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MULTIMARKET CONTACT AND SALES GROWTH: EVIDENCE FROM INSURANCE

HENRICH R. GREVE*
INSEAD, Singapore

Research on pricing, profits, and firm survival has shown that multimarket contact causes mutual forbearance against competition, but has not considered the consequences of imperfect observability of competitive moves. Here, predictions are developed to explain how mutual forbearance occurs—but sometimes fails—in markets with imperfect observability. Mutual forbearance means that firms do not seek to take market share from each other through price cuts or nonprice competition, and thus that sales grow at uniform rates. Firms defect from mutual forbearance, and hence have higher sales growth, if the potential rewards are high and the likelihood of being discovered is low. This theory is tested on a panel of firms operating in the Norwegian general insurance industry. The evidence suggests that sales growth is most rapid in firms that do not meet many multimarket competitors in a given market and firms that are economically troubled. Growing or highly concentrated markets have higher heterogeneity of growth rates. Copyright © 2007 John Wiley & Sons, Ltd.

INTRODUCTION

Many firms meet their competitors in multiple markets, which means that markets are overlaid with a web of multimarket contacts among firms. Multimarket contacts give managers experience with the competitive behaviors of other firms and allow competitive responses across markets, which can cause firms to mutually forbear from competing (Edwards, 1955; Karnani and Wernerfelt, 1985; Bernheim and Whinston, 1990; Scott, 1991). Interest in how multimarket contacts alter firm behaviors has led to a broad range of empirical work (Scott, 1993; Baum and Greve, 2001). The evidence has developed from an initial mix of supportive and contradictory findings (e.g., Scott, 1982; Mester, 1987) to a largely consistent body of work showing that multimarket contacts lead to mutual forbearance. Firms with multimarket contacts raise prices (Evans and Kessides, 1994; Singal, 1996; Jans and Rosenbaum, 1996; Gimeno and Woo, 1996; Barros, 1999) and have higher profits and survival rates (Scott, 1991; Barnett, Greve, and Park, 1994; Baum and Korn, 1999; Pilloff, 1999; Haveman and Nonnemaker, 2000; Gimeno, 2002; Li and Greenwood, 2004).

Theoretical modeling of mutual forbearance has produced an asymmetry result. A collusive equilibrium can be held in place by the threat of retaliation in multiple markets if the firms have different costs or the markets have different numbers of firms or growth rates (Bernheim and Whinston, 1990), but is not possible if the markets and firms are identical. Such asymmetries give firms the ability to transfer incentive constraints across markets and thus to punish defections from collusive equilibria.

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*Correspondence to: Henrich R. Greve, INSEAD, 1 Ayer Rajah Avenue, 138676 Singapore. E-mail: henrich.greve@insead.edu

Some writers regard asymmetry as a plausible condition for mutual forbearance (Evans and Kessides, 1994; Singal, 1996), and it has received support in experiments (Phillips and Mason, 1992). Others view it as strict and have argued that weaker conditions suffice (Spagnolo, 1999; Scott, 2001), and experiments have also shown that mutual forbearance can occur in markets that do not have this structure (Phillips and Mason, 2001).

A distinct feature of this model is its full observability condition, where defections from the equilibrium are always detected and punished (Bernheim and Whinston, 1990). This means that the focus of the modeling is not whether defections from a collusive equilibrium can be detected or not (they always are), but instead whether there is sufficiently strong punishment to deter defections. In many markets, however, prices are difficult to observe or are combined with nonprice competition through service and product features that are difficult to evaluate. Because it assumes full observability, the usual model of multimarket competition and its predictions do not apply in markets with imperfect observability.

The perfect-observability model fits many of the markets that have been studied empirically. Computerized ticketing systems allow easy observation of pricing in airline markets, which is an important context for studying multimarket competition (Evans and Kessides, 1994; Singal, 1996; Gimeno and Woo, 1999; Gimeno, 1999). In banking, multimarket effects have been seen in consumer lending prices (Barros, 1999; Feinberg, 2003), which are advertised to consumers and are easy to observe because multimarket banks tend to have uniform prices across branch locations (Hannan and Prager, 2004). It is not surprising that in these industries, evidence of mutual forbearance can be obtained both directly through inspection of prices and indirectly through examining profit and survival (Barnett *et al*., 1994; Gimeno and Woo, 1999). Researchers' fondness for markets with easily available price data suggests a potential bias in the empirical record, however, because it means that tests of the mutual forbearance hypothesis are disproportionately from markets that fulfill the perfect-observability assumption.

There is a model of multimarket competition that assumes imperfect observability and still yields mutual forbearance, but for a different reason than the full observability model (Matsushima, 2001). If markets are so noisy that defections from a collusive equilibrium are not obvious, then multimarket contacts can hold a collusive equilibrium in place by making it easier to detect that a competitor defects. This conclusion does not require that the markets are structurally different, only that they are stochastically independent. However, this model has not been tested empirically.

Because the perfect and imperfect observability accounts of multimarket effects on mutual forbearance are different, evidence of multimarket effects in perfect observability contexts is not transferable to imperfect observability contexts. Empirical testing in contexts with less observable pricing or quality is needed in order to establish whether mutual forbearance results from multimarket contacts in such markets as well. Observation of the prices and quality offered by competitors is difficult or costly in a wide range of markets, so the strategic significance of multimarket contacts is not well known until the imperfect observability context has been studied empirically. The quandary is that prices and quality in imperfect observability contexts are, of course, imperfectly observable, which precludes testing of mutual forbearance through price analysis. An alternative approach is needed. Clearly, mutual forbearance will increase profitability, but profitability is determined by so many other factors that it is a less direct measure of mutual forbearance than market behavior. A particular threat against inference from firm profits is that firms receiving high profits from mutual forbearance in their core markets may squander them through increased costs or ill-conceived market entries, while firms that have slimmer margins will be more frugal.

The key to testing for mutual forbearance in such markets is that imperfect observability models are based on equilibria in which the players are tempted to defect by offering a higher volume of goods than the collaborative multimarket equilibrium calls for, and thus obtain higher total profits (Matsushima, 2001). Defection is observable through heterogeneity in the sales growth because firms that collaborate will see uniform sales growth, while firms that defect will grow faster. Defections have higher expected profits for firms with fewer multimarket contacts, as they are detected with greater difficulty for such firms. Thus, firms with fewer multimarket contacts will defect more often. Also, defections are more profitable in markets in which the overall level of collusion is higher, so they are more likely in such markets. Hence, imperfect-observability models predict which firms are more likely to defect and which market structures will see more defections, and these defections can be observed through study of the sales growth rates of firms. Conversely, because collaboration in a mutual forbearance market is sustained through the threat of retaliation against firms that make aggressive competitive moves, high sales growth is a risky outcome for the firm, and thus not likely to occur unintentionally. Thus, in order to explore the imperfect observability model of multimarket competition, it is necessary to return to the original approach of analyzing how mutual forbearance affects market stability (e.g., Heggestad and Rhoades, 1978).

The empirical test uses a panel dataset of Norwegian general insurance firms. Insurance has significant leverage for imperfectly observable competitive moves, and thus fits the model. Like other markets used for multimarket research, insurance has a comparatively stable technology and environment, which means that the interfirm competitive moves have a large effect on the sales growth relative to other factors such as technological capabilities or environmental fluctuations. Multimarket research often chooses such contexts in order to isolate the effects of mutual forbearance from other influences on the outcomes.

BACKGROUND

Collusion under imperfect observability

Theory of mutual forbearance in multimarket contexts can be derived from either fully or boundedly rational models, and in both cases the theory rests on two key insights (Karnani and Wernerfelt, 1985; Bernheim and Whinston, 1990): First, mutual forbearance is the best collective outcome for the firms because it offers higher prices, and it may also result in lower costs as firms use less resources on competitive attacks and counterattacks. Second, mutual forbearance is not necessarily the best outcome for an individual firm, as an inflated price level and complacent competitors offer opportunities for profitable growth through undercutting the others. Hence, the focus of mutual forbearance theory is how the firms can maintain the desired collective outcome through some set of plausible threats against firms that pursue individual profit maximization. Multimarket contacts accomplish this when each firm is in a position to threaten a competitor with retaliation in selected markets, and also puts itself at risk of retaliation, making defection from the mutual forbearance unprofitable (Edwards, 1955; Bernheim and Whinston, 1990). When the web of multimarket contacts leaves all firms vulnerable to retaliation, there are incentives to not initiate aggressive competitive actions and common knowledge of these incentives so that aggressive competitive actions are not initiated by mistake.

A key assumption of the standard mutual forbearance model is that firms can tell when other firms initiate aggressive competitive actions by observing prices or other behaviors such as building plants, launching new products, or initiating larger than usual marketing campaigns (Karnani and Wernerfelt, 1985). However, firms can defect through a number of imperfectly observable competitive moves. For example, they can make small price decreases (when prices are difficult to observe) or small quality or service increases (when these are difficult to observe), and they can make these changes to a subset of the customers rather than to all in order to make detection more difficult. Stealthy attacks that are difficult to observe or have an ambiguous interpretation are less likely to draw a response (Chen and Hambrick, 1995). Hence, there is a temptation to chisel by pretending to participate in mutual forbearance while using the available opportunities to increase profits through stealthy competitive attacks, which creates a need for theory predicting firm behaviors under imperfect observability.

The model of mutual forbearance under imperfect observability is a two-player repeated prisoner's dilemma (Matsushima, 2001). It can be justified as a quantity-setting oligopoly where cooperation is to supply a small quantity and defection is to supply a large quantity. The players meet in m markets. The quantity supplied is not observable by the other player, but players can observe a stochastic public signal with probabilities dependent on the players' actions. The key to sustaining collaboration is that a player sets a threshold number of markets (r) in which to observe the signal that is more likely when the opponent has defected, and starts punishing in all markets in the period after observing at least the threshold number of apparent defections. Each player must then consider whether it is optimal to not defect in any market, to defect

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in some number of markets k, or to defect in all markets. The firms use a discount rate to compare profits occurring in different periods. The cost of being punished increases in m, while the probability of initiating punishment increases in k and decreases in r. Matsushima (2001) proved that the optimal number of markets in which to defect becomes zero if the multimarket contact (m) is sufficiently high. It is a key feature of the model that the number of markets in which the firms meet determines the cooperative equilibrium, as more markets give the players greater ability to observe the other and greater stake in the cooperative equilibrium.

This model is an improvement on earlier models of multimarket competition because it permits imperfect observability of defections, which is realistic and less restrictive than assuming perfect observability. However, the same imperfect observability represents a challenge for testing the model. Because of the great variety of imperfectly observable competitive moves that are available, the only generic outcome that can be predicted is that these competitive moves will cause an increase in sales as customers switch from the competitors' offering to that of the focal firm. Hence, the prediction from the imperfect observability model is that firms with fewer multimarket contacts have higher sales growth. The sales growth of the firm that defects is also a good candidate for a signal that can help competitors discover that it has defected, though other signals such as high profits for the defecting firm or low profits for the competitor are also possible. If these signals are detected with difficulty or may be attributed to other factors than a defection, such as random variation or customer decisions outside the firm's control, then there is a chance that the defection will not be noticed.

Because the model is one of two players, it is not immediately applicable to empirical contexts, which usually have more than two firms with multimarket contact. Extending the model beyond the two-player structure is necessary, and can be done by reformulating the multiplayer context as a set of games between pairs of players. To see how, consider Firm A, which meets multiple competitors in its markets. The key step in analyzing multimarket games under imperfect observability is to consider Firm A's incentive to defect from the collaborative outcome in one or more markets. Figure 1a shows the two-player situation in which Firms A and B overlap in markets 1 through m. Firm A considers defecting in k markets, and knows that Firm B will punish if it observes the defection signal in r markets. The markets are noisy, so the defection signal is triggered in non-defection markets with probability p_n and in defection markets with probability p_d, such that $0 < p_n < p_d < 1$. Firm A decides the optimal number of markets in which to defect by taking into account the excess profits of defecting, the likelihood of being discovered, and the cost of the punishment if B discovers the defection.

In Figure 1b we extend the model by introducing Firm C, which has the same market overlap as Firm B. Will this change Firm A's analysis? Clearly, defecting against B is the same as defecting against C because they are in the same market. It is possible to construct a collusive equilibrium so that the benefits of defecting and costs of punishment are made the same in each game. If the probability of detection by each firm does not change, then the two games against two opponents yield exactly double the costs and benefits of the single game against one opponent, which means that the addition of an identical competitor does not

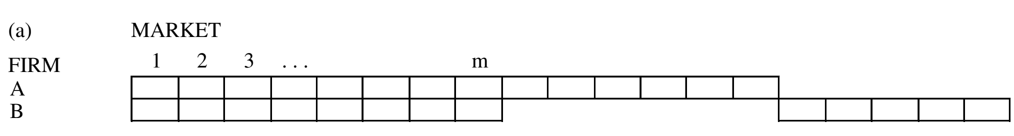

Figure 1a. Two-player game

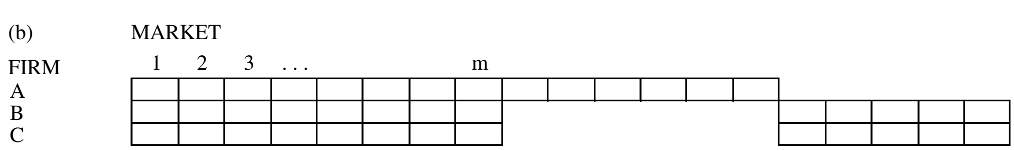

Figure 1b. Game against two identical opponents

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affect A's decision. Its behavior against two identical opponents is the same as its behavior against a single opponent. This construction is unrealistic, however, because it assumes that the likelihood of detection is unchanged if a firm is added. It is more realistic to assume that B and C can independently discover defections (possibly with a correlation), and that each of them will understand that a defection has occurred by observing that the other punishes. Hence, an additional multimarket contact in the market increases the probability of defections being discovered. By that reasoning, it is possible to have levels of pairwise multimarket contact m_{AB} and m_{AC} that are individually too small to make the optimal number of defections be zero, but are jointly sufficient. Also, as long as each firm observes that the other punishes and joins the punishment, m_{AB} and m_{AC} do not have to be equal. When the pairwise multimarket contact is different, the trigger levels of observed defections (r_{AB} and r_{AC}) will also be different because they are optimally set as a function of the multimarket contact. A player requires fewer defection signals in order to judge that a defection has occurred if its level of multimarket contact is low.

Now consider a situation in which multiple firms have multimarket contact with A, and the level of contact differs across markets, as in Figure 1c. Firm A wants to estimate the probability that at least one of its multimarket contacts i will see r_{Ai} defection signals and initiate punishment. Having a different number of multimarket contacts in each market gives an additional lever for designing an optimal defection strategy, because now Firm A can choose the optimal markets in which to defect. Punishment is initiated when any one competitor i observes r_{Ai} defection signals, so the probability of a single defection being detected is lower when there are few multimarket contacts in the market. Thus, from the viewpoint of making a defection less visible, the most promising market in the figure is market 7, which has only one multimarket contact. Thus, a parallel result to Matsushima (2001) is obtained. In his model, defection is more likely when two firms have contacts in fewer markets, while in this extended model, defection is more likely when a firm has multimarket contact with fewer firms in the focal market.

Deciding the target markets for defection based on the number of multimarket contacts assumes that the magnitude of punishment is the same regardless of where a defection is observed, so that only the probability of detection varies. Some punishment schemes have this feature. For example, price wars spill across markets if each multimarket contact punishes for *n* periods in all its markets, and all their contacts react by punishing for *n* periods in all their markets. This punishment scheme works even if the firms do not know the identity of the firm that originally defected, but more targeted punishment is possible if the firms can communicate the target of their punishment. Research on competitive dynamics often finds that press sources identify whether competitive moves are responses to specific competitors (e.g., Chen and Hambrick, 1995), suggesting that such communication occurs. Thus, from the lower probability of detection and the unchanged cost of being discovered, we can deduce that defection is more likely in markets where the focal firm has few multimarket contacts. This leads to:

Hypothesis 1: The firm's multimarket contact in a focal market is negatively related to its sales growth in the same market.

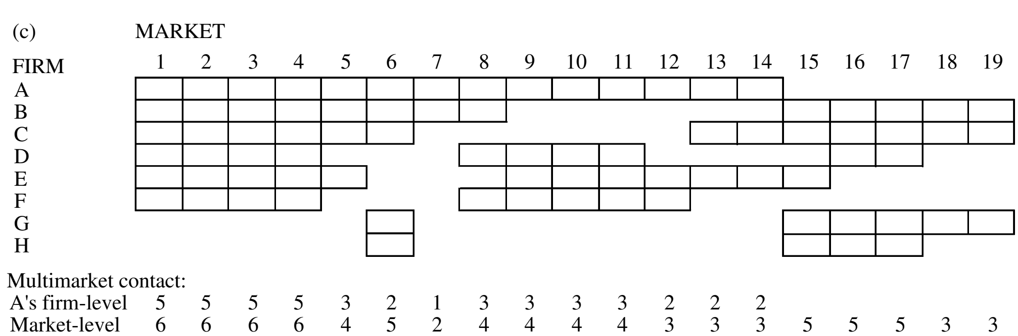

Figure 1c. Game against seven different opponents

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We can make an additional hypothesis by considering how much room there is for undercutting the competitors through imperfectly observable competitive moves such as a price reduction or value increase. For simplicity, we argue this point from the viewpoint of a price change. An optimal defection from mutual forbearance must be small enough to be difficult to detect by the competitors, large enough to induce customers to move from the competitors, and small enough to leave the firm with more profit than it would have had by not defecting. The last of these conditions implies that the temptation to defect is greater if the mutual forbearance leads to a price much higher than the competitive price, because that will give greater profit increase for a given sales increase. A mutual forbearance price barely above the competitive price does not leave room for profitable price decreases, but as the gap between the mutual forbearance price and the competitive price increases, it becomes more profitable to undercut it.

The gap between the mutual forbearance price and the competitive price is a result of the overall level of multimarket contact in the market. When considering how much to raise the price over the competitive equilibrium, managers take into account that a higher price level will give greater incentives to defect, which means that stronger punishment is required to prevent defection. More multimarket contacts in a given market give a greater likelihood that defection will be observed, so if the punishment strength is kept constant, the expected punishment for a defection is stronger the more multimarket firms are in a market. Hence, a higher price can be sustained when the participating firms have sufficiently many multimarket contacts that their managers are confident of discovering defectors.

This argument can be illustrated through inspection of Figure 1c. We have already found that the level of collaboration among the firms depends on how many other firms with multimarket contacts are present because other firms are 'eyes on the market' that decrease the likelihood of defections. Taking that into account, the profit-maximizing mutual forbearance strategy is not a uniform price increase across all markets, but greater price increase in markets with many firms engaged in multimarket contact. This strategy, however, can tempt firms with comparatively fewer multimarket contacts to defect. These firms can exploit the fact that other firms set the price level high in recognition of the many multimarket contacts that they have in the market, leaving an opening for firms with fewer multimarket contacts to defect with lower likelihood of detection. In Figure 1c, the markets in which Firm A has two multimarket competitors differ in the extent to which they contain multimarket relations that Firm A is not a part of. In market 6, Firm A's multimarket contacts are Firms B and C, while Firms G and H have only a single contact point with Firm A. Firms G and H have multimarket contact with Firms B and C, however, resulting in a total of five firms with some multimarket contact in this market. The high number of firms with multimarket contact in market 6 results in a high overall level of collusion, so market 6 is the most promising place to defect among the markets in which Firm A has two contacts. The other markets only have the multimarket contacts in which Firm A participates, and are thus less promising. The general hypothesis is:

Hypothesis 2: The market-level multimarket contact is positively related to the firm's sales growth in the focal market.

Finally, we can make a third prediction by assuming that the combination of low observability and high potential profits is more powerful than each one in isolation. If this is true, then an interaction of the firm-level multimarket contact and the market-level multimarket contact should have a negative effect on the firm's sales growth as a result of firms being especially prone to defect when the rewards are great and the potential for discovery is small. The prediction is:

Hypothesis 3: A firm with low level of multimarket contact in a focal market combined with high level of market-level multimarket contact will have high sales growth in the focal market.

These hypotheses are based on the model in Matsushima (2001), but are novel extensions of the model. The theory is more suitable for real markets than the original model, but is still simplified because it considers only the multimarket competition, and not other factors that increase or decrease the potential collusion in a given market. This introduces two important considerations for the analysis. First, single-market competitors could compete fully in each market, resulting in

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less mutual forbearance than one would expect from the level of multimarket contact alone. Such competition would make defections less attractive by reducing the potential reward from defecting. Second, high market concentration raises prices as a result of within-market collusion. If competition is reduced yet more as a result of multimarket contact, the prices become so high that they tempt firms to defect more than would be predicted from the level of multimarket contact only. Both of these considerations are modeled in the analysis. In addition, a separate analysis of single-market competitors is conducted in order to examine whether they react differently to market-level multimarket contact than multimarket firms do. Such an analysis is theoretically interesting because it is possible that single-market firms participate in the collusion, which would make them react similarly to multimarket contact as multimarket firms do.

It is important to emphasize three features of the theory presented here. First, it is a novel and untested theory of mutual forbearance, and the only model of mutual forbearance that applies to markets with imperfect observability. Hence, empirical testing is needed. Second, the predictions made here required some theory extensions and additional assumptions in order to go beyond the two-player structure of the theory. It would be possible for the basic theory to hold but these hypotheses not to be supported. Specifically, all three hypotheses rely on the focal firm finding the optimal defection (if there is one—the model predicts that no firm will defect if the firm-level multimarket contact is sufficiently high). Hypotheses 2 and 3 additionally require firms to set an optimal level of mutual forbearance given the number of multimarket competitors present. Either of these assumptions could be incorrect under bounded rationality. However, the strategizing requires no more complex mental operation than a count of multimarket competitors, which puts it within reach of boundedly rational managers as well as fully rational ones. Mistakes in the strategy, such as defecting when it is not optimal or failing to defect when it would have been optimal, will enter the error term of the analysis.

Third, this theory focuses exclusively on the probability of detection as the mechanism driving the decision to defect, and assumes constant punishment strength when a defection is discovered. This is different from the usual multimarket models, which assume that greater level of multimarket contact increases punishment strength as well. The predictions would still hold true if punishment strength also affected the reaction, however, because in each hypothesis the increase in multimarket competitors that increases the *expected* punishment (holding punishment strength constant) would also increase the punishment strength. The main difference is that the present theory is operationalized differently because detection likelihood is a function of the number of multimarket contacts, while punishment strength is a function of the extent of their market overlap. However, it is possible to construct measures that weigh these two mechanisms, and the Methods section reports an additional analysis with such a compound measure.

The general insurance industry

The general insurance industry is a good example of markets with imperfect observability of prices. On the surface it appears easy to observe pricing because the products are standardized and the pricing follows actuarial principles. Indeed, in some legislative regimes the pricing is made public by regulations requiring filing of price schedules (e.g., in Canada, Li and Greenwood, 2004). However, even when prices are posted there is imperfect observability as a result of the risk evaluations. Insurance markets involve risk evaluation of the insured object (and its user and use) as a part of the price setting. This evaluation leads to a risk assessment, which is private to the firm, and a corresponding price, which may be known, and thus observation of the price relative to the risk classification is imperfect. For example, ship insurance involves judgment of the ship's condition and the risks of its use, and machine insurance involves judgment of the stoppage or damage risks for a given machine in a given factory. In insurance markets for business customers, which constitute most of the niches in the data, such assessments are made at levels of fineness that can go as far down as the individual asset. The assessor expertise is to some extent shared across firms, as each firm participating in a given market needs staff that can make risk classifications, but classification is costly and involves some individual judgment, which complicates the task of discovering whether

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a given competitor is undercutting prices relative to how it evaluates the risks.

Despite this imperfect observability, insurance firms collaborate extensively in pricing. In order to obtain accurate risk estimates, they pool information on past insurance objects and damages. In many legal environments, they are allowed to set uniform prices through rate pools, which are price agreements that can be nonbinding or binding depending on the legislation. Price agreements break down and are cheated on with some frequency, however, as firms may withdraw from rate pools, or may claim to stay in the pool but secretly price below it (Schneiberg and Bartley, 2001). Hence, the complications in judging prices relative to costs are reflected in the instability of legal price agreements.

These data are from Norway, which allowed voluntary and nonbinding price agreements during the study period. Agreements were subject to inspection and could be ruled illegal if they resulted in too high prices, which is the same as the partial rate control system used to govern insurance in many U.S. states (Schneiberg and Bartley, 2001; Schneiberg and Soule, 2005). Other systems are full rate control governed by a state insurance board or unregulated rates with a ban on price agreements. All these systems have been used in some states in the United States (Schneiberg and Bartley, 2001), so the legislative environment of insurance is considerably more heterogeneous in the United States than in Norway. All three systems leave enough room for unobserved price-quality changes to be suitable for testing these hypotheses, but full rate control may constrain individual firm strategies more than the other two systems.

As one would expect from these competitive conditions, the annual reports of the Insurance Association in Norway often mentioned establishment or breakdown of price agreements in individual insurance markets, as well as cases of individual firms entering or leaving agreements. They also report bouts of aggressive competition, as when firms in the automobile insurance market eliminated the higher prices for young drivers in 1982. The prices were higher for a good reason—young drivers have more accidents—and the elimination was a way of fighting for market share in the younger and more mobile customer segment (the price difference was later reinstated). The annual reports also record attempts to defuse competition, as when firms reacted to a 1984 breakdown in the price agreement for industrial fire insurance by offering more complex insurance products that induced their customers to select insurer based on product features rather than direct price comparison. Insurance firms can compete on price, but can also manipulate the terms of insurance in order to alter the intensity of competition.

Most general insurance firms insure risks associated with damage to the production equipment of firms. For example, maritime insurance has niches for protection and indemnity (P&I; damage done by the ship to others), ship loss/damage, cargo loss/damage, and fishing (loss/injury to vessel, gear, and crew). Businesses buy machine insurance, protection and indemnity, and fire insurance, and individual consumers buy fire, burglary, automobile, and other insurance policies. General insurance firms vary widely in the range of markets covered and the particular markets occupied by multimarket firms, but overall there is significant multimarket contact. Because the markets have different demands, they fulfill the model's assumption of stochastic independence, which makes it easier for firms to observe defections.

Table 1 shows the markets in the data. For each market, the average number of firms, Herfindahl

Table 1. Insurance markets in the data

Market	Number of Firms	Herfindahl index	Multi-market firms
Fire	54.327	0.126	43.090
Storm damage	4.841	0.574	4.466
Water pipe damage	34.972	0.159	32.749
House fungus	3.200	0.817	2.200
Guarantee	33.247	0.168	31.428
Credit	37.678	0.201	31.753
Protection and indemnity	35.853	0.143	33.924
Glass	31.406	0.130	27.727
Livestock	12.797	0.389	8.346
Machinery	26.374	0.236	25.037
Rent	4.000	0.556	2.000
War	22.672	0.550	20.924
Automobile	42.711	0.092	37.247
Marine transport	95.758	0.056	40.941
Air transport	37.015	0.168	35.384
Medical	30.704	0.148	26.296
Accident/personal injury	36.007	0.132	33.899
Theft	24.687	0.142	23.896
Burglary	34.788	0.144	32.732
Reinsurance	14.312	0.445	12.647
Other	32.946	0.361	32.111

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index of sales concentration, and number of firms having multimarket contact with at least one other firm in the market are shown to give an indication of the potential for within- and across-market collusion. This classification of markets is used by the Insurance Council, which regulated the industry during the study period, but it still suffers from a shortcoming. Some markets in this classification have niches in which firms stake out spheres of influence (Gimeno, 1999), as in the different types of maritime transportation insurance noted above. This problem is serious for the residual category 'other,' which consists of exotic niches with few incumbents. The niches are generally more concentrated than the markets in the table, but data disaggregated to the niche level are not available. Niches imply that multimarket contacts may be less extensive than the measures indicate, because firms that appear to meet in a market may in fact be in different niches. The only adjustment done here was to remove the residual 'other' market when calculating multimarket contact measures, as other adjustments would have involved guesswork. Despite this problem, letting the market definition follow regulatory boundaries is common practice (e.g., Li and Greenwood, 2004), and has the important advantage that these are likely to influence managerial perceptions of competitive relations because the data availability makes reports on market shares easier to calculate from these market definitions than from more detailed niches. Indeed, data on market shares would probably not have been available if the regulating authority had not collected and published them.

The analysis considers product markets and not geographical markets. This differs from recent research on multimarket competition, which has favored contexts in which firm branches are represented in geographical markets, as in the studies of banking (Barnett *et al*., 1994; Haveman and Nonnemaker, 2000; Hannan and Prager, 2004; Fuentelsaz and Gomez, 2006), or contexts in which the product is linked to a location, as in the studies of airlines (Evans and Kessides, 1994; Gimeno and Woo, 1996; Korn and Baum, 1999). In some cases geographical and product markets have been considered jointly (Li and Greenwood, 2004), but evidence on mutual forbearance is currently so weighted toward geographical markets that more studies on product markets are needed as a balance. The theory of multimarket competition is sufficiently general to cover both cases, as the models make no special assumptions on why multiple markets exist.

Although there is a clear need for product market studies, the emphasis on product markets in this study is a reflection of the context. Insurance was regulated as a single national market, and firms generally had a national focus. Some firms deliberately kept a local focus, which affects the measures in the same way as niches in the product-market domain, as it leads to an underestimate of the market concentration and an overestimate of the multimarket contact faced by these firms. The local focus strategy was historically important because many firms followed it in the nineteenth century, but in the modern period insurance firms viewed it as incompatible with the requirements of obtaining an efficient scale and a diversified risk pool, so it is rare in the data. Some firms had international coverage through insuring merchant ships, which is an international market centered in the United Kingdom. The annual reports of the Insurance Association show close contact between United Kingdom and Norwegian maritime insurers regarding prices, so mutual forbearance took place in spite of the international market.

DATA AND METHODOLOGY

Sales data

The data on sales are taken from the yearbooks published by the Insurance Council, which was the regulator of the insurance industry in Norway until it was merged with other regulators of financial markets in 1986. All yearbooks from 1912 (volume 1) through 1986 (final volume) were obtained and used for data collection, and all firms under the supervision of the Insurance Council[1] were listed in the yearbooks, resulting in a wide and deep panel. There are 329 firms and 73 years in the data after omitting the first year to construct lagged measures of multimarket contact and assigning new firm numbers after mergers and acquisitions. The average number of markets covered by a given firm was 3.9. In total there were 30,175

[1] Insurance sold by firms not under Insurance Council supervision has two sources. One is that some rural communities had a special form of fire insurance mutual (a village fire mutual) that operated under a separate law. The other is that insurance could be purchased from foreign firms through domestic agents. A count of foreign firms operating in each market niche is entered into the model.

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observations before missing-data deletions. Sixty-nine observations were deleted because they were from monopoly markets and 37 observations were deleted because of missing data on the firm size, leaving 30,069 observations (firm-market-years). Sales are defined as revenue from own premiums, which equals premiums sold minus premiums reinsured and is the standard sales measure in the insurance industry.

Sales growth deviation

The dependent variable seeks to identify sales growth patterns that would occur as a result of firms defecting from a mutual-forbearance equilibrium. Although the folk theorem construction behind the limited-observability model of mutual forbearance allows multiple equilibria, it is likely that observed equilibria will seek to lock in place the preexisting market shares, as this structure conforms to equity norms and gives each firm a stake in the collaboration that is proportional to its size. In this equilibrium, each firm's sales growth is proportional to the growth of the focal market. Defection by a single firm will give it a higher growth rate and will give the other firms equal growth rates below the market growth rate. The difference between the focal firm growth rate in the market and the median growth rate of all firms in the market is positive for a firm that defects and zero for a firm that does not. The reason for preferring the median to the mean is that the expected difference between the focal firm rate of growth and the mean firm rate of growth is below zero rather than exactly zero for a firm that does not defect.

In real data, we cannot expect the difference from the median to be exactly zero for a non-defecting firm; nor can we expect that only one firm defects at a time. Neither issue poses problems for the analysis. The difference from the median for a cooperating firm is simply stochastic error that increases the standard error of the estimates but does not cause bias. Multiple defections lead to multiple firms with positive differences, but the median growth rate is still associated with a cooperating firm as long as fewer than half of the firms defect. A defection may trigger punishment, which is done by jointly lowering prices to the fully competitive level, and results in low and uniform levels of sales growth. The sales growth will be low (possibly negative) because of the price decrease and uniform because joint price decreases do not give customers an incentive to change insurer. Hence, either collusion or punishment will result in uniform growth, whereas defection gives the defecting firm higher growth than the rest.

Negative deviations need to be dealt with suitably. They may happen through stochastic noise or as a result of a defection by a firm other than the focal firm, but in a naïve regression with just the growth difference as the dependent variable, negative values would suggest producing less than the equilibrium calls for, as if the firm were over-cooperating. Two analytical approaches are used to address this problem. The first is to focus on positive differences by left censoring the growth difference variable at zero and estimating a tobit regression. This follows the theoretical model because it treats positive growth differences as potential defections and ignores negative differences. The second approach is to take the absolute value of the growth difference (Heggestad and Rhoades, 1978). This approach takes advantage of the fact that most large differences are positive, as one would expect if large differences are defections from the collusive equilibrium while small differences are the result of stochastic variation, so all the absolute-value operator does is to pool small positive and negative differences. The second approach yields findings that are more suitably interpreted as turbulence than as defections, and is a useful comparison with the main findings based on the tobit model.

Multimarket contact

The two main predictions are that a lower level of multimarket contact of a firm with its competitors increases defections because the probability of detection is lower and that a higher level of multimarket contact in the market increases defections because the level of collusion is higher. Testing these predictions calls for measuring multimarket contact at the firm-in-market and market level (Gimeno and Jeong, 2001). The firm-in-market level (hereafter referred to as the firm level for simplicity) of multimarket contact is the multilevel contact that a given firm has with all its competitors in a given market, which is suitable for testing its commitment to mutually forbear against competing. The market level of multimarket contact is the multilevel contact of all firms present in the

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market, which is suitable for testing the effect of the overall level of mutual forbearance in a market.

At each level of analysis, multiple measures have been used in the past work, but only one measure is suitable for the theoretical model applied here. This measure is a count of the multimarket competitors (Barnett *et al*., 1994). In the usual interpretation, this measure captures the number of multimarket firms that would punish a firm for defecting in a given market. In the context of this model, however, the measure should be interpreted as the number of firms that monitor a firm in a given market and might discover a defection. At the market level, this measure is the count of firms that have one or more multimarket competitors present in the market. At the firm level, it is the count of firms that have multimarket contact with the focal firm. In figure 1c, these measures are given below each market to illustrate the computation (the firm level measure is from the viewpoint of Firm A).

The count measure does not capture differences in the punishment strength if a defection is discovered. Instead, an overlap measure formed as the number of markets in which two firms jointly participate is generally interpreted as providing information about the punishment strength (e.g., Evans and Kessides, 1994; Gimeno, 2002), but this measure is less appropriate in the context of the imperfect observability model. The core of the model is the risk of discovery rather than the punishment strength. Extending the two-player model to a multiplayer context requires the players to collaborate to punish the defectors (Green and Porter, 1984), and such collaboration includes players who did not observe the defection. Thus, measuring the market overlap of the firm with other firms in the same market would not capture the punishment strength well, because firms that have not observed the defection may also join. The mechanism for such joint punishment would most likely be price wars that spilled across markets, as discussed previously. Although the main analysis only uses the count measure, a supplementary analysis using a weighted average of standardized count and overlap measures was also conducted. All weights from zero to one in 0.1 increments were tried. The best-fitting mix assigned a weight of 0.9 to the count measure, which means that the pure count measure used in the main analysis is nearly optimal. This analysis gave results that were consistent with the main analysis.

Yet other alternative measures include the proportion of a firm's market in which it also meets a given competitor firm (Baum and Korn, 1996) and the degree to which multimarket contact is intentional (Scott, 1993; 2001). These measures are less suitable for the imperfect observability model, because each removes the effect of the sheer number of contacts that is so important for the prediction. The proportion measure makes small and large firms with the same degree of overlap equally likely to forbear from competition, but this is contrary to the prediction that many contacts increase the detection likelihood, and thus that a larger firm with the same proportion of overlaps will be more likely to forbear. The intentionality measure makes the same count of overlaps between two firms more important if there were many markets in which they could have met but did not, which is contrary to the prediction that the level of forbearance is determined only by the markets in which they overlap.

A number of control variables are entered. Kim and Singal (1993) observed that airline mergers involving an economically troubled firm led to price increases in routes served previously by the troubled firm (and subsequently by the merged firm). Their interpretation was that economically troubled firms are less likely to participate in collusive equilibria, but that the mergers brought them into the fold. Similarly, we expect that low-performing firms are more likely to show high growth (Greve, 2008). To capture this effect, we enter the loss ratio, which equals the losses on own insurance (i.e., total insurance minus reinsurance) divided by the sales on own insurance, a typical measure of performance in the insurance industry (Viswanathan and Cummins, 2003). Firms with a small market share may act more aggressively because they have a lower stake in maintaining the higher price and gain more from growing when there are market-specific economies of scale, so the market share is entered in the regression. We enter indicator variables for whether the firm was a specialist with a single market or a mutual. The latter indicator variable is constant within firms and thus omitted when fixed-firm effects are entered.

Market growth is thought to endanger collusion by giving greater incentives to grab market share, and is entered in the regression. Industry concentration raises the level of collusion, and thus also the potential benefit of defecting. Hence, the Herfindahl index of concentration in

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the market is entered. This measure is important to correctly adjudicate between within-market concentration and multimarket contact as causes of collusion. Finally, foreign firms and firms with no multimarket ties may be less likely to collude, raising the intensity of competition and thus lowering the potential benefit from defecting. Counts of both types of firms are entered.

Table 2 shows the descriptive statistics and correlation table of the variables used in the analysis. The most important feature of the table is the high correlation between positive deviation and absolute deviation, which reflects the fact that large deviations are nearly always positive, as one would expect if large deviations were caused by firms defecting from mutual forbearance, while small deviations were largely random. This feature of the data is consistent with the theory. The clustering of observations near zero causes a highly skewed dependent variable that is not modeled well by the linear regression approach used in the analysis of absolute deviations. On the other hand, this pattern fits well with a normal distribution that is left censored, as a tobit model of positive deviations specifies. Despite this drawback of the absolute deviation measure, this analysis is still shown for comparison, and because it was the approach used by an earlier study of multimarket effects on sales growth (Heggestad and Rhoades, 1978).

Models

Positive deviation is modeled by a tobit regression, and absolute deviation is modeled by a linear regression. The models control for time period, firm, and market effects. Temporal effects were initially modeled by entering an indicator variable for each year. The estimates revealed little year-by-year volatility but a gradual decrease in the deviations over the course of the study period. In response, the yearly indicator variables were replaced by indicator variables grouping the years into five-year time periods.

The analysis of positive deviations was first conducted using random effects for firms and fixed effects for markets. Next, a model with fixed effects for firms was estimated using the Honore (1992) estimator with a squared loss function. This estimator was chosen because there is no conditional fixed effects tobit model, and the unconditional fixed effects tobit model is biased (Honore, 1992). Honore's Pantob routine under Gauss was used, and each solution was tested by reestimating the model from the optimum with a different optimization approach, and then again with different starting values and the same optimization approach. The Broyden-Fletcher-Goldfarb- Shannon approach was used as the main estimating method and the Polak-Ribiere approach was used for testing. The regressions for absolute deviation model firm effects through either random effects or conditional fixed effects. In the random effects models, a random market effect nested within the firm effect was estimated, giving a multilevel model (Goldstein, 1995). In the fixed effects models, unconditional fixed effects for markets were estimated.

EMPIRICAL RESULTS

Positive deviation

Table 3 displays the analysis of positive deviations from the average growth rate. Positive deviations are the expected results of defections, and are thus most important for evaluating the theoretical predictions. Model 1 shows the findings from a random-effect tobit model. As predicted, defections occur when the focal firm has few multimarket contacts with other firms in the market (Hypothesis 1) and when there are many multimarket firms in the market (Hypothesis 2). Hence, firms are more likely to defect when the probability of discovery is low and the rewards are high, as the theory specifies.

The control variables also show some interesting results. Defections are more likely in growing markets, which is expected given the greater incentives to pursue increased market share in such contexts. High concentration also makes defections more likely, so within-market collusion can provide a price umbrella that makes defections profitable. The number of foreign firms and single-market firms in the market reduces defections, presumably by increasing the overall competitive pressure and thus reducing the incentives to defect. Firms with a high market share are less likely to defect, and firms with greater loss proportion are more likely to defect. Both findings are easy to explain by differences in the incentives to maintain the market status quo. The parameter rho gives the intragroup correlation, which is low (only

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Table 2. Descriptive statistics and correlations

Variable	Mean	SD	1	2	3	4	5	6	7	8	9	10	11	12	13
1 Positive deviation	0.203	0.707	1.00												
2 Absolute deviation	0.319	0.725	0.93	1.00											
3 Market growth	0.119	0.534	0.06	0.07	1.00										
4 Herfindahl index	0.153	0.121	0.08	0.11	0.04	1.00									
5 Foreign firms	11.568	13.572	−0.04	−0.05	−0.04	−0.44	1.00								
6 Single-market firms	13.832	21.145	−0.03	−0.03	−0.05	−0.41	0.79	1.00							
7 Market share	0.002	0.008	−0.05	−0.06	−0.00	−0.12	0.30	0.20	1.00						
8 Loss ratio	0.612	0.498	0.09	0.11	−0.01	0.00	0.14	0.15	0.03	1.00					
9 Specialist	0.155	0.362	−0.04	−0.05	−0.01	−0.14	0.48	0.52	0.01	0.10	1.00				
10 Log firm premiums	7.555	2.453	−0.03	−0.04	0.03	0.11	−0.36	−0.34	0.18	−0.11	−0.51	1.00			
11 Mutual	0.160	0.367	−0.03	−0.05	0.01	−0.09	0.35	0.39	0.02	0.07	0.74	−0.28	1.00		
12 Market-level multimarket contact	34.097	11.826	−0.06	−0.08	−0.12	−0.56	0.40	0.33	0.09	−0.05	0.06	−0.06	0.02	1.00	
13 Firm-level multimarket contact	26.350	16.301	−0.02	−0.02	−0.05	−0.18	−0.15	−0.26	0.05	−0.11	−0.69	0.34	−0.53	0.51	1.00
14 Market-firm interaction	98.496	221.546	0.03	0.04	0.07	0.44	−0.18	−0.27	0.03	−0.02	−0.29	0.11	−0.21	−0.35	0.22

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Table 3. Panel tobit regression analysis of positive deviations from median sales growth

Model type	Main effects	Main effects	Main and interactions	Main and interactions
Model number	1	2	3	4
Time period effects	Fixed	Fixed	Fixed	Fixed
Firm effects	Random	Fixed	Random	Fixed
Niche effects	Fixed	Fixed	Fixed	Fixed
Market growth	0.034*	0.704**	0.035*	0.711**
	(0.014)	(0.175)	(0.014)	(0.177)
Herfindahl of market shares	0.393**	1.831*	0.431**	2.036*
	(0.122)	(0.788)	(0.124)	(0.829)
Foreign firm count	−0.0093**	−0.042**	−0.0091**	−0.042**
	(0.0029)	(0.0011)	(0.0029)	(0.0011)
Single-market firm count	−0.0054**	−0.0127*	−0.0056**	−0.0130*
	(0.0014)	(0.0058)	(0.0014)	(0.0058)
Firm market share	−8.949**	−59.41**	−9.025**	−60.45**
	(1.552)	(17.74)	(1.554)	(18.20)
Firm loss ratio	0.121**	0.607**	0.120**	0.607**
	(0.016)	(0.084)	(0.016)	(0.084)
Specialist	−0.446**	−1.148*	−0.417**	−0.823
	(0.060)	(0.480)	(0.062)	(0.515)
Log firm premiums	−0.020**	−0.248**	−0.020**	−0.252**
	(0.007)	(0.077)	(0.007)	(0.078)
Mutual	0.075†		0.075†	
	(0.038)		(0.038)	
Market-level multimarket contact	0.0053**	0.0095	0.0035†	0.0111
	(0.0017)	(0.0108)	(0.0020)	(0.0107)
Firm-level multimarket contact	−0.0058**	−0.0170†	−0.0042**	−0.0144
	(0.0013)	(0.0096)	(0.0016)	(0.0194)
Market X firm level multimarket contact			−0.00011†	−0.00053†
			(0.00006)	(0.00027)
Firm random effect	0.163*		0.162*	
Residual	1.107*		1.107*	
Rho	0.021		0.021	
Chi-square test of joint sign		447.5**		458.3**

† $p < 0.10$; * $p < 0.05$; ** $p < 0.01$; two-sided tests. Standard errors are given in parentheses.

0.021). This information is useful because the random effects estimator assumes individual effects that are orthogonal to the regressors, and may be biased if this assumption is incorrect. However, the potential for bias is small when the intragroup correlation is low.

Model 2 replaces the firm random effect with fixed effects. The result is that the market-level multimarket contact no longer has a significant effect, but the firm-level multimarket contact still has the expected negative effect on defections, but now only at the 10 percent level. The control variables show qualitatively similar results as in Model 1, and some variables have numerically greater coefficient estimates when fixed effects are entered. Recall that this estimator is a loss function rather than a maximum likelihood estimator, so a Hausman test for the significance of the coefficient differences with the random effects model is not available.

The greater tendency for low-contact firms to deviate in high-contact markets suggests the potential for an interaction effect between the level of market contact and the level of firm contact with other firms in the markets. Specifically, if the overall level of contact is low, there may not be sufficient rewards to defecting, so we may observe a negative interaction between the market and firm levels of multimarket contact. Model 3 tests this prediction with the same random effects specification as Model 1. The negative coefficient estimate predicted in Hypothesis 3 is seen, but only at the

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10 percent level of significance. The market-level coefficient estimate is still positive as predicted, but now only at the 10 percent level. The firm-level coefficient estimate is negative and highly significant. Model 4 replaces the random effects with fixed effects. With this specification, only the interaction variable reaches statistical significance, and it is negative as predicted by Hypothesis 3.

Figures 2a and 2b help interpret these effects. The figures show the predicted growth based on the random-effects Models 1 and 3 in Table 3. The figures are made as follows. First, three typical market levels of multimarket contact are selected. The center one is 35, which is between the mean of 34 and the median of 36, and the two others are at the first and third quartile. For each of these levels of market-level multimarket contact, the growth of a firm that has firm-level contact with all market-level contacts (except itself, of course) is normalized to zero. Next, the model estimates are used to draw the line of estimated growth rates over a range of two standard deviations from the mean firm-level multimarket contact. Hence, the lines show growth rate estimates that are computed based on a realistic distribution of covariates. The vertical axes of the two graphs are made equal to facilitate comparison.

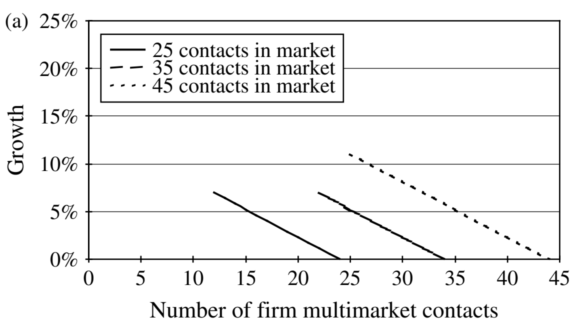

Figure 2a. Estimated growth rates without interactions

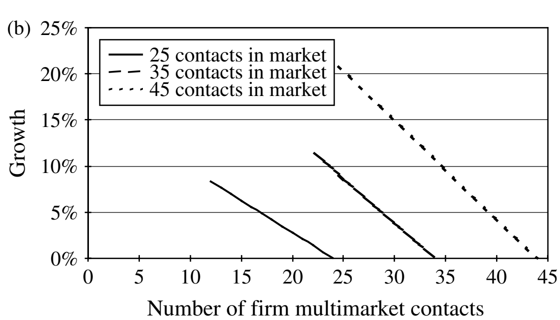

Figure 2b. Estimated growth rates with interactions

The graphs show that the model with interaction effects (Figure 2b) predicts greater variation in the growth rate. Indeed, the highest growth rate predicted is about 20 percent for a firm with 25 multimarket contacts in a market with 45 multimarket contacts. This is probably too high, and suggests caution in using this model to predict at extreme values. These predictions and the marginal significance of the interaction effect suggest that the model without interactions is preferable. The graph using the model without interactions (Figure 2a) has a smaller range of predicted values even though this graph also displays some combinations of parameter values that are rare in the data. It shows growth estimates that are substantively important without being unrealistically large, which gives confidence in the theory and model predictions.

Absolute deviation

Table 4 shows the results of analyzing the absolute level of all deviations. As in Models 1 and 2, the firm-level multimarket contact is negative and significant with either random (Model 5) or fixed effects (Model 6). In these models, however, the market-level multimarket contact is no longer significant. When the interaction variable is entered, Model 7 with random effects shows a positive and marginally significant effect of market-level multilevel contact, but none of the firm-level contact or the interaction. Model 8 with fixed effects has an unexpected positive effect of firm-level contact and a negative (and larger) negative effect of the interaction variable. As one might expect when treating positive and negative deviations equivalently, the results are less clear than in the earlier analysis.

The control variables show similar findings as in the previous table. There is more dispersion in the growth rate in growing markets and concentrated markets. Foreign firms and single-market firms reduce dispersion in the growth rate. Firms with high market share have less dispersion in the growth rate, and firms that have experienced losses have more dispersion.

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Table 4. Panel regression of absolute deviations from median sales growth

Model type	Main effects	Main effects	Main and interactions	Main and interactions
Model number	5	6	7	8
Time period effects	Fixed	Fixed	Fixed	Fixed
Firm effects	Random	Fixed	Random	Fixed
Niche effects	Random	Fixed	Random	Fixed
Market growth	0.055**	0.059**	0.057**	0.058**
	(0.008)	(0.008)	(0.008)	(0.008)
Herfindahl of market shares	0.637**	0.479**	0.670**	0.513**
	(0.066)	(0.064)	(0.064)	(0.061)
Foreign firm count	−0.011**	−0.014**	−0.012**	−0.014**
	(0.002)	(0.002)	(0.002)	(0.002)
Single-market firm count	−0.0026**	−0.0035**	−0.0021**	−0.0026**
	(0.0007)	(0.0008)	(0.0007)	(0.0007)
Firm market share	−3.776**	−2.877**	−3.787**	−2.858**
	(0.820)	(0.616)	(0.821)	(0.617)
Firm loss ratio	0.138**	0.144**	0.139**	0.145**
	(0.009)	(0.009)	(0.009)	(0.009)
Specialist	−0.259**	−0.204**	−0.177**	−0.053
	(0.035)	(0.045)	(0.029)	(0.036)
Mutual	−0.067**		−0.063*	
	(0.026)		(0.026)	
Log firm premiums	−0.045**	−0.059**	−0.045**	−0.068**
	(0.004)	(0.005)	(0.004)	(0.005)
Market-level multimarket	−0.0000	0.0017	0.0093†	−0.0073
contact	(0.0010)	(0.0011)	(0.0054)	(0.0054)
Firm-level multimarket	−0.0026**	−0.0028**	0.0006	0.0184**
contact	(0.0007)	(0.0010)	(0.0021)	(0.0036)
Market X firm level			−0.00051	−0.00198**
			(0.00057)	(0.00057)
Niche random effect	0.220*		0.217*	
Firm random effect	0.203*		0.203*	
Residual	0.681*	0.695	0.681*	0.695
Firm fixed effect		0.335		0.339
Rho		0.188		0.192

† $p < 0.10$; * $p < 0.05$; ** $p < 0.01$; two-sided tests. Standard errors are given in parentheses.

Firm differences

Analysis of firm differences in sales growth can help explore some issues that are not directly addressed by the imperfect observability model of mutual forbearance. As noted earlier, the model does not specify whether firms that are not engaged in multimarket contact will participate in mutual forbearance (Matsushima, 2001). Nor, for that matter, does the commonly used model of mutual forbearance under perfect observability make a prediction on the behavior of single-market contact firms (Bernheim and Whinston, 1990). It seems unlikely that these firms will defect every time, as such a strategy would run the risk that the multimarket firms joined forces to attack them. On the other hand, it is likely that single-market contacts will forbear less than multimarket competitors do. Thus, the prediction is that the positive effect of market-level multimarket contact on growth is greater for single-market than for multimarket firms.

Testing this prediction calls for a distinction between two types of single-market contacts. First, some firms are specialists that only compete in a single market. As long as they retain the specialist strategy, they are committed single-market competitors that cannot enter into multimarket contact even in principle. Second, some firms participate in more than one market, but they happen not to have multimarket contacts with the other

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firms in the focal market. Such firms could in the future establish multimarket contact through market entry, or some of the other multimarket firms in the market could establish multimarket contacts with them by entering one of their markets. These firms are potential multimarket contacts. It is plausible that these two types of single-market contacts will behave differently, and that the potential multimarket contacts will be more similar to the actual multimarket contacts.

Finally, the hypotheses so far have assumed some version of profit maximizing behavior. However, mutual firms are not profit maximizers, but are instead supposed to maximize the benefit relative to the cost for their member/owners. It seems to follow from this mission that they do not participate in mutual forbearance, and hence that they would grow more rapidly when the market level of multimarket contact is high. However, mutual firms may also be cautious about competing aggressively if this could unleash a response from multimarket firms.

Table 5 analyzes these three organizational forms one by one. Because the differences among

Table 5. Panel tobit regression analysis of positive deviations from median sales growth, subgroup analysis

Group 1 Group 2	Generalist Specialist	Multimarket Singlemarket	Stock Mutual
Model number	9	10	11
Time period effects	Fixed	Fixed	Fixed
Firm effects	Random	Random	Random
Niche effects	Fixed	Fixed	Fixed
Market growth	0.033*	0.034*	0.035*
	(0.014)	(0.014)	(0.014)
Herfindahl of market shares	0.389**	0.392**	0.408**
	(0.122)	(0.122)	(0.121)
Foreign firm count	−0.0088**	−0.0094**	−0.0086**
	(0.0029)	(0.0029)	(0.0029)
Single-market firm count	−0.0056**	−0.0054**	−0.0054**
	(0.0014)	(0.0014)	(0.0014)
Firm market share	−8.818**	−8.937**	−9.166**
	(1.554)	(1.553)	(1.549)
Firm loss ratio	0.120**	0.121**	0.121**
	(0.016)	(0.016)	(0.016)
Specialist	−0.513**	−0.430**	−0.398**
	(0.078)	(0.064)	(0.056)
Log firm premiums	−0.020**	−0.018**	−0.022**
	(0.007)	(0.006)	(0.005)
Mutual	−0.069†	−0.070†	
	(0.039)	(0.039)	
Market-level multimarket	0.0030	0.0080†	0.0053**
Contact, group 1	(0.0023)	(0.045)	(0.0018)
Market-level multimarket	0.0065**	0.0051**	0.0053**
Contact, group 2	(0.0020)	(0.0017)	(0.0018)
Test for group difference	*1.95*	*0.41*	*0.00*
Firm-level multimarket	−0.0040*	−0.0085†	−0.0063**
Contact, group 1	(0.0018)	(0.0044)	(0.0014)
Firm-level multimarket			0.0033
Contact, group 2			(0.0021)
Test for group difference			*22.35***
Firm random effect	0.175*	0.162*	0.161*
Residual	1.108*	1.107*	1.107*
Rho	0.024	0.021	0.021

† $p < 0.10$; * $p < 0.05$; ** $p < 0.01$; two-sided tests. Standard errors are given in parentheses.
Group difference tests (in italics) are likelihood ratio tests with 1 degree of freedom.

the forms might be small, the models contrast one pair of forms at a time. Mutual firm is a time constant characteristic, and the two other characteristics are also stable in many firms, so the random effects model is more appropriate than the fixed-effects model. The effect of market-level multimarket contact is calculated separately for each form by interacting it with an indicator variable for the form. A likelihood ratio test for equality of the group effects is computed to test whether the forms have significantly different behavior. For mutuals, separate variables are also estimated for firm-level contacts, but this is not done for specialists and single-market competitors, which always have a firm-level multimarket contact of zero.

Model 1 compares generalists (Group 1 coefficient) with specialists (Group 2). The coefficient estimate for specialists is positive and larger in magnitude, as predicted, but the test below shows that the difference in coefficient estimates is not statistically significant. The analysis does not prove a greater incidence of defecting for specialist firms. Similarly, in Model 10 the coefficient estimate is actually larger for multimarket firms (Group 1), against expectation, but the difference fails the test for significance. In Model 11, the effect of market-level multimarket contact is identical across joint-stock firms (Group 1) and mutuals (Group 2). However, while joint-stock firms are less likely to defect when they have a higher firm-level multimarket contact, mutual firms have a statistically insignificant effect of firm-level multimarket contact. The difference between these two coefficient estimates is significant.

The conclusion is that there are no detectable firm type differences in the response to market-level multimarket contact. This is a theoretically promising finding because it suggests that single-market firms also join the mutual forbearance, which explains why mutual forbearance can exist when markets have single-market competitors as well as multimarket competitors. It would be hard to explain mutual forbearance if some firms in the market consistently undercut the others. Mutuals also show remarkably similar behavior to joint stock firms when adapting to the market level of multimarket contact. On the other hand, mutuals do not appear responsive to firm-level multimarket contact, which may mean that they are less active in initiating mutual forbearance than joint-stock firms are.

DISCUSSION

The hypothesis that multimarket contact leads to forbearance from competition has been known since Edwards (1955), but just over ten years ago Evans and Kessides (1994: 365) concluded that 'the results of most previous efforts to empirically test this hypothesis have been equivocal.' Later work has yielded much more consistent findings (Scott, 1993; Evans and Kessides, 1994; Singal, 1996; Jans and Rosenbaum, 1996; Gimeno and Woo, 1996; Barros, 1999; Pilloff, 1999), but this progress has happened at the cost of emphasizing industries that enable easy observation of prices. This would have been harmless if the theory for mutual forbearance were the same for industries with perfect and imperfect observability of competitive actions, but the model most often applied to predict mutual forbearance from multimarket contact applies only to full-observability contexts (Bernheim and Whinston, 1990). A model for imperfect observability exists (Matsushima, 2001), but has not been subject to rigorous testing. The theoretical contribution of the present work is to derive hypotheses from the imperfect-observability model on sales growth deviations. Making such predictions is essential in order to advance research on mutual forbearance into imperfect-observability contexts, so this theory opens new possibilities for research.

The empirical contribution is to test the model's predictions on data from the general insurance industry. The findings are mostly supportive of the predictions. The best-supported prediction is that firms with fewer multimarket competitors in a given market, and thus with less risk of being discovered when defecting, are more likely to defect. Hence potential defectors take the risk of detection into account. There is also support for the prediction that defections are more likely to occur when the overall level of multimarket contact is high, and hence the rewards of defecting are high. The multimarket effects are strong enough to be detectable despite the natural variation in growth rates across firms and markets. They showed limited variation across the organizational forms generalist and specialist, multimarket and single-market contacts, and joint stock firm and mutual, and hence appear to be widely generalizable.

The findings support theory of mutual forbearance in multimarket contexts as a result of a repeated game with imperfect observation of prices and quantities. This is a major extension of the empirical support for mutual forbearance theory, and ought to encourage additional theoretical and empirical work on mutual forbearance as a result of repeated games. There are clear opportunities to develop the theory to encompass multiple actors and actors without contacts (such as single-market firms), and such theoretical work may yield additional empirical predictions that can be evaluated.

The empirical test applied methodology new to multimarket research. Analysis of sales growth does not require price data on homogeneous goods, as much of the multimarket research has used, so it enables work on mutual forbearance in contexts that have not yet been studied. The variable and fixed-effects tobit estimators overcome the difficulties that face researchers when seeking to account for firm effects on a left-censored outcome, and have broad application. The fixed-effects estimator makes strict demands on the within-firm variation of data values, but offers the strongest possible control for stable firm differences in the propensity to grow. If the data contain firms that have strategies of not participating in mutual forbearance, then the fixed effects will greatly reduce the effects of such firms on the estimates. The drawback of the fixed-effects model is that it is not suitable for testing effects of firm characteristics that are constant over time or change rarely, and in such cases the random-effects model should be used instead. These data may not have had sufficient change in market participation to allow precise estimates of the multimarket effects with fixed effects. Similarly, time period and niche controls are needed if the data contain time periods or markets in which the mutual forbearance broke down or was maintained by other mechanisms than multimarket contact.

The analysis was specified in a way that captures important alternative explanations of sales growth. The market concentration was measured through the Herfindahl index, which captures the effect of within-market competitive conditions. It is interesting that the Herfindahl index had a positive coefficient estimate just like the market-level multimarket contact did, because this suggests that either within-market or multimarket mutual forbearance resulted in price levels that tempted individual firms to defect. Similarly, the effects of foreign firms and single-market firms would normally be to depress market prices by reducing the potential for mutual forbearance, and indeed both types of competitors led to a reduction of the sales growth. Hence, all market-level control variables have coefficient estimates that accord with expectations.

The models also controlled for firm sources of growth strategies. Firms that were small in the specific market or were less profitable had stronger incentives to grow, and indeed grew more quickly. Mutual firms grew marginally faster, suggesting a lower propensity to participate in mutual forbearance, but also had lower volatility in growth. These findings accord well with the emphasis on stable operations and low price that mutuals traditionally have. The model specifies market conditions and firm strategies quite richly, which gives confidence in the results.

A practical implication of the findings is that firms may mutually forbear from competing even when having less information than earlier models assumed was needed. It has been thought that a simple mechanism of introducing uncertainty (such as preventing sharing of price information) may reduce collusion among firms, but in multimarket contexts firms can still discover defections from a collusive equilibrium. In fact, firms following a behavioral rule of competing more intensely when losing market share and less intensely when the market share is constant might be able to follow a mutual forbearance approach much like that of the fully rational model of mutual forbearance under uncertainty. The model thus has behavioral plausibility even though it assumes full rationality instead of bounded rationality. Still, the details on how boundedly rational managers learn to forbear needs additional theoretical and empirical analysis (Phillips and Mason, 2001; Korn and Rock, 2001).

Given the great spread of multimarket contacts throughout the economy (Greve and Baum, 2001) and the apparent ease of establishing a pattern of mutual forbearance among competitors that meet each other often, it is likely that mutual forbearance strategies are an important item in the competitive repertoire of many firms. As with all strategies that seek to weaken the competitive pressure, mutual forbearance strategies come with a built-in dilemma. Firms that compete less intensely earn higher profits in the short run, but may in the long run lose the ability to withstand intense competition (Barnett *et al.*, 1994; Barnett and McKendrick, 2004). This leaves an opening for challengers who see a competitive

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battle as more advantageous than collaboration, as attacks on leader firms often succeed (Ferrier, Smith, and Grimm, 1999). The findings reported here show that mutual forbearance is not complete, because defections from the collaborative equilibrium occur when some firms have few enough multimarket contacts to escape detection. Hence firms that mutually forbear against competing face a short-term challenge of responding to defections as well as a long-term problem of eroding competitive strength, making mutual forbearance a precarious strategy.

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