergers never increase consumer welfare. When the shocks are instead idiosyncratic, for high enough levels of risk aversion, the merger reduces prices and benefits consumers.

For the nonmerging firms there is never a conflict. Outsiders produce more than before the merger exactly when prices are higher. Therefore outsiders will be better off whenever condition (11) is satisfied, which, for substitutable goods, is equal to $(1 - \rho)R\sigma^2 < kd$. Their profits are higher whenever the industry output and consumer welfare is lower.

Summing up, the mergers not only take place more often in the presence of uncertainty and risk aversion, but they are also better for society as a whole. Representing social welfare as the sum of firms' utility and consumer surplus, we have the following result.

Proposition 3: *Under Cournot competition with homogeneous goods and independent shocks, when firms are risk neutral no merger increases social welfare. When firms are risk averse, mergers may improve social welfare. As risk aversion or uncertainty increases, more mergers are welfare enhancing.*

Figure 2 plots the change in welfare when $k = 2$ firms merge in a market with n (≥ 2) firms, with risk neutrality ($R\sigma^2 = 0$, continuous curve) and risk aversion ($R\sigma^2 = 1$, dashed curve). Figures 1 and 2 illustrate that mergers involving a small part of the industry are not only profitable, but they are also easily welfare enhancing. Instead, large mergers tend to be privately profitable but socially harmful.

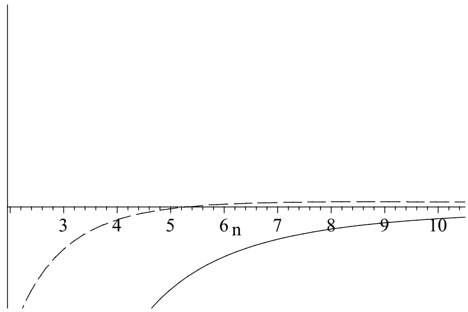

FIGURE 2. SOCIAL CONSEQUENCES OF A MERGER IN A COURNOT MARKET

5. Bertrand Competition with Cost Uncertainty

The second leading case of our model covers mergers among price-setting firms competing under cost uncertainty. For example, this case applies to banks that borrow from depositors at fixed rates (prices) and lend at variable interest rates (costs). Bertrand competition with cost uncertainty is complicated by the fact that the variance of profits of a given firm is affected not only by the firm's actions but also by the rivals' actions. Indeed, the profits of an independent firm, for example, are

$$\Pi^i_{p,c} = (\alpha - \beta p_i + \gamma p_{-i})(p_i - \upsilon_i)$$

and therefore $E(\Pi^i_{p,c}) = (\alpha - \beta p_i + \gamma p_{-i})p_i$ and $\mathrm{Var}(\Pi^i_{p,c}) = \sigma^2(\alpha - \beta p_i + \gamma p_{-i})^2$.

5.1 Prices

Following the same procedure as in Section 4, when no merger is produced in the first stage, all set the same price $p_i \equiv p$ for $i = 1 \ldots, n$, where

$$p = \frac{\alpha(1 + \beta R\sigma^2)}{2\beta - \gamma(n-1) + \beta R\sigma^2(\beta - (n-1)\gamma)}. \tag{14}$$

As pointed out by Asplund (2002), in this case higher levels of risk aversion lead to higher prices and hence softer competition.

When k firms decide to merge in the first stage, the prices in equilibrium are

$$p_t = \frac{\alpha(1 + \tau L)[\beta + (1 + \beta R\sigma^2)(\beta + \gamma)]}{M(1 + \tau L) + N} \quad \text{for} \quad t = 1, \ldots, k \tag{15}$$

and

$$p_o = \frac{\alpha(1 + R\sigma^2\beta)[\beta - \gamma(k-1) + (1+\tau L)(\beta+\gamma)]}{M(1+\tau L) + N} \quad \text{for}$$

$$o = k+1, \ldots, n, \qquad (16)$$

where $M \equiv \beta[\beta - \gamma(k-1)] + (\beta+\gamma)(1 + R\sigma^2\beta)[\beta - \gamma(n-1)]$, $N \equiv [\beta - \gamma(k-1)][\beta + [\beta - \gamma(n-k-1)](1 + R\sigma^2\beta)]$ and $L \equiv R\sigma^2[1 + \rho(k-1)][\beta - \gamma(k-1)]$. In this case, as the largest shareholder is made less risk averse through a reduction in its stake, the opponents become more aggressive and reply with lower prices.

Comparing (14), (15), and (16), we conclude that the merger leads to an increase in the prices of the insiders as well as the outsiders whenever

$$\beta R\sigma^2[1 - \tau(1 + \rho(k-1))][\beta - \gamma(k-1)] \leq \gamma(k-1). \qquad (17)$$

5.2 Private Incentives

When designing the optimal contract, the two effects identified in Section 3 push in opposite directions. A more equal division of shares has the benefit of increased diversification. But it also has the cost of inducing aggressive behavior in the product market, as the rivals reply to the insiders' lower prices by further cutting prices and this reduces the insiders' profits. The optimal division of shares trades off these two effects:

Proposition 4: *Under Bertrand competition and cost uncertainty, the optimal sharing rule gives* $\tau^* = 1 - \frac{(k-1)}{k}\frac{M(1+L)+M}{M(1+L)+N}$ *shares of the new entity to one shareholder, whereas all the other shares are split equally among the rest. This agreement is intermediate between a merger of equals and a takeover,* $\tau^* \in (\frac{1}{k}, 1)$.

In this case, the optimal sharing rule depends on the level of risk aversion. Substituting the optimal sharing rule in the insiders' utility level, we obtain that mergers are still profitable.

Proposition 5: *Under Bertrand competition and cost uncertainty (substitute products and independent shocks), any merger is profitable.*

5.3 Consumer and Social Welfare

In the agreement, risk-averse firms end up taking advantage of some of the diversification possibilities of the merger, even if this triggers aggressive competition in the product market. This has important consequences for consumer and social welfare.

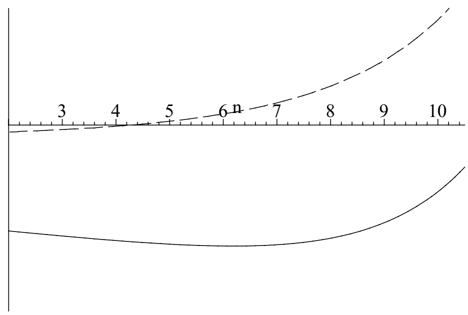

FIGURE 3. SOCIAL CONSEQUENCES OF A MERGER IN A BERTRAND MARKET WITH COST UNCERTAINTY

Consumer welfare is again deterministic, because the prices are set before the realization of the uncertainty. To see the effect mergers on the price levels and therefore on consumer welfare, we need to substitute the percentage of shares of the largest shareholder, τ^*, into (17).

PROPOSITION 6: *Under Bertrand competition and cost uncertainty (substitute products and independent shocks), a merger decreases prices and increases consumer welfare whenever* $R\sigma^2 \geq \widehat{R\sigma^2}$, *where* $\widehat{R\sigma^2}$ *is uniquely defined by the solution of* $\widehat{R\sigma^2}[1 - \tau^*(\widehat{R\sigma^2})] = \frac{\gamma(k-1)}{\beta[\beta - \gamma(k-1)]}$.

When firms are sufficiently risk averse, competition is tougher and prices of both insiders and outsiders decrease following the merger. Social welfare is also enhanced, as illustrated in Figure 3 for an example with $\beta = 10$ and $\gamma = 1$. The figure plots the change in expected social welfare after a merger between $k = 2$ firms in a market with n risk-neutral ($R\sigma^2 = 0$, thin curve) and risk-averse firms ($R\sigma^2 = 0.01$, dashed curve).

6. Conclusion

In this paper we have investigated the private and social effects of horizontal mergers with risk-averse firms. We have proposed a tractable model with mean variance preferences and a differentiated-product linear demand system. We have studied how the outcomes depend on whether competition is in quantities or in prices, and on whether the uncertainty is about the intercept of the firms' demand or the level of marginal costs. The main results of the paper for the case of substitutable goods are summarized in Table I.[36]

36. For Cournot competition, the result on the effects of the merger on consumer welfare assumes homogeneous goods ($b = d$), and the profitability result assumes homogeneous goods and independent shocks ($\rho = 0$). For the Bertrand cases, the results

Table I.
Summary of Main Results for Substitutable Goods

	Cournot Demand or Cost	Bertrand Demand	Bertrand Cost
Contractual agreement	Merger of equals	Merger of equals	Hybrid
Insiders' strategy	Higher quantities if $(1-\rho)R\sigma^2 > kd$	Higher prices	Lower prices if $R\sigma^2 > \widehat{R\sigma^2}$
Outsiders' strategy	Higher quantities if $(1-\rho)R\sigma^2 < kd$	Higher prices	Lower prices if $R\sigma^2 > \widehat{R\sigma^2}$
Consumer welfare	Increased if $(1-\rho)R\sigma^2 > kd$	Reduced	Increased if $R\sigma^2 > \widehat{R\sigma^2}$
Merger profitability	Higher than under risk neutrality	Always positive	Always positive

In the presence of risk aversion, a meaningful distinction emerges between mergers and takeovers. The division of shares of the new company has a direct effect on risk sharing and an indirect strategic effect. First, risk sharing improves when the shares of the individual merging firms are more equally responsive to risk, holding constant the strategies in the product market. In a merger of equals the decisionmaker is then exposed to less risk than in a takeover. Second, the division of shares affects strategic behavior in the product market. The merging firms derive a strategic benefit from diversification in Cournot markets as well as in Bertrand markets with demand uncertainty. In markets with Bertrand competition and cost uncertainty, diversification has an undesirable strategic effect for the merging firms. As a result, the optimal sharing rule is a merger of equals, unless firms compete in prices under cost uncertainty. In that case, a hybrid between a proper merger and a complete acquisition is instead optimal.

We have found that more mergers take place in uncertain markets. If risk aversion is taken into account, firms have more incentives to merge in Cournot markets. As consolidation makes firms more aggressive, mergers involving few firms become profitable with a relatively low level of risk aversion. This can explain why we observe mergers in relatively unconcentrated industries. This can be seen as a resolution to the "merger paradox," according to which outsiders benefit but insiders are hurt from small mergers. As a result of their improved risk bearing, insiders can even increase their production above pre-merger levels

on prices, consumer welfare, and profitability assume independent shocks. $\widehat{R\sigma^2}$ is defined in the text.

at the expense of the outsiders (and to the benefit of consumers). In price-setting markets, mergers among firms selling substitute goods are always profitable in the presence of risk.

Because of the risk-sharing effect identified here, mergers can result in efficiency gains.[37] In Cournot markets, the level of uncertainty and risk aversion need to be quite large for mergers to be socially beneficial. In price-setting markets, consumers do not benefit from mergers with demand uncertainty, but can easily benefit in the presence of cost uncertainty.

Our model has implications for industries in which risk management is important, such as insurance and banking. For example, banks' concerns with risk management can be attributed to the increasing costs of raising nondeposit external finance. As Froot and Stein (1998) put it: "In an effort to avoid these costs, the bank will behave in a risk-averse fashion". In this context, consolidation can reduce the risk of the merging banks and reduce the overall probability of failure, as the other affiliates serve as a source of strength. In an empirical analysis of mergers and acquisitions on the efficiency and profitability of European banks, Vander Vennet (1996) found that universal banks in Europe had both higher revenues and higher profitability. This could be attributed in part to improved risk diversification.

Our results might also shed some light on recent empirical findings by Sapienza (2002) on the effect of mergers among Italian banks on prices of loans. Mergers involving banks with small market shares led to a reduction in the interest rates charged to borrowers. This result is consistent with the fact that the mergers generate efficiency gains. Mergers of banks with sizeable market shares led instead to increased interest rates, suggesting that market power dominates cost synergies. Although part of these cost synergies are probably due to operational cost savings, part might be due to risk diversification. Indeed, Demsetz and Strahan (1997) have shown that large bank holding companies are better diversified and pursue riskier strategies than small bank holding companies.[38]

We conclude by stressing an important limitation of our approach with exogenously given risk aversion by firms. Our welfare implications

37. For discussions of the difficulties with efficiency defences see Farrell and Shapiro (1990) and Röller et al. (2001).

38. Sapienza (2002) also finds that the reduction in interest rates following mergers among banks with small market shares is higher when these banks operate in the same province. This finding suggests that the cost synergies are higher for mergers among banks that operate in the same market, contrary to what we would expect if these synergies were exclusively due to diversification effects.

are valid only if there is no alternative way of achieving diversification and if the mean variance preferences of the firms accurately reflect the risk attitudes of their owners. In order to obtain more compelling welfare effects of mergers, the imperfection in the insurance markets as well as the limited diversification of shareholders should be derived from first principles. In the presence of informational asymmetries and agency problems, the preferences of the firm might not fully represent those of the owners. If so, the social planner should appropriately adjust for the divergence in the objectives of the firm with those of the owners. Investigation of this problem is a challenging task for future research.

Appendix A: Extensions

A.1 Cournot Competition with Cost Uncertainty

The analysis for markets characterized by the presence of demand or cost uncertainty is identical when firms compete in quantities.[39] Indeed, the profits of an independent firm under cost uncertainty are

$$\Pi^i_{q,c} = (a - bx_i - dX_{-i})x_i - \upsilon_i x_i. \tag{A1}$$

Because $E(\Pi^i_{q,d}) = E(\Pi^i_{q,c})$ and $\text{Var}(\Pi^i_{q,d}) = \text{Var}(\Pi^i_{q,c})$, we have $U(\Pi^i_{q,d}) = U(\Pi^i_{q,c}) \equiv U(\Pi^i_q)$. Similarly for a shareholder of the merged firm, $U(\tau_t\Pi^M_{q,d} + F_t) = U(\tau_t\Pi^M_{q,c} + F_t) \equiv U(\tau_t\Pi^M_q + F_t)$. Accordingly, the analysis of the case in which quantity-setting firms compete in the presence of cost uncertainty is identical to the one presented in Section 4, in which quantity-setting firms compete under demand uncertainty. Consumer welfare is again certain because quantities and prices are independent of the realization of the uncertainty.

A.2 Bertrand Competition with Demand Uncertainty

Unlike the Cournot case, the utility of price-competing firms depends on the type of uncertainty. The profits of an independent firm under demand uncertainty are

$$\Pi^i_{p,d} = (\alpha - \mu_i - \beta p_i + \gamma p_{-i})p_i. \tag{A2}$$

Note that although $E(\Pi^i_{p,d}) = E(\Pi^i_{p,c})$ we have that $\text{Var}(\Pi^i_{p,d}) \neq \text{Var}(\Pi^i_{p,c})$ and hence $U(\Pi^i_{p,d}) \neq U(\Pi^i_{p,c})$.

39. The analysis of an industry characterized by the presence of both types of uncertainty would be identical.

Bertrand competition with demand uncertainty and substitutable (complementary) products is the dual of Cournot competition with complementary (substitutable) products (Singh and Vives, 1984). Once we identify q_i with p_i, a with α, b with β, c with $-\gamma$, we obtain an utility function identical to the one used in the text for Cournot competition. The equilibrium prices in this case can be easily obtained from the equilibrium quantities of Section 4. In turn, from conditions (10) and (11), the insiders price higher than before the merger whenever

$$(1-\tau(1+\rho(k-1)))R\sigma^2 \geq -(k-1)\gamma$$

and the outsiders whenever

$$\gamma(1-\tau(1+\rho(k-1)))R\sigma^2 \geq -(k-1)\gamma^2.$$

In this case, giving less stakes to the largest shareholder will result in a merged firm that prices higher and therefore in softer competitor in the product market. However, with price competition, the outsiders reply with higher prices to the insiders' higher price. It follows that the two effects for the design of the optimal contract go again in the same direction. An equal distribution of shares increases diversification and results in less aggressive competition in the product market. Both effects boost profits in Bertrand competition. The optimal agreement will be, again, a merger of equals.

For risk-neutral firms competing in prices to sell substitute goods, Deneckere and Davidson (1985) have shown that mergers are always profitable. The next proposition shows that this result still holds when the firms are risk averse.[40]

Proposition 7: *Under Bertrand competition and demand uncertainty with substitute products and independent shocks, any merger is profitable.*

Proof. From (2) and (A2) the utility of each insider evaluated at the prices arising from Bertrand competition with the distribution of shares $(\tau_1, \dots, \tau_k)$ is given by

$$U^*\left(n, k, \alpha, \beta, \gamma, R\sigma^2, \tau_1, \dots, \tau_k\right) = \frac{1}{k}\left[\sum_{i=1}^{k}[\alpha-\beta p_i+\gamma p_{-i}]p_i - \left(\sum_{i=1}^{k}\tau_i^2\right)\frac{R\sigma^2}{2}\sum_{i=1}^{k}p_i^2\right],$$

40. For the dual case in which goods are complements, Proposition 2 implies that more mergers are profitable if the firms are more risk averse. Similarly, Proposition 7 implies that all mergers are profitable in the case of Cournot competition with complementary goods.

whereas the utility of an independent firm if the merger does not take place is given by $U^*(n, 1, \alpha, \beta, \gamma, R\sigma^2, 1, \ldots, 0)$.

In order to show that any merger is profitable, we can appeal to Theorem 1 of Deneckere and Davidson (1985). That result guarantees that in a linear demand, differentiated market with Bertrand competition any merger among k firms is profitable in the absence of uncertainty and risk aversion. Translated into our notation, they show that

$$U^*(n, k, \alpha, \eta, \gamma, 0, 1, \ldots, 0) - U^*(n, k, \alpha, \eta, \gamma, 0, 1, \ldots, 0) > 0,$$

for any differentiation parameter η.

This is equivalent to say that in a market characterized by the presence of uncertainty and risk aversion, any merger in the form of takeover is profitable. To see this, define $\eta = \beta + \frac{R\sigma^2}{2}$ and rewrite the previous inequality as

$$U^*(n, k, \alpha, \beta, \gamma, R\sigma^2, 1, \ldots, 0) - U^*(n, k, \alpha, \beta, \gamma, R\sigma^2, 1, \ldots, 0) > 0.$$

Because the optimal sharing rule is a merger of equals, merging is even more profitable. Because $U^*(n, k, \alpha, \beta, \gamma, R\sigma^2, \frac{1}{k}, \ldots, \frac{1}{k}) > U^*(n, k, \alpha, \beta, \gamma, R\sigma^2, 1, \ldots, 0)$, we have that

$$U^*\left(n, k, \alpha, \beta, \gamma, R\sigma^2, \frac{1}{k}, \ldots, \frac{1}{k}\right) - U^*(n, k, \alpha, \beta, \gamma, R\sigma^2, 1, \ldots, 0) > 0,$$

and any merger is profitable. □

Similarly to our finding for the case of Cournot competition, risk aversion and uncertainty increase the incentives to merge when firms compete in prices.

To understand the effect on consumer welfare, note that consumers are subject to risk in this case, unlike in the other three cases analyzed earlier. As shown below, consumers are made worse off if they are risk neutral. For this case with risk-neutral consumers, the expected consumer welfare is a rigorous measure of consumer welfare (see Stennek, 1999). Given that expected consumer is equal to

$$E(CS) = \frac{1}{2}\left(\sum_{i=1}^{n} bE(x_i)^2 + \sum_{j\neq i} dE(x_i)E(x_j)\right) + \frac{1}{2}n\sigma^2(b + d\rho(n-1)),$$

we can use the first term to determine the effect of a merger. Consumers are then concerned only about the changes in the expected quantities and therefore in the differences in prices. Because both the insiders and outsiders set higher prices as a result of the merger, the expected consumer welfare is lower and consumers are worse off.

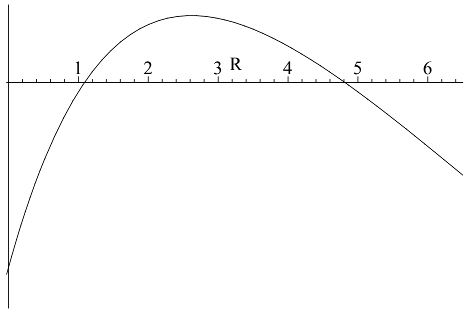

FIGURE 1A. SOCIAL CONSEQUENCES OF A MERGER IN A BERTRAND MARKET WITH DEMAND UNCERTAINTY

Social welfare may increase, but more risk aversion does not necessarily lead to higher welfare. To see this, consider the example $n = 10, k = 2, \beta = 10, \gamma = 1, \sigma^2 = 1$, and $\rho = 0$, illustrated in Figure 1A. The figure plots the change in expected social welfare after a merger as a function of the level of risk aversion, R. Note that the loss in consumer surplus is higher than the increase in the firms' expected utility when the level of risk aversion is intermediate.

Appendix B: Proofs

Proof of Proposition 1. All but the main shareholder should receive the same ownership, $\tau_j = \frac{1-\tau_l}{k-1}$ for all $j \neq l$, reducing as much as possible $\Sigma_{t=1}^{k} \tau_t^2$ without affecting production decisions. Therefore we will have that $\Sigma_{t=1}^{k} \tau_t^2 = \tau_l^2 + (k-1)\frac{(1-\tau_l)^2}{(k-1)^2} = \frac{k\tau_l^2 - 2\tau_l + 1}{k-1}$. Substituting (8) and (9) into (2) we have that

$$U^*(\tau) = \frac{a^2[S - d(n-k)]^2 \left[P + R\sigma^2(1 + \rho(k-1)) \frac{(1-\tau)(k\tau - 1)}{k-1} \right]}{2[SP - d^2(n-k)k]^2} \quad \text{(B1)}$$

and

$$\frac{\partial U^*(\tau)}{\partial \tau} = \frac{a^2[S - d(n-k)]^2 R\sigma^2(1 + \rho(k-1))B(\tau)}{2[SP - d^2(n-k)k]^3},$$

where

$$B(\tau) = \frac{2k(1-\tau)}{k-1}[SP - d^2(n-k)k] - 2S\left[[P + R\sigma^2(1 + \rho(k-1)] \frac{(1-\tau)(k\tau - 1)}{k-1} \right].$$

Because $B(\frac{1}{k}) \leq 0$ and $B'(\tau) < 0$ for $\tau \in [1/k, 1]$, we have that $\partial U^*(\tau)/\partial\tau < 0$ and the optimal sharing rule is a merger of equals or $\tau^* = 1/k$. Substituting into (B1), we obtain

$$U^* = \frac{a^2[S - d(n-k)]^2 P}{2[SP - d^2(n-k)k]^2}, \tag{B2}$$

as was to be shown. □

Proof of Proposition 2. Substituting $\tau^* = \frac{1}{k}$, and denoting for simplicity $r \equiv R\sigma^2$ and $d = 1$ (equivalent to a change of units), the difference in utility due to a merger can be obtained by subtracting (B2) with $k = 1$ to the same expression for a general k, or

$$\Delta U^* = \frac{a^2[S - (n-k)]^2 P}{2[SP - (n-k)k]^2} - \frac{a^2[S - (n-k-1)]}{2[S+k]^2}.$$

The merger is profitable whenever $F(n, k, r) \equiv [S - (n-k)]^2 P[S + k]^2 - [S - (n-k-1)][SP - (n-k)k]^2$ is positive. In what follows we are going to show that for any (n^*, k^*, r^*) such that $F(n^*, k^*, r^*) = 0$, the merger is profitable whenever $n < n^*(k^*, r^*)$ and $\partial n^*(k^*, r^*)/\partial r > 0$. Higher levels of risk aversion, *ceteris paribus*, enlarge the region where mergers are profitable and therefore increase the incentive to merge. For notational simplicity, we dropped the arguments of the functions $S(n, k, r)$ and $P(n, k, r)$.

We start by identifying the combinations (k^*, r^*) for which n^* such that $F(n^*, k^*, r^*) = 0$ exists. $F(n, k, r)$ is a quadratic function in n with the following properties, $F(k, k, r) = \frac{(k-1)}{k} S^2 P[(2+r)r + k(k-1)] > 0$, $\frac{\partial F(k,k,r)}{\partial n} \equiv G(k, r) = \frac{(k-1)}{k} 2SP[(2+r)r - k]$ and also $\partial^2 F(n, k, r)/\partial n^2 \equiv H(k, r) = 2[S^2 P - (S+1)(P-k)^2]$. Because we have that $H(k, 0) = -4k(k-1) < 0$ and $\partial^2 H(k, r)/\partial r^2 = 4(k-1)(2k^2 + 2 + 3r)/k > 0$ for any r, there exists a unique $\hat{r}(k)$ such that $H(k, r) > 0$ if and only if $r > \hat{r}(k)$. If we show that whenever $r > \hat{r}(k)$ we also have that $G(k, r) > 0$, then there is no $n^*(k, r)$ such that $F(n^*, k, r) = 0$ (and therefore for any n the merger is profitable), whereas if $r < \hat{r}(k)$, then there exists a unique $n^*(k, r)$ such that $F(n^*, k, r) = 0$ (and therefore the merger is profitable only if the industry is concentrated, i.e., when n is small).

We have that $G(k, r)$ is positive if and only if $r > \tilde{r}(k) = \sqrt{k+1} - 1$. Because we have that $H(k, \tilde{r}(k)) = -2(k-1)(k+1)(\sqrt{k+1} - 1) < 0$ we have that $\tilde{r}(k) < \hat{r}(k)$. Hence, for any r such that $r > \hat{r}(k)$ (i.e., $H(k, r) > 0$) we have that $r > \tilde{r}(k)$ (i.e., $G(k, r) > 0$).

Take now (k^*, r^*) such that $r^* < \hat{r}(k^*)$. Because $F(n, k^*, r^*)$ is a concave function in n with $F(k^*, k^*, r^*) > 0$, we have that there exists a unique n^* such that the merger is profitable whenever $n < n^*(k^*, r^*)$. It remains to be shown that for $r^* < \hat{r}(k^*)$ we have that $\partial n^*(k^*, r^*)/\partial r > 0$. By the implicit function theorem, $\partial n^*(k^*, r^*)/\partial r = -\frac{\partial F(n^*,k^*,r^*)}{\partial r} / \frac{\partial F(n^*,k^*,r^*)}{\partial n}$. The denominator is negative because $H(k^*, r^*) = \partial^2 F(n, k^*, r^*)/\partial n^2 < 0$ for any n, and as shown above, for any $(k,\ r)$ and in particular for (k^*, r^*), $F(k^*, k^*, r^*) > 0$. It can be verified algebraically that the numerator, $\partial F(n^*, k^*, r^*)/\partial r > 0$, is positive. □

Proof of Proposition 3. Outsiders' utility and consumer surplus are computed as insiders' utility in the previous propositions. Denoting again for simplicity $r \equiv R\sigma^2$ and $d = 1$, social welfare is

$$W^* = k\frac{a^2[S-(n-k)]^2 P}{2[SP-(n-k)k]^2} + (n-k)\frac{a^2[P-k]^2[S-(n-k-1)]}{2[SP-(n-k)k]^2} + \frac{a^2[k[S-(n-k)]+(n-k)[P-k]]^2}{2[SP-(n-k)k]^2}.$$

Proceeding in a similar way as in the proof of the previous proposition, we can obtain the change in welfare due to a merger, ΔW^*. By eliminating the denominator, we construct a function $L(n, k, r)$ such that mergers are welfare enhancing if and only if this function is positive. Suppose that there exists (n^*, k^*, r^*) such that $L(n^*, k^*, r^*) = 0$. It can be verified algebraically that $\partial L(n^*, k^*, r^*)/\partial r > 0$. By the implicit function theorem we have that $\operatorname{sgn} \partial n^*(k^*, r^*)/\partial r = -\operatorname{sgn} \partial L(n^*, k^*, r^*)/\partial n$ and therefore, the region where mergers are welfare enhancing is increased. If $\partial L(n^*, k^*, r^*)/\partial n < 0$, then the region where $n < n^*(k^*, r^*)$ (mergers are welfare enhancing) is larger when r is increased because $\partial n^*(k^*, r^*)/\partial r > 0$. If instead $\partial L(n^*, k^*, r^*)/\partial n > 0$, the region where $n > n^*(k^*, r^*)$ (again where mergers are welfare enhancing) is larger when r is increased because $\partial n^*(k^*, r^*)/\partial r < 0$. □

Proof of Proposition 4. All but the main shareholder should receive the same ownership, $\tau_j = \frac{1-\tau_l}{k-1}$ for all $j \neq l$, reducing as much as possible $\Sigma_{t=1}^{k} \tau_t^2$ without affecting production decisions. Therefore we will have that $\Sigma_{t=1}^{k} \tau_t^2 = \tau_l^2 + (k-1)\frac{(1-\tau_l)^2}{(k-1)^2} = \frac{k\tau_l^2 - 2\tau_l + 1}{k-1}$. Substituting (15) and (16) into (2) we have that

$$U^*(\tau) = \alpha^2[\beta + (\beta+\gamma)(1+\beta R\sigma^2)](\beta - (k-1)\gamma) \times \frac{2 + L\left(\tau(2-\tau) - \dfrac{(\tau-1)^2}{k-1}\right)}{2(M(1+\tau L)+N)^2}.$$

We have that $\frac{\partial U^*(\tau^*)}{\partial \tau} = 0$ where

$$\tau^* = 1 - \frac{(k-1)}{k}\frac{M(1+L)+M}{M(1+L)+N}, \tag{B3}$$

and $\partial^2 U^*(\tau^*)/\partial\tau^2 < 0$. Because $M > 0$, $N > 0$, and $L > 0$ we have that $\tau^* < 1$ and because $N - M = \gamma^2 k(n-k)(1+\beta R\sigma^2) > 0$ (i.e., $N > M$), we have that $\tau^* > \frac{1}{k}$. □

Proof of Proposition 5. The proof follows the same arguments used in the proof of Proposition 7 reported above. □

Proof of Proposition 6. If we show that $D(R\sigma^2) = R\sigma^2[1-\tau^*(R\sigma^2)]$ is an increasing function of $R\sigma^2$ and that $\lim_{R\sigma^2\to\infty} D(R\sigma^2) = +\infty$ (clearly $D(0) = 0$), then there should exist a unique $\widehat{R\sigma^2}$ where $D(\widehat{R\sigma^2}) = \widehat{R\sigma^2}[1-\tau^*(\widehat{R\sigma^2})] = \gamma(k-1)/\beta[\beta-\gamma(k-1)]$ such that if $R\sigma^2 < \widehat{R\sigma^2}$ then $D(R\sigma^2) < \gamma(k-1)/\beta[\beta-\gamma(k-1)]$ and by (17) both insiders and outsiders increase prices, whereas if $R\sigma^2 > \widehat{R\sigma^2}$ then $D(R\sigma^2) > \gamma(k-1)/\beta[\beta-\gamma(k-1)]$ and again by (17) both insiders and outsiders reduce prices.

We have seen in the proof of Proposition 4 that we can write $N - M = a_1 + a_2 R\sigma^2$ with $a_1 > 0$ and $a_2 > 0$. Hence, from (B3) we can write $1-\tau^*(R\sigma^2) = \frac{(k-1)}{k}\frac{O(R\sigma^2)}{O(R\sigma^2)+a_1+a_2R\sigma^2}$ where $O(R\sigma^2) = M(1+L)+M$ is a polynomial function with all coefficients in $R\sigma^2$ positive. It follows then that $R\sigma^2 O'(R\sigma^2) > O(R\sigma^2)$. Hence $1-\tau^*(R\sigma^2)$ is increasing, $\frac{\partial}{\partial R\sigma^2}(1-\tau^*(R\sigma^2)) = \frac{(k-1)}{k}\frac{O'(R\sigma^2)(a_1+a_2R\sigma^2)-O(R\sigma^2)a_2}{(O(R\sigma^2)+a_1+a_2R\sigma^2)^2} > 0$ because $O'(R\sigma^2) > 0$. It follows that $D(R\sigma^2)$ is the product of two positive and increasing functions of $R\sigma^2$ and therefore it is an increasing function of $R\sigma^2$. Moreover, because $1-\tau^*(R\sigma^2)$ is bounded above we have that $\lim_{R\sigma^2\to\infty} D(R\sigma^2) = R\sigma^2[1-\tau^*(R\sigma^2)] = +\infty$. □

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