AN EXAMINATION OF AIRLINE PRICING: TESTING THE EFFECTS OF MERGERS AND UNCERTAINTY ON AVERAGE FARE AND DISPERSION

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ABSTRACT

JOHN A. MacDONALD: An Examination of Airline Pricing: Testing the Effects of Mergers and Uncertainty on Average Fare and Dispersion
(Under the direction of John F. Stewart)

This dissertation uses data from the late 1980s to examine pricing, mergers, and market concentration in the airline industry. It is motivated by a current airline pricing theory that predicts prices dispersion is increasing with demand uncertainty and costly capacity. This theory directs my analysis towards three concurrent goals. First, I provide quantifiable figures for uncertainty in airline pricing. Second, I empirically establish the relationships between airline price dispersion and uncertainty, competition, and costly capacity. And third, I attempt to evaluate the effects mergers have on average fares and fare dispersion in the airline industry.

Two key results obtained in the analysis contradict the theory: uncertainty is found to negatively impact dispersion, and average fares are found to fall with mergers. The former casts doubt on the applicability of the theory, while the latter suggests efficiency gains can be expected to outweigh market power abuses following a merger. While these results cannot definitively disprove the going theories, they call into question the true roles demand uncertainty and competition play in the specific case of the airline industry.

The empirical analysis is followed by a detailed discussion of the drawbacks inherent in the current theory's underlying assumptions and key results. Potential alternate applications of demand uncertainty theory are also explored. Finally, I present the groundwork for a new concept of "residual supply" as a determinant of airline pricing.

To my parents, to my children, and most of all, to my wife. This one's for you, Laurie!

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CHAPTER I

INTRODUCTION

The historical source of current airline pricing practices can be traced to the deregulation of the industry. In 1978, the Airline Deregulation Act (ADA) forced the airline industry onto a path from inefficiency to competition. While the process would surely include mergers, bankruptcies, and entry, it has proven to be slow. Three decades later, we still categorize airlines based on their relationship to the regulated era. Inefficient “legacy carriers” existed prior to the ADA, while efficient “startup carriers” emerged afterwards. Both still exist today in a fiercely competitive business environment. It would appear that legacy carriers are reluctant to give up their markets without a fight.

The primary difference between the old and new carriers is their cost structures: legacy carriers are high cost, startups are low cost. During regulation, airlines faced few competitive pressures to obtain or maintain efficient operations. The Civil Aeronautics Board (CAB) chose routes, fares, and competitors for any airlines operating at the time. High fares and protected markets led to expensive union concessions, bloated management structures, and other inefficient business practices. The giant airlines that resulted were ill-equipped to handle deregulation, as startup carriers proved to be very aggressive competitors.

In situations where protected firms are suddenly exposed to low cost entrants, they face three options: compete, retreat, or disappear. Thus, legacy carriers could match rivals’ costs, consolidate into monopolistic hubs, or go bankrupt. Obviously, bankruptcy is not an attractive option,[1] and the adoption of low cost business practices is difficult; otherwise it would have happened by now. This leaves consolidation as the easiest route, even if it is but a temporary reprieve from the low cost onslaught. Regardless of the reasoning, consolidation ensued, providing mergers with an integral role in shaping this new environment.

Since deregulation was achieved under the premise that airline markets were in some way highly contestable,[2] mergers may have been part of the deregulatory plan from the start. Free market consolidation of airline markets was expected to achieve a more competitively fair consumer environment characterized by efficient operations. With this thinking, virtually every airline merger that had been sought in the years following the ADA was approved by the U.S. Department of Transportation (DOT).

The 1980s in particular appear to be a lax period of antitrust enforcement in which no proposed merger was denied approval (see Kim and Singal 1993, Singal 1996). Then, in the 1990s, merger activity dried up as major airlines tended to retreat into monopolistic "fortress hub" networks (Zhang, 1996) rather than seek further consolidation. In more recent years, however, the issue of airline mergers and their effects on society has once again aroused attention. Various code-sharing alliances, merger agreements like the 2005 deal linking US Airways and America West, and the 2006 proposed merger of US Airways and Delta have fueled speculation of another merger wave. A contraction is perhaps unsurprising given the prolonged industry-wide financial crisis highlighted and exacerbated by the terrorist attacks of September 11, 2001.

[1] Bankruptcy, in this context, is considered final. It should not be confused with Chapter 11 bankruptcy, a potentially desirable legal protection allowing struggling firms to restructure operations in order to survive.
[2] See Graham (1983) for early empirical evidence against contestable market theory.

Thus, in an effort to better understand the implications of the next contraction, this paper looks to the late 1980s for evidence of what to expect. This period was chosen for three reasons. First, since this was a period of heightened, uncontested merger activity, there are numerous observations to analyze (see table 1). Second, rich data from this period are available due to DOT data accumulation efforts following deregulation. And third, since the practice of inventory management was well developed by this time, pricing patterns should be more consistent and less experimental than they were in the early days of deregulation.

Table 1:

Merger Market Information

First Quarter after merger	Affected markets	Percent of all markets	Acquirer	Target
86q4	1948	8%	NWA Inc	Republic Airlines
86q4	757	3%	Trans World Airlines Inc	Ozark Holding Inc
87q1	0	0%	Texas Air Corp (Continental)	Rocky Mountain Aviation
87q1	1287	5%	Texas Air Corp (Continental)	Eastern Air Lines Inc
87q1	403	2%	Delta Air Lines Inc	Western Airlines Inc
87q1	5	0%	Alaska Air Group Inc	Jet America Airlines
87q1	157	1%	Texas Air Corp (Continental)	People Express Inc
87q3	131	1%	American Airlines Inc(AMR)	ACI Holdings (AIRCAL)
87q3	24	0%	US Air Group Inc	Pacific Southwest Airlines
87q4	19	0%	Alaska Air Group Inc	Horizon Air Industries Inc
88q1	2553	11%	US Air Group Inc	Piedmont Aviation Inc
88q1	2	0%	Braniff Inc(Dalfort/Hyatt Air)	Florida Express (IMM Inc)
88q4	0	0%	AMR Corp	Wings West Airlines Inc
88q4	0	0%	AMR Eagle-East (AMRCorp)	Command Airways Inc
89q1	1002	4%	American Airlines Inc (AMR)	Braniff-Leasehold Interests

The empirical approach employed is an examination of relationships between merger activity and various relevant economic variables. It uses data that was accumulated and constructed over an extensive set of representative U.S. markets, and is motivated by a theoretical pricing model found in the economic literature. The theory's main conclusions – that price dispersion increases with competition, uncertainty, and capacity costs – serve as the basis for variable definition and coefficient determination in the empirical analyses. Consequently, this paper also attempts to test the conclusions predicted by the theory.

Two models are utilized in the analysis, each with its own benefits and limitations.[3] First, fixed-effects regressions are performed on panel data to discern the impact of changing each variable on price dispersion and average fare. Second, ordinary least squares (OLS) regressions on cross sections of first-differenced data are performed in an attempt to deal with endogeneity problems present in the fixed-effects approach. Results from each model are presented, and comparisons between the two are made.

Most merger studies of this time period consider a one-time effect a merger might have on pricing at, immediately prior to, or immediately following completion of the merger. This paper differs in its attempt to track the effects of mergers over time. It also differs in its incorporation of demand uncertainty as an explanatory variable.

The approach will be useful on four main counts. First, this empirical analysis offers creative ways to quantify demand uncertainty as identified in the theory. Second, the resulting uncertainty figures are used in regressions to determine that the true role of uncertainty in price dispersion may be opposite to the theoretical predictions: dispersion appears to be *falling* with uncertainty. Third, I use my empirical results to test hypotheses derived from the theory of pricing under demand uncertainty with costly capacity. And fourth, it is useful to see whether or not airlines exhibit different patterns of price dispersion after merging versus before.

Hence, from an academic standpoint, the results of this study will aid in the evaluation of the theory itself. In the instances where they contradict the theory, as with the effect of uncertainty on dispersion, researchers should question the shortcomings of the theory and seek ways to improve them. Similarly, when mergers cause increases in concentration but the airlines involved fail to exercise market power, we should question the underlying concerns of antitrust authorities. Conversely, in the instances where my results support the theory, as with demonstrating the role costs play in determining dispersion, we have better reason to believe those aspects of the theory are sound.

From a policy standpoint, any new information we can obtain from analyzing the pricing activities of merging firms can be used as a means of evaluating proposed mergers. Although any attempts thus far to evaluate the merits of airline mergers *ex ante* are subject to a great deal of debate, the more information available to evaluate mergers, the better. Evaluating the merits and drawbacks of changes in price dispersion, for example, will be a good way to do this if it seems to be a direct indicator of monopolistic pricing – even though the intuition of price discrimination leads us to conclude the opposite whenever dispersion falls with mergers.

Finally, from an industry standpoint, firms can also benefit from understanding the implications of historical mergers by modifying their pricing behavior following future mergers. If airlines know that significantly reduced price dispersion, coupled with higher average fares, sends strong monopolistic signals to antitrust authorities, they may attempt to avoid such scrutiny by stabilizing pricing practices for some time after they merge. While this may complicate the evaluation process, such behavior could lead to net societal welfare gains – assuming at least some efficiency gains are obtained – without excessively transferring welfare from consumers to airlines. In the spirit of limit pricing theory, airlines with newly obtained monopoly power may, as a result, seek to maintain some threshold level of "limit dispersion" indefinitely to avoid triggering DOJ scrutiny.

[3] Benefits and limitations of each setup will be discussed later in the paper.

The remainder of this paper is organized as follows. Chapter 2 provides a review of the general airline and price dispersion literature. Chapter 3 presents a simplified version of the theoretical model. Chapter 4 discusses the basic empirical setup and data, while chapter 5 is a detailed data analysis. Chapter 6 describes the empirical models I employ, and chapters 7 and 8 discuss and interpret the results. Finally, chapters 9 and 10 conclude the study.

CHAPTER II

REVIEW OF THE LITERATURE

In order to understand the context in which this project is pursued, three brief, topical reviews of the empirical airline literature are warranted. The first is a review of how the newly deregulated environment developed. The second is to see how price dispersion arose amidst new and highly sophisticated pricing tactics. The third is a survey of the mergers studies performed to date and how they relate to the present paper.

Airline Deregulation

Airline deregulation was largely pursued under the promise that contestable markets would lead to more competition, increased output, and lower prices. The idea is an extension of limit pricing theory: the mere ability of airlines to freely enter markets without cost would act as a deterrent against monopolistic pricing.[4] While this deregulation clearly enabled and inspired several mergers between various carriers, it also led to significant developments in pricing practices and competitive interaction.

After deregulation, there was an initial movement to determine whether or not airline markets are in fact contestable.[5] Results suggest they are not. Peteraf and Reed (1994) assert that deregulation has not resulted in the anticipated contestability of markets, although

[4] Limit pricing: where monopolists mark up price as far above marginal cost as possible without provoking entry.
[5] See Baumol, Panzar, and Willig (1982) for contestable markets theory.

potential entry is in some way a disciplinary force against incumbent pricing abuses.[6] Yet Morrison and Winston (1987) show that the effects of potential competition on limit pricing behavior are small, and are much less significant than actual competition. They find that frequent flier programs, attractiveness of branded carriers, and airport dominance increase prices but decrease competition. They also find that the monopolist's national market share has a positive effect on fares over and above that of airport share and route share.

Their most statistically significant result is that distance has the greatest effect on yields: for every 10% increase in distance, we can expect average fares per passenger mile to fall 6.4%. Interestingly, the lowest cost potential entrant[7] that is present on at least one endpoint of the monopoly routes is usually a rather high cost major airline like United or Delta. This is the case 94% of the time. Thus, on the routes where low cost carriers share endpoints, the effect of potential competition is much higher. Abromowitz and Brown (1993) find similar results.

In short, while it is generally believed that contestable markets did not materialize, a wide variety of competitive forces has shaped the industry since deregulation. Pure monopoly, fierce competition, and everything in between has occurred, thus presenting researchers with plenty of fodder for analysis.

Price Dispersion Papers and Studies

In order to understand the direction the literature on price dispersion has taken, a distinction between the terms price discrimination and price dispersion must be made. Much of the theoretical literature departs from the traditional view of price discrimination that

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[6] See Borenstein (1992) for a summary of results. See Peteraf (1994) for evidence of limit pricing.

analysts have long assumed was the source of fare variation. *Price discrimination* refers to the individual firm's ability to segment the demand it faces into different populations with different price elasticities to which it can charge different prices. By doing so, the firm with monopoly power can extract consumer surplus from the market demand. Similarly, such pricing is believed to increase with concentration. While some discrimination is good from the regulator's perspective (i.e., if it expands market size to service more customers), they generally frown upon abusive price discrimination as it may unfairly strengthen the power of the firm at the expense of the consumer.

Price dispersion, on the other hand, can exist for reasons other than simple price discrimination, and is not necessarily increasing with concentration. Generally defined, price dispersion refers to the variation in prices offered by different firms selling essentially the same product to the same group of consumers. The differentiation arises from consumers' real or perceived differences in how they value the products they face. While traditional price discrimination will lead to dispersion, demand uncertainty and costly capacity may influence or even be the sole cause of dispersion as well. Gale and Holmes (1993) provide a strong theoretical model explaining this phenomenon. In addition, it is widely acknowledged that peak load pricing tactics will lead to price dispersion no matter what the level of competition or demand uncertainty. Thus, the fact that price dispersion cannot be attributed entirely to the implementation of monopoly power must be acknowledged when interpreting empirical results based on the analysis of any measurement of dispersion.[8]

With this in mind, the first paper to empirically estimate the extent of price dispersion in airline markets is Borenstein and Rose (1994). Their cross sectional analysis of the industry

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[7] Defined as the carrier with the lowest cost structure already operating flights at least one of the endpoint airports that may enter the market in question relatively easily

for the second quarter of 1986 has two main objectives. First, they aim to quantify the extent of fare inequality in the airline industry and describe patterns of price dispersion across markets. Second, they attempt to distinguish price dispersion due to discriminatory pricing from the type resulting from differences in cost. To do so, they use a Gini coefficient to measure intra-firm price dispersion in approximately 521 U.S. airline markets served by 11 major carriers.

They found considerable price dispersion in the U.S. In 1986, the average difference in prices paid by two random passengers was 36% of the mean ticket price. They also found that more competitive routes seem to have more price dispersion, whereas market power and highly homogenous passenger attributes are associated with lower price dispersion. Further, they found that more congestion (in terms of flights per market, signifying highly demanded routes) implies more price dispersion, which is consistent with peak load pricing. Interestingly, they find that price dispersion is positively correlated with average fare. While this supports the traditional assertion that market power leads to price discrimination along with higher average fares, it may be explained by the characteristics of the airlines that exhibit market power. That is, major airlines employing hub-spoke networks may have better segmentation techniques than smaller competitors, which lead to more dispersion.

The next paper to measure price dispersion in the U.S. is by Hayes and Ross (1998), who extends the work done by Borenstein and Rose in several ways. First, the data are more recent and comprehensive: the panel data set employed is for several quarters from 1990-1992. Second, price dispersion is defined under three different alternatives: the Gini coefficient, Atkinson index, and entropy index. Third, their analysis focuses on separating

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[8] Measurements of dispersion include but are not limited to standard deviation and the gini coefficient.

the sources of price dispersion based largely on the existence of fare wars. Finally, the sample includes many more airports, and regional differences are accounted for.

Hayes and Ross find robust results that suggest a disjunction between price dispersion and price discrimination. They find that price dispersion is mainly associated with peak load pricing schemes rather than market power. Planned price dispersion will occur when airlines have sufficient information about the demand they face, while continuously updated fares contribute to the accuracy of such information. Unplanned price dispersion allegedly results from fare wars. If an airline tries to keep prices above marginal cost but lacks the market power to sustain such markups, it will invoke a price war. This particular result pertains to the present analysis as mergers should reduce the incidence and scope of fare wars.

Finally, Kim and Singal (1993) used the event study approach to evaluate the mergers of the 1980s by distinguishing between market power and efficiency effects that result from mergers. Rather than looking at stock valuations, as event studies typically do, they focused on the average fares paid by travelers. In order to distinguish between the two opposing price effects, they formulate a theory about when each effect takes place. First, the announcement of the merger is enough to signal market power that will affect the way the merging firm marks price above marginal cost. Second, once the merger is "complete," the newly merged firm will be able to take advantage of cost synergies and charge lower fares to its consumers. Their model compares the routes that are affected by the merger with unaffected routes and concludes that airline mergers do in fact lead to higher average fares on affected routes: fares on affected routes increase almost 10% compared with unaffected routes. This results in a wealth transfer from consumers to producers.

In sum, while some studies have looked at cross sectional data on the airline industry to measure the effect of market power on price dispersion, others have looked at the effects of mergers on average fares. A goal of this paper is to take these two types of empirical literature discussed above and bring them together to further evaluate mergers in the airline industry. The main contribution of this paper over previous studies is thus an attempt to evaluate mergers over time on the basis of their effects on both price dispersion and average fare, while incorporating uncertainty and elapsed time from merger completion as explanatory variables. If observed price dispersion can indicate the extent to which monopoly power is being used or abused, we can use the mergers of the 1980s as a basis for evaluating merged airline anticompetitive behavior *ex post*, particularly if average fares rise. This has important policy implications because it provides antitrust authorities with a directly observable means with which to evaluate historical airline mergers as a premise for evaluating future merger proposals *ex ante*.

Merger Questions

When evaluating mergers in general, the following three antitrust questions arise, assuming that mergers produce increases in market power. First, are there efficiency gains from the merger that will lower production costs? Second, will those lower costs be passed on to the consumer in the form of lower prices? And third, which effect will have a dominant influence on prices: will net prices be lower from efficiency gains or higher from market power abuses?

Answers to these questions in the context of the airline industry have been provided by numerous studies with varying conclusions. While each has benefited from and relied upon the wealth of revenue data provided by the DOT, each has suffered from a general lack of accurate carrier and market-specific cost data. Such data tends to be proprietary. However, industry-wide estimates of fuel and non-fuel costs per seat mile are readily available, as are certain market characteristics, like distance and hub congestion, all of which provide decent proxies for cost.

Direct Merger Studies

Most of the studies, including part of the present one, focus on the direct impact mergers have on average fares paid by passengers (Kim and Singal, 1993; Singal, 1996; Borenstein, 1990; Morrison et al, 1990; Beutal and McBride, 1992; Morrison, 1996). Such studies have an intuitive appeal: if, on average, fares tend to be higher after the merger, we can assume that market power dominates efficiency gains. Under such circumstances, we can argue that the merger has resulted in a transfer of welfare from consumers to the airlines involved. If, on the other hand, average fares tend to be lower following a merger, we can assume that efficiency gains outweigh market power creation, ultimately benefiting consumers and producers alike. The typical results suggest market power is stronger: Borenstein and Rose, for example, demonstrated that average fares rose about 10% on routes affected by mergers, while Singal found fares to rise as much as 14% due to increased multi-market contact resulting from mergers. Some, like Beutel and McBride's 1992 study of the Northwest-Republic merger, show evidence of weakened pricing power following mergers.

Morrison and Winston (1990) provide strong support for the deregulation that occurred – despite the merger waves – in a hypothetical comparison of actual fares to those which would have occurred had regulation endured.[9] The goal was to show that market forces, rather than deregulation, caused increases in fare levels.[10] They conclude that, on average, regulated fares would have been 18% higher than the deregulated fares we see, although route distance matters: long-haul markets are found to have decreased fares (probably due to increased real competition through alternate route permutations resulting from the hub/spoke system), while shorter markets have increased fares (due to increased monopoly hub activity to and from specific short-haul spokes). Also, the effective number of competitors at the route level is still on average a mere 1.9, further suggesting that the competitive gains from deregulation are limited. Nonetheless, they tend to advocate the deregulated climate over the regulated one, despite the implications of any particular merger.

Regardless of the data or outcome, the method of directly measuring a merger's impact on average fares is not immune from criticism. For example, it is possible that mergers in the 1980s dealt with the problem of excess capacity that developed in the deregulated environment. Excess capacity leads to low average prices, possibly below the average cost of production, making economic viability difficult. Through consolidation, merged airlines may have provided a healthier, more sustainable environment in which to operate profitably.[11] Such an environment would lead to higher, more stable prices and thus would explain – or perhaps even justify – the higher average fares. Similarly, it has been argued that many failing airlines which charge very low "fire sale" fares on the eve of bankruptcy are prime candidates for takeover.[12] Once they are acquired, the fire sale markets return to

[9] They used techniques employed by the Civil Aeronautics Board (CAB) for pricing fares prior to the deregulation of 1978 to see what CAB pricing might have looked like; this was compared to actual fares.
[10] "Fare Levels" in Morrison/Winston means average fare levels, which is not to be confused with the dispersion figure "Farelevels" in the empirical analysis of this paper.
[11] Found in either Kim/Singal or Hayes/Ross.
[12] Also found in Kim/Singal or Hayes/Ross.

“normal” pricing schemes and average fares subsequently rise. In either of these cases, the expected result is for average prices to rise – which may not be a bad thing if it stabilizes the industry, even though higher average fares might appear to indicate the exercise of excess market power.

The present paper, in fact, finds that merger activity might actually lead to *lower* average prices in each of the four quarters following completion of a merger, which would indicate that efficiency gains outweigh any market power creation. One possible source for the discrepancy between studies is the breadth of the data used: for example, while Borenstein and Rose tested 1,201 markets from one quarter and Singal tested 11,628 markets over sixteen quarters, the present study tests 23,439 routes over twenty quarters. The present study also includes certain key measures, discussed in detail below, that were excluded from other studies.

Indirect Merger Studies

A second approach in evaluating mergers is to focus on indirect methods of evaluation. One way is to bypass fares and costs altogether, using event studies to check for abnormal stock returns[13] of affected firms to discern the effects of the merger on society (Eckbo 1983, Knapp 1990). This theory stipulates that, if a merging airline’s stock value sees abnormally high returns but their competitors see negative returns, efficiency gains have been made and the stock run-up is attributed to the merged airline’s ability to compete more effectively relative to other airlines. On the other hand, if both the merged airlines and their competitors exhibit higher returns, the resulting industry consolidation theoretically makes collusion easier; hence, the market power outweighs efficiency gains.

This event study method is subject to much criticism as it is, at best, an indirect, incomplete, and controversial way of measuring the effects of a merger. As such, it will not be part of the present analysis.

This Paper's Approach

A third, subtler method of evaluating mergers is presented in this paper. I believe the behavioral effects and societal impacts of mergers in the airline industry that are attributable to market power can be determined by examining both the change in average fares *and* the change in the extent of price dispersion practiced by the newly merged airlines. This idea is motivated by the literature that emphasizes the roles of costly capacity and demand uncertainty in determining the amount of price dispersion on a route (Dana, 1999). The theoretical model predicts that dispersion and average fares will rise with uncertainty and capacity costs. Accordingly, measures of both are included in this study of mergers to help explain the many ways mergers can affect a market.

Evidence of a merger's impact on price dispersion, for example, is obtained through fixed effects regressions that include several merger dummy variables. As such, this analysis is an indirect evaluation of mergers through their effects on other key market indices. It is also a dynamic study that departs slightly from the empirical literature in that a merger is considered to be time varying in its effect on a market.

At the same time, the occurrence of a merger in any particular market will, for some time, cast an uncertain tone on the competitive environment. This will have significant ramifications on both average fare and dispersion pricing behavior. It will be argued later in the paper that competitive stability goes a long way towards providing demand certainty and

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[13] A related study of average fare "returns" is discussed in the literature section.

pricing stability, both of which are desirable traits from the standpoint of any market participant.

CHAPTER III

DANA'S THEORY OF PRICE DISPERSION

Since the theory upon which this paper is based comes from James Dana (1999), a detailed review of his model is warranted. I have constructed a simplified version of his model based on the assumption of linear demand and have verified the theoretical result that prices will be most dispersed in the competitive environment, less dispersed in duopoly (which can be generalized to any sized oligopoly), and least dispersed in monopoly.[14] Similarly, average fares are theoretically highest in monopoly, lower in duopoly, and lowest in perfect competition. The results are applicable to the firm and, consequently, market levels of dispersion and average fare. The model assumes identical firms and thus provides no insights regarding the differences in fares across firms.[15]

The basic premise of the theory is that the levels of demand uncertainty and costly capacity facing firms will, *ceteris paribus*, determine the level of equilibrium price dispersion. While Dana's analysis can be applied to any industry with these characteristics – he suggests the hotel, restaurant, and rental car industries, among others – his focus is on the airline industry as it seems to fit the spirit of his theoretical results most closely.[16] As opposed to earlier studies by Prescott (1975) and Eden (1990), Dana's model predicts inter and intra-firm price dispersion in the context of various types of competition, including

[14] Standard Deviation is used as the measurement of dispersion in the simplified theoretical model.
[15] This is consistent with Dana's results, which are based on symmetric outcomes for non-monopoly setups.

monopolies and monopolistic competition. The earlier models consider intra-firm price dispersion in perfect competition only.

The theory is not without flaws, however, as it relies on several crucial assumptions and outcomes that seem unrealistically rigid when applied to real-world situations. The assumptions and outcomes that require critical attention are as follows: 1) dispersion is increasing with uncertainty, 2) uncertainty and prices are "rigid," 3) demand shows up in random order, and 4) residual demand is the primary mechanism through which the aforementioned results are obtained. Each will be addressed in the discussion section following the empirical results of this paper. In the meantime, the model is presented as justification for the empirical specifications.

The simplest way to look at the problem is to consider two demand types: a high demand type with low price elasticity and a low demand type with high price elasticity. The high demand type is typically thought to be the time-sensitive business traveler, while the low demand type is typically thought to be the price-sensitive leisure traveler. When two firms compete in a market containing such distinct demand types, they tend to aggressively bid for the low demand types. This competition brings down the prices offered to these highly elastic consumers. The firms do not, however, compete away their profit margins on the high demand consumers as much as in the low demand case. To some extent this is due to the fact that high demand consumers choose their flights based on very inflexible criteria, such as specific flight times, comfort, reliability, and, of course, brand loyalty.[17] Hence, high demand consumers are not very responsive to increased competition. Accordingly, the fares

[16] The restrictions, on the other hand, are imperfect when applied to any industry, but are reasonable for advancement of the theory.
[17] Frequent flyer programs provide strong sentiments of brand loyalty.

they pay do not change much as a result of increased competition. Borenstein (1989) and Bilotkach (2005) found evidence of this fact.

A related explanation concerns the nature of a market's competition. Often the "competition" on a given route will occur between a major carrier and a regional one. Regional airlines typically do not compete for high-paying business travelers, whereas they compete aggressively for the bargain traffic.[18] In this case, the interfirm spread, or "dispersion," between fares is fairly high. Yet if the two firms merge, they will not have to compete anymore for the price sensitive leisure travelers. Thus, the new firm will charge higher prices to the low demand consumers without increasing the prices they charge to the high demand consumers. Accordingly, the spread or "dispersion" between fares narrows with mergers as intense competition for elastic consumers is reduced.

Further, dispersion arises from the type of price discrimination practiced in the airline industry. As mentioned earlier, consumers of airline products have fairly distinct tastes and preferences. While airlines have a good idea about the general aggregate distribution of these preferences, they have difficulty identifying them when making sales. As such, they conduct second degree price discrimination by offering packages of price/quality combinations. The "quality" component is reflected in such ticket restrictions as Saturday night stayovers, non-refundability of tickets, and advance ticket purchase requirements. These restrictions enable ticket sales to distinguish the time sensitive business travelers who are willing to pay a premium for last minute, fully refundable tickets. It is an imperfect distinction, however, because business travelers have much less predictable flight schedules than leisure travelers. This unpredictability adds to the uncertainty that their demand will

[18] Probably do to less desirable slots, fewer flight options, lack of frequent flier programs, etc. that tend to drastically reduce the demand for regional flights by inflexible business travelers.

materialize close to flight time. Holding perishable seats open for last minute potential walk-up sales to such consumers is expensive if the seats have a high probability of going unsold. Hence, the firm facing this demand uncertainty requires higher marginal revenue for those seats if they wish to keep expected revenues on par with "cheap seats" sold ahead of time with much more certainty.[19]

Finally, although specific airline cost figures are generally unavailable, purchasing airplanes and running airlines is known to be an expensive endeavor. Capacity is constrained in the short run, making availability of walk-up seats more expensive to the airlines from an opportunity cost standpoint. Hence, the more expensive this shadow cost of capacity, the more an airline is going to charge to provide it. It must cover the expected loss in case that walk-up demand fails to materialize.

Thus, the basic model derived from Dana's theory considers a two demand state situation that compares the equilibrium outcomes of perfectly competitive, oligopolistic, and monopolistic firms that operate amongst characteristics mirroring those that are laid out above. The problem facing these firms is one of expected profit maximization in a market characterized by demand uncertainty and costly capacity. Development of the model relies on the concept of residual demand.

The Theoretical Model

Linear demand is assumed for three reasons. First, as this paper provides a simplification of Dana's model, linear demand enables a more intuitive understanding of the points found therein. Second, extending the basic two-state approach to include oligopolies is more

[19] A seat sold in advance for $100 with 100% certainty must sell for $200 at the last minute if there is a 50% certainty of sale at that time in order to justify holding the seat. As the probability of sale falls, this price rises.

tractable with linear demand.[20] And third, from a graphical standpoint, many of the demand curves in the airline markets analyzed in this paper are fairly linear.

The intuition behind the model is that there are two possible demand states facing firms for any day's sales: low and high demand that each occur with known probabilities. In the context of the model, low demand means a small number of travelers show up to buy tickets, while high demand means a large number do. Demand uncertainty is represented by the probability of each demand state occurring: high demand occurs with probability λ, and low demand occurs with probability $(1-\lambda)$. Costly capacity is represented by the marginal cost, c.

Firms must make their daily output and pricing decisions before it is clear which demand state will materialize on any given day, reflecting the real-world practice of airlines setting aside expensive seats far in advance of those seats being sold. They set their high and low outputs and prices based on probabilities of sale. One restriction is that these prices and quantities are rigid and cannot be changed once they are set. Another restriction is that all consumers arrive in random order and purchase tickets on a first come/first serve basis, choosing the cheaper seats first – regardless of their reservation prices.

Given the two demand states, the model assumes that all consumers' reservation prices are distributed uniformly on the interval [0,N]. The reservation price is defined as each individual consumer's maximum price he or she would be willing to pay to purchase a seat. In the low demand state, N consumers show up to buy tickets. Thus, at price $P < N$, $(N - P)$ low demand consumers are willing to purchase tickets. In the high demand state, αN consumers show up to buy tickets, where $\alpha > 1$ is some positive constant that effectively increases the number of consumers willing to purchase tickets at any given price. Hence, at

[20] Cournot duopoly models presented in textbooks use linear demand; such is the case when presented here.

that same price $P < N$, $\alpha(N - P)$ consumers are willing to purchase tickets in the high demand state. In effect, given the same distribution of reservation prices, the high demand state simply increases the number of potential consumers willing to pay *any* given price by a factor of α. Thus, the demand in either state can be summarized by the following functions:

(3.1) $$Q_L(P) = N - P \quad \text{or} \quad P(Q_L) = N - Q_L$$

(3.2) $$Q_H(P) = \alpha N - \alpha P \quad \text{or} \quad P(Q_H) = N - Q_H/\alpha$$

Perfect Competition

The perfectly competitive firm must choose its profit maximizing price/output combinations taking the aggregate distribution of prices and quantities in the market as given. This follows from the necessary condition that perfectly competitive firms are price-takers. As a result, each price-taking firm offers some small amounts of the overall market's seats at the price(s) determined by the market. The competitive market will determine the equilibrium output at the point where expected revenue equals the marginal cost of offering a seat for sale.

Given the demand uncertainty facing them, firms will offer two prices: a low price in the event that demand turns out to be low and a high price in the event that demand turns out to be high. The necessary conditions for competitive market equilibria require that the competitive firms will set the quantity of tickets produced and priced for sale at the point where expected price equals the marginal cost of production. All of the low-priced seats will sell regardless of the demand state because demand will be at least as high as in the low demand state. Therefore, since there is a 100% chance of selling any cheap seats, the expected revenue per cheap seat equals P_L and the cost per cheap seat equals c. Hence, competitive firms will offer their cheap seats at price $P_L = c$.

The high-price seats are not as sure to sell. Since high demand may not materialize, there is a non-zero probability that the seats offered for sale at the high price will remain unsold at the end of the day. This uncertainty drives down the expected revenue of high priced seats at any price. Given the probability λ that the high demand state materializes, the expected revenue per seat is thus λP_H. Therefore, the only way to justify offering additional seats for sale is to set a second price high enough to cover expected marginal cost. Price competition will force the high price to an equilibrium at which expected revenue equals marginal cost, or $P_H = c/\lambda$.

Notice that $dP_H/d\lambda < 0$. This implies that, as the probability of the high demand materializing falls, the high demand equilibrium price in competitive markets must rise to compensate for lower expected marginal revenue.[21] To sum, the competitive equilibrium market prices are as follows:

$$P_H^* = \frac{c}{\lambda} \tag{3.3}$$

$$P_L^* = c \tag{3.4}$$

Market quantities are determined according to the following demand curves:

$$q_L = f(P_L) = N - P_L \tag{3.5}$$

[21] Average fares are thus increasing in uncertainty. It can also be shown that average fares increase with costs.

(3.6) $$q_H = g(P_H) = \alpha N - \alpha P_H$$

(3.7) $$q_H^{RD} = \frac{g(P_L) - f(P_L)}{g(P_L)} * g(P_H) = \frac{(\alpha N - \alpha P_L) - (N - P_L)}{(\alpha N - \alpha P_L)} * (\alpha N - \alpha P_H)$$

Notice that the quantity of high priced seats is determined by the residual demand function, q^{RD}. This residual demand is derived from the high demand state: since prices are set ahead of demand revelation, some seats are priced and offered at low prices in the event of low demand – even though high demand may actually materialize. Therefore, if the high demand state does occur, the low priced tickets will be purchased by those who show up first, leaving a smaller pool of eligible purchasers for the high priced tickets. Since they show up in random order, some of the high demand consumers who are willing to pay more for their seats only have to pay the low price in the event that they show up first, leaving behind some proportion of the high demand to purchase tickets at the high demand price. Hence, the residual demand curve is a proportionally diminished function of the "high demand state" demand curve.[22]

In terms of the model's notation, if high demand materializes, $q_H(P_L)$ is the number of consumers with a reservation price > P_L willing to buy the q_L available tickets, but only $q_L/q_H(P_L)$ can be served. The residual demand is the proportion $[1 - q_L/q_H(P_L)]^* q_H(P_H)$ of the high demand that remains after the low priced seats are sold. Hence, given equilibrium prices and the demand functions laid out above, equilibrium quantities are as follows:

[22] Note that there is no residual demand in the event that the low-demand state materializes.

$$q_H^{RD} = \left[1 - \frac{q_L(P_L)}{q_H(P_L)}\right] q_H(P_H)$$

(3.8)
$$= \left[1 - \frac{(N - P_L)}{\alpha N - \alpha P_L}\right](\alpha N - \alpha P_H)$$

$$= \left[1 - \frac{1}{\alpha}\right](\alpha N - \alpha P_H) = \left[\frac{\alpha - 1}{\alpha}\right]\left[\alpha N - \alpha \frac{c}{\lambda}\right]$$

(3.9)
$$q_H^{RD*} = [\alpha - 1]\left[N - \frac{c}{\lambda}\right] \qquad \text{and} \qquad q_L^* = N - c$$

For expositional purposes, let (α – 1) = γ > 0. From these equilibrium quantities and prices we may compute the following average price and standard deviation for the competitive market:

(3.10)
$$P_{AVG}^{PC} = \frac{\left[\gamma\left(N - \frac{c}{\lambda}\right)\right]\left(\frac{c}{\lambda}\right) + (N - c)c}{\gamma\left(N - \frac{c}{\lambda}\right) + (N - c)} = \frac{\gamma c(N\lambda - c) + \lambda^2 c(N - c)}{\gamma\lambda(N\lambda - c) + \lambda^2(N - c)}$$

$$SD^{PC} = \sqrt{\frac{(P_H - P_{AVG})^2 q_H + (P_L - P_{AVG})^2 q_L}{q_H + q_L}}$$

$$SD^{PC} = \sqrt{\frac{\left(\frac{c}{\lambda} - P_{AVG}\right)^2 \gamma\left(N - \frac{c}{\lambda}\right) + (c - P_{AVG})^2 (N - c)}{\gamma\left(N - \frac{c}{\lambda}\right) + N - c}}$$

or

(3.11)
$$SD^{PC} = \sqrt{\frac{\gamma(c - \lambda P_{AVG})^2 (N\lambda - c) + \lambda^3 (c - P_{AVG})^2 (N - c)}{\lambda^2 \gamma(N\lambda - c) + \lambda^3 (N - c)}}$$

Monopoly

In the case that this market is served by a monopoly, the monopolist chooses quantities and prices to maximize its expected profit. Again, like the competitive firm, the monopolist does not know which demand state will materialize when it makes its fixed pricing and output decisions. Hence, the monopolist's expected profit maximization problem is as follows:

$$(3.12) \quad \max_{q_H^{RD}, q_L, P_H, P_L} E(\Pi) = \lambda\left[P_H q_H^{RD} + P_L q_L\right] + (1-\lambda)\left[P_L q_L\right] - c\left[q_H^{RD} + q_L\right]$$

or

$$(3.13) \quad \max_{q_H^{RD}, q_L, P_H, P_L} E(\Pi) = (\lambda P_H - c) q_H^{RD} + (P_L - c) q_L$$

$$s.t. q_L = f(P_L) = N - P_L$$

$$s.t. q_H^{RD} = \frac{g(P_L) - f(P_L)}{g(P_L)} * g(P_H) = (\alpha - 1)(N - P_H)$$

As with the competitive firm, notice that the monopolist chooses the high demand quantity and price based on a residual demand function, q^{RD}, since it has to offer some "cheap seats" given the probability of only the low demand state occurring. The demand function in the event that high demand materializes would be $q_H = g(P) = \alpha N - \alpha P$. However, this is not the actual demand that is present in the event that high demand materializes, since some proportion of these high demand consumers will be able to purchase tickets that have been offered at lower prices to satisfy the *ex ante* possibility of low demand. Therefore, if the high demand state occurs, the low priced tickets will be purchased by those who show up first, leaving a smaller pool of eligible purchasers for the high priced tickets. Hence the residual demand curve is a diminished function of the "high demand state" demand curve.

Substituting the constraints into the maximization problem, we get the following monopolist expected profit maximization problem:

$$\max_{P_H, P_L} E(\Pi) = (\lambda P_H - c)(\alpha - 1)(N - P_H) + (P_L - c)(N - P_L) \quad (3.14)$$

The first order conditions for maximization imply the following:

$$\frac{dE(\Pi)}{dP_H} = (\alpha - 1)[(\lambda P_H - c)(-1) + (N - P_H)(\lambda)] = 0$$

$$(N - P_H)\lambda = (\lambda P_H - c)$$

$$P_H^* = \frac{N\lambda + c}{2\lambda} \quad (3.15)$$

and

$$Q_H^{RD*} = (\alpha - 1)(N - P_H^*) = \frac{(\alpha - 1)(N\lambda - c)}{2\lambda} \quad (3.16)$$

$$\frac{dE(\Pi)}{dP_L} = (N - P_L) - (P_L - c) = 0$$

$$P_L^* = \frac{N + c}{2} \quad (3.17)$$

and

$$Q_L^* = N - P_L^* = \frac{N - c}{2} \quad (3.18)$$

From these equilibrium quantities and prices we may compute the following average price and standard deviation for the monopoly firm:

$$P_{AVG}^{MO} = \frac{\left(\frac{N\lambda + c}{2\lambda}\right)\left(\frac{\gamma(N\lambda - c)}{2\lambda}\right) + \left(\frac{N+c}{2}\right)\left(\frac{N-c}{2}\right)}{\frac{(\alpha - 1)(N\lambda - c)}{2\lambda} + \frac{(N-c)}{2}} \tag{3.19}$$

$$= \frac{\gamma(N\lambda + c)(N\lambda - c) + \lambda^2 (N+c)(N-c)}{2\lambda\left[\gamma(N\lambda - c) + \lambda(N-c)\right]}$$

$$SD^{MO} = \sqrt{\frac{(P_H - P_{AVG})^2 Q_H + (P_L - P_{AVG})^2 Q_L}{Q_H + Q_L}}$$

$$SD^{MO} = \sqrt{\frac{\left(\frac{N\lambda + c}{2\lambda} - P_{AVG}\right)^2 \left(\frac{(\alpha - 1)(N\lambda - c)}{2\lambda}\right) + \left(\frac{N+c}{2} - P_{AVG}\right)^2 \left(\frac{N-c}{2}\right)}{\left(\frac{(\alpha - 1)(N\lambda - c)}{2\lambda}\right) + \left(\frac{N-c}{2}\right)}}$$

or

$$SD^{MO} = \sqrt{\frac{(N\lambda + c - 2\lambda P_{AVG})^2 \gamma(N\lambda - c) + \lambda^3 (N + c - 2P_{AVG})^2 (N-c)}{4\lambda^2 \gamma(N\lambda - c) + 4\lambda^3 (N-c)}} \tag{3.20}$$

Oligopoly

Since markets in the airline industry are more accurately described as oligopilies than monopolies or perfect competition, the model should be solved as such. I employ a standard Cornout duopoly model using residual market demand in the high demand state. The representative duopolists allocate their seats for high and low demand taking each other's output decisions as given in order to maximize their expected profits. As is the case in any Cornout model, their aggregate output decisions affect market prices.

Letting q_{Li} and q_{Hi} be firm i's low and high outputs, respectively, market and inverse demand and residual demands are as follows:

(3.21) $$Q_L = f(P_L) = N - P_L$$

(3.22) $$P_L = N - Q_L = N - (q_{L1} + q_{L2})$$

(3.23) $$Q_H = g(P_H) = \alpha N - \alpha P_H$$

(3.24) $$Q_H^{RD} = \left[\frac{g(P_L) - q_L}{g(P_L)}\right] g(P_H) = \left[\frac{(\alpha N - \alpha P_L) - (N - P_L)}{g(P_L)}\right](\alpha N - \alpha P_H)$$

or

(3.25) $$Q_H^{RD} = (\alpha - 1)(N - P_H)$$

(3.26) $$P_H = N - \left(\frac{1}{a-1}\right) Q_H^{RD} = N - \left(\frac{1}{a-1}\right)\left(q_{H1}^{RD} + q_{H2}^{RD}\right)$$

Given these inverse market demand curves, firm i's profit maximization problem follows:

(3.27) $$\max_{q_{Hi}^{RD}, q_{Li}} E(\Pi) = \lambda\left[P_H q_{Hi}^{RD} + P_L q_{Li}\right] + (1-\lambda)\left[P_L q_{Li}\right] - c\left[q_{Hi}^{RD} + q_{Li}\right]$$

$$s.t.\ P_H = N - \left(\frac{1}{\alpha - 1}\right)(q_{Hi}^{RD} + \overline{q}_{Hj}^{RD})$$

$$s.t.\ P_L = N - (q_{Li} + \overline{q}_{Lj})$$

Substituting the constraints into the maximization problem, firm i faces the following:

$$\max_{q_{Hi}^{RD},q_{Li}} E(\Pi)=\left[\lambda\left(N-\frac{q_{Hi}^{RD}+\overline{q}_{Hj}^{RD}}{\alpha-1}\right)-c\right]q_{Hi}^{RD}+\left(N-c-q_{Li}^{RD}-\overline{q}_{Lj}^{RD}\right)q_{Li}$$

or

$$\text{(3.28)}\quad \max_{q_{Hi}^{RD},q_{Li}} E(\Pi)=\lambda N q_{Hi}^{RD}-\frac{\lambda}{\alpha-1}{q_{Hi}^{RD}}^{2}-\frac{\lambda}{\alpha-1}\overline{q}_{Hj}^{RD}q_{Hi}^{RD}-cq_{Hi}^{RD}+Nq_{L1}-{q_{L1}}^{2}-\overline{q}_{L2}q_{L1}-cq_{L1}$$

The first order conditions for maximization imply the following:

$$\frac{dE(\Pi)}{dq_{Li}}=N-2q_{Li}-\overline{q}_{Lj}-c=0$$

$$\text{(3.29)}\quad q_{Li}^{*}=\frac{N-c-\overline{q}_{Lj}}{2} \quad \text{and, by symmetry,} \quad q_{Lj}^{*}=\frac{N-c-\overline{q}_{Li}}{2}$$

$$\frac{dE(\Pi)}{dq_{Hi}}=N\lambda-c-\frac{2\lambda}{\alpha-1}2q_{Hi}-\frac{\lambda}{\alpha-1}\overline{q}_{Hj}=0$$

$$\text{(3.30)}\quad q_{Hi}^{*}=\frac{N\lambda(\alpha-1)-c(\alpha-1)-\lambda\overline{q}_{hj}}{2\lambda} \quad \text{and, by symmetry,}$$

$$q_{Hj}^{*}=\frac{N\lambda(\alpha-1)-c(\alpha-1)-\lambda\overline{q}_{hi}}{2\lambda}$$

This leads to the following results:

$$\text{(3.31)}\quad q_{Li}^{*}=q_{Lj}^{*}=\frac{N-c}{3}$$

$$\text{(3.32)}\quad Q_{L}^{*}=\frac{2(N-c)}{3},$$

$$\text{(3.33)}\quad P_{L}^{*}=\frac{N+2c}{3}$$

(3.34) $$q_{Hi}^{RD*} = q_{Hj}^{RD*} = \frac{(\alpha-1)(N\lambda - c)}{3\lambda}$$

(3.35) $$Q_{H}^{RD*} = \frac{2(\alpha-1)(N\lambda - c)}{3\lambda},$$

(3.36) $$P_{H}^{*} = \frac{N\lambda + 2c}{3\lambda}$$

From these equilibrium quantities and prices we may compute the following average price and standard deviation for the oligopoly firms:

$$P_{AVG}^{O} = \frac{\left(\frac{2(N-c)}{3}\right)\left(\frac{N+2c}{3}\right) + \left(\frac{2(a-1)(N\lambda - c)}{3\lambda}\right)\left(\frac{N\lambda+2c}{3\lambda}\right)}{\left(\frac{2(N-c)}{3}\right) + \left(\frac{2(a-1)(N\lambda - c)}{3\lambda}\right)}$$

(3.37) $$P_{AVG}^{O} = \frac{\lambda^2 (N-c)(N+2c) + \gamma(N\lambda - c)(N\lambda + 2c)}{3\lambda\left[\lambda(N-c) + \gamma(N\lambda - c)\right]}$$ where $\gamma = (\alpha - 1)$

$$SD^{O} = \sqrt{\frac{\left(\frac{N\lambda+2c}{3\lambda} - P_{avg}^{O}\right)^2\left(\frac{2(a-1)(N\lambda-c)}{3\lambda}\right) + \left(\frac{N+2c}{3} - P_{avg}^{o}\right)^2\left(\frac{2(N-c)}{3}\right)}{\frac{2(a-1)(N\lambda-c)}{3\lambda} + \frac{2(N-c)}{3}}}$$

(3.38) $$SD^{O} = \sqrt{\frac{\gamma(N\lambda - c)\left(N\lambda + 2c - 3\lambda P_{avg}^{O}\right)^2 + \lambda^3 (N-c)\left(N + 2c - 3P_{avg}^{o}\right)^2}{9\lambda^2\left[\gamma(N\lambda - c) + \lambda(N-c)\right]}}$$

Comparing the outcomes of the three models results in the following propositions:

Proposition 1: $P_{AVG}^{MO} \geq P_{AVG}^{O} \geq P_{AVG}^{PC}$

Proof: *see appendix B*.

Proposition 2: $SD^{MO} \leq SD^{O} \leq SD^{PC}$

Proof: *see appendix C*.

Hence, it can be shown that increasing the concentration in a market characterized by demand uncertainty (λ) and costly capacity (c) will lead to higher average prices and lower dispersion. Dana's analysis extends these results to more general cases and includes varying levels of oligopoly.

CHAPTER IV

DATA and EMPIRICAL INTRODUCTION

The conclusions of the theory provide direction for estimating the impacts of concentration, costs, uncertainty, and mergers on average fare and fare dispersion in the airline industry. Given the nature, depth, and breadth of airline markets, as well as the data available to study them, a rich set of panel data has been accumulated. Aggregate market sales are presented as a cross section (by market) over time (by quarter). Two empirical approaches are taken: a fixed effects approach incorporating as much of the panel data as possible and a first-differencing approach incorporating observed variations amongst relevant two-period subsets of the data.

General Fixed Effects Estimation

The fixed effects model assumes the presence of time-invarying, unobserved market heterogeneity, which is possibly correlated with the regressors. Since markets are defined here as one-way flights between origin and destination cities, certain aspects of a particular market do not change with time. Among them are seasonal desirability for, family obligations to, and general tourist curiosity about a city. Since these relevant variables are unobserved, cross sectional analyses suffer from omitted variable bias. The fixed effects model removes this bias by focusing on variations of each observation from the mean of that observation within a single market over time rather than variation between markets. Doing so removes unobserved variables such as those mentioned above, as well as observable ones like distance, from the analysis.

In specifying the nature of the model, average fare and fare dispersion were shown in the theory to be functions of essentially the same groups of exogenous regressors: cost variables, concentration variables, demand variables, and uncertainty variables. Thus, a reduced form equation for average fare is

$$(4.1) \quad P_{it} = \alpha + X'_{Cit}\,\beta_1 + X'_{MCit}\,\beta_2 + X'_{Dit}\,\beta_3 + X'_{Uit}\,\beta_4 + \mu_i + \varepsilon_{1it}$$

where P_{it} is the average fare in market i at time t, X_{Cit} represents cost regressors, X_{MCit} represents market characteristic regressors, X_{Uit} represents uncertainty variables, and X_{Dit} represent exogenous factors affecting demand for the good. The variable μ_i represents unobserved heterogeneity, and β_{1-4} are coefficient vectors. The error term, ε_{1it}, is a random variable error term unique to each market and time period with an assumed mean of zero and variance σ^2. It captures the effects of all other factors that influence fares but are not observed. It is assumed to be uncorrelated with the dependent variable, and the subscript one is used to distinguish this random error term from the dispersion equation's error term.

Similarly, a reduced form equation for fare dispersion is

$$(4.2) \quad D_{it} = \gamma + X'_{Cit}\,\delta_1 + X'_{MCit}\,\delta_2 + X'_{Dit}\,\delta_3 + X'_{Uit}\,\delta_4 + \eta_i + \varepsilon_{2it}$$

where D_{it} is the calculated level of fare dispersion in market i at time t. The regressors are the same as in the average fare equation, δ_{1-4} are coefficient vectors, and η_i represents the unchanging, unobserved market heterogeneity for each market i. The error term, ε_{2it}, is defined in the same manner as ε_{1it} is defined above, except that it pertains to dispersion. The subscript 2 is used to distinguish this random error term from the average fare's error term.

First Difference Estimations

Two additional sets of regressions are run using first-differencing. The main reason for employing this second approach is to reduce endogeneity problems inherent in the fixed effects estimation. While the variable-specific endogeneity issues are discussed in detail later in this section, the reduced-form empirical models follow.

For the straight first differencing regressions, the average fare and fare dispersion equations above are lagged by n time periods and subtracted from the current time period's average fare and fare dispersion equations. This will remove any bias that comes from unobserved heterogeneity. The resulting first-differences equations follow.

$$\begin{aligned}(4.3)\quad &(P_{it} - P_{i,t-n}) = (x_{Cit} - x_{Ci,t-n})'\phi_1 + (x_{Dit} - x_{Di,t-n})'\phi_2 + (x_{Mi} - x_{Mi,t-n})'\phi_3 + (x_{Ui} - x_{Ui,t-n})'\phi_4 \\ &+ (x_{MCi} - x_{MCi,t-n})'\phi_5 + \varepsilon_{3it}\end{aligned}$$

and

$$\begin{aligned}(4.4)\quad &(D_{it} - D_{i,t-n}) = (x_{Cit} - x_{Ci,t-n})'\pi_1 + (x_{Dit} - x_{Di,t-n})'\pi_2 + (x_{Mi} - x_{Mi,t-n})'\pi_3 \\ &+ (x_{Ui} - x_{Ui,t-n})'\pi_4 + (x_{MCi} - x_{MCi,t-n})'\pi_5 + \varepsilon_{4it}\end{aligned}$$

The changes in average fare and fare dispersion are regressed on changes in exogenous variables related to costs (x_{Cit}) and demand characteristics (x_{Dit}), the number of changes in concentration (x_{Mi}) and competitive uncertainty (x_{Uit}), and potentially endogenous variables affecting market structure (x_{MCit}). Such first-differencing will not remove the endogeneity issues present with certain concentration and cost variables. Hence, a second set of first-differecing regressions is run where changes in endogenous concentration and cost variables are replaced by changes the values they held in time period t-4. This produces the following first-differences equations.

$$(4.5)\quad (P_{it} - P_{i,t-n}) = (x_{Cit} - x_{Ci,t-n})'\rho_1 + (x_{Dit} - x_{Di,t-n})'\rho_2 + x_{Mi}'\rho_3 + x_{Ui}'\rho_4 + x_{MCi,t-n}'\rho_5 + \varepsilon_{5it}$$

and

$$(4.6) \quad (D_{it} - D_{i,t-n}) = (x_{Cit} - x_{Ci,t-n})'\eta_1 + (x_{Dit} - x_{Di,t-n})'\eta_2 + x_{Mi}'\eta_3 + x_{Ui}'\eta_4 + x_{MCi,t-n}'\eta_5 + \varepsilon_{6it}$$

In this setup, the changes in average fare and fare dispersion are regressed on changes in exogenous variables related to costs (x_{Cit}) and demand characteristics (x_{Dit}), the number of changes in concentration (x_{Mi}) and competitive uncertainty (x_{Uit}), and the "starting points" of potentially endogenous variables affecting market structure (x_{MCit}). Time-unvarying, unobserved heterogeneity is removed through the first-differencing process. While this setup has the appeal of being less prone to endogeneity and possibly more flexible in its analysis, it is more limited than the fixed effects model in the variety of regressors employed.[23] Elaboration on this point follows the variable next section.

Variable Definitions

Given the average fare and fare dispersion equations, the variables used in the fixed effects and first differences analyses are grouped in Tables 2 and 3 below. All observations for variables beginning with "REAL" are adjusted for inflation with a base year of 2005. Average fare observations are similarly adjusted.

Source Data

While various data sources are used, the primary data for this paper come from the Department of Transportation's "Ticket Dollar Value Origin and Destination Survey (TDVOD survey)."[24] Since deregulation, the Department of Transportation (DOT) has kept

[23] The first-difference regressions are run on a set of independent variables that differ slightly from the fixed-effects regressions. For a more direct comparison, the same set of independent variables was used for both regressions but not formally reported in the results section. The magnitudes and p-values remained essentially unchanged with each specification; see the alternative results in appendix A.
[24] Data obtained through Severin Borenstein at Cal-Berkeley, who compiles and cleans the DOT data for distribution to academics for research purposes

extensive records to closely follow the developments of airlines in this new competitive environment. As a result, large, detailed data sets of the industry are available for analysis.

The TDVOD survey is a random, ten percent sample of airline tickets sold in the U.S. This sample is compiled quarterly, and is drawn from all domestic flights, where a "domestic flight" is defined as any flight for which the origin and destination airports are both within the United States. Each record in the survey includes the origin and destination, airline, mileage, price paid, passengers per sale, and any stopovers used on the route for change-of-plane service. The basic observational units in the data are sales records for individual flights on American air carriers. Relevant limitations on the data include the following: there is no information on time of flight, number of flights per market, capacity or load per flight (and, therefore, load factors), dates of flights, indications of number of stops, or use of hubs (unless there is a change of plane).

Table 2:

Variable Definitions: First-Difference Regressions

First-Difference regressors	Category	Interpretation
gini4yrCHG	dependent variable	four year change: fare dispersion; quarterly gini
Avgfpm4yrCHG	dependent variable	four year change: average fare/mile (cents, quarterly)
herf4yrchg	concentration	four year change: HHI
startingHERF	concentration	the value of the HHI at time period t-n
changesincomp(100s)	concentration	frequency of competitive basket changes over 4 years
percdir4yrCHG	market attribute	four year change: percent of travelers flying direct
REALfuelcost4yrCHG	cost	four year change: estimated fuel costs
REALnonfuelcost4yrCHG	cost	four year change: estimated non-fuel costs
lowcostshare4yrCHG	cost	four year change: share of passengers on lowcost carriers
startingLOWCOSTshare	cost	share of passengers flying on lowcost airlines, period t-n
regshare4yrchg	market attribute	four year change: percent of passengers on regionals
startingREGIONALshare	market attribute	share of passengers flying on regional airlines, period t-n
mergers4yrTOTAL(10s)	concentration	total number of mergers over 4 years (by period)
metropop4yrchg1000000sO	exogenous	change in metro population over four years (100,000s)
REALpcinc4yrchg10000sO	exogenous	the change in pc income over four years ($1000s)

Table 3:

Variable Definitions: Fixed Effects Regressions

Fixed Effects regressors	Category	Interpretation
gini	Dependent variable	fare dispersion measured by the gini coefficient per quarter
avgfpm	Dependent variable	average fare per mile (cents)
herf	concentration	Herfindahl-Hirschman Index (sum of squared market shares)
monopoly	concentration	indicator variable = 1 if market is served by a sole carrier
knownqtq	uncertainty	indicates if competition was the same in quarters t and t-1
knownyoy	uncertainty	indicates if competition was the same in years t and t-1
regional	market attribute	indicates the presence of a regional carrier in the market
alaska	exogenous/demand	indicates if market contains an Alaskan origin/destination
premium	exogenous/demand	indicates if the market is serviced by a premium carrier
percdir	market attribute	percent of travelers in a market flying direct
REALfuelcosts	cost	average quarterly price of jet fuel (cents per seat mile)
REALnonfuelcosts	cost	average non-fuel quarterly costs/flight (cents per seat mile)
lowcost	cost	indicates if the market is serviced by a low cost carrier
lowcostshare	cost	indicates percent of travelers serviced by low cost carriers
regionalshare	market attribute	indicates percent of travelers serviced by regional carriers
md1	concentration	indicates if a merger was completed in quarter t-1
md2	concentration	indicates if a merger was completed in quarter t-2
md3	concentration	indicates if a merger was completed in quarter t-3
md4	concentration	indicates if a merger was completed in quarter t-4
REALmetropop	Exogenous/demand	origin population measured in $1,000,000 increments
REALpcinc	Exogenous/demand	origin per capita income measured in $1,000 increments

Variable Cleansing

For the purposes of this study, the observations found in the TDVOD survey are aggregated to the market level. This is a slight departure from the relevant price dispersion theories, which predict intra-firm dispersion (and, by extension, intra-firm average fares). In using market figures, it is assumed that intra-firm pricing will correspond, in aggregate, to market-wide pricing. As such, there are currently no tests of average fare or dispersion at the firm level in this project.

A market is defined as a directionally unique combination of cities serviced by distinct airports. For example, LGA-PIT is different from PIT-LGA, as well as from JFK-PIT. The decision to aggregate data in this manner reduces the complexity of the analysis by focusing on inter-market, rather than inter-firm, dispersion.

In contrast with the standards set by Borenstein and Rose and employed subsequently by Hayes and Ross, I have included all markets in which a change of airplane occurs mid-route. From the standpoint of the consumer, change of plane service is significantly less desirable than nonstop service or same-plane one-stop service, as well as artificially more expensive when interline travel occurs.[25] Accordingly, I have decided to include these observations, accounting for their presence with an independent variable representing the extent to which a market is served by such flights. Interestingly, this variable turns out to be among the most important determinants of dispersion and average fare.

In accordance with prior studies, I have dropped all markets for which there are zero observations in any quarters. Within markets, I have also dropped all observations where distance equals zero, passenger equals zero, or fare equals zero. Such observations distort the analysis because they are assumed to be key stroke errors, restricted frequent flier seats, or some other human input error. Fares equal to zero make Gini calculations meaningless, further biasing any analysis based on that statistic. While distances equal to zero might be plausible, they suggest that a passenger's origin and destination airports are the same. Even if they are not key stroke errors, such observations represent extreme, extenuating circumstances that do not fit the spirit of the analysis. Hence, they are dropped.

I have also dropped all observations where fares appear to be excessively large. Following the standard employed by Borenstein and Rose (1994), all fares greater than four times the imputed Standard Industry Fare Level (SIFL) were dropped. In approaching this

[25] One might also argue that direct service on, say, older DC-9's is significantly less desirable than direct (or even one-stop) service on Boeing 777s, although we certainly wouldn't drop either group of observations.

issue, other studies chose to drop all coach seats greater than $1500 under the assumption that they are to be data entry errors (see Hayes and Ross, 1998; Morrison, 1996).[26] I prefer the Borenstein method because the $1500 rule seems too arbitrary. Plus, such a method seems to favor unconditional exclusion of all large fares despite the possibility that some routes might warrant them.[27]

Most of the studies referenced here also drop observations of first class tickets, since such records allegedly distort price dispersion. Yet, although first class comprises at most 3% of all fares in any quarter, dropping these records may remove an important source of price discrimination employed strategically by many airlines that may have significant impacts on observed dispersion. As such, I have chosen to include first class fares in the analysis.[28] Finally, in accordance with Morrison (1996), observations identified as open jaw tickets are dropped. These include ground transportation as part of the travel itinerary, which makes direct comparisons with other service much less exact.[29] See table 4 for a summary.

The resulting data sets each contain 23,081 unique markets of summary data for the twenty quarters from quarter 1, 1986 through quarter 4, 1990. This time period provides pre and post-merger comparison data for the following sixteen mergers: Air Wisconsin-Aspen, American Airlines-Braniff, American Airlines-AirCal, AMR-Wings West, AMR-Command, Alaska-Horizon, Alaska-Jet America, Braniff-Florida Express, Texas Air Corp (Continental)-Rocky Mountain Air, Texas Air Corp (Continental)-Eastern, Texas Air Corp (Continental)-People Express, Delta-Western, Northwest-Republic, TWA-Ozark, USAir-Piedmont, and

[26] Morrison used the "U.S. General Accounting Office's Fare Screen 1990" in order to account for carrier misinformation.
[27] See Appendix R for a table showing the number of observations dropped as a percentage of all observations.
[28] Again, the ultimate product here is transportation from one point to another. Expensive first class seats represent the most price inelastic, high demand consumer, and I believe they should not be dropped.
[29] See Morrison p 241 for a discussion of slot controls, tourist markets and their potential effects on fares.

USAir-Pacific Southwest (PSA).[30] There are also several partial mergers in this timeframe, which typically constitute the acquisition of routes from an existing airline. As such, they will not be explicitly included in the merger analysis.[31]

Table 4:

Dropped, Change-of-Plane, First Class Observations as Percentages of All Obs

Quarter	Fare = 0	Change of plane	Open Jaw	Passgrs = 0	Orig = Dest	Fare >$1500	1st Class
86q1	1%	30%	2%	0%	0%	1%	3%
86q2	1%	30%	2%	0%	0%	1%	3%
86q3	1%	28%	2%	0%	0%	2%	3%
86q4	1%	29%	2%	0%	0%	2%	3%
87q1	2%	31%	2%	0%	0%	0%	3%
87q2	3%	32%	2%	0%	0%	0%	3%
87q3	4%	32%	2%	0%	0%	0%	3%
87q4	4%	33%	2%	0%	0%	0%	3%
88q1	5%	32%	2%	0%	0%	0%	3%
88q2	5%	32%	2%	0%	0%	0%	3%
88q3	5%	32%	2%	0%	0%	0%	3%
88q4	5%	32%	2%	0%	0%	0%	3%
89q1	4%	31%	2%	0%	0%	0%	3%
89q2	4%	32%	2%	0%	0%	0%	3%
89q3	5%	32%	2%	0%	0%	0%	3%
89q4	4%	32%	2%	0%	0%	0%	3%
90q1	4%	32%	2%	0%	0%	0%	3%
90q2	5%	33%	2%	0%	0%	0%	3%
90q3	5%	33%	2%	0%	0%	0%	3%
90q4	7%	33%	2%	0%	0%	0%	3%

Variable Construction: Dependent Variables

Recall that a market is defined as a one-way, airline-only trip from an origin city to a destination city. The TDVOD airline information proves useful as it identifies the number of carriers, enables calculations of passenger concentration, and enables identification of both

[30] There are 21 full mergers identified in this period. Some were not included because all affected markets were dropped in data cleansing, and some purely horizontal mergers, which are defined as two or more airlines operating in markets that do not overlap at all, are not observed in the data. See table 7 for a summary of mergers.

[31] The effect of partial mergers will be seen in carrier composition, total carrier, and herfindahl changes for affected markets. There is no indicator of the event that caused these, as they are market acquisitions, as opposed to “true” mergers

competitive baskets and merger activity for each route. With this in mind, I produce two dependent variables: average fare (per mile) per market and fare dispersion per market.

Average fare per mile is calculated for each market. Measured in cents, this figure is simply the sum of all fares paid by all passengers in a market divided by the passenger totals and distance traveled. Calculating average fare per mile allows for meaningful comparisons of fare information between any two markets, regardless of distance.

The other dependent variable is price dispersion, which can be measured in several ways. These include simple standard deviation or the coefficient of variation,[32] the Gini coefficient, the Entropy Index, and the Atkinson Index.[33] I have chosen to construct a Gini coefficient from the TDVOD survey data.[34] While certain limitations of the Gini coefficient are discussed below, this statistic provides a direct calculation of the percentage difference between any two randomly drawn tickets regardless of relative market characteristics.

Notes About the Gini Coefficient

While the Gini coefficient is typically associated with income distribution within a nation's population, it is often used to represent fare distribution in the airline industry. As such, a Gini coefficient has been constructed for this paper in the usual manner as a proportion of the graphical areas generated by the Lorenz curve. Graphs are constructed for each market with the "percent of demand" on the horizontal axis and the "percent of revenue generated" on the vertical axis. "Percent of demand" is interpreted as the population of passengers flying on a given route, regardless of airline, distributed along the horizontal axis in fare order. This is analogous to the percent of a nation's population that earn a certain

[32] Cook (2000) is a recent example that uses the coefficient of variation.
[33] There are other ways of calculating dispersion; these are the methods common to the airline literature.

level of income. “Percent of revenue generated” is interpreted as the percent of total revenue generated in a market that is attributed to each grouping of fares. This, too, is analogous to the usual employment of the Gini coefficient: overall revenue generated by a market is akin to GDP generated by an economy.

The Lorenz curve shows the actual fare distribution for a unique market while a 45-degree line shows “perfect” fare distribution. The area generated between the Lorenz curve and the 45 degree line is divided by the area below the 45 degree line and above the horizontal axis, bounded by 0 and 1. The resulting figure is the Gini coefficient for each market, which also ranges from a value of 0 to 1.

Gini coefficients close to 0 imply very little difference between the fares that are paid by all passengers. One might imagine a market with eleven different fares ranging from $95 to $105 dollars, each incrementally greater than the previous by $1: the average is $100, but no single fare represents much more than nine percent of total revenue. The top 18% of buyers (the two highest-paying travelers) represent 19% of market revenue. Hence, the cumulative distribution of the fares paid by passengers as a percentage of total market revenue does not deviate much from a 45 degree line.

Compare that with a situation where the first nine passengers paid $40-$48 each while the last two passengers paid $352 and $354. The average is still $100, but the top 18% is responsible for 64% of market revenue. This dispersion creates a wider deviation from the 45 degree line, resulting in a bigger calculation of the Gini coefficient. Higher coefficients imply higher levels of dispersion, and the Gini essentially measures the extent to which mean and median fares diverge.

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[34] Using the Gini appears to be standard practice, and is part of all empirical analyses mentioned in this paper.

Since the number of passengers, number of fare levels, and actual fares vary by market, each Gini coefficient is a discreetly calculated figure based on unique information. In table 5, I have provided sample data and Gini calculations for four representative markets: Allentown-Albequerque (ABE-ABQ), Allentown-Albany (ABE-ALB), Allentown-Atlanta (ABE-ATL), and Atlanta-Chicago (ATL-ORD).[35]

Table 5:

Sample Source Data for Various Gini Constructs

Market	Passengers	Fares	Distance	Points on Lorenz Curve	Gini
ABE-ABQ	4	3	1737	2	0.299525
ABE-ALB	9	6	167	5	0.074897
ABE-ATL	124	42	693	41	0.167758
ATL-ORD	5237	248	607	247	0.241658

The corresponding Lorenz Curve graphs are as follows in Figures 1-4, which show the Lorenz curves from which the Gini coefficients are calculated. Some markets, such as ABE-ABQ ABE-ALB have very little traffic. This produces few reference points, and, subsequently, very discreet, linear Lorenz curves.

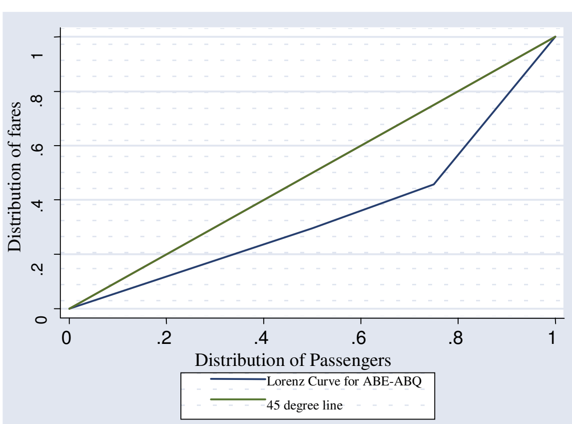


Figure 1: ABE-ABQ Lorenz Curve

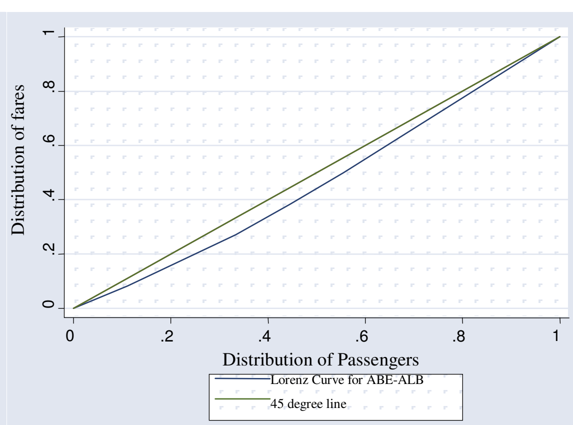
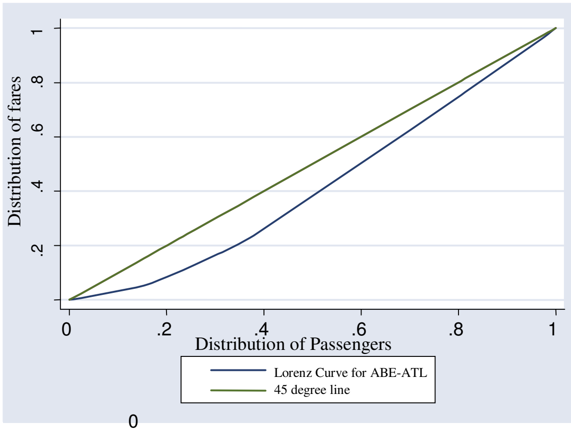


Figure 2: ABE-ALB Lorenz Curve

[35] ABE-ABQ, ABE-ALB, and ABE-ATL are the first three markets in the data. ATL-ORD is a large market



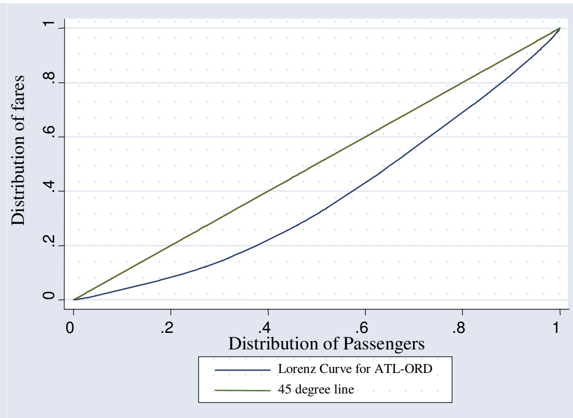


Figure 3: ABE-ATL Lorenz Curve

Figure 4: ATL-ORD Lorenz Curve

As market traffic increases, the number of fares offered tends to increase as well, providing more points of reference for the Lorenz curve. ABE-ATL has 124 passengers traveling on 42 different fares, while ATL-ORD has 5,237 passengers traveling on 248 different fares. Both of these markets have very smooth Lorenz curves, in effect enabling the discreet calculations to approximate continuous ones.

The fact that some Gini calculations are more discrete than others, however, does not necessarily affect the ability to compare Gini's across markets. Note that the Gini's can still vary widely within groups of small markets and that any potential downward bias in the Gini that may result from fewer observations should be accounted for in the regressions with the market population independent variable.[36] ABE-ABQ and ATL-ORD, for example, have remarkably similar Gini coefficients, despite ABE-ABQ's vastly smaller sample size. The number of passengers in a market is but one of many variables explaining the Gini coefficient, and as such a proxy for it is included in the regressions.

[36] Regressions will help determine if the number of reference points affects the value of the Gini, *ceteris paribus*

Variable Construction: Independent Variables

The independent variables are drawn from the theory and can be grouped into one of four categories, each of which is predicted to impact price dispersion: market size, market structure, costs, and certainty.[37] As proxies for market size, I use metropolitan population and market income data,[38] the percent of direct flights on a route, and indicator variables for atypical markets such as those with Alaskan, premium, and/or regional service. The percent of direct flights variable, *percdir*, is the percent of travelers who are on a direct flight between the origin and destination cities. This is a relevant explanatory variable because there is a big difference between consumers' desirability of and thus willingness to pay for a direct flight versus one with change-of-plane service. As such, a high percentage of direct flights should imply that the market size is large enough to sustain enough travelers to warrant the use of direct flights. The expected effect of this variable is a positive relationship to dispersion and average fare because a high percentage of direct flights might imply larger markets, greater competition, and increased dispersion.[39] Interestingly, while the observations used to construct this variable were excluded from most previous empirical studies,[40] the percdir variable is found to be among the most important determinants of dispersion and average fare in the present analysis.

The market structure variables used include concentration, merger dummies representing market-level merger activity, and a dummy variable for pure monopolies. Concentration is measured by the Herfindahl-Hirschman Index (HHI), which is constructed by taking the sum

[37] Several variables included in other studies are not included here. Brueckner et al (1992) used temperature differentials and per capita income, for example. This data is available for the present study but has not yielded meaningful results.
[38] obtained from the Bureau of Labor Statistics
[39] It is assumed that larger markets will provide more opportunities for entry as it will be easier for potential competitors to meet minimum efficient scale in such markets than it would be in smaller markets.
[40] Cook (2000) uses a similar figure of "nonstop travel" in his cross sectional study.

of the squared market shares of paying passengers on a route by each airline operating on the route.[41] The HHI directly indicates the amount of competition present on a route. Although there are various endogeneity issues that need to be addressed concerning the HHI, it is an essential variable for use in any analysis of market power.[42]

The number of mergers affecting a route indicates a specific change in concentration, while the number of carriers on a route gives a basic indication of the level of competition. Population and total income levels, on the other hand, while not providing a direct sense of the amount of competition on a route, indicate whether or not demand in a local market is large enough to sustain multiple carriers. Bigger markets have more passenger traffic, which allows additional carriers to satisfy any minimum efficient scale (MES) requirements. Thus, population as a proxy for passenger traffic levels should be a strong indication of the extent of competition and the level of demand on a route.[43]

Previous studies have found distance to be an important determinant of both average fare and fare dispersion.[44] Since it does not vary with time, distance will not be used as an explanatory variable in the fixed effects or first differencing analyses.

Given the difficulty of obtaining accurate cost data for any airline, costs are represented by the average quarterly price of jet fuel and the Department of Transportation's quarterly estimate of non-fuel costs per available seat mile.[45] Daily information for jet fuel prices was obtained through the Energy Information Administration at the Department of Energy and aggregated to average quarterly figures,[46] while the non-fuel costs per available seat mile

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[41] Singal (1996) used the same method for constructing concentration from the data.
[42] See appendix for a discussion of endogeneity issues concerning the Herfindahl Hirschman Index.
[43] Population information was used as a proxy for market passenger data due to endogenous nature of actual market passenger data.
[44] See Borenstein (1989), Kim and Singal (1993), Singal (1996), Hurdle et al (1989)..
[45] See http://ostpxweb.dot.gov/aviation/X-50%20Role_files/standindustfarelevel.htm for non-fuel cost data.
[46] See http://tonto.eia.doe.gov/steo_query/appparesult.asp

were obtained from the Department of Transportation's Office of Aviation Analysis. The price of jet fuel, which is a crucial component in the marginal cost of operating an airline, fluctuates significantly from quarter to quarter. The amount of dispersion in a particular market can, *ceteris paribus*, be expected to fluctuate as well. Since the theory predicts increasing dispersion with increasing cost, there should be a positive coefficient on the price of jet fuel when regressed on dispersion. For similar reasons, the average quarterly non-fuel costs per available seat mile should have a similar effect on pricing.

Variable Construction: Independent Variables: Certainty

The final category, certainty, is the most difficult to quantify. The theory expressly predicts that dispersion increases with uncertainty. Conversely, dispersion should decrease with certainty. The type of uncertainty described by the theory concerns the total demand that will have materialized by the day of the flight. Since the true state of demand, large or small, is not revealed until the day of the flight, there is a substantial element of uncertainty involved with planning sales in advance of departure. The further a sale is from departure,[47] the more uncertainty there is.

One way to approach the question of quantifying uncertainty is to look at the process of planning for advance ticket sales. Airlines typically employ inventory managers to determine seat allocations for sale some 320 days before the departure date for all flights. Managers can base reasonable predictions of the airline's demand on historical demand and familiarity with the markets in which the airline operates. The more historical data available, the easier it is to gauge future demand. Further, this familiarity-based forecasting is more

[47] For example, a ticket sold 300 days ahead of departure versus one sold three days ahead of departure.

"certain" when the market basket of competitors remains stable.[48] For example, three straight data sets in period t-3 through period t-1, in which the competition remained unchanged, leads to a fairly clear expectation of the demand an airline will face in period t. In contrast, a lack of data, a changing competitive environment, or both, will cast considerable doubt on the accuracy of the forecast. In essence, the general rule is that a less "changing" competitive environment is a more "certain" competitive environment.

With this in mind, I have constructed five fairly simple "certainty" variables. For the fixed effects analysis, the first certainty measure is a quarter-to-quarter certainty variable equal to 1 if the same competitors were present in the quarter immediately prior to the current quarter, and is equal to 0 otherwise. The second is a year-over-year certainty variable equal to 1 if the same competitors were present in the quarter one year prior to the current quarter, and is equal to 0 otherwise.

For the first-differences analysis, "changes in competition" statistics are generated to capture the extent to which the market basket of competitors had changed on a year-over-year basis. This statistic counts the number of times quarterly competition changed during the overall time period in question.

Since none of these figures pay attention to the relative importance of each competitor, all that matters is that the same few airlines find themselves competing with one another in subsequent time periods. As for the periods of comparison, the use of both quarter-to-quarter and year-over-year as separate certainty figures is warranted because of the cyclical nature of airline demand. Some markets may experience high amounts of carrier competition in, for example, the summer, but not the winter. Each market also has its own local idiosyncrasies

[48] From 1995-1997, the author was responsible for setting seat allocations for sale on USAirways flights between several major northeastern cities and several major Florida cities.

which may adhere to a cyclical schedule. In fact, it is instructive to view each grouping of quarters as a quasi-separate data set of continuous observations.

At the same time, in the spirit of the learning-by-doing models, each subsequent quarter of consistent competition should yield meaningful information irrespective of cyclical consistency. Providing a running count of the competition would indicate a very high degree of "certainty." In fact, this is the exact kind of analysis inventory managers undertake on a daily basis in order to best discern the demand they face. Any deviation from the expected basket of competitors hinders predictive power, especially if the deviation includes a low-cost carrier like Southwest Airlines.

Table 6:

Summary Table of Means: Fixed Effects Dependent and Independent Variables

Variable	Obs	Mean	Std. Dev.	Min	Max
Gini	466180	0.258	0.090	0	0.89
Avgfpm	466180	20.201	9.519	0.01	82.90
Herf	466180	0.660	0.259	0.003	1
Monopoly	466180	0.249	0.432	0	1
Knownqtq	443099	0.562	0.496	0	1
Knownyoy	396937	0.380	0.485	0	1
Regional	466180	0.029	0.167	0	1
Alaska	466180	0.003	0.057	0	1
Premium	466180	0.000	0.019	0	1
Percdir	466180	0.147	0.282	0	1
REALfuelcost	466180	1.976	0.300	1.64	2.64
REALnonfuelcost	466180	10.769	0.615	9.98	12.01
Lowcost	466180	0.140	0.347	0	1
lowcostshare	466180	0.043	0.161	0	1
regionalshare	466180	0.007	0.062	0	1
md1	443099	0.021	0.144	0	1
md2	420018	0.022	0.148	0	1
md3	396937	0.024	0.152	0	1
md4	373856	0.025	0.157	0	1
metropop (millions)	466180	1.700	2.707	0.01	19.80
REALpcinc (1000s)	466180	28.946	5.102	9.79	53.56
lnGINI	459196	-1.425	0.485048	-7.7	-0.12
lnAVGFPM	466180	2.8936	0.483429	-4.34	4.418
lnHERF	466180	-0.504	0.44028	-5.96	0
lnmetpopO	466180	-0.261	1.292444	-4.47	2.99
lnREALpcincO	466180	3.3502	0.174272	2.28	3.98

CHAPTER V

DETAILED DATA TREND ANALYSIS

Tables 7 and 8 contain the pairwise correlation matrices for most of the variables included in the regressions. The merger dummy variables, cost variables, and squared population variables were excluded from the fixed effects table because they were not significantly correlated with any of the other independent variables. Most of the population and all of the income variables were excluded from the first difference table for similar reasons. The remaining correlations follow expectations.

Figures 5 and 6 show the quarterly trends of the weighted Gini coefficient and HHI, respectively.[49] Figure 7 shows the quarterly trend of weighted Average Fares, figure 8 shows the average number of carriers per quarter, and figure 9 shows the quarterly price of jet fuel. Over the time period studied, there is a slight increase in concentration that corresponds to a more pronounced increase in dispersion, as well as an increase in the average fare per mile. The average number of carriers operating in a market trended upwards over this time period as well, which is interesting considering the slight upward trend in concentration. The quarterly fuel trends found in figure 9, appear to be relatively stable.

Regardless of the reasons for these upward trends, the theory predicts a different relationship between dispersion and concentration: dispersion should be falling with concentration, not rising with it. Further, the increase in the number of carriers in the

[49] The Gini coefficient and HHI are weighted by passenger volume and sales.

markets does not necessarily imply increased levels of competition. Evidence of this fact is the concurrent increase in concentration. The increasing HHI figures suggest that any gains from competition-enhancing entry were more than offset by losses from incumbent expansion.

Table 7:

Pairwise Correlation Matrix for First Difference Regressions

Variable	gini 4yr CHG	avgfpm 4yr CHG	starting HERF	herf 4yrchg	changes in comp	percdir 4yr CHG	REAL fuelcost 4yr CHG
gini4yrCHG	1.00						
avgfpm4yrCHG	-.01	1.00					
startingHERF	.05	-.04	1.00				
herf4yrchg	-.15	.09	-.46	1.00			
changesincomp	-.01	.04	-.34	-.04	1.00		
percdir4yrCHG	.03	.11	-.06	.11	.01	1.00	
REALfuelcost4yrCHG	.12	-.05	-.03	.01	-.04	-.02	1.00
REALnonfuelcost4yrCHG	-.11	.05	.04	-.01	.04	.02	-.98
lowcost4yrCHG	.01	-.07	.03	-.18	.03	.00	.03
startingLOWCOSTshare	.09	.04	-.04	.03	.09	-.02	-.04
lowcostshare4yrCHG	-.03	-.07	.01	-.08	.00	.05	.05
startingREGIONALshare	.00	.00	-.03	.02	.07	-.07	.00
regshare4yrchg	-.01	.02	.02	-.04	-.04	.08	.00
mergers4yrTOTAL	.00	.06	-.41	.18	.29	.02	.00
metropop4yrchgOxD	.04	.02	-.19	.02	.21	.01	.00

	REAL nonfuel cost 4yr CHG	Low cost 4yr CHG	starting LOW COST share	lowcost share 4yrCHG	starting REGION share	regshare 4yrchg	mergers 4yr TOTAL
REALfuelcost4yrCHG							
REALnonfuelcost4yrCHG	1.00						
lowcost4yrCHG	-.04	1.00					
startingLOWCOSTshare	.05	-.31	1.00				
lowcostshare4yrCHG	-.06	.61	-.56	1.00			
startingREGIONALshare	.00	-.10	.12	-.13	1.00		
regshare4yrchg	.00	.14	-.11	.19	-.75	1.00	
mergers4yrTOTAL	.00	.03	.02	.01	.03	-.03	1.00
metropop4yrchgOxD	.00	.08	.05	.02	.03	-.03	.34

Table 8:

Pairwise Correlation Matrix for Fixed Effects Regressions

Variable	gini	avgfpm	herf	monopoly	knownqtq	knownyoy	percdir
gini	1.00						
avgfpm	-.29	1.00					
herf	-.36	.23	1.00				
monopoly	-.34	.12	.74	1.00			
knownqtq	-.09	.04	.18	.26	1.00		
knownyoy	-.11	.06	.24	.30	.39	1.00	
percdir	.03	.16	-.06	-.18	-.15	-.14	1.00
lowcost	.06	-.07	-.26	-.20	-.11	-.12	.29
lowcostshare	-.07	-.02	-.05	-.08	-.04	-.04	.20
regionalshare	-.05	.07	-.03	-.05	-.04	-.04	.12
metropop1000000sO	.13	-.06	-.09	-.09	-.08	-.08	.18
metropop1000000sD	.13	-.06	-.09	-.10	-.08	-.08	.18
metropopOxD1000000s	.14	-.06	-.14	-.13	-.13	-.12	.31
REALpcinc1000sO	.14	-.12	-.14	-.14	-.11	-.10	.17
REALpcinc1000sD	.13	-.12	-.15	-.14	-.11	-.10	.17
REALpcincOsquared	.13	-.12	-.13	-.13	-.10	-.09	.16
REALpcincDsquared	.13	-.13	-.13	-.13	-.10	-.09	.16
REALpcinc1000sOxD	.20	-.17	-.23	-.21	-.18	-.16	.27

Variable	lowcost	lowcost share	regional share	metropop 1000000sO	metropop 1000000sD	metropop OxD 1000000s	REAL pcinc 1000sO
lowcost	1.00						
lowcostshare	.66	1.00					
regionalshare	.08	.09	1.00				
metropop1000000sO	.08	.02	.01	1.00			
metropop1000000sD	.07	.02	.01	-.10	1.00		
metropopOxD1000000s	.14	.05	.01	.43	.43	1.00	
REALpcinc1000sO	.09	.00	.03	.50	-.12	.22	1.00
REALpcinc1000sD	.09	.00	.03	-.13	.51	.22	-.13
REALpcincOsquared	.08	.00	.03	.50	-.11	.22	.99
REALpcincDsquared	.08	.00	.03	-.12	.50	.22	-.12
REALpcinc1000sOxD	.14	.00	.04	.28	.28	.35	.65

Variable	REAL pcinc 1000sD	REAL pcinc OxO	REAL pcinc DxD	REAL pcinc 1000sOxD
REALpcinc1000sD	1.00			
REALpcincOsquared	-.12	1.00		
REALpcincDsquared	.99	-.11	1.00	
REALpcinc1000sOxD	.65	.65	.65	1.00

Figure 5:

Quarterly Weighted Gini Coefficients

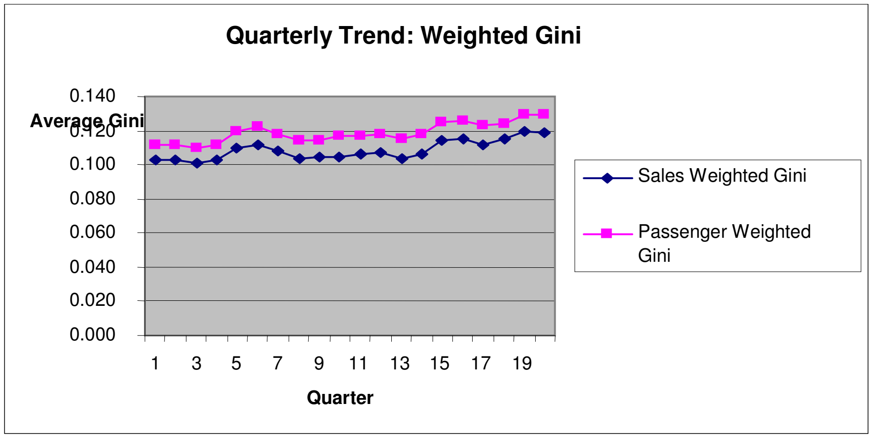


Figure 6:

Quarterly Weighted Concentration

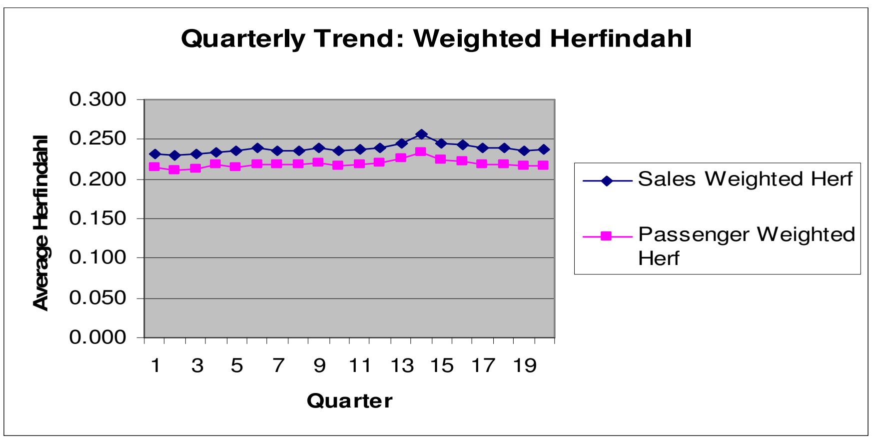


Figure 7:

Quarterly Weighted Average Fares

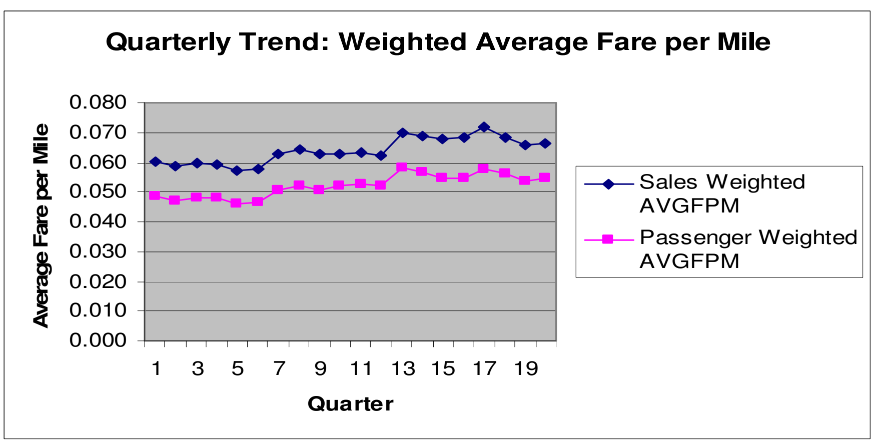


Figure 8:

Quarterly Average Number of Carriers

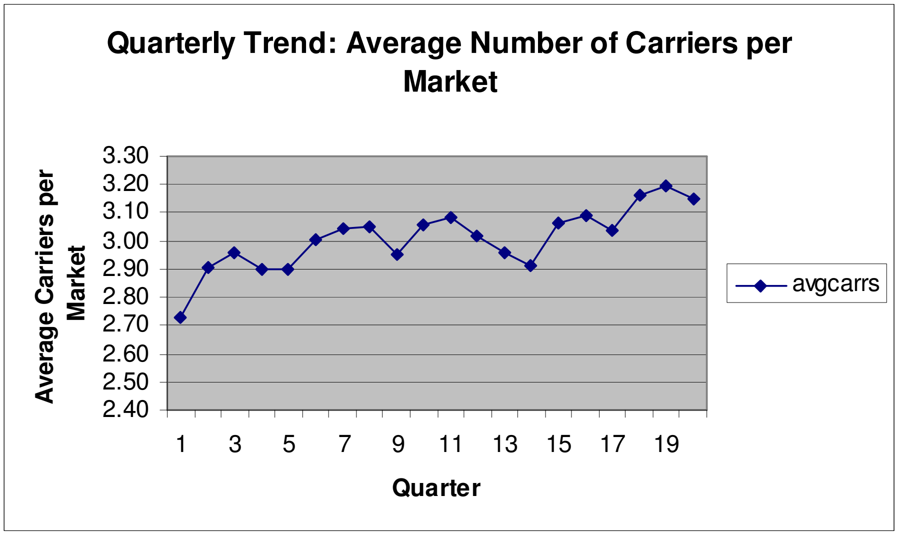
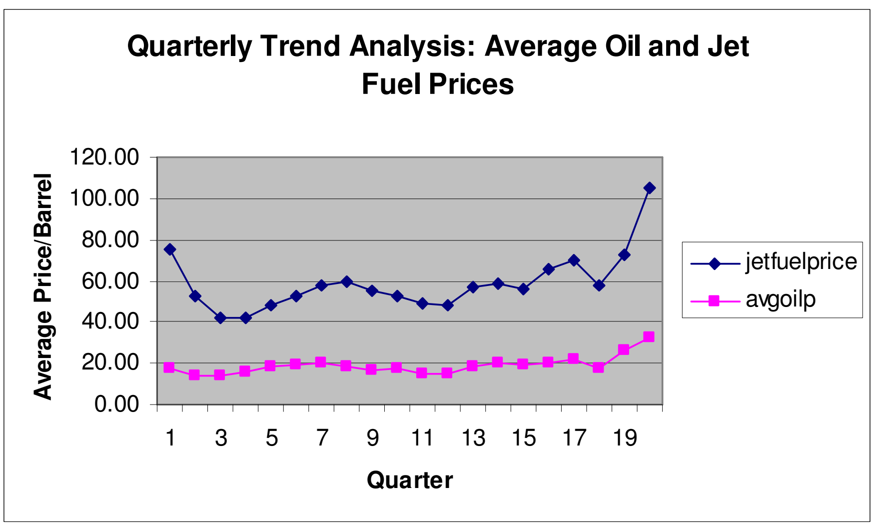


Figure 9:

Quarterly Average Oil and Jet Fuel Prices



Figures 10-13 show the same data broken into four separate trend lines by quarter. Grouping the data in this manner assumes that cyclical idiosyncrasies have a stronger influence on some of the variables than simple quarter-to-quarter data suggest. The upward trend in carrier presence, for example, is much more clear and discernable.

The data trends for average overall concentration are more easily observed at the quarterly level of observation as well. There appears to be a slight rise in concentration in each quarterly grouping over the first four years followed by a noticeable drop in concentration during the fifth year. This happens regardless of the quarter observed, and it occurs in both the sales and passenger weighted observations (see figure 11).

At the same time, there is a clear indication that average fares are increasing year over year when observing the data in similar quarters. Figure 12 shows a steady increase in average fares that can be partially explained through the simultaneous observation of increasing concentration. While the fifth year of data fails to show as pronounced a drop in average fares as the fifth year of concentration showed for that statistic, there is definitely a consistent trend that affects both statistics in predictably aligned ways.

Finally, there appears to be an upward trend in Gini price dispersion over the same time periods in which concentration, average fares, and the number of carriers are rising. This is still a bit of a discrepancy in that the predicted effect of increased concentration is decreased dispersion. Whereas the continuous change in concentration from one quarter to the next failed to show any obvious rise, the year-over-year comparisons of similar quarters reveal that concentration is definitely rising. As discussed with the quarterly data, dispersion should be falling over this period. In any event, it is clear from the charts that year-over-year upward trends occur in every quarter for every statistic measured here: carriers, concentration, average fares, and dispersion all show very noticeable upward trends when isolating yearly data points by quarter.

Figure 10:

Overall Average Carriers per Market Broken Down by Quarter

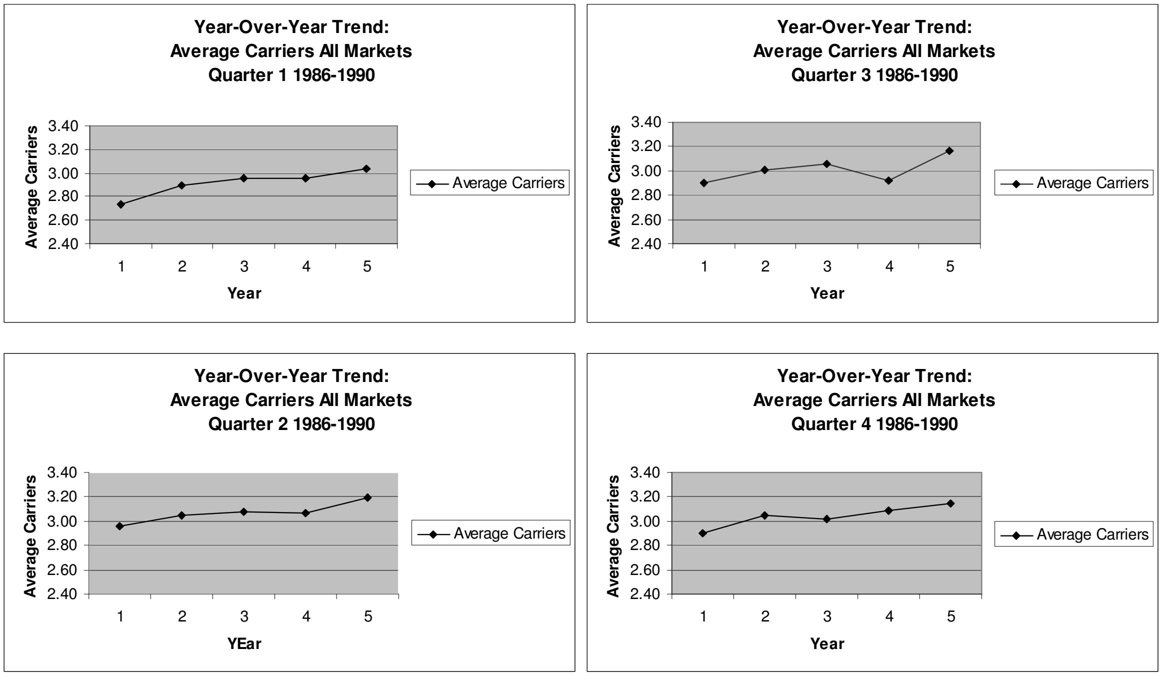


Figure 11:

Year-Over-Year Concentration Trends Broken Down by Quarter

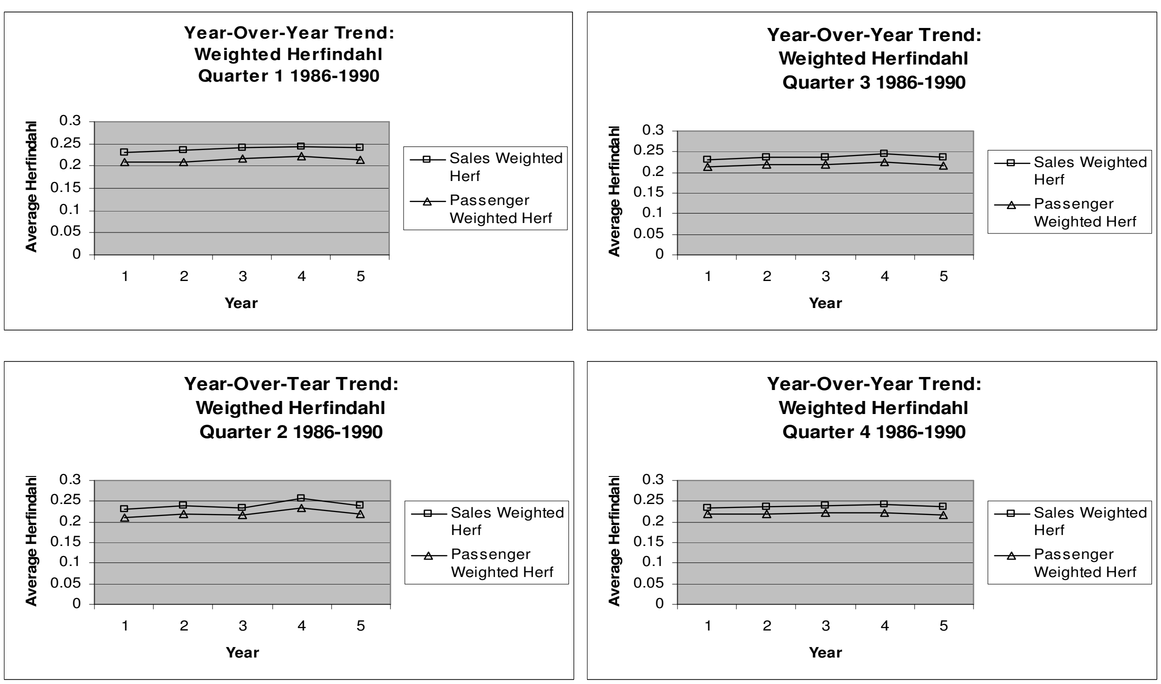


Figure 12:

Year-Over-Year Average Fare Per Mile Trends Broken Down by Quarter

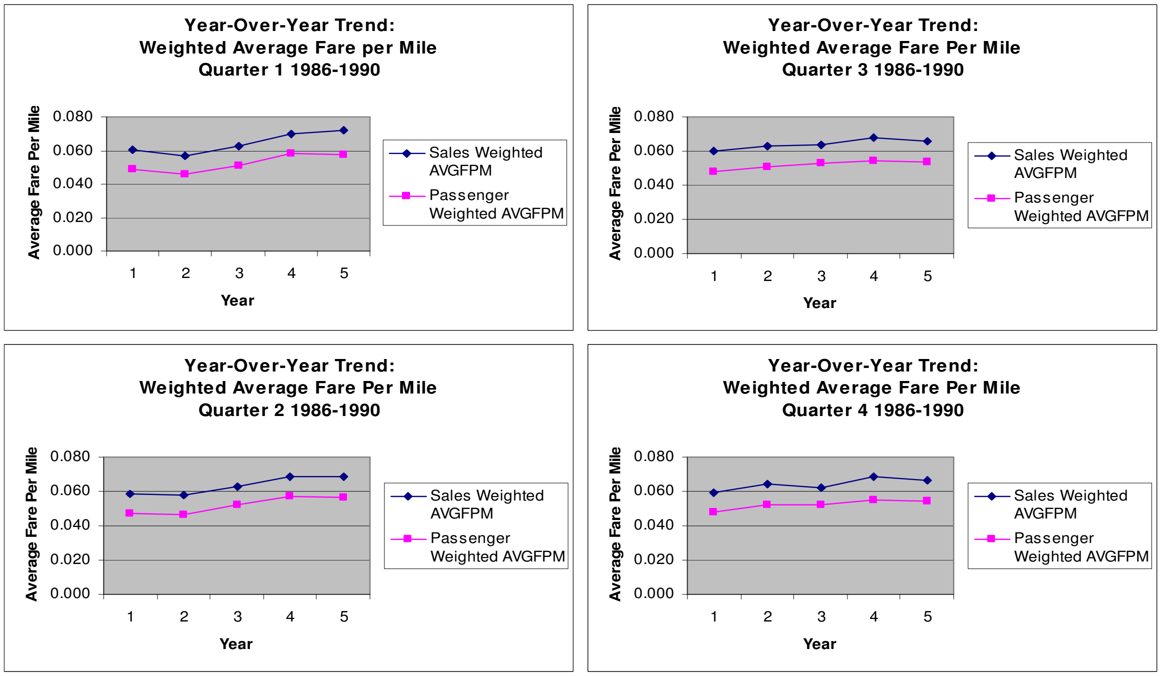
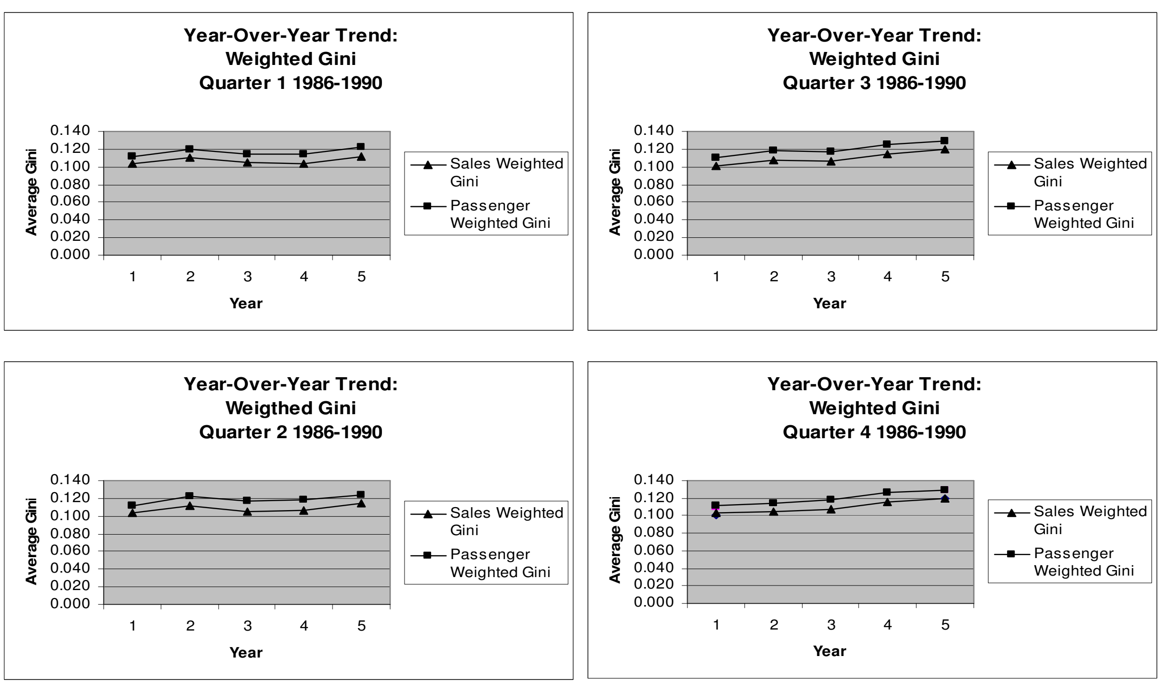


Figure 13:

Year-Over-Year Dispersion Broken Down by Quarter



CHAPTER VI

EMPIRICAL MODEL

Fixed effects and first difference regressions of the Gini coefficient and average fare are run on regressors drawn from the theory. The main benefit of the fixed effects regressions is that the results are descriptive of the relationships amongst the variables in question: they incorporate a wide breadth of regressors, providing more thorough direction in subsequent analysis of the theory than previous studies. The main cost is endogeneity: there are insurmountable endogeneity issues arising from the inability to identify proper instruments. The structurally more robust first difference regressions reduce these issues of endogeneity, but at a cost. The tradeoff is that fewer regressors are included, limiting this model's ability to test the effects of certain key theoretical predictions. Hence, both approaches are useful in their respective ways, and are separately pursued, presented, and interpreted in this analysis.

Since the theory assumes linear demand, the independent variables in the regressions that follow take linear and linear-in-the-logs form. Separate regression results including time-varying dummies and quadratic market proxies are included in Appendix A.

Fixed Effects Regressions

The independent variables for the fixed effects regressions were selected to meet the theoretical criteria of the model. Separate models of the Gini Coefficient as a measure of dispersion and average fare per mile are estimated in both linear and linear in the logs fashion using the same set of independent variables.[50] The linear model is a straight panel data regression of the market values of each dependent variable on the market values of the independent variables. The linear in the logs model is specified in one of two ways: a model where the independent variables are converted to natural logarithmic form and a model where both the independent and dependent variables are converted to natural logarithmic form. Since the theory does not provide any guidance as to the exact structural nature of the relationships investigated in this paper, all regressions were run on each variable, and a goodness of fit test is run on each to determine the most appropriate form.

The Gini coefficient is regressed on cost proxies, uncertainty proxies, market structure variables, and merger dummy variables that are determined by the theory. The independent variables include the HHI Index, merger dummies, proxies for cost, potential demand indicators of population and metropolitan income for the origin and destination cities, low cost carrier information, indicator variables for special circumstances like Alaska routes and premium service, and a trio of certainty variables.

Many of the regressors have been used in prior studies of price dispersion in the literature, and all conform to the theory laid out by Dana. New to this study is an attempt to quantify and estimate the effects of certainty on dispersion and average fare. Certainty in a market is defined in any period as the observation of the same bundle of competing airlines that occurred in the previous quarter. Of interest are the quarters immediately prior to and one year prior to the current quarter. For example, if the current airline mix is United, Delta, and American Airlines, the year-over-year certainty variable (knownyoy) equal 1 if that exact same basket of competitors existed one year prior and 0 otherwise. Similarly, if that exact same combination occurred in the quarter immediately prior, the quarter-to-quarter certainty

[50] Both will be calculated at the market level, as opposed to the firm level.

variable (knownqtq) will equal 1. Finally, in the first-differences regressions discussed later, the number of times a market basket of competitors changes (changesincompetiton) is used as an indication of uncertainty. Demand certainty is decreasing with the frequency of changes to the competitive mix.

All of the certainty variables are based on the logical assumption that, for airlines operating in a market, prior experience with a specific set of competitors is more "certain," *ceteris paribus*, than an entirely new, previously unknown basket of competitors. However, it is important to note that the exact kind of "uncertainty" being tested for here is slightly different from the type described by the Dana model. Nonetheless, the inclusion of these proxies provides a starting point for explaining the true role uncertainty plays in the pricing decisions of firms.

In order to determine the most appropriate empirical fit, a Hausman specification test was performed after the regressions were run under both fixed and random effects specifications. The results indicate that a fixed-effects model is the appropriate specification, which is warranted as many of the cross sectional differences between airlines and markets generally do not change from quarter to quarter.

Using various merger indicator variables, the regressions should effectively isolate the impact of mergers on various price indices. Sixteen full and ten partial mergers have been identified in this time frame, although data cleansing has reduced the number of full mergers observed in the dataset to twelve. The ten partial mergers are not explicitly identified as they tend to be picked up in isolated market transfers. The four full mergers not observed were purely horizontal in nature and, accordingly, fail to appear in the data due to lack of market overlap.

The first regression estimated on the 20 quarters of panel data is as follows:

$$\begin{aligned}
&Gini_{it} = \gamma + \delta_1 herf_{it} + \delta_2 monopoly_{it} + \delta_3 knownqtq_{it} + \delta_4 knownyoy_{it} \\
&+ \delta_5 regional_{it} + \delta_6 alaska_{it} + \delta_7 premium_{it} + \delta_8 PercDir_{it} + \delta_9 REALfuel\cos t_{it} \\
(6.1)\quad &+ \delta_{10} REALnonfuel\cos t_{it} + \delta_{11} low\cos t_{it} + \delta_{12} low\cos tshare_{it} \\
&+ \delta_{13} regionalshare_{it} + \delta_{14} MD1_{it} + \delta_{15} MD2_{it} + \delta_{16} MD3_{it} + \delta_{17} MD4_{it} \\
&+ \delta_{18} metropop1000000s_{it} + \delta_{19} REALpcinc1000s_{it} + \omega_{1i} + \varepsilon_{1it}
\end{aligned}$$

The dependent variable, Gini, is the quarterly level of market price dispersion as measured by the Gini coefficient. This is regressed on the Herfindahl index/HHI ($Herf_{it}$), the percentage of direct passengers flying in each market ($PercDir_{it}$),[51] quarterly jet fuel prices and DOT non-fuel cost estimates as proxies for cost ($jetfuelprice_{it}$), two measures of demand uncertainty ($knownyoy_{it}$, $knownqtq_{it}$), metropolitan population and income figures as proxies for market size ($metropop1000000s_{it}$ and ($REALpcinc1000s_{it}$), and various dummy variables for merger activity ($MD1$-$MD4_{it}$), the presence of low cost carriers, regional carriers, premium service, and Alaska routes. The variable ω_{1i} represents unobserved market heterogeneity, and the error term ε_{1it} is a random variable disturbance term unique to each market and time period assumed to be normally distributed with a mean of zero and a standard deviation of σ^2.

As per Dana's theory, I expect positive changes in the HHI to be negatively associated with price dispersion: the more concentrated the market, the lower the dispersion we should expect. Since I expect increases in the market size to indicate peak load pricing, larger markets, and, more potential for competition, I expect positive population and total income effects. Since the theory suggests that dispersion increases as costs rise, I expect the cost variables to have a positive effect on dispersion.

[51] The data distinguishes between direct and change-of-plane service. Prior studies dropped all observations with change-of-plane service. I choose to include these observations but account for their presence.

The percentage of passengers flying direct in a market should have a negative effect on price dispersion. This should be the case since changing planes reduces the efficiency and attractiveness of the product. In order to entice passengers to buy tickets with change-of-plane requirements, one should expect the airlines to offer reduced fares on such tickets. Thus, when the percentage of passengers changing planes is higher, the observed price dispersion should be too.[52] This result would counter the intuition suggested by prior research that change-of-plane service should raise the cost of travel.

One of the key points to the Dana theory is that increased uncertainty leads to more dispersion. As such, I would expect a negative effect on dispersion with each of the three certainty variables: more certainty should equal less dispersion.

The time varying merger dummy variables indicate when, if, and how mergers affect a market. I define a "market affected by a merger" as one in which two newly merged firms both operated prior to their merger. After a merger occurs, a dummy variable will indicate the event for each of four quarters following completion of the merger in order to track the effects of the merger over time. Each dummy will take the value $MD = 1$ in the event that the merger criteria are met that quarter, and $MD = 0$ otherwise. Each merger dummy variable is indicated by MD_{it}, where i = the market in which the merger occurs, and t = the quarter in question. Since mergers results in greater concentration, I expect them to have negative impacts on dispersion.

For the panel data regressions of average fare, most of the independent variables will be the same as mentioned above. The unobserved market heterogeneity is represented by

[52] This may not hold at the extremes: if, for example, all passengers on a route experience change-of-plane service, then all fares and revenues are reduced in tandem, which may actually lead to less price dispersion.

variable ω_{2i}, and the error term ε_{1it} is a random variable assumed to be normally distributed with a mean of zero and a standard deviation of σ^2. The average fare regression is

$$
\begin{aligned}
& Avgfpm_{it} = \alpha + \beta_1 herf_{it} + \beta_2 monopoly_{it} + \beta_3 knownqtq_{it} + \beta_4 knownyoy_{it} \\
& + \beta_5 regional_{it} + \beta_6 alaska_{it} + \beta_7 premium_{it} + \beta_8 PercDir_{it} + \beta_9 REALfuel\cos t_{it} \\
(6.2) \quad & + \beta_{10} REALnonfuel\cos t_{it} + \beta_{11} low\cos t_{it} + \beta_{12} low\cos tshare_{it} + \beta_{13} regionalshare_{it} \\
& + \beta_{14} MD1_{it} + \beta_{15} MD2_{it} + \beta_{16} MD3_{it} + \beta_{17} MD4_{it} + \beta_{18} metropop1000000s_{it} \\
& + \beta_{19} REALpcinc1000s_{it} + \omega_{2i} + \varepsilon_{2it}
\end{aligned}
$$

Average fare should be increasing with the HHI, the percentage of passengers flying direct, mergers, and certainty, and decreasing with market potential. It should also be decreasing with the presence of low cost carriers, especially if low cost carriers comprise a large percentage of the traffic in a market.

First-Differences Regressions

The second set of regressions attempts to deal with the endogeneity issues raised with the fixed effects regressions. Two versions of this regression are run: a straight first difference regression and a modified first difference regression. The dependent variables in the straight first difference model are defined as changes from one period to the next rather than static values obtained in a given quarter. The independent variables are chosen to coordinate with the fixed effects regressions as closely as possible in order to maintain logically consistent results comparisons. In some cases, however, the same independent variables do not carry over from the fixed effects regressions. An example is the certainty variables. Recall that the year-over-year certainty variable equals one if the same basket of competitors is operating in the market one year to the next, and equals zero otherwise. Since the first difference regressions take a much broader, four-year look at the changes in dispersion and average fares, this variable is no longer a strong indicator of certainty. The same goes for the quarter-to-quarter certainty variable, which is essentially meaningless over the four year period. The number of changes to competition, however, is included because it is a better indicator of certainty. It is constructed for each time period to assess the number of times competition changed on the route.

For the modified first difference regression, changes in the Gini coefficient and average fare per mile are regressed in OLS cross sections on various exogenous changes, various endogenous starting points, and changes to market structure. The change variables are the same as in the straight first difference regressions. Included among them are pc income and population information. The number of mergers that were completed during each time period in each market is also included in both types of regressions. Finally, the endogenous starting points include initial concentration (HHI), initial share of low cost carriers, and initial share of regional carriers.

These regressions are done by quarter over the entire time period. I looked at the changes in dispersion and average fare over the following four-year periods: quarter 1 1986 through quarter 1 1990; quarter 2 1986 through quarter 2 1990; quarter 3 1986 through quarter 3 1990; and quarter 4 1986 through quarter 4 1990. I performed each of these regressions separately, running each regression as both a straight first-difference regression and as a modified first-difference regression using the endogenous starting points described above. I also ran a pooled first difference regression with dummy variables for each season to account for the possibility of seasonal demand variation. Although the interpretations are less direct, I expect the results of these regressions to correspond with the theory in the much the same way as the fixed effects regressions described above. In each equation, the error terms and unobserved market heterogeneity follow the same structure and assumptions as the fixed effects regressions. The cross section regressions are

$$\begin{aligned}
(6.3)\quad & Gini4yrCHG_{it} = \kappa + \pi_1 herf4yrCHG_{it} + \pi_2 changesincomp_{it} + \pi_3 percdir4yrCHG_{it} \\
& + \pi_4 REALfuelcosts4yrCHG_{it} + \pi_5 REALnonfuelcosts4yrCHG_{it} \\
& + \pi_6 lowcostshare4yrCHG_{it} + \pi_7 regshare4yrCHG_{it} + \pi_8 mergers4yrTOTAL_{it} \\
& + \pi_9 REALmetropop4yrCHG100000s_{it} + \pi_{10} REALpcinc4yrCHG10000s_{it} \\
& + \omega_{3i} + \varepsilon_{3it}
\end{aligned}$$

$$\begin{aligned}
(6.4)\quad & avgfpm4yrCHG_{it} = \theta + \phi_1 herf4yrCHG_{it} + \phi_2 changesincomp_{it} + \phi_3 percdir4yrCHG_{it} \\
& + \phi_4 REALfuelcosts4yrCHG_{it} + \phi_5 REALnonfuelcosts4yrCHG_{it} \\
& + \phi_6 lowcostshare4yrCHG_{it} + \phi_7 regshare4yrCHG_{it} + \phi_8 mergers4yrTOTAL_{it} \\
& + \phi_9 REALmetropop4yrCHG100000sO_{it} + \phi_{10} REALpcinc4yrCHG10000s_{it} \\
& + \omega_{4i} + \varepsilon_{4it}
\end{aligned}$$

$$\begin{aligned}
(6.5)\quad & Gini4yrCHG_{it} = \kappa + \rho_1 startingHERF_{it} + \rho_2 changesincomp_{it} + \rho_3 percdir4yrCHG_{it} \\
& + \rho_4 REALfuelcosts4yrCHG_{it} + \rho_5 REALnonfuelcosts4yrCHG_{it} \\
& + \rho_6 startingLOWCOSTshare_{it} + \rho_7 startingREGIONALshare_{it} \\
& + \rho_8 mergers4yrTOTAL_{it} + \rho_9 REALmetropop4yrCHG100000s_{it} \\
& + \rho_{10} REALpcinc4yrCHG10000s_{it} + \omega_{3i} + \varepsilon_{3it}
\end{aligned}$$

$$\begin{aligned}
(6.6)\quad & avgfpm4yrCHG_{it} = \vartheta + \eta_1 startingHERF_{it} + \eta_2 changesincomp_{it} + \eta_3 percdir4yrCHG_{it} \\
& + \eta_4 REALfuelcosts4yrCHG_{it} + \eta_5 REALnonfuelcosts4yrCHG_{it} \\
& + \eta_6 startingLOWCOSTshare_{it} + \eta_7 startingREGIONALshare_{it} \\
& + \eta_8 mergers4yrTOTAL_{it} + \eta_9 REALmetropop4yrCHG100000s_{it} \\
& + \eta_{10} REALpcinc4yrCHG10000s_{it} + \omega_{4i} + \varepsilon_{4it}
\end{aligned}$$

$$\begin{aligned}
(6.7)\quad & GiniCHG_{it} = \kappa + \zeta_1 herfCHG_{it} + \zeta_2 qtrchanges_{it} + \zeta_3 yrchanges_{it} + \zeta_4 percdirCHG_{it} \\
& + \zeta_5 lowcostshareCHG_{it} + \zeta_6 regionalshareCHG_{it} + \zeta_7 md1_{it} + \zeta_8 md4_{it} \\
& + \zeta_9 metropopCHG_{it} + \zeta_{10} REALpcincCHG_{it} + \zeta_{11} winter_{it} + \zeta_{12} spring_{it} + \zeta_{13} summer_{it} \\
& + \omega_{5i} + \varepsilon_{5it}
\end{aligned}$$

$$\begin{aligned}
(6.8)\quad & avgfpmCHG_{it} = \theta + \tau_1 herfCHG_{it} + \tau_2 qtrchanges_{it} + \tau_3 yrchanges_{it} + \tau_4 percdirCHG_{it} \\
& + \tau_5 lowcostshareCHG_{it} + \tau_6 regionalshareCHG_{it} + \tau_7 md1_{it} + \tau_8 md4_{it} \\
& + \tau_9 metropopCHG_{it} + \tau_{10} REALpcincCHG_{it} + \tau_{11} winter_{it} + \tau_{12} spring_{it} + \tau_{13} summer_{it} \\
& + \omega_{6i} + \varepsilon_{6it}
\end{aligned}$$

CHAPTER VII

EMPIRICAL RESULTS: FIXED EFFECTS MODEL

Regression results are based on all twenty time periods, which include 466,180 observations on 23,309 one-way markets. The estimations were corrected for heteroskedasticity using robust errors. Due to correlation concerns between two sets of independent variables (monopoly/herfindahl and knownqtq/knownyoy), six formulations of the models were run for each dependent variable. All of these results are reported in the corresponding tables. Additional results that consider quadratic income data, quadratic population data, and quarter specific dummy variables are found in Appendix A. They are not separately reported here because the results are essentially the same across specifications. Table 17-A in Appendix A provides a summary comparison of the different results.

Gini as Price Dispersion

The results are essentially in line with expectations for both the linear and linear in the logs regressions of the Gini coefficient as price dispersion, and it should be noted that virtually all of the coefficients are of the same sign for both regressions. The only sign change is for the market population, while four of the sixteen independent variables obtained coefficients opposite to expectations.

Table 9:

Regression Output: Linear Gini Dispersion

	Gini Regressions With Herfindahl and the Following Certainty Variables:			Gini Regressions With Monopoly and the Following Certainty Variables:		
	qtq and yoy	qtq only	yoy only	qtq and yoy	qtq only	yoy only
herf	-.056**	-.056**	-.056**	-	-	-
	(.001)	(.001)	(.001)			
monopoly	-	-	-	-.031**	-.031**	-.031**
				(.001)	(.001)	(.001)
knownqtq(100s)	.075*	.069*	-	.181**	.190**	-
	(.024)	(.024)		(.024)	(.024)	
knownyoy(1000s)	-.312	-	-.145	.464	-	.859**
	(.272)		(.268)	(.272)		(.268)
regional(100s)	.558**	.561**	.549**	.665**	.660**	.644**
	(.077)	(.077)	(.077)	(.077)	(.077)	(.077)
alaska(100s)	.076	.070	.087	-.025	-.016	.005
	(.589)	(.589)	(.589)	(.583)	(.583)	(.583)
premium(100s)	-.589	-.588	-.594	-.809	-.811	-.824*
	(.363)	(.363)	(.363)	(.355)	(.355)	(.355)
percdir	.028**	.028**	.028**	.019**	.019**	.019**
	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)
REALfuelcost	.021**	.021**	.021**	.021**	.021**	.021**
	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)
REALnonfuelcost(100s)	.743**	.741**	.744**	.726**	.730**	.728**
	(.023)	(.022)	(.023)	(.023)	(.022)	(.023)
lowcost(100s)	.462**	.465**	.459**	.707**	.703**	.701**
	(.056)	(.056)	(.056)	(.055)	(.055)	(.055)
lowcostshare	-.013**	-.013**	-.013**	-.014**	-.014**	-.013**
	(.003)	(.003)	(.003)	(.003)	(.003)	(.003)
regionalshare	-.014**	-.014**	-.014**	-.012**	-.012**	-.011**
	(.003)	(.003)	(.003)	(.003)	(.003)	(.003)
md1	-.004**	-.004**	-.004**	-.004**	-.004**	-.004**
	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)
md2	.003**	.004**	.004**	.003**	.003**	.003**
	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)
md3	.003**	.003**	.003**	.003**	.003**	.004**
	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)
md4	-.006**	-.006**	-.006**	-.006**	-.006**	-.006**
	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)
metropop(1,000,000s)	.017**	.017**	.017**	.016**	.016**	.016**
	(.003)	(.003)	(.003)	(.003)	(.003)	(.003)
REALpcinc($100,000s)	-.220**	-.220**	-.221**	-.217**	-.217**	-.218**
	(.017)	(.017)	(.017)	(.017)	(.017)	(.017)
F-Stat	560.19	593.15	591.44	568.65	601.97	599.04
R-Squared	.519	.519	.519	.521	.521	.521
Number of Units	373856	383856	373856	373856	373856	373856

Standard errors in parentheses; * Significant to the .05 level; ** Significant to the .01 level.

Table 10:

Regression Output: Linear in the Logs Gini Dispersion

	lnGINI Regressions With lnHERF and the Following Certainty Variables:			lnGINI Regressions With Monopoly and the Following Certainty Variables:		
	qtq and yoy	qtq only	yoy only	qtq and yoy	qtq only	yoy only
lnHERF	-.136**	-.137**	-.136**	-	-	-
	(.003)	(.003)	(.003)			
monopoly	-	-	-	-.144**	-.143**	-.143**
				(.003)	(.003)	(.003)
knownqtq	.001	.001	-	.007**	.007**	-
	(.001)	(.001)		(.001)	(.001)	
knownyoy	-.003	-	-.002	.002	-	.004*
	(.002)		(.001)	(.002)		(.001)
regional	.033**	.033**	.033**	.037**	.036**	.036**
	(.004)	(.004)	(.004)	(.004)	(.004)	(.004)
alaska	.018	.018	.019	.005	.005	.006
	(.041)	(.041)	(.041)	(.041)	(.041)	(.041)
premium	-.043	-.043	-.043	-.050*	-.050*	-.051*
	(.023)	(.023)	(.023)	(.022)	(.022)	(.022)
percdir	.136**	.137**	.136**	.092**	.092**	.092**
	(.007)	(.007)	(.007)	(.007)	(.007)	(.007)
lnFUELCOST	.191**	.190**	.191**	.194**	.195**	.195**
	(.005)	(.005)	(.005)	(.005)	(.005)	(.005)
lnNONFUELCOST	.381**	.379**	.381**	.369**	.371**	.369**
	(.015)	(.015)	(.015)	(.015)	(.015)	(.015)
lowcost	.029**	.029**	.029**	.041**	.041**	.041**
	(.003)	(.003)	(.003)	(.003)	(.003)	(.003)
lowcostshare	-.045**	-.045**	-.045**	-.049**	-.049**	-.048**
	(.015)	(.015)	(.015)	(.015)	(.015)	(.015)
regionalshare	-.088**	-.088**	-.087**	-.076**	-.075**	-.075**
	(.022)	(.022)	(.022)	(.022)	(.022)	(.022)
md1	-.008**	-.008**	-.009**	-.007**	-.007**	-.009**
	(.003)	(.003)	(.003)	(.003)	(.003)	(.003)
md2	.023**	.023**	.023**	.022**	.021**	.022**
	(.002)	(.002)	(.002)	(.002)	(.002)	(.002)
md3	.020**	.021**	.020**	.021**	.021**	.021**
	(.002)	(.002)	(.002)	(.002)	(.002)	(.002)
md4	-.022**	-.021**	-.021**	-.021**	-.021**	-.020**
	(.002)	(.002)	(.002)	(.002)	(.002)	(.002)
lnMETROPOP	-.103**	-.103**	-.102**	-.117**	-.117**	-.117**
	(.035)	(.035)	(.035)	(.035)	(.035)	(.035)
lnPCINC	-.405**	-.405**	-.405**	-.392**	-.392**	-.393**
	(.031)	(.031)	(.031)	(.031)	(.031)	(.031)
F-Stat	324.09	343.1	324.09	343.1	342.17	329.69
R-Squared	0.46	0.46	0.46	0.46	0.46	0.46
Number of Units	369,413	369,413	369,413	369,413	369,413	369,413

Standard errors in parentheses; * Significant to the .05 level; ** Significant to the .01 level.

The most significant detractor to the theory is the coefficient on the certainty variables, which were consistently positive: both certainty variables had positive coefficients when significant in the regressions. This is a direct contradiction of the theory that demand *un*certainty, not certainty, will raise dispersion.

The other surprises include the coefficients on the percent direct variable, the dummy indicating presence of low cost carriers, and two of the lagged merger dummy variables. All were expected to be negative, yet all came out significantly positive. With regards to the percdir variable, it is entirely possible that the greater the percentage of direct flights in a market, the greater the probability of business travelers making purchases, which would certainly drive up dispersion.

The estimated coefficient on the indicator variable for low cost carrier presence on a route is somewhat harder to explain. There was a concern that the low cost indicator variable was correlated with the "low cost as a share of route traffic" variable. Including both in the regressions produced opposite signs on the coefficients. Yet, when the regressions were run with each variable individually, the signs and significance remained consistent for each. This suggests that the mere presence of a low cost carrier on a route indicates sufficiently large traffic on that route, which warrants entry by low cost competition. Hence, as an indirect way to indicate the extent of competition on a route, the low cost carrier indicator would likely garner a positive coefficient. However, as the share of the market borne by low cost carriers increases, the cost effect appears to overwhelm the competition effect, resulting in decreasing dispersion.

Finally, the two lagged merger dummy variables that were surprisingly positive came in the t-2 and t-3 time periods. In order to understand why, it is best to view all four merger dummy variables together. If a merger was completed exactly one quarter or one year ago, that event has had a significant negative impact on dispersion. If a merger occurred exactly two or three quarters ago, that event has had a significant positive impact on dispersion. A likely explanation for this discrepancy lies in the certainty result reported earlier: when markets are *less certain*, dispersion *falls*. This would imply that the opposite is also true: when markets are *more certain*, dispersion *rises*. Combining this with the concept of a merger leads to the following observation: a merger, *ceteris paribus*, reduces certainty in the first full quarter immediately following completion of the merger. Such an environment would lead to less confident price discrimination by those firms remaining in the new, *less certain* market, which would imply less dispersion. As the first full quarter of data is accumulated in this new environment, airlines gain confidence in their ability to price accordingly, leading to more discrimination in the subsequent period and, as a result, more dispersion. A similar logic would explain why the coefficient on the MD4 variable for merger activity one year ago was also negative.[53]

The most significant determinant of Gini dispersion is the regionalshare variable. All significance figures that follow are based on a one standard deviation change in the value of the independent variable in question. For example, a one standard deviation change in the percent of traffic carried by regional carriers leads to a 13% decline in Gini dispersion. This is plausible, since regional carriers are often monopolistic on seldom traveled “spoke” routes. The next most significant are changes lowcostshare, percdir, and monopoly, which result in a 5% decrease, a 4.5% increase, and a 4% decrease in Gini dispersion, respectively.

[53] We have to assume that the next observation in such a sequence, MD8, is positive rather than test for it, since to do so would require giving up four more degrees of freedom.

The linear in the logs estimation of Gini dispersion yields very similar results. Regional share is the most influential as a one standard deviation change in regional share leads to an expected decrease in Gini of 76%. Such increases in percdir lead to an expected increase in Gini of 22%, increases in monopoly lead to an expected decrease in Gini of 20%, and increases in the share of traffic carried by low cost airlines lowers the Gini 17%.

Average Fare

The results for the average fare regressions are given in tables 11 and 12 below. While most of the coefficients fall well within the realm of expectations, two important exceptions warrant additional attention. The first regards the merger dummy variables. Without exception, in the two equations, all of the significant merger dummy variables show negative impacts on the average fare paid in affected markets. This suggests the possibility that mergers lead to efficiency gains that are large enough to make up for any resulting increases in market power.

The second exception, the monopoly dummy variable, is harder to explain. This variable is significantly negative in each of the linear in the logs estimations, suggesting that markets served by monopolies have lower average fares than those characterized by any other level of competition. Not only does this result contradict logical expectations, it does not seem to fit with the significant positive coefficients on the herfindahl variables. Nor does it seem to be a result of monopoly markets being poorer, smaller, and more prone to change-of-plane service. Although these things would suggest lower fares, they are accounted for in the regressions through use of pc income, population, and percent direct variables.

One possible explanation for this negative coefficient is that monopolized airline routes might be considered natural monopolies: regardless of the benefits derived from competition, the cost advantage of going from two airlines to one is unambiguously large. Two planes, two sets of pilots, two sets of ground crews, higher advertising costs, and other redundancies are present with competition. A monopoly eliminates this collective cost burden, enabling the remaining airline to simultaneously lower prices while increasing profit margins.[54] If true, this might help explain why increased concentration tends to raise average fares right up to the moment of monopoly, at which point the cost advantages kick in and start reducing fares.

Another explanation concerns the markets that happen to be monopolies. In looking at the data, there appear to be a tremendous number of very small, very unlikely markets among the monopolistic markets. While the full list is exhaustive,[55] examples include routes like TPA-DLH (Tampa, Fl – Duluth, MN), TOL-JAN (Toldeo, OH – Jackson, MS), SYR-TRI (Syracuse, NY – Johnson City, TN). It is plausible to think that many of these routes were made possible by the hub-spoke system that developed with deregulation. Not only is it possible that demand is so low for many of these markets that lower prices are warranted, but it is also very possible that many of the passengers flying on obscure routes are using frequent flyer discounts to do so.

Regardless of the reason, the magnitude of the effect is small, and it is only significant in the linear in the logs regressions. A one standard deviation change in the monopoly variable leads to a 3% decrease in price. This, along with the certainty variables, is among the lower determinants of average fares. The biggest impacts come from the population, regional

[54] Profit margins will rise if price falls as long as average costs fall further.
[55] Monopolies comprise 25% of all markets, which is roughly 5800 markets.

share, percent direct, and lowcostshare variables. One standard deviation changes in each of the first three lead to 105%, 60%, and 59% increases, respectively, while a one standard deviation change in lowcostshare lowers average fares by 21%. As for mergers, a one standard deviation change in merger activity causes an expected decrease in average fares of 17-24%.

In any event, while costs, concentration, and perhaps even certainty raise average fares, mergers and monopolies appear to be unambiguously associated with lower average fares. These are important results, since they imply that, overall, airline mergers have resulted in enough efficiency gains to overwhelm and outweigh any potentially adverse market power enhancements. Further, these results are in direct contrast with the majority of the papers cited above. As mentioned earlier, a likely explanation for the divergence of results is the vastly expanded data set and regressors used in the present study, including but not limited to the percent of direct traffic statistics.

Table 11:

Regression Output: Linear Average Fare

	Avgfpm Regressions With Herfindahl and the Following Certainty Variables:			Avgfpm Regressions With Monopoly and the Following Certainty Variables:		
	qtq and yoy	qtq only	yoy only	qtq and yoy	qtq only	yoy only
herf	1.119**	1.122**	1.126**	-	-	-
	(.078)	(.078)	(.077)			
monopoly	-	-	-	-.046	-.040	-.049
				(.041)	(.041)	(.041)
knownqtq	-.066**	-.062**	-	-.077**	-.069**	-
	(.017)	(.017)		(.017)	(.017)	
knownyoy	.020	-	.005	.041	-	.024
	(.019)		(.019)	(.019)		(.019)
regional	-.150	-.152	-.142	-.222**	-.227**	-.214**
	(.083)	(.083)	(.083)	(.083)	(.083)	(.083)
alaska	-1.746**	-1.742**	-1.756**	-1.828**	-1.820**	-1.840**
	(.616)	(.616)	(.616)	(.616)	(.616)	(.616)
premium	-1.045	-1.046	-1.041	-.940	-.941	-.934
	(.667)	(.667)	(.667)	(.667)	(.667)	(.667)
percdir	6.069**	6.068**	6.068**	6.216**	6.215**	6.215**
	(.124)	(.124)	(.124)	(.123)	(.123)	(.123)
REALfuelcost	-.275**	-.273**	-.278**	-.315**	-.309**	-.319**
	(.029)	(.028)	(.029)	(.029)	(.028)	(.029)
REALnonfuelcost	.841**	.843**	.841**	.831**	.835**	.831**
	(.016)	(.016)	(.016)	(.016)	(.016)	(.016)
lowcost	-.473**	-.475**	-.470**	-.558**	-.562**	-.556**
	(.044)	(.044)	(.044)	(.044)	(.044)	(.044)
lowcostshare	-1.228**	-1.229**	-1.234**	-1.199**	-1.200**	-1.205**
	(.191)	(.191)	(.191)	(.191)	(.191)	(.191)
regionalshare	2.968**	2.972**	2.962**	2.851**	2.859**	2.842**
	(.376)	(.376)	(.376)	(.377)	(.377)	(.377)
md1	-.692**	-.694**	-.675**	-.674**	-.679**	-.654**
	(.048)	(.048)	(.047)	(.047)	(.047)	(.047)
md2	-.416**	-.420**	-.420**	-.404**	-.411**	-.408**
	(.039)	(.039)	(.039)	(.039)	(.039)	(.039)
md3	-.742**	-.746**	-.746**	-.733**	-.741**	-.738**
	(.036)	(.036)	(.036)	(.036)	(.035)	(.036)
md4	-.097**	-.101**	-.102**	-.082	-.091**	-.088*
	(.037)	(.037)	(.037)	(.037)	(.037)	(.037)
metropop(1,000,000s)	-2.812**	-2.811**	-2.817**	-2.801**	-2.799**	-2.808**
	(.187)	(.187)	(.187)	(.187)	(.187)	(.187)
REALpcinc($1,000s)	.304**	.304**	.304**	.310**	.310**	.310**
	(.012)	(.012)	(.012)	(.012)	(.012)	(.012)
F-Stat	695.13	735.79	734.4	680.58	720.05	718.99
R-Squared	0.78	0.78	0.78	0.78	0.78	0.78
Number of Units	373,856	373,856	373,856	373,856	373,856	373,856

Standard errors in parentheses; * Significant to the .05 level; ** Significant to the .01 level.

Table 12:

Regression Output: Linear in the Logs Average Fare

	lnAVGFPM Regressions With lnHERF and the Following Certainty Variables:			lnAVGFPM Regressions With Monopoly and the Following Certainty Variables:		
	qtq and yoy	qtq only	yoy only	qtq and yoy	qtq only	yoy only
lnHERF	.024**	.024**	.024**	-	-	-
	(.002)	(.002)	(.002)			
monopoly	-	-	-	-.016**	-.016**	-.016**
				(.002)	(.002)	(.002)
knownqtq	-.003**	-.002**	-	-.003**	-.002**	-
	(.001)	(.001)		(.001)	(.001)	
knownyoy	.001	-	.000	.002**	-	.002*
	(.001)		(.001)	(.001)		(.001)
regional	.010**	.009**	.010**	.006	.006	.006
	(.004)	(.003)	(.003)	(.003)	(.003)	(.003)
alaska	-.152**	-.152**	-.152**	-.156**	-.156**	-.157**
	(.026)	(.026)	(.026)	(.026)	(.026)	(.026)
premium	-.041	-.042	-.041	-.036	-.036	-.036
	(.025)	(.025)	(.025)	(.025)	(.025)	(.025)
percdir	.299**	.299**	.299**	.305**	.305**	.305**
	(.006)	(.006)	(.006)	(.006)	(.006)	(.006)
lnFUELCOST	-.059**	-.058**	-.059**	-.063**	-.062**	-.063**
	(.003)	(.003)	(.003)	(.003)	(.003)	(.003)
lnNONFUELCOST	.419**	.420**	.419**	.413**	.415**	.412**
	(.009)	(.009)	(.009)	(.009)	(.009)	(.009)
lowcost	-.025**	-.025**	-.025**	-.030**	-.030**	-.029**
	(.002)	(.002)	(.002)	(.002)	(.002)	(.002)
lowcostshare	-.058**	-.058**	-.058**	-.057**	-.057**	-.057**
	(.009)	(.009)	(.009)	(.009)	(.009)	(.009)
regionalshare	.073**	.073**	.073**	.068**	.068**	.067**
	(.015)	(.015)	(.015)	(.015)	(.015)	(.015)
md1	-.036**	-.036**	-.035**	-.035**	-.035**	-.034**
	(.002)	(.002)	(.002)	(.002)	(.002)	(.002)
md2	-.026**	-.026**	-.026**	-.025**	-.026**	-.025**
	(.002)	(.002)	(.002)	(.002)	(.002)	(.002)
md3	-.039**	-.039**	-.039**	-.038**	-.039**	-.038**
	(.002)	(.002)	(.002)	(.002)	(.002)	(.002)
md4	.001	.001	.001	.001	.001	.001
	(.002)	(.002)	(.002)	(.002)	(.002)	(.002)
lnMETROPOP	-.211**	-.211**	-.212**	-.211**	-.211**	-.212**
	(.021)	(.021)	(.021)	(.021)	(.021)	(.021)
lnPCINC	.373**	.373**	.374**	.383**	.383**	.384**
	(.018)	(.018)	(.018)	(.018)	(.018)	(.018)
F-Stat	715.85	757.72	756.53	711.44	752.65	751.95
R-Squared	0.81	0.81	0.81	0.81	0.81	0.81
Number of Units	373,856	373,856	373,856	373,856	373,856	373,856

Standard errors in parentheses; * Significant to the .05 level; ** Significant to the .01 level.

CHAPTER VIII

EMPIRICAL RESULTS: FIRST-DIFFERENCES REGRESSIONS

Tables 13-17 show the first-difference regression results. Although the variables used in the first-difference regressions are intended to correspond closely to those used in the fixed-effects regressions, it should be noted that the fuel cost and non-fuel cost variables drop out of the first difference equations. This is because these time-specific variables do not vary across markets. As a result, the first-differencing process generates identical changes in fuel and nofuel costs across markets, which therefore do not affect the dependent variables.

The Effects of Mergers and Concentration

Mergers and concentration are expected to raise average fares and reduce dispersion. While the fixed effects results reported earlier suggest that high concentration and mergers are associated with lower dispersion, the first difference regressions indicate that mergers increase dispersion. Specifically, markets with high levels of merger activity are shown to exhibit greater increases in dispersion over the full period of 1986 through 1990 than markets with little merger activity. In addition, although the pooled first difference regression results are mixed, the straight and modified first difference regressions support the theory that mergers should result in higher prices. This is counter to the fixed effects results.

The Effects of Uncertainty

Using the number of changes in competition as a proxy for uncertainty in the first difference regressions produces results in line with the fixed effects model. Dispersion falls with uncertainty while average fares rise. In the modified first difference regressions, markets experiencing greater numbers of changes also witnessed larger changes to average fares. This is probably related to the effects of mergers on changes in average fares, which tended to be increasing with merger activity: the more mergers in a market, the greater the expected change in average fare.

In the straight first difference model, dispersion is found to clearly fall with increases in uncertainty, providing more evidence counter to the theory. Average fare is found to increase with uncertainty just like it was in the panel data models.

The uncertainty results for the pooled first difference model are mixed. Quarterly uncertainty appears to raise dispersion while lowering fares, while year-over-year uncertainty does the opposite.

The Effects of Costly Capacity

The interesting cost figure is the startingLOWCOSTshare variable, which is positively and significantly related to both dispersion and average fare. Markets in which low cost carriers have high market shares are somehow prone to greater positive changes in dispersion over the full time period of 1986-1990. This is perhaps counter to the theory that costs are positively related to dispersion and average fare: the higher the percentage of low cost carriers on a route, the lower the expected fares and dispersion. One of the two following interpretations of this result is possible: either low cost carriers that come to dominate markets are, over time, behaving more like monopolies (and thus raising average fares), or the remaining "high cost" carriers in markets dominated by low cost carriers increased the extent to which they served high-paying passengers over this time period. Either way, these somewhat surprising results lend further evidence to the negative relationship obtained between lowcost shares and both average fares and dispersion in the fixed effects and first difference models.

Table 13:

Straight First-Difference Regression: Linear Dispersion (Without Dummies)

	Cross Section Results: Full Period Change in Dispersion 1986-1990			
	1st Period (1st Qtrs) gini4yrCHG	2nd Period (2nd qtrs) gini4yrCHG	3rd period (3rd qtrs) gini4yrCHG	4th period (4th qtrs) gini4yrCHG
herf4yrchg	-.080**	-.074**	-.071**	-.066**
	(.003)	(.003)	(.003)	(.003)
changesincomp	-.003**	-.001	-.002**	-.003**
	(.001)	(.001)	(.001)	(.001)
percdir4yrCHG	.032**	.034**	.027**	.027**
	(.004)	(.004)	(.004)	(.004)
lowcostshare4yrCHG	-.031**	-.031**	-.048**	-.031**
	(.004)	(.004)	(.004)	(.005)
regshare4yrCHG	-.036**	-.018*	.003	.015
	(.010)	(.008)	(.008)	(.009)
mergers4yrTOTAL	.005**	.004**	.003**	.008**
	(.001)	(.001)	(.001)	(.001)
metropop4yrchg1000000sO	.040**	.029**	.020**	.026**
	(.006)	(.006)	(.005)	(.006)
REALpcinc4yrchg1000sO	.003**	-.001	-.002**	-.001*
	(.001)	(.000)	(.000)	(.001)
F(8, 23072)	108.62	97.15	103.25	75.82
R-squared	.036	.033	.035	.026
Number of obs	23081	23081	23081	23081

Standard errors in parentheses; * Significant to the .05 level; ** Significant to the .01 level.

Table 14:

Modified First Difference Regression: Linear Dispersion (Without Dummies)

	Cross Section Results: Full Period Change in Dispersion 1986-1990			
	1st Period (1st Qtrs) gini4yrCHG	2nd Period (2nd qtrs) gini4yrCHG	3rd period (3rd qtrs) gini4yrCHG	4th period (4th qtrs) gini4yrCHG
startingHERF	.041**	.025**	.031**	.016**
	(.003)	(.003)	(.003)	(.003)
changesincomp(100s)	-.012	.156**	-.018	-.133*
	(.061)	(.058)	(.055)	(.055)
percdir4yrCHG	.024**	.023**	.016**	.017**
	(.004)	(.004)	(.004)	(.004)
startingLOWCOSTshare	.054**	.054**	.059**	.038**
	(.004)	(.003)	(.004)	(.004)
startingREGIONALshare	.017	-.012	-.033**	-.047**
	(.009)	(.008)	(.009)	(.010)
mergers4yrTOTAL(10s)	.048**	.017	.017	.060**
	(.011)	(.010)	(.010)	(.010)
metropop4yrchg1000000sO	.044**	.031**	.022**	.027**
	(.006)	(.006)	(.005)	(.006)
REALpcinc4yrchg10000sO	.033**	-.003	-.019**	-.007
	(.005)	(.005)	(.005)	(.005)
F(8, 23072)	61.91	47.13	59.05	25.33
R-squared	.021	.016	.020	.009
Number of obs	23081	23081	23081	23081

Standard errors in parentheses; * Significant to the .05 level; ** Significant to the .01 level.

Table 15:

Straight First-Difference Regression: Linear Average Fare (Without Dummies)

	Cross Section Results: Full Period Change in Average Fare 1986-1990			
	1st Period (1st Qtrs) avgfpm4yrCHG	2nd Period (2nd qtrs) avgfpm4yrCHG	3rd period (3rd qtrs) avgfpm4yrCHG	4th period (4th qtrs) avgfpm4yrCHG
herf4yrchg	2.937**	2.505**	1.856**	2.392**
	(.243)	(.225)	(.210)	(.219)
changesincomp	.231**	.184**	.128**	.180**
	(.048)	(.043)	(.040)	(.039)
percdir4yrCHG	4.317**	4.782**	4.456**	5.415**
	(.325)	(.308)	(.279)	(.294)
lowcostshare4yrCHG	-5.206**	-4.825**	-1.564**	-2.501**
	(.326)	(.305)	(.307)	(.388)
regshare4yrCHG	5.133**	3.539**	-.164	4.039**
	(.783)	(.661)	(.628)	(.697)
mergers4yrTOTAL	.373**	.668**	.502**	.221**
	(.082)	(.074)	(.069)	(.069)
metropop4yrchg1000000sO	-.680	-.647	-2.468**	-.498
	(.486)	(.438)	(.412)	(.416)
REALpcinc4yrchg1000sO	-.053	-.036	.063	.077*
	(.041)	(.038)	(.037)	(.039)
F(8, 23072)	93.86	109.67	68.97	80.2
R-squared	.032	.037	.023	.027
Number of obs	23081	23081	23081	23081

Standard errors in parentheses; * Significant to the .05 level; ** Significant to the .01 level.

Table 16:

Modified First Difference Regression: Linear Average Fare (Without Dummies)

	Cross Section Results: Full Period Change in Average Fare 1986-1990			
	1st Period (1st Qtrs) avgfpm4yrCHG	2nd Period (2nd qtrs) avgfpm4yrCHG	3rd period (3rd qtrs) avgfpm4yrCHG	4th period (4th qtrs) avgfpm4yrCHG
startingHERF	-.321	-.441	.482*	-.661**
	(.252)	(.230)	(.211)	(.210)
changesincomp	.132**	.076	.112**	.099*
	(.050)	(.045)	(.042)	(.041)
percdir4yrCHG	4.596**	5.060**	4.757**	5.740**
	(.326)	(.308)	(.277)	(.292)
startingLOWCOSTshare	2.574**	3.022**	-.344	.596
	(.298)	(.271)	(.267)	(.325)
startingREGIONALshare	-2.045*	-.314	2.912**	-.488
	(.756)	(.659)	(.642)	(.715)
mergers4yrTOTAL	.516**	.790**	.692**	.270**
	(.087)	(.078)	(.073)	(.072)
metropop4yrchg1000000sO	-1.269**	-1.171**	-2.586**	-.768
	(.491)	(.441)	(.414)	(.419)
REALpcinc4yrchg1000sO	-.029	-.008	.058	.089*
	(.042)	(.039)	(.037)	(.039)
F(8, 23072)	46.45	74.24	57.61	58.66
R-squared	.016	.025	.020	.020
Number of obs	23081	23081	23081	23081

Standard errors in parentheses; * Significant to the .05 level; ** Significant to the .01 level.

Table 17:

Pooled First Difference Regressions: Linear Gini and Average Fare

	Pooled First Difference Results: Quarter-to-quarter Changes, 1986-1990			
	Dispersion		Average Fare	
	gini	lnGINI	avgfpm	lnAVGFPM
herfCHG/lnHERF	-.062**	-.144**	.233**	-.006**
	(.001)	(.004)	(.069)	(.002)
qtrchanges	.001**	.005**	-.072**	-.004**
	(.000)	(.002)	(.021)	(.001)
yrchanges	-.001**	-.003	.122**	.008**
	(.000)	(.002)	(.021)	(.001)
percdir	.030**	.153**	7.570**	.376**
	(.002)	(.009)	(.106)	(.005)
lowcostshare	-.034**	-.148**	.131	.006
	(.003)	(.017)	(.196)	(.009)
regionalshare	.005	.015	2.614**	.062**
	(.004)	(.024)	(.277)	(.013)
md1	.009**	.037**	-.679**	-.027**
	(.001)	(.006)	(.074)	(.003)
md4	-.007**	-.027**	.673**	.038**
	(.001)	(.005)	(.061)	(.003)
metropop1000000o/lnmetpopO	.067**	.315**	-2.552**	-.077
	(.009)	(.103)	(.587)	(.057)
REALpcinc1000o/lnREALpcincO	-.001*	-.284**	.272**	.438**
	(.000)	(.074)	(.026)	(.042)
winter	.001	.008	.974**	.030**
	(.001)	(.005)	(.052)	(.003)
spring	.012**	.057**	-.637**	-.029**
	(.000)	(.002)	(.027)	(.001)
summer	.007**	.032**	.174**	.004**
	(.000)	(.002)	(.027)	(.001)
F(13,373557)	438.31	227.32	893.63	812.23
R-squared	0.02	0.008	0.03	0.0275
Number of obs	373571	365362	373571	373571

Standard errors in parentheses.
*Significant to the .05 level.
** Significant to the .01 level.

CHAPTER IX

CLOSING REMARKS ON EMPIRICAL ANALYSIS

Three main conclusions can be reached from this analysis. First, the theory clearly predicts that dispersion should increase with competition, costs, and uncertainty. Yet, in all of the fixed-effects and first difference regressions of Gini dispersion, the certainty variables show positive coefficients, suggesting that dispersion increases with certainty, not uncertainty. These results call into question the appropriateness of applying this one key aspect of Dana's theory to the airline industry, although it is important to note that the type of "uncertainty" described by Dana is slightly different from the kind used here.

Second, markets that are directly affected by mergers are shown to have decreasing average fares in the four quarters following the merger, but higher average fares over the four year time period studied. This seemingly contradictory result indicates that the long run impact of consolidation is more likely to be higher fares than the initial post-merger period suggests. The short-term findings are also an important detraction from several empirical studies performed to date that show evidence of market power with mergers. I believe the difference in the outcomes results from the previous studies having used less extensive data, omitted appropriate variables, and studied shorter post-merger time periods. The two most appropriate types of variables left out of previous studies are certainty and percentage of direct traffic variables.

Third, the surprising result that monopolies are associated with lower average fares is obtained. This provides evidence that mergers produce enough efficiency gains through economies of scale to outweigh abuse of pricing power, at least in the short run.

Fourth, while the restrictions on the model seem somewhat unrealistic, the overall predictions of the model appear to be consistent with the empirical evidence from industry records. With the exception of uncertainty, the results that dispersion rises with competition and costs are fairly well aligned with the data.

In sum, an extensive analysis of the effects airline mergers have on the pricing practices in the airline industry constitutes an valuable step forward in understanding the nature and consequences of consolidation in all industries characterized by demand uncertainty and costly capacity or, at the very least, widespread dispersion. The implications from this analysis may lead to a more equitable pricing environment, either through increased regulation by the DOJ, increased "self regulation" by the firms themselves electing not to abuse their power, or the acknowledgement by antitrust authorities that market concentration may actually benefit consumers in the case of the airline industry.

CHAPTER X

RE-EXAMINING THE ROLE OF PRICE DISCRIMINATION

While the rigid assumptions of Dana's model attempt to motivate the spirit behind airline pricing and, importantly, empirical results appear to justify the theoretical setup by corresponding to its predictions, the extremely complex model seems paradoxically oversimplified and unrealistic for the airline industry in a few crucial ways. Specifically, the following six results/assumptions require critical examination: 1) dispersion is increasing with uncertainty, 2) uncertainty and prices are "rigid," 3) demand shows up in random order, 4) dispersion is increasing with costs, 5) dispersion is increasing with competition, and 6) residual demand is the primary mechanism through which the aforementioned results are obtained. Each will be addressed in the following discussion.

Does Dispersion Increase With Uncertainty?

The first problem lies in the belief that demand uncertainty increases dispersion. Oddly, although several empirical studies have followed the two prevailing theories on price dispersion in the airline industry,[56] this is the first to openly question and empirically test the role of uncertainty. But does uncertainty truly lead to greater dispersion? While it may sound plausible given the cleanliness of Dana's model, there appears to be a disconnect between the theoretical model and previous empirical studies as most empiricists jump directly from the knowledge that price dispersion occurs in the airline industry to testing the extent of its influence. In estimating the impact of uncertainty directly, the results obtained in this paper call into question the validity of this crucial theoretical result.

Further, it needs to be acknowledged that the peak-load-pricing literature alone proves that Dana's impressive modeling provides *sufficient but not necessary* conditions for price dispersion to arise, bringing up the obvious point that, even in situations of demand *certainty*, predictable, widespread, welfare-enhancing dispersion will occur. Evidence abounds to this effect: pizzerias, movie theaters, cell phone service, and even airlines are a few examples. In each situation, the producer's desire to siphon price elastic consumers away from peak periods in which demand cannot be fully satisfied to off-peak periods in which capacity is underutilized is driven by the goal of increasing profits. Among the many effects of this process is greater price dispersion. Few would argue, however, that consumers are worse off as a result. If Dana is correct, what he has introduced is ultimately an extension of our knowledge of price dispersion theory: any dispersion occurring for whatever reason *may* be exacerbated by uncertainty facing suppliers of costly, perishable goods.[57]

Thus, societally beneficial dispersion occurs regardless of the level of uncertainty, and may in fact fall as uncertainty increases.[58]

Are Uncertainty and Prices "Rigid?"

It is assumed in the Dana model that uncertainty and prices are rigid. Yet both of these assumptions seem to grossly disregard the actual pricing practices of airlines in reality. For

[56] Dana's theory of demand uncertainty and costly capacity is one of the two theories explaining airline price dispersion; the widely accepted Gale/Holmes theory of peak-load-pricing is the other.
[57] Or it may be limited by uncertainty, as the empirical results of this paper suggest, depending on the industry.
[58] Again, see the results of the above empirical study.

airline inventory managers, price is not “rigid” in any meaningful way. Sales in any particular market are announced and ordinary prices are adjusted almost daily, sometimes even more frequently, in response to changing states of demand (real or perceived). On this basis alone, the model’s assumption of price rigidity for airlines seems very unrealistic.

Such pricing flexibility goes a long way towards mitigating the potentially adverse effects of demand uncertainty. As a result, demand is rarely so uncertain that analysts lack a decent grasp of how to price their products. This is due largely to the somewhat unique nature of how the product is sold: highly substitutable seats are allocated to different pricing classes 325 days or so in advance of delivery, and sold on a first-come first-serve basis.[59] It is also due to the somewhat unique nature of airline demand: the first people to buy tickets are the most price elastic (vacationers, retirees, etc) whereas the last people to buy tickets are the least price elastic (business travelers, bereavement passengers, etc). Finally, the product changes very little year over year: a seat on a plane to get home for Thanksgiving is essentially the same thing year in, year out. This enhances the ability to use historical data for an otherwise unchanged product to predict current and even future demand.[60]

Since prices are highly malleable, the long window of sales allows managers to constantly adjust both prices and seat allocations as the true demand states unfold. For example, if a manager allocates 15 seats for sale in the lowest fare class and those seats sell out faster than expected, he or she might adjust the prices, seat allocations, or both on the remaining capacity in order to reflect the updated, *more certain*, demand. As long as the analyst in charge of the market in question responds diligently to demand that deviates from

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[59] Concert tickets are similarly sold, although the location of your seat at a concert is a very subjective product. Airline seats are largely substitutable.

[60] Such product stability is not inherent in most industries. Fashion, for example, is always changing, and is not clearly delineated by date as the airline industry.

expectations, any downside risk – in terms of lost pricing power – to initially incorrect projections is small and easily correctible.[61] This is the case regardless of how uncertain demand was at the initial opening of sales.[62] Hence, it seems fair to question the appropriateness of using such rigid assumptions as price rigidity and demand uncertainty when modeling airline pricing.

Does Demand "Show Up" in Random Order?

Another crucial assumption of the model is that customers show up in random order. This, too, does not quite seem to fit the airline industry. It is easily argued, if not widely acknowledged, that highly elastic leisure travelers seeking the lowest possible prices for their trips show up very early on in the booking cycle, relatively less flexible "wedding-type" travelers with more of a "need" for a particular flight show up next,[63] and extremely inflexible business travelers show up last.

While individual customers are difficult or impossible to identify *ex ante*, there are clearly group-based consumer attributes that provide a strong indication of demand at various junctures during the course of ticket sales. Indeed, one of the most commonly imposed segmentation methods employed by airlines is a time-dependent mechanism that restricts seat/fare availability based on the number of days prior to departure: flights purchased within seven days of departure are the most expensive, flights purchased between seven and twenty-one days of departure are less expensive, and flights purchased more than twenty-one days

[61] The process has 325 days or so to unfold, due to the advance-planning nature of the industry.
[62] In other words, whether or not the competition has been seen before, "demand shocks" do occur and are accounted for.
[63] Wedding travelers, reunion attendees, fickle vacationers, etc, often don't have the benefit of knowing the dates of travel until the events approach. As such, they have less time, less flexibility, and fewer travel options – not to mention inflexible destinations – all of which increase willingness to pay for seats.

prior to departure are the least expensive. Airlines presumably set their ticket distinctions at these intervals because they reflect consumers' general tendencies relatively well. At the same time, consumers, in aggregate, know that time prior to departure matters when buying their tickets. This knowledge not only allows, but inspires, highly elastic consumers to seek tickets as far in advance of departure as possible.

Business travelers, on the other hand, are essentially powerless in their desires to buy cheaper seats long before departure since they don't know where they'll need to be until a few days prior to the trip. This is the case despite their understanding of airline pricing policies. As a result, the issue of residual demand that ostensibly arises because some high demand customers are able to purchase their tickets at low prices – simply because they randomly show up when cheap seats still exist – is largely defused before it has a chance to materialize. Such is the nature of demand segmentation in the airline industry.

Is Dispersion Increasing With Costs?

The empirical results of this paper and others like it suggest that the dispersion indeed increases with costs. Yet the idea of "costly capacity" should not be misinterpreted as a unique characteristic of airline-type industries. As with demand uncertainty, costly capacity as a strict requirement for, let alone determinant of, price dispersion is also a constraint faced in *every industry*. Retailers of all stripes have limited shelf space that is difficult to increase in the short run. Professional contractors (plumbers, tree surgeons, electricians, etc) have little ability to increase their output beyond their own capacity constraints (hours per day, number of stump grinders, skilled laborers employed). And manufacturers face a classic increasing marginal cost of production beyond full capacity: worker overtime pay. In each case, capacity costs are arguably high, or at least existent, and increase rapidly under short-term conditions of surging demand. Any cost-based results for the airline industry might thus be generalized to hold for all industries.

Is Dispersion Increasing With Competition?

Dana suggests that dispersion is increasing with competition. The regression results offer mixed evidence: mergers are shown to raise dispersion while increases in concentration are shown to lower it. Fare levels fall with mergers and monopolies but rise with concentration.

Note that this does not help clear up any confusion concerning the blurry line between "normal" price dispersion and monopolistic price discrimination. Microeconomic theory has long suggested that airlines perform various types of intentional price discrimination, at least one of which can be viewed as both dispersion and discrimination.[64] A brief look at standard academic textbooks[65] reveals alternating, sometimes vague applications of price discrimination theory to the airline industry: first degree, second degree,[66] peak load pricing, and other classifications.[67] Yet many introductory texts seem hesitant to pinpoint the exact type of dispersion employed, and for good reason: the pricing of airline tickets seems too complex to warrant a definitive, one-size-fits-all classification.

Nonetheless, a more thorough discussion of the role of competition on dispersion is presented below.

[64] Peak Load Pricing is clearly a deliberate attempt to extract consumer surplus while simultaneously aiding consumers as a whole through expanded service that otherwise would not be cost-effective.
[65] Introductory Texts provide a generalized explanation; Industrial Organization texts are more explicit.
[66] Waldmen and Jensen (2001) characterize the airline industry as 2nd degree price discrimination.

How Important Is Residual Demand?

While it has been established that dispersion occurs in several aforementioned industrial situations, dispersion certainly appears to be large in the airline industry,[68] both in terms of spread about the mean and the number of actual prices paid for an otherwise identical product.[69] This must be explained by at least one aspect of the airline industry that distinguishes it from others. The Dana model argues that the relevant distinction is residual demand: coupling an expensive, time-expiring seat with uncertainty as to the revelation of the true demand state ostensibly leads airlines to vary prices in an effort to maximize their expected profit under the opposing likelihoods that each state occurs. As already acknowledged, this model creates the result that dispersion increases with competition.

Yet residual demand as a concept seems limited to special cases of oligopoly in which an entrant commandeers a portion of the incumbent's demand. The remaining demand facing the incumbent(s) after entry occurs is considered residual, and the main implication is that pricing power falls. Note that dispersion would likely fall as competition increases, since each residual demand curve resulting from entry becomes flatter with each subsequent entrant. Further, it seems odd to portray demand curves as "shrinking" when one group or another purchases a product, regardless of their reservation price. For example, if I were to buy a limited edition DVD, the demand curve doesn't really shift left by one unit with my purchase, given the tiny proportion of demand that I represent.

Finally, while it might be appropriate to use residual demand in the event that consumers show up in the manner described by Dana, the airline industry does not seem to exhibit this

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[67] Pindyck and Rubinfeld (2001) hint at 1st degree tactics, but decline to categorize it for airline pricing.
[68] Anecdotal as though the evidence may be, such thoughts presumably inspire studies of this industry.
[69] It is assumed for the present discussion that a seat purchased a month in advance is identical to one purchased an hour in advance.

characteristic. This industry does, however, exhibit a mechanically similar tendency on the *supply* side. Thus, a model with a more realistic necessary assumption might be one that focuses on residual *supply* instead of residual *demand*.

Reconsidering the Role of Price Discrimination

"Residual supply" is a concept that I define analogously to residual demand, and is based on the following intuition. One very important characteristic that sets the airline industry apart from most others is the nature of the product's planned expiration (so to speak): output and capacity are announced well in advance of delivery, at which point the selling commences. This structural fact, coupled with the tendency of more price-elastic consumers to purchase items first, enables the airline to employ a sort of "reverse inter-temporal price discrimination." Inter-temporal price discrimination allows firms, particularly in rapidly changing industries like fashion and technology, to charge high initial prices to eager, inelastic consumers before lowering prices for more elastic consumers who, by definition, arrive later.[70] Airlines, in contrast, must employ radically different pricing tactics that enable them to extract as high a profit margin as possible on the *tail end* of production. While the mechanics are similar, the resulting dispersion seems to be much greater and appears to conform to both first-degree and "reverse" inter-temporal price discrimination policies.[71] Thus, while residual demand might be a sufficient condition for determining some amount of dispersion under such a scenario, it is not necessary and may, in fact, be incorrectly applied.

[70] See Stokey (1979) for more on inter-temporal price discrimination theory or Xie and Shugan (2001) for an example of such pricing in retailing.
[71] Not to mention peak-load pricing

Residual supply, on the other hand, is a characteristic of the airline industry[72] that may more thoroughly explain the price dispersion found therein. From the moment seats are allocated to a flight,[73] the number available for sale declines by one with each seat subsequently sold.[74] In addition, due to characteristics like gate capacity constraints, limited aircraft interchangeability, and FAA regulations, overall short-term capacity is unlikely to shift in response to greater-than-expected demand once the flights in a market are set.[75] Accordingly, supply can be viewed as continually shrinking, or shifting left, with each subsequent sale. Thus, I define the remaining capacity available for sale as the residual supply. When this occurs against the backdrop of a fairly stable, fairly *certain* demand curve,[76] one can quickly observe increasing prices for each subsequent ticket sold as the seats available for sale – the last of which are available just prior to takeoff – continually match with the remaining consumers according to each consumer's willingness to pay.

Since the demand curve is "normal" in the sense that it is downward sloping (i.e., more elastic as price falls and quantity increases), the structural nature of residual supply provides the airlines with a wonderful mechanism through which to extract continually more surplus from every subsequent consumer as the time prior to delivery approaches zero. It might be argued that this environment provides the purest, most powerful example of first degree price discrimination found in traditional markets in our economy.[77] It also might be argued that a

[72] "Residual Supply" is much less common than residual demand. Airline, Hotel, Rental Cars have it.
[73] "Seat allocation" means the number of seats allocated to be sold at each fare/restriction level.
[74] A one seat reduction in supply is significant when a typical flight has 120 or so seats available.
[75] This is the basis for a rapidly increasing marginal cost curve once the capacity constraint is reached.
[76] Unlike other studies of dispersion that consider the costs of information seeking (see Dahlby and West, 1986), it is assumed here that pricing information is readily, cheaply, and easily obtained by airline consumers.
[77] Auction markets like Ebay enable sellers to extract surplus as well, but on a case-by-case basis that often leaves potential demand unsatisfied.

continually shrinking supply in the face of any normal demand curve would lead to the same result, regardless of the varying nature of demand.[78]

This sort of thinking has significant implications on the interpretation of price dispersion in the airline industry. Peak-load-pricing has long been considered to be a key pricing tactic that enabled airlines to expand output at lower costs than otherwise, servicing a much broader portion of demand at lower prices while extracting greater amounts of surplus from inelastic consumers. Yet it may be argued that peak-load-pricing is just another mechanism through which first degree price discrimination is achieved. Nonetheless, the concept and practice of peak load pricing seem much more palatable to those concerned with the welfare of airline consumers.

James Dana further complicated the issue by suggesting price dispersion results from forces entirely out of the control of the firms who wield it: demand uncertainty. The conclusion is that dispersion in fact is more pronounced as the level of competition increases. This is the key result that seems to justify the argument, as price dispersion resulting from monopolistic exploitation of inelastic demand has long been the driving force behind dispersion. The opposite result is somewhat startling.

There is, however, a problem with this theory. It obscures price discrimination as the primary cause of dispersion in the airline industry. Coupled with the previously determined idea that uncertainty is actually much less of an issue for airlines than elsewhere, we will now revisit the instinctive causes of discrimination-based price dispersion.

It may be argued that the bulk of airline price dispersion comes from highly sophisticated, deliberate pricing tactics employed by the airlines. Competition confuses the process to a

[78] Airline demand seems to increase as departure approaches; even if the demand curve were steady, continually shrinking supply would produce dispersed pricing, albeit not so dramatically.

certain extent, and may result in greater dispersion.[79] A simple example of how this might occur comes from the following definitional difference between monopoly and competition: monopolies restrict output, competitive firms do not. In order to satisfy the ambitions of expanded capacity, the firms involved will undoubtedly need to lower prices at the tail end of the demand curve. Since a basic tenet of classical economic theory is that, *ceteris paribus*, monopolies neither expand output as aggressively as nor lower prices as far as firms in competition do, the resulting disparity of fares will be greater under competition.[80] In addition, while each airline has a fairly good idea of the demand it faces through years of data accumulation, surveys, census information, etc, the monopolist has greater control over the pricing decisions. The main uncertainty introduced by competition, in this case, is the possibility of a fare war that does not otherwise occur.

Uncertainty is further reduced by the restricted output enjoyed by monopolies because monopolists are more likely to sell their entire inventory. This reduces the likelihood of last-minute offerings of bargain or stand-by fares, which are common in all airline markets. In either case, uncertainty and dispersion would increase with competition. Xie and Shugan (2001) use capacity constraints to further support the idea that concentration lowers dispersion by arguing that constrained capacity raises the value of advance purchase sales, allowing the seller to charge a premium on such sales. If monopolies constrain capacity more than competitive firms, their argument is consistent with the observation that concentration leads to lower dispersion.

Another way competition might positively influence dispersion is the creative destruction nature of intense airline competition. Since deregulation, there has been a very noticeable

[79] Competitive impacts on price dispersion are a component of price dispersion, and may not be conclusive.
[80] The upper range of fares should be similar for monopolistic and competitive firms with similar costs.

difference between the established carriers and the startups.[81] While accurate cost information is difficult to estimate and nearly impossible to acquire, startups are typically viewed as having vastly lower cost structures due to a variety of characteristics that distinguish them from the majors.[82] This would suggest that, *ceteris paribus*, every time a startup enters a market to compete with a major, they push the supply curve out further than the major would be willing to satisfy. Their lower marginal and average cost of production enables them to sell seats at lower prices than were previously available.

There is, however, a problem with this analysis: all firms in such a situation – majors and startups alike – continue to employ first degree price discrimination tactics as subsequent sales shift their individual and, consequently, collective supply curves to the left. This shouldn't ultimately impact the marginal value (i.e. sale price) of the last few units sold, since those consumers willing to pay high prices for such walkup seats are willing to do so precisely because they don't know they want them until they walk up to the counter (and find them in scarce supply). Thus, as low-cost competition increases, low-priced capacity expands, the quantity of airline tickets sold at lower prices increases, and, although the highest fares don't necessarily change, the average price of all tickets sold will fall.

Both of these results – that low cost entry increases dispersion while decreasing average fares – are verified in the empirical analysis conducted earlier in this study. However, the extent of the low cost carrier presence in a market also matters in determining dispersion. The empirical analysis shows that overall market dispersion falls with increasing concentration of flights provided by low cost carriers.

[81] "Established" refers to the major airlines in existence during regulation, like United and American. "Startups" refers to those airlines that emerged after deregulation (like Jet Blue) or shortly prior to (Southwest). In the latter case, Southwest played a role in forcing deregulation.

This all points towards the following conclusion: cost, in addition to level of competition, is a primary determinant of dispersion when residual supply influences pricing decisions. Moreover, the effects appear to influence each other: competition will increase dispersion more if the cost differential between carriers is great than if costs are similar across carriers in a market. As a result, it is possible to have two seemingly contradictory positive influences on dispersion: greater competition from a low cost carrier can increase dispersion while lower competition resulting from efficiency-enhancing mergers can also increase dispersion. While imperfect, support for this premise is provided by the empirical results reported above.

The best way to motivate this theory is to compare the pricing outcomes between markets with different levels of competition facing identical demand curves. As per the above discussions, it is assumed that the demand curve is known by all sellers in a market. For expositional purposes, it is also assumed that the demand curve is linear. Further, the analysis will pertain to a single days' worth of airline flights in a single market: a flight scheduled for departure at some time t in the future[83] is a different product than a flight scheduled for time t + 1. Different times on the same day are assumed to be equivalent. I begin with the presence of "competition," which is defined as two or more firms simultaneously operating in a market.

Generally speaking, when there are two or more price-taking competitors in a market, the market supply curve is comprised of the horizontal summation of the individual firms' marginal cost curves. If the representative firm's average cost is less than price, output expansion will occur as new firms enter the market. This results in a rightward shift of

[82] Low levels of unionization, streamlined fleets, quicker turnaround, etc – all of which serve to lower the marginal cost of producing an airline seat.

market supply and a corresponding decrease in market clearing prices. Entry stops once the market clearing price equals the average cost for the representative firm.

Assuming our market is full and entry no longer occurs, pricing and sales commence. The initial price offered for sale is the lowest possible price in this market. Once a seat is sold at this price, the individual and market supply curves shift slightly leftward, resulting in a new, residual supply curve. The interaction of this residual supply with market demand leads to a new, higher equilibrium price for the next seat sold. This process continues indefinitely until all seats are sold.

If this market were instead being served by a monopolist with a marginal cost structure identical to the market summation of the competitive cost curves, the mechanics would be very similar, except that the monopolist's marginal cost curve would interact directly with the market demand. Unlike the single-price charging monopolist who charges prices higher than marginal cost, first-degree price discriminating monopolists charge prices equal to marginal cost. Thus, the initial market clearing price will be the same under monopoly as under competition. Once that seat sells, the interaction of the new residual supply curve with the market demand curve will lead to a higher price for the next seat. This process is repeated until the last seat is sold.

Under conditions of identical costs, the dispersion of fares will approximate first-degree price discrimination in each situation, and should be roughly equal (with more fare levels being offered by the competitive market simply as a function of slightly differentiated inter-firm prices at every stage of market clearing). In reality, this cost condition seems unrealistic. *Ceteris paribus*, a single carrier serving a market with capacity x will have lower marginal costs than the combined costs of four carriers, each of which serves the market with

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[83] "t" is measured in days.

capacity x/4. For example, a monopolist can lower gate, fuel, pilot, and other costs by using one, two, or even three planes instead of four. They may also enjoy lower advertising costs as well as lower average fixed costs associated with overhead. In short, it seems reasonable to conclude that monopolistic markets will be served, in the long run, by carriers with lower cost structures than competitive markets. This will have a significant impact on dispersion as the monopolist will expand output to reflect the lower cost structure. Amidst a stationary demand curve, the net result is a decrease in the lowest price they are willing to charge to the first consumer who buys that first seat. Once the selling begins, the same process as before produces a gradually decreasing residual supply curve resulting in higher and higher prices for each seat subsequently sold. Therefore, a monopolistic airline market with lower costs will have lower initial fares, lower average fares, and greater dispersion than a competitive airline market facing identical demand conditions.

This analytical conclusion, while not explicitly modeled, seems to fit nicely with the empirical results obtained in this paper. While I found that dispersion is negatively associated with concentration, I found that it tends to increase with mergers, suggesting that efficiency gains are significant in merger situations. This corresponds to the results that average fares fall with mergers, suggesting that efficiency gains lower the threshold of discount fares without reducing the pricing power on the tail end of sales. Finally, the surprisingly negative coefficient on the monopoly dummy variable furthers the point.

All of this supports the premise that higher costs associated with numerous carriers serving a market decreases competition’s ability to lower initial fares below those offered by the low cost monopolist, potentially driving prices up and dispersion down with competition.

A formal model of this outcome will be developed as the primary directive of a future research project.

Appendix A:

Regression Results for Alternative Specifications

The following eight tables contain regression results to be compared with the results presented in the paper. They do not include coefficients on the quarter dummy variables, although quarter dummies were used when regressions are identified as being "with Quarter Dummies." Standard errors are included in parenthesis, * denotes significant to the .05 level, and ** denotes significant to the .01 level.

Fixed Effects Regressions:

The fixed-effects regressions that follow are different from those in the paper in the following ways:

1) They are run with quarterly dummy variables to account for time trends.
2) They include quadratic market demand regressors for population and income.
3) Comparison Tables 1A – 4A exclude standard errors in order to fit on the page.

First-Difference Regressions:

The first-difference regressions that follow are different from those in the paper in the following ways:

1) The independent variables used are intended to correspond as closely as possible to those used in the fixed-effects regressions.
2) They include quadratic market demand regressors for population and income.

Appendix Table	Corresponds to Table	Found on
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Comparison Table 1-A

Gini Fixed Effects Results						
	Linear		Quadratic		Quadratic with Quarter Dummies	
herf	-.056**		-.056**		-.056**	
monopoly		-.031**		-.031**		-.031**
knownqtq(100s)	.075*	.181**	.070**	.175**	.050*	.154**
knownyoy(100s)	-.031	.046	-.036	.042	-.021	.060*
regional	.006**	.007**	.005**	.006**	.006**	.007**
alaska	.001	.000	.001	.000	-.005	-.007
premium	-.006	-.008	-.006	-.008*	-.009*	-.011**
percdir	.028**	.019**	.028**	.019**	.027**	.019**
REALfuelcost	.021**	.021**	.020**	.020**		
REALnonfuelcost	.007**	.007**	.007**	.007		
lowcost	.005**	.007**	.004**	.007**	.003**	.005**
lowcostshare	-.013**	-.014**	-.013**	-.014**	-.009**	-.010**
regionalshare	-.014**	-.012**	-.014**	-.011**	-.015**	-.013**
md1	-.004**	-.004**	-.003**	-.003	.002**	.002**
md2	.003**	.003**	.004**	.004**	-.002**	-.003**
md3	.003**	.003**	.004**	.004**	-.001*	-.001**
md4	-.006**	-.006**	-.006**	-.006**	-.003**	-.003**
metropop1,000,000sO	.017**	.016**	.002	-.001	.005	.003
metropop1,000,000sD			.019**	.017**	.022**	.021**
metropopOsq			.003**	.003**	.002**	.003**
metropopDsq			.002**	.003**	.002**	.003**
metropop1,000,000sOxD			-.002**	-.002**	-.003**	-.003**
REALpcinc100,000sO	-.220**	-.217**	-.432**	-.411	-.130	-.096
REALpcinc100,000sD			-.383**	-.375	-.082	-.061
REALpcincOsq			.005**	.005*	.004**	.003*
REALpcincDsq			.006**	.005**	.004**	.004**
REALpcinc100,000sOxD			-.003	-.002	-.002	-.002
F-Stat	560.19	568.65	403.76	410.03	458.93	460.96
R-Squared	0.519	0.521	0.52	0.521	0.53	0.53
Number of Units	373856	373856	373856	373856	373856	373856

Comparison Table 2-A

Linear in the Logs Gini Fixed Effects Results						
	Linear		Quadratic		Quadratic with Quarter Dummies	
lnHERF	-.136**		-.136**		-.134**	
monopoly		-.144**		-.144**		-.143**
knownqtq	.001	.007**	.001	.006**	.000	.005**
knownyoy	-.003	.002	-.003*	.002	-.002	.003
regional	.033**	.037**	.032**	.035**	.036**	.039**
alaska	.018	.005	.021	.007	-.005	-.020**
premium	-0.043	-.050*	-.041	-.049*	-.056**	-.063**
percdir	.136**	.092**	.136**	.092**	.132**	.088**
lnFUELCOST	.191**	.194**	.185**	.189**		
lnNONFUELCOST	.381**	.369**	.390**	.379**		
lowcost	.029**	.041**	.028**	.040**	.021**	.032**
lowcostshare	-.045**	-.049**	-.046**	-.049**	-.029	-.031*
regionalshare	-.088**	-.076**	-.085**	-.073**	-.091**	-.079**
md1	-.008**	-.007**	-.006*	-.004	.018**	.019**
md2	.023**	.022**	.024**	.023**	-.002	-.004
md3	.020**	.021**	.021**	.022**	-.002	-.001
md4	-.022**	-.021**	-.021**	-.020**	-.006*	-.005
lnmetpopO	-.103**	-.117**	-.037	-.050	-.078*	-.084*
lnmetpopD			.048	.036	.008	.002
lnmetpopOsq			.077**	.076**	.086**	.086**
lnmetpopDsq			.109**	.109**	.117**	.118**
lnmetpopOxD			-.079**	-.072**	-.085**	-.079**
lnREALpcincO	-.405**	-.392**	-.196	-.135	-.757	-.667
lnREALpcincD			-.999*	-1.011*	-1.562**	-1.544**
lnREALpcincOsq			-.142	-.181*	-.039	-.071
lnREALpcincDsq			-.013	-.040	.091	.070
lnREALpcincOxD			.257	.319*	.317*	.359**
F-Stat	324.09	343.1	244.95	250.12	276.09	277.98
R-Squared	0.46	0.46	0.457	0.4591	0.4634	0.4655
Number of Units	369413	369413	369413	369413	369413	369413

Comparison Table 3-A

Average Fare Fixed Effects Results						
	Linear		Quadratic		Quadratic with Quarter Dummies	
herf	1.119**		1.095**		1.039**	
monopoly		-.046		-.062		-.081*
knownqtq	-.066**	-.077**	-.061**	-.071**	-.070**	-.079**
knownyoy	.020	.041	.028	.049**	.020	.042*
regional	-.150	-.222**	-.111	-.182*	-.206**	-.276**
alaska	-1.746**	-1.828**	-1.812**	-1.895**	-1.651**	-1.736**
premium	-1.045	-.940	-1.229	-1.139	-1.065	-.978
percdir	6.069**	6.216**	6.061**	6.203**	6.101**	6.235**
REALfuelcost	-.275**	-.315**	-.168**	-.206**		
REALnonfuelcost	.841**	.831**	.773**	.762**		
lowcost	-.473**	-.558**	-.445**	-.531**	-.379**	-.461**
lowcostshare	-1.228**	-1.199**	-1.152**	-1.123**	-1.375**	-1.346**
regionalshare	2.968**	2.851**	2.899**	2.784**	2.962**	2.851**
md1	-.692**	-.674**	-.806**	-.788**	-.895**	-.881**
md2	-.416**	-.404**	-.482**	-.469**	-.260**	-.247**
md3	-.742**	-.733**	-.740**	-.730**	-.497**	-.483**
md4	-.097**	-.082	-.047	-.030	-.146**	-.130**
metropop1000000sO	-2.812**	-2.801**	-3.664**	-3.642**	-5.177**	-5.139**
metropop1000000sD			-2.365**	-2.375**	-3.879**	-3.873**
metropopOxO			-.002	-.009	.039	.031
metropopDxD			-.056	-.061*	-.014	-.020
metropopOxD1000000s			.301**	.325**	.398**	.420**
REALpcinc1000sO	.304**	.310**	.481**	.480**	-.147*	-.148*
REALpcinc1000sD			.426**	.424**	-.199**	-.201**
REALpcincOxO			-.008**	-.008**	-.003**	-.003**
REALpcincDxD			-.006**	-.006**	-.002	-.002
REALpcinc1000sOxD			.007**	.008**	.009**	.009**
F-Stat	695.13	680.58	511.9	502.16	452.03	445.2
R-Squared	0.78	0.78	0.778	0.778	0.78	0.78
Number of Units	373856	373856	373856	373856	373856	373856

Comparison Table 4-A

Linear in the Logs Average Fare Fixed Effects Results						
	Linear		Quadratic		Quadratic with Quarter Dummies	
lnHERF	.024**		.022**		.021**	
monopoly		-.016**		-.018**		-.018**
knownqtq	-.003**	-.003**	-.003**	-.003**	-.003**	-.003**
knownyoy	.001	.002**	.002	.003**	.001	.003**
regional	.010**	.006	.010**	.006	.005	.002
alaska	-.152**	-.156**	-.153**	-.158**	-.140**	-.145**
premium	-.041	-.036	-.053*	-.049*	-.041	-.036
percdir	.299**	.305**	.299**	.304**	.302**	.307**
lnFUELCOST	-.059**	-.063**	-.045**	-.049**		
lnNONFUELCOST	.419**	.413**	.409**	.402**		
lowcost	-.025**	-.030**	-.029**	-.033**	-.025**	-.029**
lowcostshare	-.058**	-.057**	-.054**	-.053**	-.067**	-.066**
regionalshare	.073**	.068**	.076**	.071**	.078**	.073**
md1	-.036**	-.035**	-.035**	-.034**	-.037**	-.036**
md2	-.026**	-.025**	-.022**	-.021**	-.008**	-.007**
md3	-.039**	-.038**	-.032**	-.032**	-.019**	-.018**
md4	.001	.001	.009**	.010**	.002	.003
lnmetpopO	-.211**	-.211**	-.195**	-.193**	-.327**	-.322**
lnmetpopD			-.101**	-.101**	-.234**	-.232**
lnmetpopOsq			.024**	.027**	.002	.005
lnmetpopDsq			.043**	.045**	.022**	.024**
lnmetpopOxD			.161**	.166**	.174**	.178**
lnREALpcincO	.373**	.383**	-1.259**	-1.299**	-1.545**	-1.573**
lnREALpcincD			-2.079**	-2.121**	-2.370**	-2.401**
lnREALpcincOsq			.124**	.126**	.044	.047
lnREALpcincDsq			.258**	.260**	.179**	.183**
lnREALpcincOxD			.198**	.208**	.309**	.312**
F-Stat	715.85	711.44	548.07	546.32	542.63	541.95
R-Squared	0.81	0.81	0.8112	0.8112	0.8153	0.8153
Number of Units	373856	373856	373856	373856	373856	373856

Comparison Table 5-A

Straight First-Difference Gini Comparisons: With and Without Dummy Changes								
	1st Period		2nd Period		3rd Period		4th Period	
	gini4yrCHG		gini4yrCHG		gini4yrCHG		gini4yrCHG	
herf4yrchg	-.078**	-.037**	-.073**	-.039**	-.070**	-.031**	-.065**	-.034**
	-(.003)	-(.004)	-(.003)	-(.004)	-(.003)	-(.004)	-(.003)	-(.004)
monopoly4yrCHG		-.031**		-.028**		-.033**		-.025**
		-(.002)		-(.002)		-(.002)		-(.002)
changesincomp	-.003**	-.004**	-.001**	-.002**	-.002**	-.003**	-.003**	-.003**
(10s)	-(.001)	-(.001)	-(.001)	-(.001)	-(.001)	-(.001)	-(.001)	-(.001)
regional4yrCHG		.003		-.098*		.036		.089**
(10s)		(.040)		(.036)		(.035)		(.036)
alaska4yrCHG		-.045		.025*		-.007		-.009
		(.025)		(.011)		(.011)		(.011)
premium4yrCHG		-.030		-.041		-.038		-.041*
		(.023)		(.022)		(.023)		(.021)
percdir4yrCHG	.034**	.028**	.035**	.029**	.029**	.021**	.028**	.023**
	(.004)	(.004)	(.004)	(.004)	(.004)	(.004)	(.004)	(.004)
lowcost4yrCHG	.032	.238	-.335	-.128	-.051	.010	.787**	.833**
	.217	.219	.193	.195	.184	.186	.208	.212
lowcostshare4yrCHG	-.032**	-.035**	-.027**	-.030**	-.048**	-.049**	-.045**	-.045**
	(.005)	(.005)	(.005)	(.005)	(.005)	(.005)	(.006)	(.006)
regshare4yrchg	-.033**	-.029**	-.017*	-.007	.001	-.005	.012	.000
	(.010)	(.011)	(.008)	(.010)	(.008)	(.010)	(.009)	(.011)
mergers4yrTOTAL	.003**	.003**	.002	.001	.001	.002	.007**	.007**
(10s)	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)
metropop4yrchgO	.024**	.025**	.017	.016	-.007	-.005	.021*	.020*
	(.010)	(.010)	(.009)	(.009)	(.009)	(.009)	(.009)	(.009)
metropop4yrchgD	.003	.004	.020*	.021*	.004	.005	.017	.017
	(.010)	(.010)	(.009)	(.009)	(.009)	(.009)	(.009)	(.009)
metropop4yrchgOxO	.002*	.002*	.001	.001	.003**	.003**	.000	.001
	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)
metropop4yrchgDxD	.004**	.004**	.002**	.002**	.003**	.003**	.000	.000
	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)
metropop4yrchgOxD	-.001	.000	.003	.003*	.001	.002	-.002	-.001
	(.001)	(.002)	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)
REALpcinc4yrchgO	-.005*	-.005*	-.010**	-.010**	-.007**	-.008**	-.012**	-.012**
	(.002)	(.002)	(.002)	(.002)	(.003)	(.003)	(.003)	(.003)
REALpcinc4yrchgD	-.007**	-.007**	-.014**	-.013**	-.012**	-.012**	-.009**	-.009**
	(.002)	(.002)	(.002)	(.002)	(.003)	(.003)	(.003)	(.003)
REALpcinc4yrchgOxO	.017**	.016**	.018**	.017**	.013**	.012**	.023**	.022**
(100s)	(.003)	(.003)	(.003)	(.003)	(.003)	(.003)	(.004)	(.004)
REALpcinc4yrchgDxD	.018**	.017**	.023**	.022**	.020**	.019**	.021**	.020**
(100s)	(.003)	(.003)	(.003)	(.003)	(.003)	(.003)	(.004)	(.004)
REALpcinc4yrchgOxD	-.012*	-.011*	-.009	-.008	-.015**	-.011*	-.015*	-.012
(100s)	(.006)	(.006)	(.005)	(.005)	(.006)	(.006)	(.006)	(.006)
F(16, 23064)	64.4	64.43	61	61.77	62.63	66.98	43.38	41.18
R-squared	0.043	0.06	0.041	0.058	0.042	0.063	0.029	0.04
Number of obs	23081	23081	23081	23081	23081	23081	23081	23081

Comparison Table 6-A

Straight First-Difference Avgfpm Comparisons: With and Without Dummy Changes								
	1st Period		2nd Period		3rd period		4th period	
	Avgfpm4yrCHG		Avgfpm4yrCHG		Avgfpm4yrCHG		Avgfpm4yrCHG	
herf4yrchg	2.701**	3.016**	2.376**	2.154**	1.826**	1.627**	2.346**	3.374**
	(.248)	(.328)	(.229)	(.294)	(.213)	(.272)	(.221)	(.280)
monopoly4yrCHG		-.237		.197		.171		-.859**
		(.164)		(.149)		(.140)		(.145)
Changesincomp	.245**	.243**	.163**	.159**	.154**	.150**	.187**	.186**
	(.049)	(.049)	(.044)	(.044)	(.041)	(.041)	(.040)	(.040)
regional4yrCHG		.125		.688*		.563*		.647*
		(.330)		(.286)		(.269)		(.265)
alaska4yrCHG		.086		-1.427		-1.912*		-3.422**
				(.836)		(.852)		(.826)
premium4yrCHG		-1.360		-5.076**		-8.215**		-5.230**
				(1.771)		(1.758)		(1.562)
percdir4yrCHG	4.232**	4.186**	4.703**	4.717**	4.440**	4.432**	5.429**	5.207**
	(.325)	(.327)	(.309)	(.311)	(.280)	(.282)	(.295)	(.297)
lowcost4yrCHG	-.851**	-.842**	-.495**	-.557**	-.050	-.088	-.130	-.110
	(.177)	(.180)	(.153)	(.155)	(.140)	(.142)	(.155)	(.158)
Lowcostshare	-3.922**	-3.938**	-4.039**	-3.962**	-1.505**	-1.453**	-2.276**	-2.285**
4yrCHG	(.424)	(.426)	(.387)	(.388)	(.374)	(.374)	(.459)	(.459)
regshare4yrchg	5.096**	4.936**	3.624**	2.829**	-.112	-.752	4.076**	3.450**
	(.784)	(.915)	(.662)	(.785)	(.630)	(.762)	(.698)	(.828)
mergers4yr	.424**	.424**	.640**	.641**	.556**	.554**	.226**	.233**
TOTAL	(.086)	(.086)	(.078)	(.078)	(.073)	(.073)	(.072)	(.072)
metropop4yrchg	.020	-.003	-.730	-.822	-2.931**	-3.116**	-1.042	-1.213
O (Origin)	(.805)	(.807)	(.724)	(.726)	(.678)	(.679)	(.682)	(.682)
metropop4yrchg	.433	.420	1.358	1.224	-1.464*	-1.681**	-1.181	-1.329*
D (Destination)	(.808)	(.809)	(.728)	(.730)	(.681)	(.682)	(.685)	(.685)
metropop4yrchg	-.083	-.082	.005	.005	.074	.078	.063	.069
OxO	(.067)	(.067)	(.060)	(.060)	(.057)	(.057)	(.057)	(.057)
metropop4yrchg	-.140*	-.141*	-.123*	-.119*	.016	.022	.075	.082
DxD	(.067)	(.067)	(.061)	(.061)	(.057)	(.057)	(.057)	(.057)
metropop4yrchg	.128	.148	.118	.174	.099	.191	.126	.195
OxD	(.122)	(.124)	(.110)	(.111)	(.103)	(.105)	(.104)	(.105)
REALpcinc4yrchg	.232	.231	-.067	-.079	.903**	.874**	.592**	.565**
O	(.200)	(.200)	(.195)	(.195)	(.200)	(.200)	(.220)	(.220)
REALpcinc4yrchg	.175	.174	-.178	-.192	.713**	.685**	.400	.375
D	(.199)	(.199)	(.194)	(.194)	(.199)	(.199)	(.219)	(.219)
REALpcinc4yrchg	.000	.000	-.002	-.002	-.010**	-.010**	-.004	-.005
OxO	(.003)	(.003)	(.002)	(.002)	(.003)	(.003)	(.003)	(.003)
REALpcinc4yrchg	.001	.001	.001	.001	-.006**	-.006**	-.002	-.002
DxD	(.002)	(.002)	(.002)	(.002)	(.002)	(.002)	(.003)	(.003)
REALpcinc4yrchg	-.008	-.008	.005	.006	-.006	-.005	-.008	-.006
OxD	(.004)	(.005)	(.004)	(.004)	(.004)	(.004)	(.005)	(.005)
F(16, 23064)	46.23	37.55	52.78	43.58	35.53	30.3	38.84	34.62
R-squared	.033	.033	.037	.038	.026	.027	.028	.031
Number of obs	23081	23081	23081	23081	23081	23081	23081	23081

Table 9-A

Fixed Effects Regression Output for Linear Gini Dispersion With Quarter Dummies

	Gini Regressions With Herfindahl and the Following Certainty Variables:			Gini Regressions With Monopoly and the Following Certainty Variables:		
	qtq and yoy	qtq only	yoy only	qtq and yoy	qtq only	yoy only
herf	-.056**	-.056**	-.056**			
	(.001)	(.001)	(.001)			
monopoly				-.031**	-.031**	-.031**
				(.001)	(.001)	(.001)
Knownqtq(100s)	.050*	.046*		.154**	.165**	
	(.020)	(.024)		(.024)	(.024)	
Knownyoy(100s)	-.021		-.095	.060*		.094**
	(.027)		(.027)	(.027)		(.027)
regional	.006**	.006**	.006**	.007**	.007**	.007**
	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)
alaska	-.005	-.006	-.005	-.007	-.007	-.006
	(.006)	(.006)	(.006)	(.006)	(.006)	(.006)
premium	-.009*	-.009*	-.009*	-.011**	-.011**	-.011**
	(.004)	(.004)	(.004)	(.004)	(.004)	(.004)
percdir	.027**	.027**	.027**	.019**	.019**	.019**
	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)
lowcost	.003**	.003**	.003**	.005**	.005**	.005**
	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)
lowcostshare	-.009**	-.009**	-.009**	-.010**	-.010**	-.010**
	(.003)	(.003)	(.003)	(.003)	(.003)	(.003)
regionalshare	-.015**	-.015**	-.015**	-.013**	-.013**	-.012**
	(.003)	(.003)	(.003)	(.003)	(.003)	(.003)
md1(10s)	.015**	.016**	.014*	.015**	.015**	.012*
	(.006)	(.006)	(.006)	(.006)	(.006)	(.006)
md2(10s)	-.022**	-.021**	-.022**	-.025**	-.026**	-.024**
	(.005)	(.005)	(.005)	(.005)	(.005)	(.005)
md3(10s)	-.012*	-.012*	-.012*	-.012**	-.014**	-.012*
	(.005)	(.005)	(.005)	(.005)	(.005)	(.005)
md4(10s)	-.025**	-.025**	-.025**	-.025**	-.026**	-.024**
	(.005)	(.005)	(.005)	(.005)	(.005)	(.005)
metropop10,000,000sO	.054	.054	.054	.032	.033	.033
	(.054)	(.054)	(.054)	(.054)	(.054)	(.054)
metropop10,000,000sD	.223**	.223**	.224**	.208**	.208**	.209**
	(.053)	(.053)	(.053)	(.053)	(.053)	(.053)
metropopOsquared(10s)	.025**	.025**	.025**	.027**	.027**	.027**
	(.005)	(.005)	(.005)	(.005)	(.005)	(.005)
metropopDsquared(10s)	.024**	.024**	.024**	.026**	.026**	.025**
	(.005)	(.005)	(.005)	(.005)	(.005)	(.005)
metropopOxD10,000,000s	-.030**	-.030**	-.030**	-.030**	-.031**	-.030**

	(.006)	(.006)	(.006)	(.006)	(.006)	(.006)
REALpcinc10,000sO	-.013	-.013	-.013	-.010	-.010	-.010
	(.010)	(.010)	(.010)	(.010)	(.010)	(.010)
REALpcinc10,000sD	-.008	-.008	-.008	-.006	-.006	-.007
	(.010)	(.010)	(.010)	(.010)	(.010)	(.010)
REALpcincOsquared(1000s)	.037**	.037**	.037**	.031*	.032*	.032*
	(.014)	(.014)	(.014)	(.014)	(.014)	(.014)
REALpcincDsquared(1000s)	.043**	.043**	.043**	.039**	.040**	.040**
	(.014)	(.014)	(.014)	(.014)	(.014)	(.014)
REALpcinc1,000,000sOxD	-.023	-.023	-.023	-.019	-.020	-.019
	(.025)	(.025)	(.025)	(.025)	(.025)	(.025)
F(39,350451)	458.93	470.99	470.76	460.96	472.93	472.48
R-squared	0.53	0.53	0.53	0.53	0.53	0.53
Number of obs	373856	373856	373856	373856	373856	373856

Table 10-A

Fixed Effects Regressions: Linear in the Logs Dispersion With Quarter Dummies

	lnGINI Regressions With lnHERF and the Following Certainty Variables:			lnGINI Regressions With Monopoly and the Following Certainty Variables:		
	qtq and yoy	qtq only	yoy only	qtq and yoy	qtq only	yoy only
lnHERF	-.134**	-.134**	-.134**	-	-	-
	(.003)	(.003)	(.003)			
monopoly	-	-	-	-.143**	-.143**	-.143**
				(.003)	(.003)	(.003)
knownqtq(10s)	.002	-.003	-	.053**	.058**	-
	(.013)	(.013)		(.013)	(.013)	
knownyoy(10s)	-.024	-	-.024	.026	-	.037
	(.015)		(.015)	(.015)		(.015)
regional	.036**	.036**	.036**	.039**	.039**	.038**
	(.004)	(.004)	(.004)	(.004)	(.004)	(.004)
alaska	-.005	-.005	-.005	-.020	-.019	-.019
	(.041)	(.041)	(.041)	(.041)	(.041)	(.041)
premium	-.056**	-.056**	-.056**	-.063**	-.063**	-.064**
	(.023)	(.023)	(.023)	(.022)	(.022)	(.022)
percdir	.132**	.132**	.132**	.088**	.088**	.088**
	(.007)	(.007)	(.007)	(.007)	(.007)	(.007)
lowcost	.021**	.021**	.021**	.032**	.032**	.032**
	(.003)	(.003)	(.003)	(.003)	(.003)	(.003)
lowcostshare	-.029	-.029	-.029	-.031*	-.032*	-.031*
	(.015)	(.015)	(.015)	(.015)	(.015)	(.015)
regionalshare	-.091**	-.091**	-.091**	-.079**	-.079**	-.079**
	(.022)	(.022)	(.022)	(.022)	(.022)	(.022)
md1	.018**	.018**	.018**	.019**	.018**	.017**
	(.003)	(.003)	(.003)	(.003)	(.003)	(.003)
md2	-.002	-.002	-.002	-.004	-.004	-.003
	(.003)	(.003)	(.003)	(.003)	(.003)	(.003)
md3	-.002	-.001	-.002	-.001	-.002	-.001
	(.003)	(.003)	(.003)	(.003)	(.003)	(.003)
md4	-.006*	-.006*	-.006*	-.005	-.005*	-.004
	(.003)	(.003)	(.003)	(.003)	(.003)	(.003)
lnmetpopO	-.078*	-.077*	-.078*	-.084*	-.085*	-.084**
	(.037)	(.037)	(.037)	(.037)	(.037)	(.037)
lnmetpopD	.008	.009	.008	.002	.001	.003
	(.037)	(.037)	(.037)	(.037)	(.037)	(.037)
lnmetpopOsq	.086**	.086**	.086**	.086**	.086**	.086**
	(.014)	(.014)	(.014)	(.014)	(.014)	(.014)
lnmetpopDsq	.117**	.116**	.117**	.118**	.118**	.118**
	(.014)	(.014)	(.014)	(.014)	(.014)	(.014)
lnmetpopOxD	-.085**	-.084**	-.085**	-.079**	-.080**	-.078**
	(.017)	(.017)	(.017)	(.017)	(.017)	(.017)
lnREALpcincO	-.757	-.755	-.757	-.667	-.669	-.679
	(.492)	(.492)	(.492)	(.490)	(.490)	(.490)
lnREALpcincD	-1.562**	-1.560**	-1.563**	-1.544**	-1.547**	-1.556**

	(.500)	(.500)	(.500)	(.499)	(.499)	(.499)
lnREALpcincOsq	-.039	-.040	-.039	-.071	-.070	-.069
	(.075)	(.075)	(.075)	(.075)	(.075)	(.075)
lnREALpcincDsq	.091	.089	.091	.070	.071	.071
	(.076)	(.076)	(.076)	(.076)	(.076)	(.076)
lnREALpcincOxD	.317*	.319*	.317*	.359**	.357**	.360**
	(.145)	(.145)	(.145)	(.145)	(.145)	(.145)
F(39,346008)	276.09	283.35	283.21	277.98	285.23	285.13
R-squared	0.4634	0.4634	0.4634	0.4655	0.4655	0.4655
Number of obs	369413	369413	369413	369413	369413	369413

Table 11-A

Fixed Effects Regression Output for Linear Average Fare With Quarter Dummies

	Avgfpm Regressions With Herfindahl and the Following Certainty Variables:			Avgfpm Regressions With Monopoly and the Following Certainty Variables:		
	qtq and yoy	qtq only	yoy only	qtq and yoy	qtq only	yoy only
herf	1.039**	1.042**	1.046**			
	(.077)	(.077)	(.077)			
monopoly				-.081*	-.075	-.085*
				(.041)	(.041)	(.041)
knownqtq	-.070**	-.066**		-.079**	-.071**	
	(.017)	(.017)		(.017)	(.017)	
knownyoy	.020		.005	.042*		.024
	(.019)		(.019)	(.019)		(.019)
regional	-.206**	-.208**	-.197*	-.276**	-.280**	-.267**
	(.082)	(.082)	(.082)	(.082)	(.082)	(.082)
alaska	-1.651**	-1.647**	-1.661**	-1.736**	-1.727**	-1.748**
	(.617)	(.617)	(.617)	(.618)	(.617)	(.618)
premium	-1.065	-1.065	-1.059	-.978	-.977	-.971
	(.668)	(.668)	(.669)	(.669)	(.669)	(.669)
percdir	6.101**	6.100**	6.099**	6.235**	6.234**	6.234**
	(.124)	(.124)	(.124)	(.123)	(.123)	(.123)
lowcost	-.379**	-.381**	-.375**	-.461**	-.465**	-.458**
	(.044)	(.044)	(.044)	(.044)	(.044)	(.044)
lowcostshare	-1.375**	-1.375**	-1.380**	-1.346**	-1.347**	-1.352**
	(.190)	(.190)	(.190)	(.190)	(.190)	(.190)
regionalshare	2.962**	2.966**	2.955**	2.851**	2.859**	2.842**
	(.374)	(.374)	(.374)	(.375)	(.375)	(.375)
md1	-.895**	-.898**	-.879**	-.881**	-.886**	-.863**
	(.049)	(.049)	(.049)	(.049)	(.049)	(.049)
md2	-.260**	-.263**	-.264**	-.247**	-.255**	-.252**
	(.041)	(.041)	(.041)	(.041)	(.041)	(.041)
md3	-.497**	-.501**	-.501**	-.483**	-.491**	-.487**
	(.038)	(.038)	(.038)	(.038)	(.038)	(.038)
md4	-.146**	-.150**	-.151**	-.130**	-.138**	-.136**
	(.038)	(.038)	(.038)	(.038)	(.038)	(.038)
metropop1000000sO	-5.177**	-5.177**	-5.181**	-5.139**	-5.139**	-5.143**
	(.332)	(.332)	(.332)	(.332)	(.332)	(.332)
metropop1000000sD	-3.879**	-3.879**	-3.887**	-3.873**	-3.872**	-3.883**
	(.327)	(.327)	(.327)	(.327)	(.327)	(.327)
metropopOsquared	.039	.039	.039	.031	.031	.031
	(.029)	(.029)	(.029)	(.029)	(.029)	(.029)
metropopDsquared	-.014	-.014	-.014	-.020	-.020	-.019
	(.029)	(.029)	(.029)	(.029)	(.029)	(.029)
metropopOxD1000000s	.398**	.396**	.397**	.420**	.417**	.419**
	(.042)	(.042)	(.042)	(.042)	(.042)	(.042)
REALpcinc1000sO	-.147*	-.148*	-.146*	-.148*	-.149*	-.146*
	(.072)	(.072)	(.072)	(.072)	(.072)	(.072)
REALpcinc1000sD	-.199**	-.200**	-.197**	-.201**	-.202**	-.199**
	(.072)	(.072)	(.072)	(.072)	(.072)	(.072)

REALpcincOsquared	-.033**	-.033**	-.033**	-.033**	-.033**	-.034**
(10s)	(.009)	(.009)	(.009)	(.009)	(.009)	(.009)
REALpcincDsquared	-.016	-.016	-.016	-.016	-.016	-.016
(10s)	(.009)	(.009)	(.009)	(.009)	(.009)	(.009)
REALpcinc10000sOxD	.089**	.089**	.089**	.091**	.091**	.091**
	(.016)	(.016)	(.016)	(.016)	(.016)	(.016)
F(39,350451)	452.03	463.82	463.5	445.2	456.65	456.5
R-squared	0.78	0.78	0.78	0.78	0.78	0.78
Number of obs	373856	373856	373856	373856	373856	373856

Table 12-A

Fixed Effects Regressions: Linear in the Logs Average Fare With Quarter Dummies

	Avgfpm Regressions With Herfindahl and the Following Certainty Variables:			Avgfpm Regressions With Monopoly and the Following Certainty Variables:		
	qtq and yoy	qtq only	yoy only	qtq and yoy	qtq only	yoy only
lnHERF	.021**	.021**	.021**			
	(.002)	(.002)	(.002)			
monopoly				-.018**	-.018**	-.018**
				(.002)	(.002)	(.002)
knownqtq(10s)	-.032**	-.030**		-.033**	-.028**	
	(.008)	(.008)		(.008)	(.008)	
knownyoy(10s)	.012		.004	.027**		.019
	(.009)		(.009)	(.009)		(.009)
regional	.005	.005	.006	.002	.001	.002
	(.003)	(.003)	(.003)	(.003)	(.003)	(.003)
alaska	-.140**	-.140**	-.141**	-.145**	-.145**	-.146**
	(.026)	(.026)	(.026)	(.026)	(.026)	(.026)
premium	-.041	-.041	-.041	-.036	-.036	-.036
	(.025)	(.025)	(.025)	(.025)	(.025)	(.025)
percdir	.302**	.302**	.302**	.307**	.307**	.307**
	(.006)	(.006)	(.006)	(.006)	(.006)	(.006)
lowcost	-.025**	-.025**	-.025**	-.029**	-.029**	-.029**
	(.002)	(.002)	(.002)	(.002)	(.002)	(.002)
lowcostshare	-.067**	-.067**	-.068**	-.066**	-.066**	-.066**
	(.009)	(.009)	(.009)	(.009)	(.009)	(.009)
regionalshare	.078**	.078**	.078**	.073**	.074**	.073**
	(.014)	(.014)	(.014)	(.014)	(.014)	(.014)
md1	-.037**	-.037**	-.036**	-.036**	-.036**	-.035**
	(.002)	(.002)	(.002)	(.002)	(.002)	(.002)
md2	-.008**	-.008**	-.008**	-.007**	-.007**	-.007**
	(.002)	(.002)	(.002)	(.002)	(.002)	(.002)
md3	-.019**	-.019**	-.019**	-.018**	-.018**	-.018**
	(.002)	(.002)	(.002)	(.002)	(.002)	(.002)
md4	.002	.002	.002	.003	.002	.003
	(.002)	(.002)	(.002)	(.002)	(.002)	(.002)
lnmetpopO	-.327**	-.327**	-.327**	-.322**	-.323**	-.323**
	(.023)	(.023)	(.023)	(.023)	(.023)	(.023)
lnmetpopD	-.234**	-.234**	-.235**	-.232**	-.232**	-.232**
	(.023)	(.023)	(.023)	(.023)	(.023)	(.023)
lnmetpopOsq	.002	.002	.002	.005	.005	.005
	(.008)	(.008)	(.008)	(.008)	(.008)	(.008)
lnmetpopDsq	.022**	.022**	.022**	.024**	.024**	.024**
	(.008)	(.008)	(.008)	(.008)	(.008)	(.008)
lnmetpopOxD	.174**	.173**	.173**	.178**	.177**	.178**
	(.010)	(.010)	(.010)	(.010)	(.010)	(.010)
lnREALpcincO	-1.545**	-1.546**	-1.538**	-1.573**	-1.575**	-1.565**
	(.283)	(.283)	(.283)	(.283)	(.283)	(.283)

lnREALpcincD	-2.370**	-2.371**	-2.362**	-2.401**	-2.404**	-2.393**
	(.285)	(.285)	(.285)	(.285)	(.285)	(.285)
lnREALpcincOsq	.044	.044	.042	.047	.049	.046
	(.043)	(.043)	(.043)	(.043)	(.043)	(.043)
lnREALpcincDsq	.179**	.179**	.178**	.183**	.184**	.182**
	(.044)	(.044)	(.044)	(.044)	(.044)	(.044)
lnREALpcincOxD	.309**	.308**	.309**	.312**	.310**	.312**
	(.081)	(.081)	(.081)	(.081)	(.081)	(.081)
F(39,350451)	542.63	556.7	556.51	541.95	555.72	555.85
R-squared	0.8153	0.8153	0.8153	0.8153	0.8153	0.8153
Number of obs	373856	373856	373856	373856	373856	373856

Table 13-A

Straight First-Difference Regression: Quadratic, Dispersion Without Dummies

	Cross Section Results: Full Period Change in Dispersion 1986-1990			
	1st Period (1st Qtrs) gini4yrCHG	2nd Period (2nd qtrs) gini4yrCHG	3rd period (3rd qtrs) gini4yrCHG	4th period (4th qtrs) gini4yrCHG
herf4yrchg	-.078**	-.073**	-.070**	-.065**
	(.003)	(.003)	(.003)	(.003)
changesincomp	-.003**	-.001**	-.002**	-.003**
	(.001)	(.001)	(.001)	(.001)
percdir4yrCHG	.034**	.035**	.029**	.028**
	(.004)	(.004)	(.004)	(.004)
lowcostshare4yrCHG	-.032**	-.032**	-.049**	-.032**
	(.004)	(.004)	(.004)	(.005)
regshare4yrchg	-.033**	-.018*	.001	.014
	(.010)	(.008)	(.008)	(.009)
mergers4yrTOTAL	.003**	.002	.001	.007**
	(.001)	(.001)	(.001)	(.001)
metropop4yrchg10000000sO	.244**	.166	-.065	.210*
	(.099)	(.092)	(.089)	(.092)
metropop4yrchg10000000sD	.025	.205*	.044	.175
	(.099)	(.092)	(.089)	(.092)
metropop4yrchg10sOxO	.019*	.009	.029**	.005
	(.008)	(.008)	(.007)	(.008)
metropop4yrchg10sDxD	.038**	.019**	.029**	.004
	(.008)	(.008)	(.007)	(.008)
metropop10s4yrchgOxD	-.011	.025	.011	-.015
	(.015)	(.014)	(.014)	(.014)
REALpcinc4yrchg10000sO	-.054*	-.103**	-.072**	-.116**
	(.025)	(.025)	(.026)	(.030)
REALpcinc4yrchg10000sD	-.068**	-.136**	-.122**	-.094**
	(.024)	(.025)	(.026)	(.029)
REALpcinc4yrchg100sOxO	.017**	.018**	.013**	.023**
	(.003)	(.003)	(.003)	(.004)
REALpcinc4yrchg100sDxD	.018**	.023**	.020**	.021**
	(.003)	(.003)	(.003)	(.004)
REALpcinc4yrchg100sOxD	-.012*	-.009	-.015**	-.016*
	(.006)	(.005)	(.006)	(.006)
F(16, 23064)	64.4	61	62.63	43.38
R-squared	.043	.041	.042	.029
Number of obs	23081	23081	23081	23081

Table 14-A

Modified First Difference Regression: Quadratic, Dispersion Without Dummies

	Cross Section Results: Full Period Change in Dispersion 1986-1990			
	1st Period (1st Qtrs) gini4yrCHG	2nd Period (2nd qtrs) gini4yrCHG	3rd period (3rd qtrs) gini4yrCHG	4th period (4th qtrs) gini4yrCHG
startingHERF	.041**	.026**	.032**	.017**
	(.003)	(.003)	(.003)	(.003)
changesincomp(10s)	-.007	.011	-.004	-.016**
	(.006)	(.006)	(.006)	(.006)
percdir4yrCHG	.026**	.024**	.019**	.018**
	(.004)	(.004)	(.004)	(.004)
startingLOWCOSTshare	.054**	.051**	.056**	.036**
	(.004)	(.003)	(.004)	(.004)
startingREGIONALshare	.015	-.012	-.030**	-.045**
	(.009)	(.008)	(.009)	(.010)
mergers4yrTOTAL(10s)	.029**	-.009	.001	.052**
	(.011)	(.010)	(.010)	(.010)
metropop4yrchg1000000sO	.031**	.018*	-.003	.023**
	(.010)	(.009)	(.009)	(.009)
metropop4yrchg1000000sD	.010	.023**	.009	.021*
	(.010)	(.009)	(.009)	(.009)
metropop4yrchgOxO(10s)	.018*	.011	.029**	.005
	(.008)	(.008)	(.008)	(.008)
metropop4yrchgDxD(10s)	.037**	.021**	.029**	.003
	(.008)	(.008)	(.008)	(.008)
metropop4yrchgOxD(10s)	-.010	.026	.012	-.017
	(.015)	(.014)	(.014)	(.014)
REALpcinc4yrchg10000sO	-.035	-.083**	-.057*	-.120**
	(.025)	(.025)	(.027)	(.030)
REALpcinc4yrchg10000sD	-.047	-.116**	-.106**	-.100**
	(.025)	(.025)	(.026)	(.030)
REALpcinc4yrchgOxO(100s)	.016**	.016**	.012**	.023**
	(.003)	(.003)	(.003)	(.004)
REALpcinc4yrchgDxD(100s)	.017**	.022**	.019**	.021**
	(.003)	(.003)	(.003)	(.004)
REALpcinc4yrchgOxD(100s)	-.015**	-.011*	-.015**	-.013
	(.006)	(.006)	(.006)	(.007)
F(16, 23064)	42.07	35.84	39.7	18.17
R-squared	.028	.024	.027	.012
Number of obs	23081	23081	23081	23081

Table 15-A

Straight First-Difference Regression: Quadratic, Average Fare Without Dummies

	Cross Section Results: Full Period Change in Average Fare 1986-1990			
	1st Period (1st Qtrs) avgfpm4yrCHG	2nd Period (2nd qtrs) avgfpm4yrCHG	3rd period (3rd qtrs) avgfpm4yrCHG	4th period (4th qtrs) avgfpm4yrCHG
herf4yrchg	2.929**	2.510**	1.838**	2.373**
	(.243)	(.225)	(.210)	(.219)
changesincomp	.241**	.164**	.154**	.186**
	(.049)	(.044)	(.041)	(.040)
percdir4yrCHG	4.278**	4.739**	4.442**	5.436**
	(.325)	(.309)	(.280)	(.295)
lowcostshare4yrCHG	-5.220**	-4.810**	-1.581**	-2.482**
	(.327)	(.306)	(.308)	(.389)
regshare4yrchg	5.104**	3.600**	-.125	4.046**
	(.784)	(.662)	(.629)	(.697)
mergers4yrTOTAL	.402**	.630**	.556**	.224**
	(.086)	(.078)	(.073)	(.072)
metropop4yrchg1000000sO	.058	-.739	-2.931**	-1.044
	(.805)	(.724)	(.678)	(.682)
metropop4yrchg1000000sD	.464	1.359	-1.464*	-1.185
	(.808)	(.728)	(.681)	(.685)
metropop4yrchgOxO	-.087	.006	.074	.063
	(.067)	(.060)	(.057)	(.057)
metropop4yrchgDxD	-.141*	-.123*	.015	.075
	(.067)	(.061)	(.057)	(.057)
metropop4yrchgOxD	.103	.097	.097	.121
	(.122)	(.109)	(.103)	(.104)
REALpcinc4yrchg1000sO	.222	-.068	.903**	.591**
	(.200)	(.195)	(.200)	(.220)
REALpcinc4yrchg1000sD	.176	-.182	.713**	.398
	(.199)	(.194)	(.199)	(.219)
REALpcinc4yrchg100sOxO	-.041	-.192	-.966**	-.444
	(.251)	(.244)	(.252)	(.278)
REALpcinc4yrchg100sDxD	.088	.073	-.637**	-.152
	(.249)	(.242)	(.249)	(.275)
REALpcinc4yrchg100sOxD	-.726	.531	-.631	-.767
	(.450)	(.434)	(.442)	(.481)
F(16, 23064)	47.63	55.4	37.75	41.23
R-squared	.032	.037	.026	.028
Number of obs	23081	23081	23081	23081

Table 16-A

Modified First Difference Regression: Quadratic, Average Fare Without Dummies

	Cross Section Results: Full Period Change in Average Fare 1986-1990			
	1st Period (1st Qtrs) avgfpm4yrCHG	2nd Period (2nd qtrs) avgfpm4yrCHG	3rd period (3rd qtrs) avgfpm4yrCHG	4th period (4th qtrs) avgfpm4yrCHG
startingHERF	-.335	-.425	.392	-.732**
	(.253)	(.231)	(.212)	(.211)
changesincomp	.142**	.060	.133**	.105**
	(.050)	(.046)	(.042)	(.041)
percdir4yrCHG	4.544**	5.023**	4.730**	5.763**
	(.327)	(.309)	(.278)	(.293)
startingLOWCOSTshare	2.613**	3.012**	-.157	.745*
	(.300)	(.272)	(.268)	(.326)
startingREGIONALshare	-2.012**	-.399	2.861**	-.553
	(.757)	(.661)	(.643)	(.716)
mergers4yrTOTAL	.561**	.776**	.741**	.277**
	(.090)	(.081)	(.075)	(.074)
metropop4yrchg1000000sO	-.581	-1.308	-3.004**	-1.402*
	(.813)	(.730)	(.681)	(.688)
metropop4yrchg1000000sD	-.180	.767	-1.552*	-1.628*
	(.816)	(.734)	(.684)	(.690)
metropop4yrchgOxO	-.082	.016	.064	.072
	(.068)	(.061)	(.057)	(.057)
metropop4yrchgDxD	-.138*	-.113	.006	.090
	(.068)	(.061)	(.057)	(.058)
metropop4yrchgOxD	.045	.039	.076	.102
	(.123)	(.110)	(.103)	(.104)
REALpcinc4yrchg1000sO	.204	-.031	.844**	.652**
	(.202)	(.196)	(.201)	(.221)
REALpcinc4yrchg1000sD	.150	-.146	.656**	.474*
	(.201)	(.196)	(.200)	(.220)
REALpcinc4yrchgOxO(100s)	-.179	-.291	-.955**	-.512
	(.254)	(.246)	(.252)	(.279)
REALpcinc4yrchgDxD(100s)	-.041	-.030	-.638**	-.241
	(.251)	(.244)	(.250)	(.276)
REALpcinc4yrchgOxD(100s)	-.296	.712	-.474	-.787
	(.454)	(.437)	(.443)	(.483)
F(16, 23064)	24.19	37.66	31.93	30.87
R-squared	.017	.026	.022	.021
Number of obs	23081	23081	23081	23081

Appendix B:

Proof of Proposition 1

If $P_{AVG}^{MO} > P_{AVG}^{PC}$, then the following will hold:

$$P_{AVG}^{MO} = \frac{\left(\frac{N\lambda + c}{2\lambda}\right)\left(\frac{\gamma(N\lambda - c)}{2\lambda}\right) + \left(\frac{N+c}{2}\right)\left(\frac{N-c}{2}\right)}{\frac{\gamma(N\lambda - c)}{2\lambda} + \frac{(N-c)}{2}} > \frac{\left[\gamma\left(N - \frac{c}{\lambda}\right)\right]\left(\frac{c}{\lambda}\right) + (N-c)c}{\gamma\left(N - \frac{c}{\lambda}\right) + (N-c)} = P_{AVG}^{PC}$$

$$\frac{\frac{(N\lambda + c)\gamma(N\lambda - c) + \lambda^2(N+c)(N-c)}{4\lambda^2}}{\frac{\gamma(N\lambda - c) + \lambda(N-c)}{2\lambda}} > \frac{\frac{\gamma(N\lambda - c)c + (N-c)c\lambda^2}{2\lambda^2}}{\frac{\gamma(N\lambda - c) + (N-c)\lambda}{2\lambda}}$$

$$\frac{(N\lambda + c)\gamma(N\lambda - c) + \lambda^2(N+c)(N-c)}{2} > \gamma(N\lambda - c)c + (N-c)c\lambda^2$$

$$(N\lambda + c)\gamma(N\lambda - c) + \lambda^2(N+c)(N-c) > 2\gamma c(N\lambda - c) + 2c\lambda^2(N-c)$$

$$(N\lambda - c)\left[(N\lambda + c)\gamma - 2\gamma c\right] + (N-c)\left[\lambda^2(N+c) - 2c\lambda^2\right] > 0$$

$$\gamma(N\lambda - c)\left[N\lambda + c - 2c\right] + \lambda^2(N-c)\left[N + c - 2c\right] > 0$$

$$\gamma(N\lambda - c)^2 + \lambda^2(N-c)^2 > 0$$

Since $\gamma > 1$ and $\lambda \in [0,1]$ by definition, this equality holds for all N, c, λ, and γ. Hence, $P_{AVG}^{MO} > P_{AVG}^{PC}$.

If $P_{AVG}^{O} > P_{AVG}^{PC}$, then the following will hold:

$$P_{AVG}^{O} = \frac{\gamma(N\lambda - c)(N\lambda + 2c) + \lambda^2(N-c)(N+2c)}{3\lambda\left[\gamma(N\lambda - c) + \lambda(N-c)\right]} > \frac{\gamma c(N\lambda - c) + \lambda^2 c(N-c)}{\gamma(N\lambda - c) + \lambda(N-c)} = P_{AVG}^{PC}$$

$$\gamma(N\lambda - c)(N\lambda + 2c) + \lambda^2(N-c)(N+2c) > 3\lambda\gamma c(N\lambda - c) + 3\lambda^3 c(N-c)$$

$$\gamma(N\lambda - c)\left[N\lambda + 2c - 3\lambda c\right] + \lambda^2(N-c)\left[N + 2c - 3\lambda c\right] > 0$$

$$\gamma(N\lambda - c)\left[N\lambda + c(2 - 3\lambda)\right] + \lambda^2(N-c)\left[N + c(2 - 3\lambda)\right] > 0$$

Since $\lambda \in [0,1]$, $N\lambda - c(3\lambda - 2) \in [N - c, 2c]$, which is strictly positive, and $N - c(3\lambda - 2) \in [N - c, N + 2c]$, which is strictly positive, all terms in the above equation are $> 0 \ \forall \lambda, c, N$.

If $P_{AVG}^{MO} > P_{AVG}^{O}$, then the following will hold:

$$P_{AVG}^{MO} = \frac{\gamma(N\lambda - c)(N\lambda + c) + \lambda^2(N-c)(N+c)}{2\lambda\left[\gamma(N\lambda - c) + \lambda(N-c)\right]} > \frac{\gamma(N\lambda - c)(N\lambda + 2c) + \lambda^2(N-c)(N+2c)}{3\lambda\left[\gamma(N\lambda - c) + \lambda(N-c)\right]} = P_{AVG}^{O}$$

$$3\gamma(N\lambda - c)(N\lambda + c) + 3\lambda^2(N-c)(N+c) > 2\gamma(N\lambda - c)(N\lambda + 2c) + 2\lambda^2(N-c)(N+2c)$$

$$\gamma(N\lambda - c)\left[3(N\lambda + c) - 2(N\lambda + 2c)\right] + \lambda^2(N-c)\left[3(N+c) - 2(N+2c)\right] > 0$$

$$\gamma(N\lambda - c)\left[N\lambda - c\right] + \lambda^2(N-c)\left[N - c\right] > 0$$

Since N > c and Nλ > c by definition, the above inequality holds $\forall N, \lambda, c$.

Appendix C:

Proof of Proposition 2

If $SD^{PC} > SD^{MO}$, then the following will hold:

$$SD^{PC} = \sqrt{\frac{\left(\frac{c-\lambda P_1}{\lambda}\right)^2 \gamma\left(\frac{N\lambda - c}{\lambda}\right) + (c-P_1)^2(N-c)}{\gamma\left(\frac{N\lambda - c}{\lambda}\right) + N - c}} > \sqrt{\frac{\left(\frac{N\lambda + c - 2\lambda P_2}{2\lambda}\right)^2 \gamma\left(\frac{N\lambda - c}{2\lambda}\right) + \left(\frac{N+c-2P_2}{2}\right)^2 \left(\frac{N-c}{2}\right)}{\gamma\left(\frac{N\lambda - c}{2\lambda}\right) + \frac{N-c}{2}}} = SD^{MO}$$

$$\frac{\left(\frac{c-\lambda P_1}{\lambda}\right)^2 \gamma\left(\frac{N\lambda - c}{\lambda}\right) + (c-P_1)^2(N-c)}{\gamma\left(\frac{N\lambda - c}{\lambda}\right) + N - c} > \frac{\left(\frac{N\lambda + c - 2\lambda P_2}{2\lambda}\right)^2 \gamma\left(\frac{N\lambda - c}{2\lambda}\right) + \left(\frac{N+c-2P_2}{2}\right)^2 \left(\frac{N-c}{2}\right)}{\gamma\left(\frac{N\lambda - c}{2\lambda}\right) + \frac{N-c}{2}}$$

$$\frac{\frac{(c-\lambda P_1)^2 \gamma(N\lambda - c) + (c-P_1)^2(N-c)\lambda^3}{2\lambda^3}}{\frac{\gamma(N\lambda - c) + \lambda(N-c)}{2\lambda}} > \frac{\frac{(N\lambda + c - 2\lambda P_2)^2 \gamma(N\lambda - c) + (N+c-2P_2)^2(N-c)\lambda^3}{8\lambda^3}}{\frac{\gamma(N-c) + \lambda(N-c)}{2\lambda}}$$

$$(c-\lambda P_1)^2 \gamma(N\lambda - c) + (c-P_1)^2(N-c)\lambda^3 > \frac{(N\lambda + c - 2\lambda P_2)^2 \gamma(N\lambda - c) + (N+c-2P_2)^2(N-c)\lambda^3}{4}$$

$$4(c-\lambda P_1)^2 \gamma(N\lambda - c) + 4(c-P_1)^2(N-c)\lambda^3 > (N\lambda + c - 2\lambda P_2)^2 \gamma(N\lambda - c) + (N+c-2P_2)^2(N-c)\lambda^3$$

$$\gamma(N\lambda - c)\left[4(c-\lambda P_1)^2 - (N\lambda + c - 2\lambda P_2)^2\right] + \lambda^3(N-c)\left[4(c-P_1)^2 - (N+c-2P_2)^2\right] > 0$$

Now, inserting the equations for $P_1 = P_{PC}$ and $P_2 = P_{MO}$,

$$\gamma(N\lambda - c)\left[4\left(c - \lambda\left[\frac{\gamma c(N\lambda - c) + \lambda^2 c(N-c)}{\gamma(N\lambda - c) + \lambda(N-c)}\right]\right)^2 - \left(N\lambda + c - 2\lambda\left[\frac{\gamma(N\lambda + c)(N\lambda - c) + \lambda^2(N+c)(N-c)}{2\lambda[\gamma(N\lambda - c) + \lambda(N-c)]}\right]\right)^2\right]$$
$$+ \lambda^3(N-c)\left[4(c - \left[\frac{\gamma c(N\lambda - c) + \lambda^2 c(N-c)}{\gamma(N\lambda - c) + \lambda(N-c)}\right])^2 - \left(N + c - 2\left[\frac{\gamma(N\lambda + c)(N\lambda - c) + \lambda^2(N+c)(N-c)}{2\lambda[\gamma(N\lambda - c) + \lambda(N-c)]}\right]\right)^2\right] > 0$$

$$\gamma(N\lambda - c)\left[4\left(\left[\frac{c\gamma(N\lambda - c) + c\lambda(N-c) - \gamma c(N\lambda - c) - \lambda^2 c(N-c)}{\gamma(N\lambda - c) + \lambda(N-c)}\right]\right)^2\right]$$
$$-\gamma(N\lambda - c)\left[\left(\left[\frac{N\lambda\gamma(N\lambda - c) + N\lambda^2(N-c) + c\gamma(N\lambda - c) + c\lambda(N-c) - \gamma(N\lambda + c)(N\lambda - c) - \lambda^2(N+c)(N-c)}{\gamma(N\lambda - c) + \lambda(N-c)}\right]\right)^2\right]$$
$$+\lambda^3(N-c)\left[4\left[\frac{\gamma c(N\lambda - c) + c\lambda(N-c) - \gamma c(N\lambda - c) - \lambda^2 c(N-c)}{\gamma(N\lambda - c) + \lambda(N-c)}\right]^2\right]$$

$$-\left[\left(\left[\frac{N\lambda\gamma(N\lambda-c)+N\lambda^2(N-c)+c\lambda\gamma(N\lambda-c)+c\lambda^2(N-c)-\gamma(N\lambda+c)(N\lambda-c)-\lambda^2(N+c)(N-c)}{\lambda\gamma(N\lambda-c)+\lambda^2(N-c)}\right]\right)^2\right]>0$$

$$\gamma(N\lambda-c)\left[4\lambda^2\left[c\gamma(N\lambda-c)(1-\lambda)+c\lambda(N-c)(1-\lambda)\right]^2-\lambda^2\left[c\lambda(N-c)(1-\lambda)\right]^2\right]$$

$$\lambda^3(N-c)\left[4\lambda^2\left[c\lambda(N-c)(1-\lambda)\right]^2-\left[c\gamma(N\lambda-c)(\lambda-1)\right]^2\right]>0$$

$$\gamma(N\lambda-c)\left[4\left[c\gamma(N\lambda-c)(1-\lambda)+c\lambda(N-c)(1-\lambda)\right]^2-\left[c\lambda(N-c)(1-\lambda)\right]^2\right]$$

$$\lambda(N-c)\left[4\lambda^2\left[c\lambda(N-c)(1-\lambda)\right]^2-\left[c\gamma(N\lambda-c)(\lambda-1)\right]^2\right]>0$$

Expanding the equation:

$$\gamma(N\lambda-c)\left[4c^2\gamma^2(N\lambda-c)^2(1-\lambda)^2+4c^2\lambda^2(N-c)^2(1-\lambda)^2+8c^2\gamma\lambda(N\lambda-c)(N-c)(1-\lambda)^2-c^2\lambda^2(N-c)^2(1-\lambda)^2\right]$$
$$+\lambda(N-c)\left[4\lambda^2c^2\lambda^2(N-c)^2(1-\lambda)^2-c^2\gamma^2(N\lambda-c)^2(\lambda-1)^2\right]>0$$

$$4c^2\gamma^3(N\lambda-c)^3(1-\lambda)^2+4c^2\lambda^2\gamma(N\lambda-c)(N-c)^2(1-\lambda)^2+8c^2\lambda\gamma\lambda^2(N\lambda-c)^2(N-c)(1-\lambda)^2$$
$$-c^2\lambda^2\gamma(N\lambda-c)(N-c)^2(1-\lambda)^2+4\lambda^5c^2(N-c)^3(1-\lambda)^2-\lambda c^2\gamma^2(N-c)(N\lambda-c)^2(\lambda-1)^2>0$$

$$3c^2\lambda^2\gamma(N\lambda-c)(N-c)^2(1-\lambda)^2+7c^2\gamma^2\lambda(N\lambda-c)^2(N-c)(1-\lambda)^2+4c^2\gamma^3(N\lambda-c)^3(1-\lambda)^2+4\lambda^5c^2(N-c)^3(1-\lambda)^2>0$$

or

$$3\lambda^2\gamma(N\lambda-c)(N-c)^2+7\gamma^2\lambda(N\lambda-c)^2(N-c)+4\gamma^3(N\lambda-c)^3+4\lambda^5(N-c)^3>0$$

Since a) all constants are positive, b) N > c by definition, and c) Nλ –c > 0 in order to support high priced ticket allocations (otherwise, if Nλ – c < 0, no high priced seats are offered in either state and standard deviation is zero for both monopolies and competitive firms), the above inequality always holds.

If $SD^O > SD^{MO}$, then the following will hold:

$$SD^O=\sqrt{\frac{\gamma(N\lambda-c)(N\lambda+2c-3\lambda P_3)^2+\lambda^3(N-c)(N+2c-3P_3)^2}{9\lambda^2\left[\gamma(N\lambda-c)+\lambda(N-c)\right]}}>\sqrt{\frac{\gamma(N\lambda-c)(N\lambda+c-2\lambda P_2)^2+\lambda^3(N-c)(N+c-2P_2)^2}{4\lambda^2\left[\gamma(N\lambda-c)+\lambda(N-c)\right]\gamma}}=SD^{MO}$$

$$4\gamma(N\lambda-c)(N\lambda+2c-3\lambda P_3)^2+4\lambda^3(N-c)(N+2c-3P_3)^2>9\gamma(N\lambda-c)(N\lambda+c-2\lambda P_2)^2+9\lambda^3(N-c)(N+c-2P_2)^2$$

$$\gamma(N\lambda-c)\left[4(N\lambda+2c-3\lambda P_3)^2-9(N\lambda+c-2\lambda P_2)^2\right]+\lambda^3(N-c)\left[4(N+2c-3P_3)^2-9(N+c-2P_2)^2\right]>0$$

$$\gamma(N\lambda-c)\left[4\left(N\lambda+2c-3\lambda\left[\frac{\lambda^2(N-c)(N+2c)+\gamma(N\lambda-c)(N\lambda+2c)}{3\lambda\left[\gamma(N\lambda-c)+\lambda(N-c)\right]}\right]\right)^2-9\left(N\lambda+c-2\lambda\left[\frac{\lambda^2(N-c)(N+c)+\gamma(N\lambda-c)(N\lambda+c)}{2\lambda\left[\gamma(N\lambda-c)+\lambda(N-c)\right]}\right]\right)^2\right]$$

$$+\lambda^3(N-c)\left[4\left(N+2-3\left[\frac{\lambda^2(N-c)(N+2c)+\gamma(N\lambda-c)(N\lambda+2c)}{3\lambda[\gamma(N\lambda-c)+\lambda(N-c)]}\right]\right)^2-9\left(N+c-2\left[\frac{\lambda^2(N-c)(N+c)+\gamma(N\lambda-c)(N\lambda+c)}{2\lambda[\gamma(N\lambda-c)+\lambda(N-c)]}\right]\right)^2\right]>0$$

$$\gamma(N\lambda-c)\left[4\left(N\lambda+2c-\left[\frac{\lambda^2(N-c)(N+2c)+\gamma(N\lambda-c)(N\lambda+2c)}{[\gamma(N\lambda-c)+\lambda(N-c)]}\right]\right)^2-9\left(N\lambda+c-\left[\frac{\lambda^2(N-c)(N+c)+\gamma(N\lambda-c)(N\lambda+c)}{[\gamma(N\lambda-c)+\lambda(N-c)]}\right]\right)^2\right]$$

$$+\lambda^3(N-c)\left[4\left(N+2-\left[\frac{\lambda^2(N-c)(N+2c)+\gamma(N\lambda-c)(N\lambda+2c)}{\lambda[\gamma(N\lambda-c)+\lambda(N-c)]}\right]\right)^2-9\left(N+c-\left[\frac{\lambda^2(N-c)(N+c)+\gamma(N\lambda-c)(N\lambda+c)}{\lambda[\gamma(N\lambda-c)+\lambda(N-c)]}\right]\right)^2\right]>0$$

$$\gamma(N\lambda-c)\left[4\left(\left[\frac{N\lambda^2(N-c)+N\lambda\gamma(N\lambda-c)+2c\lambda(N-c)+2c\gamma(N\lambda-c)-\lambda^2(N-c)(N+2c)-\gamma(N\lambda-c)(N\lambda+2c)}{[\gamma(N\lambda-c)+\lambda(N-c)]}\right]\right)^2\right]$$
$$-\gamma(N\lambda-c)\left[9\left(\left[\frac{N\lambda^2(N-c)+N\lambda\gamma(N\lambda-c)+c\gamma(N\lambda-c)+c\lambda(N-c)-\lambda^2(N-c)(N+c)-\gamma(N\lambda-c)(N\lambda+c)}{[\gamma(N\lambda-c)+\lambda(N-c)]}\right]\right)^2\right]$$
$$+\lambda^3(N-c)\left[4\left(\left[\frac{N\lambda\gamma(N\lambda-c)+N\lambda^2(N-c)+2\lambda\gamma(N\lambda-c)+2\lambda^2(N-c)-\lambda^2(N-c)(N+2c)-\gamma(N\lambda-c)(N\lambda+2c)}{\lambda[\gamma(N\lambda-c)+\lambda(N-c)]}\right]\right)^2\right]$$
$$+\lambda^3(N-c)\left[9\left(\left[\frac{N\lambda\gamma(N\lambda-c)+N\lambda^2(N-c)+c\lambda\gamma(N\lambda-c)+c\lambda^2(N-c)-\lambda^2(N-c)(N+c)-\gamma(N\lambda-c)(N\lambda+c)}{\lambda[\gamma(N\lambda-c)+\lambda(N-c)]}\right]\right)^2\right]>0$$

$$\gamma(N\lambda-c)\left[4\left(\left[\frac{\lambda(N-c)(N\lambda+2c-N\lambda-2\lambda c)+\gamma(N\lambda-c)(N\lambda+2c-N\lambda-2c)}{[\gamma(N\lambda-c)+\lambda(N-c)]}\right]\right)^2\right]$$
$$-\gamma(N\lambda-c)\left[9\left(\left[\frac{\lambda(N-c)(N\lambda+c-N\lambda-\lambda c)+\gamma(N\lambda-c)(N\lambda+c-N\lambda-c)}{[\gamma(N\lambda-c)+\lambda(N-c)]}\right]\right)^2\right]$$
$$+\lambda^3(N-c)\left[4\left(\left[\frac{\lambda^2(N-c)(N+2c-N-2c)+\gamma(N\lambda-c)(N\lambda+2c\lambda-N\lambda-2c)}{\lambda[\gamma(N\lambda-c)+\lambda(N-c)]}\right]\right)^2\right]$$
$$+\lambda^3(N-c)\left[9\left(\left[\frac{\lambda^2(N-c)(N+c-N-c)+\gamma(N\lambda-c)(N\lambda+c\lambda-N\lambda-c)}{\lambda[\gamma(N\lambda-c)+\lambda(N-c)]}\right]\right)^2\right]>0$$

$$\gamma(N\lambda-c)\left[4\left(\left[\frac{2c\lambda(N-c)(1-\lambda)}{[\gamma(N\lambda-c)+\lambda(N-c)]}\right]\right)^2-9\left(\left[\frac{c\lambda(N-c)(1-\lambda)}{[\gamma(N\lambda-c)+\lambda(N-c)]}\right]\right)^2\right]$$
$$+\lambda^3(N-c)\left[4\left(\left[\frac{2c\gamma(N\lambda-c)(\lambda-1)}{\lambda[\gamma(N\lambda-c)+\lambda(N-c)]}\right]\right)^2-9\left(\left[\frac{c\gamma(N\lambda-c)(\lambda-1)}{\lambda[\gamma(N\lambda-c)+\lambda(N-c)]}\right]\right)^2\right]>0$$

$$\gamma(N\lambda-c)\left[16\left(\left[\frac{c\lambda(N-c)(1-\lambda)}{[\gamma(N\lambda-c)+\lambda(N-c)]}\right]\right)^2-9\left(\left[\frac{c\lambda(N-c)(1-\lambda)}{[\gamma(N\lambda-c)+\lambda(N-c)]}\right]\right)^2\right]$$
$$+\lambda(N-c)\left[16\left(\left[\frac{2c\gamma(N\lambda-c)(\lambda-1)}{[\gamma(N\lambda-c)+\lambda(N-c)]}\right]\right)^2-9\left(\left[\frac{c\gamma(N\lambda-c)(\lambda-1)}{[\gamma(N\lambda-c)+\lambda(N-c)]}\right]\right)^2\right]>0$$

$$\gamma(N\lambda-c)[c\lambda(N-c)(1-\lambda)]^2(16-9)+\lambda(N-c)[c\gamma(N\lambda-c)(\lambda-1)]^2>0$$

$$\gamma(N\lambda-c)c^2\lambda^2(N-c)^2(1-\lambda)^2+\lambda(N-c)c^2\gamma^2(N\lambda-c)^2(\lambda-1)^2>0$$

$$\lambda(N-c)+\gamma(N\lambda-c)>0$$

Both terms are positive, therefore the inequality holds $\forall N,c,\lambda$.

If $SD^{PC} > SD^{O}$, then the following will hold:

$$SD^{PC}=\sqrt{\frac{\gamma(N\lambda-c)(c-\lambda P_1)^2+\lambda^3(N-c)(c-P_1)^2}{\lambda^2\left[\gamma(N\lambda-c)+\lambda(N-c)\right]}}>\sqrt{\frac{\gamma(N\lambda-c)(N\lambda+2c-3\lambda P_3)^2+\lambda^3(N-c)(N+2c-3P_3)^2}{9\lambda^2\left[\gamma(N\lambda-c)+\lambda(N-c)\right]}}=SD^{O}$$

$$9\gamma(N\lambda-c)(c-\lambda P_1)^2+9\lambda^3(N-c)(c-P_1)^2>\gamma(N\lambda-c)(N\lambda+2c-3\lambda P_3)^2+\lambda^3(N-c)(N+2c-3P_3)^2$$

$$\gamma(N\lambda-c)\left[9(c-\lambda P_1)^2-(N\lambda+2c-3\lambda P_3)^2\right]+\lambda^3(N-c)\left[9(c-P_1)^2-(N+2c-3P_3)^2\right]>0$$

$$\gamma(N\lambda-c)\left[9\left(c-\lambda\left[\frac{\gamma c(N\lambda-c)+\lambda^2c(N-c)}{\gamma(N\lambda-c)+\lambda(N-c)}\right]\right)^2-\left(N\lambda+2c-3\lambda\left[\frac{\lambda^2(N-c)(N+2c)+\gamma(N\lambda-c)(N\lambda+2c)}{3\lambda[\gamma(N\lambda-c)+\lambda(N-c)]}\right]\right)^2\right]$$

$$+\lambda^3(N-c)\left[9\left(c-\left[\frac{\gamma c(N\lambda-c)+\lambda^2c(N-c)}{\gamma(N\lambda-c)+\lambda(N-c)}\right]\right)^2-\left(N+2c-3\left[\frac{\lambda^2(N-c)(N+2c)+\gamma(N\lambda-c)(N\lambda+2c)}{3\lambda[\gamma(N\lambda-c)+\lambda(N-c)]}\right]\right)^2\right]>0$$

$$\gamma(N\lambda-c)\left[9\left(\frac{c\gamma(N\lambda-c)+c\lambda(N-c)-\gamma c\lambda(N\lambda-c)-\lambda^3c(N-c)}{\gamma(N\lambda-c)+\lambda(N-c)}\right)^2\right]$$
$$-\gamma(N\lambda-c)\left[\frac{N\lambda\gamma(N\lambda-c)+N\lambda\lambda(N-c)+2c\gamma(N\lambda-c)+2c\lambda(N-c)-\lambda^2(N-c)(N+2c)-\gamma(N\lambda-c)(N\lambda+2c)}{\gamma(N\lambda-c)+\lambda(N-c)}\right]^2$$
$$+\lambda^3(N-c)\left[9\left(\frac{c\gamma(N\lambda-c)+c\lambda(N-c)-\gamma c(N\lambda-c)-\lambda^2c(N-c)}{\gamma(N\lambda-c)+\lambda(N-c)}\right)^2\right]$$
$$-\lambda^3(N-c)\left[\left(\frac{N\gamma\lambda(N\lambda-c)+N\lambda\lambda(N-c)+2c\gamma\lambda(N\lambda-c)+2c\lambda\lambda(N-c)-\lambda^2(N-c)(N+2c)-\gamma(N\lambda-c)(N\lambda+2c)}{\lambda[\gamma(N\lambda-c)+\lambda(N-c)]}\right)^2\right]>0$$

$$\gamma(N\lambda-c)9\lambda^2\left[\left(\frac{c\gamma(N\lambda-c)(1-\lambda)+c\lambda(N-c)(1-\lambda^2)}{\lambda\gamma(N\lambda-c)+\lambda^2(N-c)}\right)^2\right]$$
$$-\gamma(N\lambda-c)\lambda^2\left[\frac{\gamma(N\lambda-c)(N\lambda+2c-N\lambda-2c)+\lambda(N-c)(N\lambda+2c-N\lambda-2\lambda c)}{\lambda\gamma(N\lambda-c)+\lambda^2(N-c)}\right]^2$$
$$+\lambda^3(N-c)9\lambda^2\left[\left(\frac{c\lambda(N-c)(1-\lambda)}{\gamma\lambda(N\lambda-c)+\lambda\lambda(N-c)}\right)^2\right]$$
$$-\lambda^3(N-c)\left[\left(\frac{\gamma(N\lambda-c)(N\lambda+2c\lambda-N\lambda-2c)+\lambda^2(N-c)(N+2c-N-2c)}{\lambda[\gamma(N\lambda-c)+\lambda(N-c)]}\right)^2\right]>0$$

$$\gamma(N\lambda-c)\lambda^2\left[9\left(c\gamma(N\lambda-c)(1-\lambda)+c\lambda(N-c)(1-\lambda^2)\right)^2-\left[2c\lambda(N-c)(1-\lambda)\right]^2\right]$$

$$+\lambda^3(N-c)\left[9\lambda^2\left(c\lambda(N-c)(1-\lambda)\right)^2-\left[\gamma(N\lambda-c)(2c)(\lambda-1)\right]^2\right]>0$$

$$\gamma(N\lambda-c)\lambda^2\left[9\left(\gamma(N\lambda-c)(1-\lambda)+\lambda(N-c)(1-\lambda^2)\right)^2-4\left[\lambda(N-c)(1-\lambda)\right]^2\right]$$

$$+\lambda^3(N-c)\left[9\lambda^4\left((N-c)(1-\lambda)\right)^2-4\left[\gamma(N\lambda-c)(\lambda-1)\right]^2\right]>0$$

$$9\gamma(N\lambda-c)\lambda^2\left[\left(\gamma(N\lambda-c)(1-\lambda)+\lambda(N-c)(1-\lambda^2)\right)^2\right]-4\gamma\lambda^4(N-c)^2(N\lambda-c)(1-\lambda)^2$$

$$+9\lambda^7(N-c)^3(1-\lambda^2)-4\gamma^2\lambda^3(N-c)(N\lambda-c)^2(\lambda-1)^2>0$$

$$9\gamma(N\lambda-c)\left[\left(\gamma(N\lambda-c)(1-\lambda)+\lambda(N-c)(1-\lambda^2)\right)^2\right]-4\gamma\lambda^2(N-c)^2(N\lambda-c)(1-\lambda)^2$$

$$+9\lambda^5(N-c)^3(1-\lambda^2)-4\gamma^2\lambda(N-c)(N\lambda-c)^2(\lambda-1)^2>0$$

$$9\gamma(N\lambda-c)\left[\left(\gamma(N\lambda-c)(1-\lambda)+\lambda(N-c)(1-\lambda^2)\right)^2\right]+9\lambda^5(N-c)^3(1-\lambda^2)-4\gamma\lambda(N-c)(N\lambda-c)(1-\lambda)^2(\lambda(N-c)+\gamma(N\lambda-c)>0$$

$$9\gamma(N\lambda - c)\left[\left(\gamma^2(N\lambda - c)^2(1-\lambda)^2 + \lambda^2(N-c)^2(1-\lambda^2) + 2\gamma\lambda(N\lambda - c)(1-\lambda)(N-c)(1-\lambda^{2)}\right)\right]$$
$$+9\lambda^5(N-c)^3(1-\lambda^2) - 4\gamma\lambda(N-c)(N\lambda - c)(1-\lambda)^2(\lambda(N-c) + \gamma(N\lambda - c) > 0$$

$$9\gamma^3(N\lambda - c)^3(1-\lambda)^2 + 9\gamma\lambda^2(N\lambda - c)(1-\lambda^2)^2(N-c)^2 + 9\gamma^2\lambda(N\lambda - c)^2(N-c)(1-\lambda)(1-\lambda^2)$$
$$+9\lambda^5(N-c)^3(1-\lambda)^2 - 4\gamma\lambda^2(N\lambda - c)(1-\lambda)^2(N-c)^2 - 4\gamma^2\lambda(N\lambda - c)^2(N-c)(1-\lambda)(1-\lambda) > 0$$

$$9\gamma^3(N\lambda - c)^3(1-\lambda)^2 + 9\lambda^5(N-c)^3(1-\lambda)^2 + \gamma\lambda^2(N\lambda - c)(N-c)^2\left[9(1-\lambda^2)^2 - 4(1-\lambda)^2\right] + \gamma^2\lambda(N\lambda - c)^2(N-c)(1-\lambda)\left[9(1-\lambda^2) - 4(1-\lambda)\right] > 0$$

$$9\gamma^3(N\lambda - c)^3(1-\lambda)^2 + 9\lambda^5(N-c)^3(1-\lambda)^2 + \gamma\lambda^2(N\lambda - c)(N-c)^2\left[5 + 9\lambda^4 - 22\lambda^2 + 8\lambda\right] + \gamma^2\lambda(N\lambda - c)^2(N-c)(1-\lambda)\left[5 + 4\lambda - 9\lambda^2\right] > 0$$

Since $N>c$, $N\lambda>c$, and λ is bound by [0,1], all terms in this equation are positive. Therefore the entire equation is positive.

Appendix D:

Endogeneity Issues

Inclusion of the HHI requires extra discussion, as the construction of this variable raises some endogeneity questions. At issue is the fact that the passenger data that produces the HHI variable is generated from the same pricing decisions by the firms operating in a market, creating feedback between the derived market structure variable, HHI, and the market conduct dependent variables of dispersion and average fare. Given such endogeneity, consistent estimation would warrant inclusion of instrumental variables. Yet, as Schmalensee discusses at length in the Handbook of Industrial Organization, valid exogenous instruments essentially cannot be found in such a situation. He summarizes the issue of cross-sectional industrial analysis as one in which true instruments are very unlikely to be found, as all of the relevant measures of concentration and market power are produced by the same underlying conditions that determine other variables of interest (dispersion, average fare, etc). His conclusion that "in the long-run equilibria with which cross-section studies must be primarily concerned, essentially all variables that have been employed in such studies are logically endogenous" seems to apply here. As such, this empirical study has been conducted under the knowledge of endogeneity issues that cannot be corrected for. The results, therefore, are descriptive rather than structural, providing a basis for describing relationships among variables while evaluating current theories and steering the direction of new theoretical developments. A secondary empirical setup designed to limit the problems of endogeneity is presented, although the restrictions necessary to limit such problems reduce the number of interesting regressors.

This problem of HHI endogeneity is a common problem faced by all previous studies and dealt with in different ways – often not at all. Hayes and Ross (1998), as well as Stavin (2000), used the number of carriers on a route as one construction of the HHI. They also used information on flights offered per market obtained through the DOT's T100 Domestic Segment Data, which contains information about airline capacity and flight frequency on markets. This flight information was used as an instrument on HHI constructs of various types that are not used in the current paper[84]. A moving average error structure was included to reduce the autocorrelation problem inherent in the time series data, and lagged values of several variables were employed in order to reduce simultaneity bias[85]. Yet such an attempt to fix endogeneity warrants another reference to Schmalensee, who argues that the use of lagged values of relevant variables is similarly unlikely to provide consistent estimations, as such estimators are very likely to be serially correlated[86].

Borenstein and Rose (1994) used flight information obtained through the Official Airline Guide for the midpoint date in 1986-quarter 2 in order to provide a separate measure of market share[87]. Singal (1996), as well as Kim and Singal (1993), constructed the HHI in the same manner as in the current paper. They, along with Graham et al (1983) and Stavin (2000), accepted the limitations inclusion of such a variable would impose upon their results. Stavin went so far as to assume HHI to be exogenous. In sum, all of these issues that arose in previous studies are present in the current study, and will likely be present in any Industrial Organization study of pricing in such industries as the airline industry.

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[84] They used four different measures of Herfindahl deemed relevant, explaining the concern of simultaneity bias.
[85] The moving average autocorrelation correction has not been employed.
[86] See the Handbook of Industrial Organization, pp 953-956.
[87] They used May 15, 1986 as the date for their flight information because their study was a cross-sectional study of the second quarter or 1986.

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