© Academy of Management Journal
2009, Vol. 52, No. 2, 336–354.

MULTIMARKET CONTACT AND SERVICE QUALITY: EVIDENCE FROM ON-TIME PERFORMANCE IN THE U.S. AIRLINE INDUSTRY

JEFFREY T. PRINCE
DANIEL H. SIMON
Cornell University

We examine the relationship between multimarket contact and service quality. We offer two hypotheses: (1) multimarket contact negatively affects service quality and (2) multimarket contacts in less competitive markets more negatively affect service quality. We test these hypotheses using U.S. airline on-time performance data to measure service quality. We find that multimarket contact increases delays and that this effect is greater for contacts on more concentrated routes, although the effect diminishes on very highly concentrated routes. These findings provide support for the mutual forbearance hypothesis and suggest that multimarket contact facilitates tacit collusion on quality as well as price.

One of the most widely studied questions in strategy and in industrial organization economics is how market structure influences firms' competitive behavior. For many years, research on this question focused exclusively on firms competing on price in single markets. However, more recently, researchers have branched out in two directions, examining firms that compete against each other in multiple markets, and examining the influence of market structure on nonprice forms of competition.

Over the past 20 years, a stream of papers (Baum & Korn, 1996, 1999; Evans & Kessides, 1994; Fernandez & Marin, 1998; Gimeno & Woo, 1996, 1999; Jans & Rosenbaum, 1996) has tested the mutual forbearance hypothesis (Edwards, 1955), which is the proposition that firms that meet in multiple markets compete less aggressively because they recognize that a competitive attack in any one market may draw response(s) in all jointly contested markets. More recently, some research has begun to examine how competitive conditions influence nonprice forms of competition.

Like price, quality is a critical dimension of a firm's competitive strategy (Porter, 1980). Yet very few papers have examined the relationship between competition and quality (Gal-Or, 1983). One important reason for this, we believe, is that measures of quality are often more difficult to obtain than pricing data. Recently, several studies have made use of an easily observable measure of service quality in the airline industry: on-time performance. For example, Mazzeo (2003) and Rupp, Owens, and Plumly (2003) directly examined the impact of market structure on on-time performance. In addition, Rupp (2005) examined the causes of flight delays and cancellations, Januszewski (2004) studied the impact of on-time performance on demand for air travel, and Mayer and Sinai (2003) assessed the impact of "hubbing effects" and congestion externalities on on-time performance.

Linking these two areas, we examine the relationship between multimarket contact and service quality. Drawing on mutual forbearance arguments, we hypothesize that a firm's service quality in a market will worsen as its multimarket contact with rivals in that market increases. In doing so, we extend the mutual forbearance hypothesis to service quality. This is an important contribution, both theoretically and empirically, because thus far, research on multimarket contact has focused primarily on its impact on prices. We are unaware of any research that has examined the impact of multimarket contact on service quality levels.

By linking multimarket contact with service quality, we provide another mechanism to explain the positive relationship between multimarket contact and profitability. In doing so, we help to better explain how multimarket contact affects firm performance. Moreover, the strategic and societal importance of multimarket contact increases greatly if it influences other kinds of competitive behavior besides pricing. If multimarket contact reduces service quality, then the negative effects of multimarket contact on consumer welfare may be far greater than has been suggested in previous research.

In addition, this article joins a small number of others that have empirically examined competitive factors influencing service quality. Service quality is a critical issue (Liao & Chuang, 2004), and this study increases understanding of how firms may vary their service quality in response to changing competitive conditions. By focusing on multimarket contact, we suggest another competitive factor that influences firms' provision of service quality.

We empirically tested whether multimarket contact affects service quality by looking at on-time performance in the U.S. airline industry. We used United States Department of Transportation (U.S. DOT) data on all major carriers' domestic flights departing on Fridays on the 1,000 largest routes from January 1995 to August 2001 (we do not use data from September 2001 onward, because the upheaval in the airline industry created by the 9/11 attacks significantly altered the industry's competitive environment). In the airline industry, firms frequently compete against the same rivals on many different routes, making this setting ideal for testing whether multimarket contact impacts firm behavior. We controlled for route-level competition, airport market power, airport congestion externalities, hubbing effects, and economies of scope. In addition, we included fixed effects to control for unobserved airline and route characteristics as well as temporal variation in on-time performance.

Our results provide strong support for the mutual forbearance hypothesis. Using a variety of delay measures, we found that airline delays increase with multimarket contact. Moreover, consistently with our second hypothesis, multimarket contact occurring on more concentrated routes has a greater effect on delays; however, the effect diminishes on very highly concentrated routes.

Additional analysis showed that nearly all of the additional delay was due to increased time spent on the ground, primarily before aircraft left the gate. These results suggest that mutual forbearance likely results in reduced investments in check-in, baggage, and/or maintenance staff and equipment. Moreover, we found that the increase in arrival delays is not caused by spending more time in the air, nor is it caused by shorter scheduled flight times; scheduled flight times actually increase with multimarket contact. We also found that airlines cancel more flights, fly smaller planes, and offer fewer flights as their multimarket contact with rivals increases. These results provide additional evidence that multimarket contact actually influences airlines' choices, because flight schedules, as well as flight cancellations and the sizes of the planes flown, are more directly under the airlines' control.

THEORETICAL BACKGROUND

Market Structure and Quality

Just as market structure may influence a firm's pricing behavior, it may also affect a firm's provision of product or service quality. However, although competition should unambiguously reduce prices, its effect on quality is less clear, because changes in quality affect consumers' willingness to pay and producers' costs.

Several authors have discussed and analyzed the relationship between competition and service quality, both theoretically and empirically. The theoretical literature has been largely inconclusive, with some studies suggesting that competition increases quality (Schmalensee, 1974), others suggesting that competition reduces quality (Gal-Or, 1983), and still others positing either no relationship between competition and quality (Swan, 1970), or that the relationship depends on a variety of assumptions (Schmalensee, 1979). Two issues seem to underlie these divergent theoretical results: (1) difficulty in defining quality in a way that is mathematically tractable and (2) sensitivity of results to assumptions of a particular theoretical model (Schmalensee, 1979).

We posit that for competition to lead to "excessive" service quality, it must be the case that, at the competitive level of quality, the aggregate marginal revenue (for all firms) from all firms jointly providing lower quality is strictly greater than the aggregate marginal cost. In this situation, we would expect a reduction in competition to result in a reduction in product (service) quality, as firms move toward a more cooperative (monopolistic) outcome. In keeping with this expectation, Mazzeo (2003) argued that when customers have more choices, firms have an incentive to offer higher-quality goods, better service, and lower prices in order to maintain their market shares. Moreover, this incentive to improve quality is enhanced because the cost of attracting new customers is higher in markets with more rivals (Estelami, 2000).

Most empirical tests of the impact of competition on quality have focused on various measures of service quality in the service sector. However, as Dranove and White (1994) noted, difficulties in measuring quality make inference difficult. Nonetheless, researchers have found a variety of ways to measure quality. Liao and Chuang (2004) examined the impact of local competition on customer satisfaction ratings in the fast food industry. They found that the number of rivals in a given local market has a positive effect on customer ratings of overall satisfaction, customer service, and loyalty (Liao & Chuang, 2004). Similarly, Domberger and Scherr

(1989) found that competition is positively correlated with client ratings of service quality in the U.K. market for legal services. In the two articles most similar to ours, Mazzeo (2003) and Rupp et al. (2003) hypothesized that route-level market power may contribute to airline delays. In both cases, they found that on-time performance is worse on less competitive routes.

According to these findings, we should expect increased competition to lead to lower prices and higher service quality. However, it could be that in some cases firms find it optimal to reduce their service quality in order to reduce their prices even further, in response to increased competition. Intuitively, we might expect this to happen in markets in which consumers care much more about price than about service quality. Domberger, Hall, and Li (1995) empirically examined the effect of increased competition on the joint choice of price and quality for cleaning service contracts. They found no evidence that firms respond to increased competition by cutting quality. Their results showed that increased competition pushes prices down while exerting either no effect or a positive effect on quality. Studies that examine the service quality and pricing responses simultaneously are rare; however, it is worth noting that combining the results from studies of the effect of competition on pricing, which have generally shown that competition reduces prices, with the results from the studies described above, showing that competition increases service quality, provides evidence for the strong competitive response that we propose. That is, these two research streams jointly suggest that (as found in Domberger et al. [1995]) firms respond to increased competition by cutting price and increasing service quality.

Multimarket Contact and Mutual Forbearance

According to the mutual forbearance hypothesis, firms that compete in multiple markets will be more likely to cooperate, because a competitive attack in any one market may draw responses in all other jointly contested markets. Therefore, the punishment for deviations from collusive behavior would increase with the number of markets in which rivals meet. Bernheim and Whinston (1990) pointed out that if multimarket contact simply increases the costs and benefits of deviating from tacit collusion in equal proportions, then there is no reason to think that multimarket contact would affect incentives to cooperate. However, they also showed that under a variety of plausible conditions, multimarket contact may facilitate cooperative behavior. These include cost differences among firms, differences in the number of rivals in different markets, and differences in market demand growth rates—conditions that all potentially hold in the airline industry.

Recently, several studies have found evidence of a relationship between multimarket contact and higher prices. In the airline industry, Evans and Kessides (1994) and Gimeno and Woo (1996, 1999) showed that airlines charge higher prices on routes in which they face rivals against whom they compete on many different routes. Gimeno and Woo (1999) showed that contacts on routes that share an end-point airport with a focal route have a greater effect on price on the focal route. Fernandez and Marin (1998) found that Spanish hotels charge higher prices in markets that they share with rivals against whom they compete in many other markets. In the U.S. cement industry, Jans and Rosenbaum (1996) found that the effect of multimarket contact on prices is positive when weighted by a firm's market share or a Herfindahl index value in each market where the contact occurs. Parker and Roller (1997) found that multimarket contact increases the price of mobile phone service. Busse (2000) provided some evidence for the mechanism through which multimarket contact may affect prices, as she showed that cell phone providers are more likely to offer identical price schedules across markets when they compete against the same rivals in multiple markets.

Several studies have also examined the link between multimarket contact and other types of firm behavior. Baum and Korn (1996, 1999) showed that multimarket contact among California commuter airlines influences market entry and exit rates, with the effect being greatest on routes dominated by a single airline. Shankar (1999) found that multimarket contact reduces marketing expenditures by firms introducing new products and weakens responses from incumbent competitors. Jayachandran, Gimeno, and Varadarajan (1999) provided further theoretical development of the link between multimarket contact and competitive behavior, while extending the mutual forbearance hypothesis to product line rivalry and discussing how multimarket contact may influence firms' entry strategies. Vonortas (2000) explored the relationship between multimarket and multiproject contact and firm incentives to engage in R&D in the context of R&D joint ventures. Young, Smith, Grimm, and Simon (2000) showed that as multimarket contact increases, firms launch fewer new products and marketing campaigns, but they respond more quickly with their own new products or marketing campaigns after rivals have launched new products or marketing campaigns.

Another branch of the multimarket contact literature has assessed the impact of multimarket contact on profitability. In two of the earliest papers, Scott (1982, 1991) found a positive relationship between multimarket contact and performance in U.S. manufacturing firms. Hughes and Oughton (1993) found similar results for a set of U.K. manufacturing firms. Looking at the banking industry, Piloff (1999) also found that multimarket contact is positively related to profitability. And in the airline industry, Gimeno and Woo (1999) demonstrated that multimarket contact also positively affects airline profitability.

Multimarket Contact and Service Quality

Although these studies provide strong evidence for the mutual forbearance hypothesis, none of them has addressed whether mutual forbearance extends to the realm of product or service quality. However, Jayachandran et al. (1999) argued that multimarket contact should influence actions that firms undertake repeatedly. Building on this argument, and on the relationship between competition and quality, we posit that just as multimarket contact may deter firms from reducing prices, it may deter firms from improving service quality, because a firm's efforts to improve quality to gain market share in one market could trigger competitive responses in the other markets in which the firm meets other firms. Moreover, rivals do not need to respond with the same competitive weapon with which a firm has attacked them. Rivals may respond by improving service quality, but they may also respond by cutting prices.

For the mutual forbearance hypothesis to extend to service quality, two conditions must hold: First, service quality must be observable by rivals. If it is not, then rivals will not be able to coordinate behavior. Second, it must be the case that competition leads to "excessive" service quality. As mentioned above, this means that, at the competitive level of quality, the aggregate marginal revenue from all firms jointly providing lower quality is strictly greater than the aggregate marginal cost. If this condition does not hold, then quality should not be expected to diminish as competition lessens. Drawing on the studies documenting a positive effect of competition on service quality, we find it likely that in many industries this condition does hold. When it does, firms have an incentive to reduce investments in service quality in markets in which they have high multimarket contact with rivals. This reduced investment allows them to transfer resources to more competitive markets and markets with low levels of multimarket contact, where they face a stronger incentive to provide high levels of service.

Alternatively, even if the aggregate marginal revenue of jointly lowering quality is greater than the marginal cost, firms still may choose to improve quality in response to increased multimarket contact. They may make this choice if the return (i.e., the increase in profit) from raising price is increasing with quality. In such a case, improving service quality would allow a firm to further raise prices, and this could result in a bigger increase in profits. Although this is possible, a firm would need to substantially increase service quality in order for its indirect (second-order) positive effect on profits to overcome the negative direct (first-order) effect on profits (since the marginal revenue of increasing quality is less than the marginal cost).[1] Moreover, empirical research showing that reductions in market-level competition raise prices and lower service quality (particularly in the airline industry) suggests that one seldom finds market conditions in which the above response to reduced competition is optimal. Thus, it seems doubtful that firms would both raise price and service quality levels in response to increased multimarket contact.

If mutual forbearance arguments apply and the above conditions hold, firms will make fewer investments in service quality when multimarket contact is high. This set of relationships will exist because making investments in service quality may induce rivals to respond either with price cuts or with service improvements in other markets in which the firms compete, resulting in either superoptimal levels of service quality or suboptimal price levels. By reducing investments in service quality where multimarket contact is high, firms can transfer these freed-up resources to more competitive markets where multimarket contact is low. As a result, we expect to see service quality worsen as multimarket contact increases.

Hypothesis 1. Multimarket contact has a negative effect on service quality.

---

[1] To be more concrete, if $\frac{\partial \pi}{\partial p} > 0$ and $\frac{\partial \pi}{\partial s} < 0$ (where π is profit, p is price, and s is service quality), then for small changes in price and service quality, profit increases with increasing price and reducing service quality (when all firms make the same changes in behavior). However, if $\frac{\partial^2 \pi}{\partial p \partial s} > 0$, increases in service quality raise the marginal return from increasing price. This second-order effect may become substantial (making increases in service quality optimal) only for relatively large changes in service quality.

Although we expect multimarket contact to have a negative effect on service quality, we recognize that some particular multimarket contacts may have a stronger effect on quality than others (Gimeno & Woo, 1999). In general, a firm will be more influenced by contacts with rivals that occur in more profitable markets, because retaliation in more profitable "contact markets" (markets in which contact between a focal firm and one or more rivals occurs) will be more costly (Fernandez & Marin, 1998).

The threat of retaliation in highly competitive contact markets has little deterring effect in a focal market because competition in the contact markets has already forced firms to cut prices and raise quality to levels that leave little profit. In contrast, firms will fear retaliation in less competitive contact markets more, because there are more profits to be lost if rivals cut prices or increase quality in these markets. In this way, multimarket contact helps firms to transfer market power from focal markets in which collusive outcomes are easier to achieve to those in which tacit collusion is more difficult to develop and sustain (Bernheim & Winston, 1990).

Thus, firms that meet rivals in less competitive contact markets are less likely to attack their rivals in a focal market than firms that meet rivals in more competitive contact markets. Therefore, a firm is likely to offer lower-quality products and services in focal markets containing rivals whose other contacts with it (multimarket contacts) are in less competitive markets.

Hypothesis 2. Multimarket contact has a more negative effect on service quality in a focal market when it occurs in less competitive markets.

Multimarket Contact and Service Quality Competition in the Airline Industry

As others have noted, the airline industry is an ideal empirical setting for testing the effects of multimarket contact because airline routes provide well-defined markets; the hub-and-spoke system employed by nearly all major airlines creates cost differences among airlines in different markets; and there are differences in the number of carriers serving different routes (Evans & Kessides, 1994; Gimeno & Woo, 1999). Moreover, airlines are keenly aware of the relationships among the routes they serve. Airline managements routinely make decisions about prices, schedules, connections, and the like that require them to consider a network of flights, and not just one flight at a time. For our purposes, the airline industry offered an additional major benefit: on-time performance provides a good measure of service quality, which varies across carriers and routes.

To test the above hypotheses, we analyzed the relationship between multimarket contact and service quality (in the form of on-time performance) in air travel. For airlines, mutual forbearance could result in firms tacitly colluding by providing lower-than-competitive levels of on-time performance on routes in which they face high multimarket contact with their rivals. However, to test these hypotheses, we had to first make several important assumptions regarding multimarket contact and on-time performance competition in the airline industry. Our assumptions were as follows:

Assumption 1. Customers' willingness to pay increases with on-time performance.

Assumption 2. At least some customers can observe on-time performance at the carrier-route level.

Assumption 3. Airlines can influence on-time performance at the route level.

Assumption 4. Airline managers can observe or are aware of (at least approximately) multimarket contact with other airlines on the routes they manage.

Assumption 5. Competitive levels of on-time performance are higher than noncompetitive ones.

Assumptions 1 and 2 ensure that changes in on-time performance can affect airlines' market shares and profits through their effect on consumer demand. Without these assumptions, we shouldn't expect airlines to compete along this dimension at all, making concerns about mutual forbearance irrelevant. We justify Assumption 1 by noting that surveys show air travelers are willing to pay more for better on-time performance, with business travelers valuing on-time performance more than leisure travelers. Specifically, a 2001 survey indicated that business travelers were willing to pay almost $3 for each additional percentage point of on-time performance, and leisure travelers said they would be willing to pay almost $1 for each percentage-point improvement in on-time performance (Resource Systems Group, 2001). Similarly, a 1995 U.S. DOT study, drawing on a survey conducted by the Air Transport Association of America, recommended valuing passengers' travel time at $0.50 per minute (in 1995 dollars). Moreover, complaints about on-time performance routinely comprise the biggest category of complaints to the U.S. DOT's

Office of Aviation Enforcement and Proceedings (US DOT, 1998, 1999, 2000, 2001, 2002).

Assumption 2, which says that at least some customers can observe on-time performance at the route level, may seem implausible, particularly during the time period of our sample (1996–2001), when route-level on-time performance statistics were less easily accessible. However, during this period travelers could (imperfectly) observe airlines' route-level on-time performance through several avenues. First, travel agents could inform customers about route-level on-time performance for a particular itinerary. In 2001, 35 percent of travelers used travel agents to purchase airline tickets (Resource Systems Group, 2001). Second, travelers could learn through word of mouth; friends could provide information on their past experiences flying a route; for example, a traveler from Chicago, planning a trip to New York, might be told by friends that they experienced delays when flying United Airlines from O'Hare to LaGuardia. Third, business travelers, who often must fly the same route many times, could use their own past experiences to inform their future expectations. Consequently, this group is especially capable of learning about airlines' on-time performance on particular routes from personal experience and from the experiences of colleagues.

Providing additional support for Assumptions 1 and 2 is research showing that demand for air travel increases with on-time performance. Both Januszewski (2004) and Morrison and Winston (1983) showed that airlines increase prices in response to improvements in own on-time performance, and Januszewski also showed that airlines reduce prices in response to improvements in rivals' on-time performance. Similarly, Suzuki (2000) found that airline market shares increase with on-time performance. These results support the contention that customers care about on-time performance and provide evidence that customers can observe route-level on-time performance (or at least that airlines believe they can).

Assumptions 3 and 4 ensure that airlines can compete on on-time performance at the route level and link this competition to the level of multimarket contact. Although several studies have shown that airlines raise prices on routes with higher multimarket contact, it might seem less plausible that airlines would adjust their investments in service quality on a route-by-route basis and be able to link their adjustments to route-level multimarket contact.

We justify Assumption 3 by calling upon arguments and findings in the prior literature. As Mazzeo (2003) discussed, airlines can make different kinds of route-level investments that affect on-time performance. For example, they can hire additional employees to speed up processes such as loading and unloading baggage, check-in, and so forth. Similarly, airlines can avoid delays resulting from mechanical failures by maintaining an additional airplane(s) at an airport, or by having a ready supply of mechanics available. Additionally, they can reduce time spent in the air by using larger airplanes with greater flying speed. They can also acquire more slots at airports.

Although many of the investments described above are more airport- than route-specific, they are also highly fungible and can be quickly reallocated across routes within the airport. Drawing on the example used by Mazzeo (2003), if the preflight maintenance check reveals a problem with an American Airlines plane scheduled to fly from Dallas to Nashville, then American might replace it with a plane that had been scheduled to fly to Indianapolis. Similarly, airlines may transfer flight crews or baggage personnel to different routes in response to route-specific conditions. Moreover, advances in technology have greatly facilitated this sort of resource reallocation by airlines in recent years (Mazzeo, 2003).

Mazzeo (2003) and Rupp et al. (2003), as well as Mayer and Sinai (2003), have provided empirical support for the idea that airlines adjust their investments in service quality route-by-route. As noted above, Mazzeo (2003) and Rupp et al. (2003) both found that airlines provide worse on-time performance on less competitive routes. Similarly, Mayer and Sinai (2003) found that airlines provide worse on-time performance on flights leaving their hubs, because they schedule many flights to arrive at the hubs at the same time, in order to facilitate convenient connections, and because they hold flights to wait for connecting passengers. Finally, Borenstein and Netz (1999) showed that route-level competition influences airlines' flight schedules.

Typically, a local airport manager allocates airport resources to different routes. Is it reasonable, then, to assume, as in Assumption 4, that this manager can link his or her decisions to contacts between rivals in multiple routes? We argue that such linking is plausible for two reasons. First, managers at an airline's central office are likely to be aware of multimarket contact at the route level—as evidenced by pricing strategies. Although local managers may not be aware of multimarket contact at the route level, the central managers can provide direction to them by emphasizing particular routes on which on-time performance is a priority. Second, mutual forbearance does not necessarily imply that airline managers adjust their operations route-by-route in response to changes in multimarket contact on each route. They may also adjust their service quality efforts on a rival-by-rival basis. That is, when an airline's multimarket contact with a rival changes, the airline's management may choose to adjust its operations on all routes where it competes with that rival. For example, as United and American airlines compete against each other on more routes, each airline may choose to reduce its investments in service quality on all (or on some) of the routes where they meet.

Assumption 5 ensures that increased cooperation among airlines will lead to worse on-time performance. Underlying this assumption is the likelihood that improving on-time performance is costly, with the aggregate costs of airlines jointly improving on-time performance above the competitive level increasing faster than the benefits. This assumption is necessary in order to extend the mutual forbearance hypothesis to on-time performance. It provides the incentive for firms to relax on-time performance efforts. Doing so enables firms to reallocate resources, ticketing agents, baggage handlers, mechanics, and airplanes to routes with lower levels of multimarket contact, where on-time performance competition is likely to be more intense, and where airlines face stronger incentives to improve on-time performance.

To justify this assumption, we again call on the results of Mazzeo (2003) and Rupp et al. (2003). These works both provide evidence that lower levels of competition lead to worse on-time performance. Moreover, this evidence is consistent with findings from a diverse range of industries, including cleaning, fast food, and legal services, showing that competition leads to better service quality.

METHODS

Data

We tested our hypothesis using data from the DOT's Bureau of Transportation Statistics on the on-time performance of the ten major carriers providing domestic service in the United States from January 1995 through August 2001.[2] In total, our data set comprises more than 36 million flights. We restricted our sample to the 1,000 busiest routes (by monthly passenger volume). Following Mazzeo (2003), we defined a route as a directional origin-destination pair for which at least one carrier provided nonstop service. Moreover, because on-time performance is only measured for individual flights, we restricted our analysis to nonstop service.

To make estimation more manageable, we followed the same procedures used by Mayer and Sinai (2003). We restricted our data to all flights on Fridays (the results we report below also hold for other days of the week). This restriction reduced our sample to 3.5 million flights. And we aggregated our data into 134,867 carrier-route-month cells. We then estimated weighted least squares models, weighting each observation by the number of flights in each cell. Doing so yielded estimates identical to those we would have obtained via ordinary least squares analyses on the disaggregated flight-level data.

Dependent Variables: On-Time Performance

Three different measures are frequently mentioned in accounts of airline on-time performance.

Arrival delay. The simplest measure of on-time performance is the number of minutes late (or early) that a flight arrives at the gate, relative to its scheduled arrival time. Because we conducted our analysis at the carrier-route-month level, we used the average arrival delay over all of a carrier's flights, on a particular route, during a month.

Percentage of flights arriving at least 15 minutes late. In published reports, the DOT generally defines a flight as late if it arrives at the gate at least 15 minutes late. Therefore, we measured the proportion of a carrier's flights on a route in a month that arrived at least 15 minutes late.

Percentage of flights arriving at least 30 minutes late. We also measured the proportion of a carrier's flights on a route in a month that arrived at least 30 minutes late.

Independent Variables

Average multimarket contact. Following an approach similar to that used by Gimeno and Woo (1996, 1999), we defined a carrier-route-specific measure of multimarket contact that varies across carriers on each route. Specifically, for carrier i on route j, we added up all of the contacts between carrier i and other carriers on route j, over all routes, during a month. We then divided the carrier's total contacts by $(n - 1)$, where n is the number of carriers on the route. This normalization sets average multimarket contact equal to 1 for any carrier i, on any route j, when carrier i does not meet any of the carriers on route j on any other route.

To better understand how we calculated this measure of multimarket contact, consider a route k

[2] The ten major carriers are American, Alaska Airlines, Continental, Delta, America West, Northwest, TWA, United, US Air, and Southwest.

with three carriers, A, B, and C. Suppose carrier A meets carrier B 50 times and meets carrier C 10 times. Carrier A now has 60 total contacts on route k; however, its average multimarket contact on route k is 30 (60/[3 − 1] = 30). If carrier B meets carrier C on 70 routes (and meets carrier A on 50 routes), then its total contacts on route k would equal 120, and its average multimarket contact on route k would equal 60 (120/[3 − 1] = 60). Finally, carrier C's total contacts on the route would equal 80, and its average multimarket contact for the route would equal 40 (80/[3 − 1] = 40). In this way, we allowed our measure of multimarket contact to vary across carriers on a route.

Average multimarket contact on low-concentration and high-concentration routes. Hypothesis 2 posits that some multimarket contacts may be more influential than others. To consider this possibility, we split our sample into low-concentration and high-concentration routes, using the median Herfindahl index value on nonmonopoly routes (we excluded monopoly routes, because there are no multimarket contacts on these routes).[3] We then created separate measures of average multimarket contact for contacts on low- and high-concentration routes.

For example, again consider a route k with three carriers, A, B, and C. Suppose carrier A meets carrier B 50 times and carrier C, 10 times. To assess carrier A's average multimarket contact on low-concentration routes, we would sum the number of times that A meets B and C on routes for which the Herfindahl index is below the median value (and then we would normalize this value by dividing by [3 − 1]). Similarly, to determine carrier A's average multimarket contact on high-concentration routes, we would add up the number of times that A meets carriers B and C on routes for which the Herfindahl index is greater than the median value (and would normalize in the same way). Assume that carrier A meets carrier B on 30 routes for which the Herfindahl index takes values less than the median and on 20 routes where it takes values greater than the median, and carrier A meets carrier C on 4 routes where the Herfindahl is less than the median and on 6 routes where the Herfindahl is greater than the median. In this case, carrier A's average multimarket contact on low-concentration routes is 17 ([30 + 4]/[3 − 1] = 17), and carrier A's average multimarket contact on high-concentration routes is 13 ([20 + 6]/[3 − 1] = 13).

Control Variables

We considered two measures of market structure: the Herfindahl index for a given route, which we constructed using carriers' shares of flights on the route during a month, and an indicator for monopoly routes. We included the monopoly dummy to capture the nonlinearity in the relationship between route-level concentration and on-time performance (Mazzeo, 2003); that is, including the dummy allows for a different effect when the Herfindahl value decreases from 1 to 0.9 as compared to when it decreases from 0.5 to 0.4. We report all of our results including both of these measures.

To control for carriers' market power at the airports, as well as congestion externalities (Mayer & Sinai, 2003), we included a carrier's average market share of flights at the two airports involved in each route. To control for (dis)economies of scope and hubbing effects associated with offering multiple routes from the same airport, we included the average number of routes that the carrier served from the end-point airports. To further control for (dis)economies of scope associated with an airline's overall size, we also included a count of the number of routes that the airline served from all other airports. We controlled for airport congestion effects by averaging the mean number of flights departing from a route's origin airport and the mean number of flights arriving at the destination airport during the same hour as each flight on the route. To control for a carrier's flight frequency on a route, we included the number of departures the carrier made on the route each month. Finally, to control for market demand, we included the log of the total number of passengers flying on a route during a month.

Table 1 provides descriptive statistics and a correlation matrix for the variables used in the analysis. The mean arrival delay is more than 12 minutes, with the mean carrier-route having one quarter of its flights arrive at least 15 minutes late and 15 percent of its flights arrive at least 30 minutes late. The mean (median) value of average multimarket contact is 36.88 (22). Multimarket contact is 0 for all of the monopoly routes; however, for the rest of the carrier-routes, variation is substantial, with average multimarket contact values reaching as high as 140. The mean (median) carrier-route is highly concentrated, with a Herfindahl index of 0.65 (0.56). The mean (median) value of average multimarket contact is 18.03 (10.5) on low-concentration routes, and 18.85 (11) on high-concentration routes.

[3] We use the Herfindahl index as a standard measure of concentration. Specifically, it is the sum of the squared market shares for each firm serving a route, where market share for firm i is the firm's number of emplanements on the route divided by the total number of emplanements.

TABLE 1
Descriptive Statistics and Correlation Matrix[a]

Variable	Mean	s.d.	1	2	3	4	5	6	7	8	9	10	11
1. Arrival delay in minutes	12.21	13.93											
2. Arrival at least 15 minutes late	0.26	0.17	.78										
3. Arrival at least 30 minutes late	0.15	0.13	.83	.82									
4. Average multimarket contact	36.88	39.47	−.04	−.04	−.02								
5. Monopoly route indicator	0.27	0.44	−.01	−.01	−.03	−.57							
6. Route Herfindahl	0.65	0.23	−.02	−.02	−.04	−.48	.89						
7. Route passengers[b]	0.35	0.16	.07	.08	.08	.22	−.33	−.39					
8. Average market share at route airports	27.70	14.47	−.01	−.01	−.03	−.37	.61	.60	−.19				
9. Number of routes carrier offers from route airports	25.38	22.07	−.02	−.01	−.02	.02	.30	.28	.00	.55			
10. Number of routes carrier offers from other airports	457.90	165.54	−.02	.00	−.02	.04	.11	.10	−.02	.13	.02		
11. Number of departures carrier makes on the route	174.24	114.10	.04	.02	.03	−.11	.25	.22	.44	.47	.31	−.04	
12. Flights arriving/departing to/from route airports in same hour	10.25	0.55	−.03	−.01	.00	.26	−.12	−.12	.15	.00	.33	−.06	.10

[a] All correlations greater than or equal to .01 are significant at .05.
[b] Logged.

RESULTS

The Effect of Multimarket Contact

To test whether multimarket contact affects on-time performance, we estimated a set of reduced-form, fixed-effects models. In addition to controls for route market power, airport market power, hubbing effects, congestion externalities, and (dis)economies of scope, we also included carrier-route fixed effects to control for unobserved differences among carriers and routes, and month fixed effects to control for any changes in on-time performance over time.

Table 2 provides the results of our tests of Hypothesis 1 using the three measures of arrival delays: average number of minutes late, percentage of flights arriving at least 15 minutes late, and percentage of flights arriving at least 30 minutes late. If one looks first at the control variables, the results indicate that market power worsens on-time performance. Flights on monopoly routes arrived about 1.65 minutes later. Higher Herfindahl index values for a route (henceforth, the "route Herfindahl") have an additional positive effect on arrival delays, but the coefficient is statistically insignificant (the effect of the route Herfindahl is statistically significant when we exclude the monopoly dummy). The carrier's market share at the end-point airports also has a positive effect on delays. The number of flights leaving each airport during the same hour as each flight on the route has a negative effect on delays, as does the number of flights that the carrier offers on the route. The number of routes that the carrier offers from the two airports does not affect delays, and the carrier's total number of routes from other airports increases delays, possibly reflecting some diseconomies of scope. The total number of passengers flying on the route also increases delays.

The results in Table 2 provide strong support for Hypothesis 1. Multimarket contact has a positive and statistically significant effect on all three measures of arrival delays. The coefficient on average multimarket contact in column 1 indicates that a one-point increase in multimarket contact increases average arrival delay by approximately 1.2 seconds. Although this may not seem like a big effect, it means that an increase in average multimarket contact from the 25th through the 75th percentile would increase the average arrival delay by about 1.22 minutes (average multimarket contact increases by 61 points when one moves from the 25th to the 75th percentile). In other words, this effect is almost as large as that associated with an airline establishing a monopoly on a route (1.46 minutes), and it is slightly larger than the effect associated with increasing an airline's average market share at the end-point airports from the 25th to the 75th percentile ($0.21 \times 5.60 = 1.18$). Similarly, increasing multimarket contact from the 25th to the 75th percentile increases the proportion of flights that arrive at least 15 minutes late by about 1.3 percentage points, and it increases the proportion of flights that arrive at least 30 minutes late by about 2.2 percentage points.

TABLE 2
Effect of Average Multimarket Contact on Arrival Delays[a]

Covariates	Model 1: Arrival Delay in Minutes	Model 2: Proportion of Flights Arriving at Least 15 Minutes Late	Model 3: Proportion of Flights Arriving at Least 30 Minutes Late
Average multimarket contact/100	2.04 (0.70)**	0.09 (0.05)*	0.14 (0.04)**
Monopoly route indicator	1.46 (0.58)*	0.07 (0.040)†	0.11 (0.04)**
Route Herfindahl	0.43 (1.25)	0.04 (0.08)	−0.06 (0.09)
Route passengers[b]	4.92 (0.38)**	0.41 (0.03)**	0.31 (0.03)**
Average market share at route airports	5.60 (3.30)†	0.05 (0.23)	0.24 (0.24)
Number of routes carrier offers from route airports/100	−2.00 (3.42)	0.35 (0.25)	0.03 (0.26)
Number of routes carrier offers from other airports/100	0.64 (0.13)**	0.08 (0.01)**	0.04 (0.01)**
Number of flights carrier offers on the route/100	−2.96 (0.21)**	−0.15 (0.02)**	−0.13 (0.02)**
Flights arriving/departing to/from route airports during same hour/100	−1.39 (0.22)**	−0.03 (0.01)**	−0.04 (0.01)**
Constant	−33.25 (4.11)**	−5.95 (0.30)**	−5.55 (0.31)**
Carrier-route-month cells	134,864	134,867	134,867
R^2 within	.18		

[a] All models include carrier-route and month fixed effects. Standard errors clustered by carrier-route are reported in parentheses. Models 2 and 3 are fractional logit models, estimated using maximum likelihood, to account for the proportional nature of the dependent variable (Papke & Wooldridge, 1996).
[b] Logarithm.
† $p < .10$
* $p < .05$
** $p < .01$

Analysis of the Sources of Multimarket Contact–Related Delays

In this section, we take a closer look at the sources of the increased delays resulting from multimarket contact. To begin with, we note that the delays from multimarket contact may be superficial if airlines shorten the scheduled time for flights in response to increased multimarket contact. However, it seems reasonable to assume that scheduling longer flight times reduces costs by reducing the need to invest as much in on-time performance (for instance, airlines can hire fewer ticketing agents, baggage handlers, and mechanics and can use slower planes); and scheduling longer flight times also reduces demand, because travelers prefer shorter flights. Therefore, the mutual forbearance hypothesis suggests that one should actually expect longer scheduled flight times when multimarket contact is greater.

The results in column 1 of Table 3 show our direct test of whether the level of multimarket contact influences flight schedule length, using the scheduled time for a flight as the dependent variable. Here we find evidence that airlines do lengthen flight schedules as multimarket contact increases.[3] This result is consistent with Hypothesis 1, suggesting that mutual forbearance may also extend to the competition in flight schedules. Moreover, airline schedules are coordinated centrally and are also more directly under the control of the airlines. Therefore, these results provide some greater evidence that mutual forbearance is the causal mechanism underlying the positive relationship between multimarket contact and flight delays.

Column 2 of Table 3 shows the results of our examination of the effect of multimarket contact on total travel time, which is the time elapsed from when a flight is scheduled to depart to when it actually arrives. In other words, this measure includes actual travel time plus any departure delay. Because this measure of on-time performance is not relative to the scheduled arrival time, it is independent of the scheduled time for a flight. As one might expect, the effect of multimarket contact on total

[3] Note that the route Herfindahl has a negative effect on scheduled flight times. As we show below, this is because airlines on more concentrated routes (which tend to have higher route market shares) use larger planes, which reduce flying time, allowing the airlines to schedule shorter flight windows.

TABLE 3
Effect of Average Multimarket Contact on Alternative Delay Measures[a]

Covariate	Model 1: Scheduled Flight Time	Model 2: Travel Time	Model 3: Nonairtime	Model 4: Airtime
Average multimarket contact/100	0.74 (0.39)†	2.78 (0.73)**	2.37 (0.68)**	0.25 (0.27)
Monopoly route indicator	0.84 (0.31)**	2.31 (0.57)**	1.98 (0.54)**	0.16 (0.22)
Route Herfindahl	−2.51 (0.67)**	−2.08 (1.31)	−0.69 (1.22)	−1.30 (0.46)**
Route passengers[b]	−1.31 (0.27)**	3.60 (0.43)**	5.16 (0.37)**	−1.61 (0.25)**
Average market share at route airports	0.88 (1.68)	6.48 (3.18)*	8.81 (2.94)**	−2.47 (1.18)*
Number of routes carrier offers from route airports/100	12.25 (2.05)**	10.25 (3.84)**	8.76 (3.57)*	0.92 (1.53)
Number of routes carrier offers from other airports/100	−1.13 (0.07)**	−0.49 (0.15)**	−0.47 (0.14)**	0.03 (0.05)
Number of flights carrier offers on the route/100	0.46 (0.14)**	−2.51 (0.25)**	−2.85 (0.24)**	0.39 (0.10)**
Flights arriving/departing to/from route airports during same hour/100	0.93 (0.20)**	−0.46 (0.25)†	−0.57 (0.20)**	0.07 (0.16)
Constant	138.62 (2.96)**	105.38 (4.55)**	−15.97 (4.01)**	122.32 (2.61)**
Carrier-route-month cells	134,864	134,864	134,865	134,864
R^2 within	.18	.21	.21	.07

[a] All models include carrier-route and month fixed effects. Standard errors clustered by carrier-route are reported in parentheses.
[b] Logarithm.
† $p < .10$
* $p < .05$
** $p < .01$

travel time is a bit larger than its effect on arrival delays, because its positive impact on scheduled flight time is not a factor in this measure of on-time performance.

To better identify the locus of delays, we decomposed the travel time measure into two parts: airtime and nonairtime. Airtime measures the time an aircraft spends in the air, and nonairtime includes departure delay (in leaving the gate) plus time spent on the runway at each end point of a flight. Model 3 of Table 3 shows our assessment of the impact of multimarket contact on nonairtime. The coefficient on average multimarket contact indicates that increasing it from the 25th to the 75th percentile would increase the time spent on the ground (departure delay time plus time spent taxiing at both airports) by about 1.4 minutes. The effect of multimarket contact on nonairtime is effectively the same as its effect on total travel time, indicating that multimarket contact worsens on-time performance by delaying a plane while it is on the ground.

To confirm this, we assessed the impact of multimarket contact on airtime; model 4 of Table 3 shows these results. In keeping with the previous results, the coefficient on average multimarket contact is small and statistically insignificant, indicating that flying time is little affected by multimarket contact. This suggests that forbearance resulting from increased multimarket contact does not take the form of reduced investments in faster aircraft. Interestingly, we note that the route Herfindahl has a negative and statistically significant effect on airtime, indicating that airlines save time in the air on more concentrated routes.

To further pinpoint the source of delays, we examined the effect of multimarket contact on departure delay. Time spent taxiing is likely to be influenced by airport traffic conditions, but departure delay should be more under an airline's control. In Table 4, we report results for the three measures of departure delay in the data. For all three measures, the effect of multimarket contact is positive and statistically significant. The results indicate that as average multimarket contact increases from the 25th to the 75th percentile, the average departure delay increases by nearly 1 minute. Similarly, increasing multimarket contact from the 25th to the 75th percentile increases the proportion of flights that depart at least 15 minutes late by about 1.4 percentage points, while it increases the proportion of flights that depart at least 30 minutes by about 2.2 percentage points. These results show that most of the effect of multimarket contact on delays comes from increasing departure delay and is not primarily related to time spent on the runway.

From Tables 2–4, we conclude that multimar-

TABLE 4
Effect of Average Multimarket Contact on Departure Delays[a]

Covariate	Model 1: Departure Delay in Minutes	Model 2: Proportion of Flights Departing at Least 15 Minutes Late	Model 3: Proportion of Flights Departing at Least 30 Minutes Late
Average multimarket contact/100	1.58 (0.51)**	0.10 (0.05)*	0.16 (0.05)**
Monopoly route indicator	1.36 (0.44)**	0.07 (0.04)†	0.11 (0.04)**
Route Herfindahl	0.65 (1.01)	0.18 (0.09)*	0.06 (0.09)
Route passengers[b]	3.96 (0.30)**	0.43 (0.03)**	0.32 (0.03)**
Average market share at route airports	4.18 (2.48)†	0.31 (0.24)	0.48 (0.24)*
Number of routes carrier offers from route airports/100	5.39 (2.67)*	0.45 (0.26)†	−0.11 (0.26)
Number of routes carrier offers from other airports/100	0.59 (0.11)**	0.06 (0.01)**	0.03 (0.01)**
Number of flights carrier offers on the route/100	−2.32 (0.17)**	−0.14 (0.02)**	−0.12 (0.02)**
Flights arriving/departing to/from route airports during same hour/100	−0.72 (0.15)**	−0.03 (0.01)**	−0.02 (0.01)†
Constant	−27.38 (3.26)**	−6.94 (0.31)**	−6.04 (0.32)**
Carrier-route-month cells	134,865	134,867	134,867
R^2 within	.17		

[a] All models include carrier-route and month fixed effects. Standard errors clustered by carrier-route are reported in parentheses. Models 2 and 3 are fractional logit models, estimated using maximum likelihood, to account for the proportional nature of the dependent variable (Papke & Wooldridge, 1996).
[b] Logarithm.
† $p < .10$
* $p < .05$
** $p < .01$

ket contact increases airline delays, as mutual forbearance results in reduced investments in and effort toward on-time performance. Multimarket contact causes delays on the ground, primarily in the form of delay in departing from the gate. Thus, mutual forbearance likely takes the form of reduced investments in check-in, baggage, and/or maintenance staff and equipment. Moreover, multimarket contact also results in longer scheduled flight times.

Additional Measures of Service Quality/Mechanisms for the Effect of Multimarket Contact

Although we focused here on on-time performance, we recognize that there are other dimensions of service quality in the airline industry. In Table 5, we examine three additional measures of service quality: cancellations, plane size, and frequency of flights. The results show that average multimarket contact has a positive and statistically significant effect on cancellations, and a negative and statistically significant effect on plane size and the frequency of scheduled flights. In the case of cancellations, the coefficient on average multimarket contact indicates that increasing average multimarket contact from the 25th to the 75th percentile would increase cancellations by about three flights per month, which is a substantial increment over the mean of 4.5 cancellations. Compared to on-time performance, cancellations, size of plane, and flight frequency are more directly under the airlines' control. Therefore, we believe that these results provide strong evidence for the proposed causal mechanism of mutual forbearance. Finally, we also note that the route Herfindahl has a positive and statistically significant effect on plane size, suggesting that carriers on more concentrated routes use large planes, which provides an explanation for the reduction in airtime and schedule time that we note above, as larger planes tend to also be faster.

In additional analyses, we also find that multimarket contact has a negative and statistically significant effect on service costs (for space reasons, and because these data are only available on a quarterly basis, we omit the results). These results provide further evidence consistent with the mutual forbearance hypothesis.

Finally, to further verify that multimarket contact

TABLE 5
Effect of Average Multimarket Contact on Other Measures of Service Quality[a]

Covariate	Model 1: Cancellations	Model 2: Seats Per Flight	Model 3: Scheduled Departures
Average multimarket contact/100	5.45 (1.82)**	−7.64 (1.41)**	−16.29 (7.67)*
Monopoly route indicator	1.30 (0.98)	−4.13 (1.21)**	−30.26 (7.26)**
Route Herfindahl	−6.13 (2.53)*	17.53 (2.70)**	106.53 (16.21)**
Route passengers[b]	−7.93 (2.14)**	21.07 (1.19)**	106.57 (4.36)**
Average market share of route airports	29.16 (6.48)**	17.44 (5.71)**	385.77 (34.92)**
Number of routes carrier offers from route airports/100	−3.47 (9.52)	12.27 (6.41)[†]	−150.23 (36.28)**
Number of routes carrier offers from other airports/100	−1.70 (0.44)	−0.63 (0.24)**	−5.80 (1.26)**
Number of flights carrier offers on the route/100	−2.31 (2.52)	−10.04 (0.81)**	
Flights arriving/departing to/from route airports during same hour/100	0.76 (0.18)**	1.27 (0.17)**	4.30 (0.47)**
Average number of seats per flight			−0.81 (0.05)**
Constant	94.72 (20.16)**	−38.19 (11.35)**	−855.63 (47.88)**
Carrier-route-month cells	134,867	134,866	134,866
R^2 within	.15	.11	.36

[a] All models include carrier-route and month fixed effects. Standard errors clustered by carrier-route are reported in parentheses.
[b] Logarithm.
[c] In the flight frequency regression, we control for size of plane, because plane size and flight frequency are substitutes. Therefore, as multimarket contact reduces plane size, this induces a spurious positive correlation between multimarket contact and flight frequency. Including plane size as a regressor controls for this correlation.
† $p < .10$
* $p < .05$
** $p < .01$

is actually causing the increase in delays, and not merely correlated with them, we consider conditions under which multimarket contact should have a stronger or weaker effect. For example, it seems likely that interdependence among routes, exacerbated by airlines' hub-and-spoke networks, might dampen airlines' incentive to reduce on-time performance efforts in response to increased multimarket contact. In additional analyses, we found support for this idea: the effect of multimarket contact is weaker on routes where delays have a greater effect on the on-time performance of other routes, either via missed connections or by causing later flights on the same plane to be delayed.

Effects of Multimarket Contact on More vs. Less Competitive Routes

To test Hypothesis 2, we estimated the effects of average multimarket contact on high-concentration routes and on low-concentration routes. We report the results in Table 6. In all three models, we find that multimarket contact on high-concentration routes has a weaker, positive effect on arrival delays than contact on low-concentration routes. These results fail to provide any support for Hypothesis 2, as they all suggest that multimarket contact on more highly concentrated routes has a weaker deterring effect on airlines' propensity to provide high service quality.

One possible explanation for the above results is that the positive effect of multimarket contact diminishes for contacts on very highly concentrated routes. This is because, on these contact routes, a dominant carrier will have little fear of competitive attacks, while fringe players will have little to lose from a competitive attack. This scenario seems particularly likely in the airline industry because dominant carriers enjoy barriers to imitation—control of landing slots, hubs that offer connections to many other destinations, greater frequency of service, and frequent flyer programs—that make it difficult for smaller rivals to attack them. Therefore, contact in highly concentrated markets should have little effect on carriers' on-time behavior.

To assess this possibility, we separated routes into three evenly sized categories: low (0.21 ≤ route Herfindahl < 0.50), medium (0.50 ≤ route

TABLE 6
Effect of Average Multimarket Contact on Arrival Delays for Contacts on Low- and High-Concentration Routes[a]

Covariate	Model 1: Arrival Delay in Minutes	Model 2: Proportion of Flights Arriving at Least 15 Minutes Late	Model 3: Proportion of Flights Arriving at Least 30 Minutes Late
Average multimarket contact on low-concentration routes/100	5.45 (1.96)**	0.21 (0.13)†	0.30 (0.13)*
Average multimarket contact on high-concentration routes/100	1.11 (0.96)	0.07 (0.07)	0.11 (0.07)
Monopoly route indicator	1.23 (0.58)*	0.06 (0.04)	0.09 (0.04)*
Route Herfindahl	0.49 (1.25)	0.05 (0.08)	−0.05 (0.09)
Route passengers[b]	4.92 (0.38)**	0.41 (0.03)**	0.31 (0.03)**
Average market share at route airports	5.65 (3.03)†	0.05 (0.23)	0.24 (0.24)
Number of routes carrier offers from route airports/100	−2.07 (3.39)	0.35 (0.25)	0.04 (0.26)
Number of routes from other airports/100	0.64 (0.13)**	0.08 (0.01)**	0.04 (0.01)**
Number of flights carrier offers on the route/100	−2.97 (0.21)**	−0.15 (0.02)**	−0.13 (0.02)**
Flights arriving/departing to/from route airports during same hour/100	−1.43 (0.22)**	−0.03 (0.01)**	−0.04 (0.01)**
Constant	−33.08 (4.11)**	−5.93 (0.30)**	−5.51 (0.31)**
Carrier-route-month cells	134,864	134,867	134,867
R^2 within	.18		

[a] All models include carrier-route and month fixed effects. Standard errors clustered by carrier-route are reported in parentheses. Models 2 and 3 are fractional logit models, estimated using maximum likelihood, to account for the proportional nature of the dependent variable (Papke & Wooldridge, 1996).

[b] Logarithm.

† $p < .10$

* $p < .05$

** $p < .01$

Herfindahl < 0.55), and high (0.55 ≥ route Herfindahl < 0.99) concentration. We then measured average multimarket contact separately for each of these three sets of contacts. By doing so, we could assess whether the positive effect of multimarket contact diminishes for contact on the most concentrated routes. We report the results including all three measures of average multimarket contact in Table 7.

All three models reveal a similar pattern. Multimarket contact on the least concentrated (0.21–0.50) contact routes has a weakly positive effect, while contact on the most concentrated (0.55–0.99) contact routes has a negative but statistically insignificant effect on on-time performance. However, contact on the routes with an intermediate level of concentration (0.50−0.55) exerts a strong, positive effect on arrival delays. In all three models, the effect of contacts on routes with intermediate levels of concentration is significantly greater than the effect of contacts on low- or high-concentration contact routes. These results provide strong support for the view that the effect of multimarket contact first increases and then diminishes with the concentration level on the route on which a contact occurs.

DISCUSSION AND CONCLUSION

This study is the first to examine the relationship between multimarket contact and service quality. Building on research linking competition and quality, and drawing on mutual forbearance arguments, we hypothesized that a firm's service quality in a particular market will worsen as its multimarket contact with rivals in that market increases. In doing so, we extended the mutual forbearance hypothesis to service quality and expanded understanding of how competitive conditions influence service quality.

To assess this relationship, we made use of airline on-time performance data to measure service quality. We find strong evidence that airlines with higher multimarket contact provide worse on-time

TABLE 7
Effect of Average Multimarket Contact on Arrival Delays for Contacts on Low-, Medium-, and High-Concentration Routes[a]

Covariate	Model 1: Arrival Delay in Minutes	Model 2: Proportion of Flights Arriving at Least 15 Minutes Late	Model 3: Proportion of Flights Arriving at Least 30 Minutes Late
Average multimarket contact on low-concentration routes/100	1.57 (0.75)*	0.03 (0.05)	0.06 (0.05)
Average multimarket contact on medium-concentration routes/100	7.84 (0.97)**	0.47 (0.07)**	0.61 (0.07)**
Average multimarket contact on high-concentration routes/100	−1.26 (0.84)	−0.09 (0.06)	−0.01 (0.06)
Monopoly route indicator	1.43 (0.58)*	0.07 (0.04)	0.11 (0.04)*
Route Herfindahl	0.43 (1.25)	0.04 (0.08)	−0.06 (0.09)
Route passengers[b]	4.96 (0.38)**	0.42 (0.03)**	0.31 (0.03)**
Average market share at route airports	5.74 (3.02)†	0.06 (0.23)	0.25 (0.24)
Number of routes carrier offers from route airports/100	−1.90 (3.40)	0.36 (0.25)	0.04 (0.26)
Number of routes from other airports/100	0.65 (0.13)**	0.09 (0.01)**	0.04 (0.01)**
Number of flights carrier offers on the route/100	−2.96 (0.21)**	−0.15 (0.02)**	−0.13 (0.02)**
Flights arriving/departing to/from route airports during same hour/100	−1.52 (0.22)**	−0.04 (0.01)**	−0.05 (0.01)**
Constant	−33.57 (4.10)**	−5.97 (0.30)**	−5.57 (0.31)**
Carrier-route-month cells	134,864	134,867	134,867
R^2 within	.18		

[a] All models include carrier-route and month fixed effects. Standard errors clustered by carrier-route are reported in parentheses. Models 2 and 3 are fractional logit models, estimated using maximum likelihood, to account for the proportional nature of the dependent variable (Papke & Wooldridge, 1996).
[b] Logarithm.
† $p < .10$
* $p < .05$
** $p < .01$

performance. Specifically, arrival delays increase with multimarket contact. Nearly all of the additional delay is due to increased time spent on the ground, primarily before an aircraft leaves the gate. These results suggest that mutual forbearance likely results in reduced investments in check-in, baggage, and/or maintenance staff and equipment. Moreover, we show that the increase in arrival delays is not a result of spending more time in the air, nor is it caused by shorter scheduled flight times; scheduled flight times actually increase with multimarket contact. We also find that airlines cancel more flights, fly smaller planes, and offer fewer flights as their multimarket contact with rivals increases. These results provide additional evidence that multimarket contact influences airlines' choices, because flight schedules, flight cancellations, and the sizes of the planes flown are more directly under airlines' control. Moreover, these decisions, especially flight schedules, are likely to be made centrally, where managers are most likely to be aware of multimarket contact at the route level. Taken together, these results provide the first evidence that, in addition to price and entry/exit, multimarket contact affects tacit collusion on service quality.

These results also provide additional evidence on the relationship between competition and service quality. Thus far, only a few studies have assessed the impact of competition on quality, and all of these studies have focused on the impact of market structure; none has assessed the effect of multimarket contact. Yet, as globalization increases, leading to both more multimarket contact and an intensification of global competition, and consumers' expectations for high-quality service increase, it becomes increasingly important to understand how broader competitive conditions, including multimarket contact, influence service quality.

We also found some support for the hypothesis that multimarket contact in more competitive markets has less effect on service quality. Specifically, we found that the effect of multimarket contact initially increases with concentration on the route in which the contact occurs, but then diminishes at very high levels of concentration, with the strongest effects coming from multimarket contact on routes that have concentration (Herfindahl index) levels of 0.50–0.55. This makes sense because it is on these routes that retaliation is likely to pose the greatest threat. On the least concentrated routes, the higher level of competition creates incentives to reduce prices and improve service quality, reducing the threat of retaliation. Similarly, on the most highly concentrated routes, the presence of a dominant firm weakens the threat of retaliation; the dominant firm is likely to perceive little threat from fringe competitors, while airlines with a very small presence on a route may recognize that they have little to lose if the dominant firm retaliates against them. In contrast, intermediate routes are sufficiently concentrated that retaliation would be costly, yet they are not dominated by one firm having little fear of retaliation, nor do they have as many fringe rivals with little to lose from retaliation.

Although we expect that this general pattern of results will carry over to other contexts, we might expect to find that at very low levels of concentration, the effect would also go to zero. Because concentration levels in our sample were so high (the minimum route Herfindahl is 0.21), we did not observe this in our study.

Welfare Loss Calculation

We can use our estimates to conduct a simple back-of-the-envelope calculation of welfare loss due to delays resulting from multimarket contact. For the nearly seven years of our data, there was an annual average of about 5.47 million flights, with an average of 101 passengers per flight. The 2001 National Household Travel Survey shows that approximately 40 percent of air passengers are business travelers, leaving 60 percent as nonbusiness travelers. According to the Resource Systems Group's (2001) annual survey of U.S. domestic air passengers, business travelers are willing to pay \$36 for each hour of reduced travel time, and nonbusiness travelers are willing to pay \$15. Further, each flight had an average multimarket contact of 36.88. Therefore, using the estimated coefficient on average multimarket contact (column 1 of Table 2), our simple estimate of annual welfare loss due to lost time is:

$$\begin{aligned} \textit{Welfare loss } (\textit{lost time}) &= 0.020 \times 36.88 \\ &\times 5.47 \text{ million } \times 101 \times (36 \times 0.4 + 15 \times 0.6) \\ &= \$9.5 \text{ billion.} \end{aligned}$$

Therefore, although the effect of multimarket contact on airline days for an individual traveler may not be great, the aggregate effect, across all travelers, is quite substantial.

It is also important to note that the mean effect of multimarket contact is likely to mask substantial variation. We would expect the majority of each carrier's flights to take off and arrive on time, regardless of the carrier's multimarket contact. But when other factors create delay pressures—such as bad weather, unusually high air traffic, or mechanical problems—then airlines are more likely to reallocate resources from routes with higher multimarket contact to those with lower multimarket contact. Therefore, we would expect the effect of multimarket contact to be substantially greater under such conditions. Supporting this view, the results in Table 2 show that the effect of multimarket contact is greater for flights that are delayed longer. The effect is even greater for flights arriving at least one hour late (moving from the 25th to the 75th percentile in multimarket contact increases the percentage of flights arriving at least one hour late by 2.8 percentage points from a mean of 8.8 percent), and especially for flights arriving at least two hours late (3.8 percentage points from a mean of 4.2 percent). In other words, increasing multimarket contact from the 25th to the 75th percentile almost doubles the proportion of flights arriving at least two hours late.

Implications for Existing and Future Research on Multimarket Contact

The hypotheses that are developed and tested here have important implications for multimarket contact research. The results highlight the fact that the effects of multimarket contact on firm behavior are more pervasive than previously recognized. Previous research has highlighted the influence of multimarket contact on pricing and entry/exit behavior, but this research shows that it also affects firms' provision of high service quality. This relationship also expands the scope for multimarket contact to influence firm behavior, because it suggests that multimarket contact may be important even in industries in which relatively little price competition exists.

Our results also indicate that multimarket contact can influence quality even when firms face diseconomies of scope in terms of quality. Gimeno and Woo (1999) showed that multimarket contact has little effect on prices or profits in the absence of strong economies of scope. Specifically, they showed that airlines enjoy economies of scope among routes sharing a common end-point airport and that multimarket contact on routes that share a common airport has a much stronger (positive) effect on airline pricing and profits. We found that airlines face diseconomies of scope in regard to on-time performance. That is, as the number of routes that an airline offers increases, its on-time performance worsens. Moreover, this effect is stronger on routes that share a common end-point airport; that is, the number of routes that an airline serves from a particular airport has a more negative effect on on-time performance. Hubbing effects can explain these diseconomies of scope in on-time performance (Mayer & Sinai, 2003). As the number of routes from an airport offered by an airline increases, its incentive to schedule flights close together to allow for more convenient connections increases delays, as the airline holds flights to wait for connecting passengers and/or passengers wait for connecting flights that have not yet arrived. Therefore, our results suggest that multimarket contact influences service quality even in the absence of economies of scope in service quality.

At the same time, the results of this study suggest some boundary conditions for the influence of multimarket contact. Our results suggest that the effects of multimarket contact diminish at very high and low levels of concentration. Therefore, in very competitive industries and in the most highly concentrated industries, mutual forbearance may be less likely. This lower likelihood of observing mutual forbearance highlights the need to move beyond simple counts of multimarket contacts in doing research in this area. It also suggests that using weighted measures of multimarket contact, the commonly used approach for assessing the differential impact of multimarket contacts, may not be appropriate for fully assessing their nonlinear effects.

However, it is important to interpret these results in the context in which they were generated. Airline routes are highly concentrated. In our sample, the median route has a Herfindahl index of 0.56, and more than 75 percent of routes are served by only two carriers. In industries with lower levels of concentration, we would expect little if any effect of contact in the most competitive markets, and it seems unlikely that concentration levels would reach the point at which multimarket contact loses its influence.

Finally, our results also have important implications for understanding the relationship between service quality and competitive conditions. Our study highlights the need to move beyond the exclusive focus on market structure that has thus far dominated the research linking competition and quality. It appears that, as with pricing behavior, a broad range of competitive conditions influences firms' provision of service quality. Moreover, in results not reported here, we found that when we omitted multimarket contact from our analysis, the effect of the monopoly dummy became smaller and statistically insignificant. This was to be expected, given the negative correlation between market concentration and multimarket contact, and the finding suggests that ignoring the role of multimarket contact may result in underestimation of the relationship between market structure and service quality.

Managerial Implications

Our results also have important implications for managers. First, they highlight the fact that multimarket contact can have a positive effect on a firm's financial performance, by enabling it to reduce costs related to service quality. Through mutual forbearance, firms can reduce service-related costs, without cutting prices or suffering a notable drop in demand. Therefore, by allowing firms to invest less in service efforts, while maintaining demand for their product offerings, multimarket contact should have a positive effect on a firm's bottom line.

Second, our results suggest that by focusing on markets with high multimarket contact, potential entrants can identify markets that are likely to be receiving poor service and capture an opportunity to enter and compete with superior service. In the airline industry, on-time performance statistics are readily available, and therefore potential entrants can use them to identify routes on which the incumbent carriers are serving customers poorly. However, in most other industries, service quality is less easily observable. In these cases, observing high multimarket contact levels may help firms to identify markets with low service quality.

However, in both cases, it is important to recognize that these are not necessarily "one size fits all" implications. That is, some firms may benefit more than others from the influence of multimarket contact on service quality. In particular, it would seem likely that firms that offer higher levels of service quality, or firms whose strategies focus on service, would benefit less from mutual forbearance on service dimensions, just as low-cost firms benefit less from any form of tacit price collusion. In contrast, these same firms might benefit most from using multimarket contact to identify markets receiving low levels of service, as they would be the best positioned to exploit these opportunities.

Limitations and Future Research

This study has several important limitations relating to the empirical setting. First, in the airline industry, rivals can easily observe service quality because of government reporting of airline on-time performance data. The government provides monthly summaries of all major airlines' on-time performance on every route. This ease of observability facilitates airlines' ability to tacitly collude in their provision of service quality. Second, as discussed above, most airline routes are fairly highly concentrated, which increases the influence of multimarket contact. Third, as Gimeno and Woo (1999) demonstrated, airline managements are well aware of the relationships among the routes they serve. Indeed, they routinely make decisions about prices, schedules, connections, and the like that require them to consider a network of routes, and not just one route at a time. Fourth, entry into new routes is relatively rare in the airline industry. Therefore, airlines have some flexibility about engaging in mutual forbearance on price or service quality. In industries with greater entry, this would be more difficult, as elevated prices or low service quality would likely attract new entry, which would negatively impact incumbents. Nonetheless, within the airline industry, it would be interesting to assess whether the presence of potential entrants reduces the price and/or service quality response to multimarket contact.

For all of these reasons, it may be difficult to replicate our results in other settings. Nonetheless, because ours is the first study to link multimarket contact and service quality, we believe it is very important to assess this issue in other contexts. In addition, we think it would be useful to simultaneously assess the relationship between multimarket contact and both price and service quality, because firms often choose these two competitive weapons simultaneously. By assessing these relationships jointly, researchers may be able to get a better understanding of the influence of multimarket contact on firms' competitive behavior.

REFERENCES

Baum, J., & Korn, H. 1996. Competitive dynamics of interfirm rivalry. ***Academy of Management Journal,*** 39: 255–291.

Baum, J., & Korn, H. 1999. Dynamics of dyadic competitive interaction. ***Strategic Management Journal,*** 20: 251–278.

Bernheim, B., & Whinston, M. 1990. Multimarket contact and collusive behavior. ***Rand Journal of Economics,*** 21: 1–26.

Borenstein, S., & Netz, J. 1999. Why do all the flights leave at 8 a.m.? Competition and departure-time differentiation in airline markets. ***International Journal of Industrial Organization,*** 17: 611–640.

Busse, M. 2000. Multimarket contact and price coordination in the cellular telephone industry. ***Journal of Economics and Management Strategy,*** 9: 287–320.

Domberger, S., Hall, C., & Li, E. 1995. The determinants of price and quality in competitively tendered contracts. ***Economic Journal,*** 105: 1454–1470.

Domberger, S., & Sherr, A. 1989. The impact of competition on pricing and quality of legal services. ***International Review of Law and Economics,*** 9: 41–56.

Dranove, D., & White, W. 1994. Recent theory and evidence on competition in hospital markets. ***Journal of Economics and Management Strategy,*** 3: 169–209.

Estelami, H. 2000. Competitive and procedural determinants of delight and disappointment in consumer complaint outcomes. ***Journal of Service Research,*** 2: 285–300.

Evans, W., & Kessides I. 1994. Living by the "golden rule": Multimarket contact in the United States airline industry. ***Quarterly Journal of Economics,*** 109: 341–366.

Fernandez, N., & Marin, P. 1998. Market power and multimarket contact: Some evidence from the Spanish hotel industry. ***Journal of Industrial Economics,*** 46: 301–315.

Gal-Or, E. 1983. Quality and quantity competition. ***Bell Journal of Economics,*** 14: 590–600.

Gimeno, J., & Woo, C. 1996. Hypercompetition in a multimarket environment: The role of strategic similarity and multimarket contact in competitive de-escalation. ***Organization Science,*** 7: 322–341.

Gimeno, J., & Woo, C. 1999. Multimarket contact, economies of scope, and firm performance. ***Academy of Management Journal,*** 42: 239–259.

Hughes, K., & Oughton, C. 1993. Diversification, multimarket contact and profitability. ***Economica,*** 60: 203–224.

Jans, I., & Rosenbaum, D. 1996. Multimarket contact and pricing: Evidence from the US cement industry. ***International Journal of Industrial Organization,*** 15: 391–412.

Januszewski, S. 2004. ***The effect of air traffic delays on airline prices.*** Working paper, University of California, San Diego.

Jayachandran, S., Gimeno, J., & Varadarajan, P. R. 1999. Multimarket competition and interfirm rivalry: A synthesis and implications for marketing strategy. ***Journal of Marketing,*** 63(3): 49–66.

Liao. H., & Chuang, A. 2004. A multilevel investigation of factors influencing employee service performance and customer outcomes. ***Academy of Management Journal,*** 47: 41–58.

Mayer, C., & Sinai, T. 2003. Network effects, congestion externalities, and air traffic delays: Or why not all delays are evil. ***American Economic Review,*** 93: 1194–1215.

Mazzeo, M. 2003. Competition and service quality in the US airline industry. ***Review of Industrial Organization,*** 22: 275–296.

Papke, L., & Wooldridge, J. 1996. Econometric methods for fractional response variables with an application to 401(K) plan participation rates. ***Journal of Applied Econometrics,*** 11: 619–632.

Parker, P., & Roller, L. 1997. Collusive conduct in duopolies: Multimarket contact and cross-ownership in the mobile telephone industry. ***Rand Journal of Economics,*** 28: 304–322.

Piloff, S. 1999. Multimarket contact in banking. ***Review of Industrial Organization,*** 14: 63–182.

Porter, M. 1980. ***Competitive strategy.*** New York: Free Press.

Resource Systems Group, Inc. 2001. ***Air travel 2001: What do they tell us about the future of U.S. air travel?*** Industry report, December.

Rupp, N. 2005. ***Flight delays and cancellations.*** Working paper ECU0502, Department of Economics, East Carolina University, Greenville, NC.

Rupp, N., Owens, D., & Plumly, L. 2003. Does competition influence airline on-time performance. In D. Lee (Ed.), ***Advances in airline economics: Competition policy and antitrust,*** vol. 1: 251–272. New York: Elsevier.

Schmalensee, R. 1974. Market structure, durability, and maintenance effort. ***Review of Economic Studies,*** 41: 277–187.

Schmalensee, R. 1979. Market structure, durability, and quality: A selective survey. ***Economic Inquiry,*** 42: 177–196.

Scott, J. 1982. Multimarket contact and economic performance. ***Review of Economics and Statistics,*** 64: 368–375.

Scott, J. 1991. Multimarket contact among diversified oligopolists. ***International Journal of Industrial Organization,*** 9: 225–238.

Shankar, V. 1999. New product introduction and incumbent response strategies: Their interrelationship and the role of multimarket contact. ***Journal of Marketing Research,*** 36: 327–344.

Suzuki, Y. 2000. The relationship between on-time performance and airline market share: A new approach. ***Transportation Research Part E,*** 36: 139–154.

Swan, P. 1970. Durability of consumer goods. ***American Economic Review,*** 60: 884–894.

Vonortas, G. 2000. Multimarket contact and inter-firm cooperation in R&D. ***Journal of Evolutionary Economics,*** 10: 243–271.

Young, G., Smith, K. G., Grimm, C., & Simon, D. 2000. Multimarket contact and resource dissimilarity: A competitive dynamics perspective. ***Journal of Management,*** 26: 1217–1236.

Jeffrey T. Prince (jtp35@cornell.edu) is an assistant professor in the Department of Applied Economics and Management at Cornell University. He earned his Ph.D. in economics from Northwestern University. His research focuses on empirically analyzing industrial organization and demand systems for dynamic goods.

Daniel H. Simon (dhs29@cornell.edu) is an assistant professor in the Department of Applied Economics and Management at Cornell University. He earned his Ph.D. in strategic management from the University of Maryland. His research focuses on examining internal and external factors that influence firm behavior and performance.