EVALUATING THE PERFORMANCE OF MERGER SIMULATION: EVIDENCE FROM THE U.S. AIRLINE INDUSTRY*

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Abstract

This paper uses merger simulations to predict postmerger prices for five airline mergers from the 1980s and compares these predictions with observed postmerger prices. I find that standard simulation methods, which measure the effect of the change in ownership on unilateral pricing incentives, do not generally provide an accurate forecast. By incorporating postmerger information into the model, I measure the relative importance of other factors that also contributed to the observed price changes. The results indicate that the unexplained component of the price change is largely accounted for by supply-side effects. I conclude that deviations from the assumed model of firm conduct play an important role in accounting for the differences between the predicted and observed price changes. This conclusion suggests that the predictive performance of merger simulation would benefit if more flexible models of firm conduct were incorporated into the methodology.

I. Introduction

Over the past 10 years or so, economists and antitrust practitioners have devoted considerable attention to a new methodology for predicting the price effects of horizontal mergers in industries with differentiated products. In its basic form, this methodology combines an estimated structural model of consumer demand with an assumed model of pricing behavior, which allows postmerger equilibrium prices to be simulated. By now, there is a large body of literature applying these techniques to hypothetical or actual mergers in a variety of industries (see, for example, Hausman, Leonard, and Zona 1994; Werden and Froeb 1994; Nevo 2000; Dube 2004). Moreover, antitrust au-

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thorities have increasingly relied on simulations to identify potentially anticompetitive mergers.

Despite this widespread interest in the methodology, however, there has been very little research comparing the predicted price changes from merger simulation with the observed price changes following a consummated merger. One motivation for making such a comparison is that, to the extent that simulated prices are offered as forecasts of postmerger outcomes, one would like to know how accurate these forecasts are. Because simulation inevitably relies on strong assumptions about the postmerger behavior of demand, costs, and conduct, a formal comparison of the simulated and observed prices can also be viewed as a test of these assumptions. If these assumptions are violated, it is more appropriate to interpret the simulated price changes as a measure of one component of the merger's effect on prices rather than as a forecast of the overall effect (a similar point is made by Baker 1997). The availability of postmerger data then makes it possible to determine the importance of this component relative to the total price change and to identify other relevant changes that had been erroneously assumed away. Identifying the variables that most significantly influence postmerger prices is of interest because it may offer guidance on where future efforts to improve predictions are most likely to be fruitful.

The U.S. airline industry of the late 1980s offers an attractive opportunity to evaluate the performance of merger simulation, for several reasons. First, there was a wave of consolidation during a short period of time. The five mergers I examine in this paper were all completed between August 1986 and November 1987.[1] Although occurring within the same time period and in the same industry, the five cases also offer a range of distinct characteristics. In the Northwest-Republic and TWA-Ozark mergers, the merging firms shared one or more common hubs: Detroit and Minneapolis for Northwest and Republic, St. Louis for TWA and Ozark. The Continental–People Express merger is distinguished by the fact that the acquired airline was financially distressed prior to the merger. The Delta-Western merger was a substantially end-to-end combination with a relatively small number of overlap markets.[2]

[1] The five mergers I examine are Northwest-Republic, TWA-Ozark, Continental–People Express, Delta-Western, and USAir-Piedmont. A number of authors have examined the effects of one or more of these mergers. See, for example, Borenstein (1990), Werden, Joskow, and Johnson (1991), Kim and Singal (1993), Kole and Lehn (2000), and Mechanic (2002).

[2] Other end-to-end mergers occurred in this period, including American–Air Cal, USAir-PSA, and Braniff–Florida Express. As discussed in Section IV, my focus in this paper is limited to overlap markets. Because these cases have too few overlap markets to yield meaningful results, I exclude them from the analysis. I also exclude Texas Air's acquisition of Eastern, because in that case the carriers did not integrate their operations but rather continued to operate separately until Eastern entered bankruptcy and ceased operations in 1991.

Finally, USAir's merger with Piedmont serves as an example of the potentially high cost of labor force integration in the airline industry.[3]

Another advantage of looking at this period of airline consolidation is that antitrust enforcement in the industry was relatively lax, with every proposed airline merger receiving regulatory approval.[4] As a result, I am able to observe the effects of mergers that might otherwise have been prevented. Finally, a rich data set of prices and quantities is publicly available, with considerable variation across a large cross section of markets.

Two disadvantages of examining the airline industry should also be noted. One is that some important elements of product differentiation, such as departure times and how far in advance the ticket is purchased, are not included in the available data on prices and sales. This shortcoming may not have a significant effect on my results, however, since these characteristics are more likely to distinguish differently priced tickets within a single airline than systematic differences in pricing across different airlines. A more fundamental issue is that pricing in airline markets may be poorly described by the static noncooperative oligopoly model typically used in merger simulation. Indeed, an important conclusion of this paper is that the gaps between predicted and observed postmerger price changes may be largely due to deviations from the assumed model of firm conduct. To the extent that the static noncooperative oligopoly model is a better representation of competition in other industries, standard methods of merger simulation would be expected to perform better in those industries than in the airline industry.[5] As a result, one should be particularly cautious about extrapolating from my results to other industries.

The strategy that I follow in this paper is to generate predicted postmerger price changes using conventional merger simulation techniques and then to compare these predictions with observed price changes. This comparison raises the question of what accounts for the differences between the observed and predicted price changes. To address this question, I incorporate postmerger data into the model, decomposing the observed price changes into individual components. This procedure yields estimates of the relative contributions of various postmerger changes to the overall price effect.

The remainder of the paper is organized as follows: Section II provides details on the simulation methodology, including demand estimation, recov-

[3] See Kole and Lehn (2000) for a detailed analysis of this issue with respect to the USAir-Piedmont merger. Costly labor force integration proved to be an issue in the other mergers to some extent as well.

[4] The Department of Transportation had jurisdiction over airline mergers during this period and approved two of the mergers over the objections of the Department of Justice.

[5] In discussing an earlier version of this paper, Werden, Froeb, and Scheffman (2004, p. 94) note, "[W]e find merger simulation ill suited to the airline industry, because pricing is not well explained by any oligopoly model that can be used in merger simulation." This is consistent with my conclusion that the evidence in this paper suggests a need for richer models of firm conduct.

ery of marginal costs, and postmerger prediction. Section III reports the estimated demand elasticities, and Section IV compares the predicted and observed postmerger price changes. Section V describes how the model can be used to decompose the observed changes in individual components and discusses the results. Section VI briefly concludes.

II. Merger Simulation Methodology

In general, merger simulation consists of three components: estimation of consumer demand using premerger data, recovery of premerger marginal costs under a maintained assumption about firm conduct, and prediction of postmerger prices under specific assumptions about what does and does not change as a result of the merger. This section describes each of these components in turn.

A. *Demand Estimation*

The development of demand models for industries with differentiated products has been an active area of research within empirical industrial organization, with most of the models falling into one of two categories: functional-form models, in which the econometrician chooses a parametric functional form to represent the relationship between quantities and prices, and discrete-choice models, in which the econometrician explicitly specifies the underlying consumer utility function from which the demand relationship is derived. The former category includes the Almost Ideal Demand System (AIDS) and constant-elasticity models, while the latter includes the logit, nested logit, and the random-coefficients model of Berry, Levinsohn, and Pakes (1995). In the context of merger simulation, antitrust practitioners have made use of both classes of model to estimate demand in a variety of industries.

Functional-form models, however, do not generally lend themselves well to product-level demand estimation in airline markets, for several reasons. First, unlike the typical consumer products industry, where the econometrician may have a long time series of weekly scanner data from each geographic market, the available data from the airline industry are quarterly. As a result, one would need many years of data to estimate a separate demand model for each market. Moreover, in many other industries, the same group of products is observed in numerous markets where demand for each product may be similar; by contrast, each geographic market in the airline industry consists of an entirely different set of products. For example, while one might reasonably impose a restriction that the cross-price elasticity between two particular brands of beer is the same in each city, one could not plausibly assume that substitution between two airlines is the same in every city-pair, since the quality of the service that each offers (for example, whether the service requires a connection) may be very different on different routes. By contrast, the discrete-choice framework overcomes this issue by modeling demand as a function of the characteristics of the available products. This approach does not require that any individual product appear in the data more than once. For this reason, I use a discrete-choice demand model in this paper, based on an underlying consumer utility function.

Within each market, defined as an ordered origin-destination city-pair,[6] each consumer chooses among a set of products, where a product is defined as an airline-itinerary combination.[7] Each market also includes an outside good, which represents the option not to purchase any of the available itineraries. A consumer's utility is modeled as a simple function of five observable product characteristics: price (P), flight frequency (Flights), airport presence (AptP), whether the itinerary is direct (that is, it does not require a change in aircraft) (Direct), and the total distance flown (Miles). Price is computed as a passenger-weighted average of all fares reported for a given product. Flight frequency proxies for the likelihood that a consumer will be able to find a flight close to her preferred time of departure.[8] Airport presence, defined as the airline's share of all traffic at the origin airport, is included in the utility function to reflect the fact that "the dominant airline at an airport attracts a disproportionate share of the traffic that originates at the airport" (Borenstein 1991, p. 1260).[9] All else equal, consumers will generally prefer direct itineraries over connecting itineraries, and within any market, consumers will prefer to travel over shorter distances.

Adopting a loglinear functional form[10] yields the following expression for the utility of consumer i from product j at time t:

$$\begin{aligned} u_{ijt} = {} & \beta_P \ln P_{jt} + \beta_F \ln \mathrm{Flights}_{jt} + \beta_A \ln \mathrm{AptP}_{jt} \\ & + \beta_D \mathrm{Direct}_j + \beta_M \ln \mathrm{Miles}_j + \xi_{jt} + \varepsilon_{ijt}, \end{aligned} \tag{1}$$

where ξ_{jt} is unobserved product quality and ε_{ijt} is the consumer-specific deviation from mean utility.[11]

[6] A city is defined as a metropolitan statistical area (MSA), possibly including more than one airport.

[7] An itinerary is defined as an ordered sequence of airports through which a passenger travels.

[8] For an itinerary with more than one outbound segment, flight frequency is measured as the geometric mean of the frequency for each outbound segment.

[9] Explanations for this finding include consumer preferences for familiarity, economies of scale in local advertising, and the use of marketing devices such as frequent-flyer programs and travel agent commission overrides.

[10] For an individual consumer, the marginal disutility associated with an increase in price is likely to be approximately constant, so price would enter an individual's utility function linearly. However, some simple experimentation suggested that the demand function implied by the loglinear functional form fits the data better. I do not expect that the qualitative conclusions of this paper are significantly affected by this choice of functional form.

[11] The term "mean utility," attributable to Berry (1994), denotes the component of utility that does not vary across consumers. In fact, "mode utility" would be more precise, since the extreme-value distributions that are typically assumed for ε do not have a mean of zero, but I will follow convention and use the standard term.

To control for components of unobserved product quality that are constant within significant subsets of the data, I include fixed effects for airlines, markets, time periods, and airports (in multiairport cities). Formally,

$$\begin{aligned}\xi_{jt} = {} & \text{Airline}_j\alpha_a + \text{Time}_t\alpha_t + \text{Mkt}_j\alpha_m \\ & + \text{OrigApt}_j\alpha_o + \text{DestApt}_j\alpha_d + \nu_{jt},\end{aligned} \tag{2}$$

where the variables are vectors of indicator variables and ν is the component of unobserved product quality that is not constant along these dimensions.

Within this class of discrete-choice model, different assumptions about the distribution of ε correspond to different ways of modeling how the idiosyncratic component of consumers' preferences depends on product characteristics. For example, in a simple logit model, the distribution of ε does not depend on product characteristics at all, so the substitution between products is similarly independent of the products' characteristics. By contrast, more general models allow for a more flexible distribution for ε, so products with similar characteristics are closer substitutes than products with different characteristics. For example, in the nested logit model, products are grouped into nests according to some observed characteristic, where products within the same nest will generally be closer substitutes than products in different nests, all else equal. In a further generalization, substitution between products can be permitted to depend on multiple discrete characteristics with the generalized extreme value (GEV) model of Bresnahan, Stern, and Trajtenberg (1997).[12] Again, the intuition is that products with similar characteristics are permitted to be closer substitutes than products with different characteristics.[13]

In this paper, I compare the results from two models: (1) a simple nested logit, where all itineraries are placed in a single nest but separated from the outside good, and (2) a GEV model that, in addition to the nest for the outside good, allows substitution to depend on two product characteristics: whether the itinerary is direct or connecting and which pair of airports form the origin and destination, for city-pair markets with more than one airport at either endpoint city.[14,15]

[12] Bresnahan, Stern, and Trajtenberg refer to the discrete characteristics that determine product substitution patterns as "principles of differentiation."

[13] The random-coefficients model of Berry, Levinsohn, and Pakes (1995) allows still more flexibility, but at greater computational cost. In a recent application of a random-coefficients model to airline data, Armantier and Richard (2005, p. 14) note that "the estimation procedure takes nearly a month to converge."

[14] Although there are only a few cities with more than one airport (nine out of 114 cities in my data), these tend to be large cities that appear disproportionately in the data. In the sample I use here, 66 percent of the observations are in markets where travel is available to or from more than one airport.

[15] It is surprisingly rare in the airline economics literature to allow for imperfect substitution between airports. More commonly, airports within the same metropolitan area are treated as identical or as completely separate markets. One exception is Hartmann (2001).

Both of these specifications allow the data to determine the degree to which similar products are closer substitutes than dissimilar products, through a vector of free parameters, ρ, that define the distribution of ε. In my GEV model, ρ has three elements: ρ_0, which indexes the extent to which different itineraries (inside goods) tend to be closer substitutes for each other than for the outside good; ρ_D, which indexes the extent to which direct itineraries tend to be closer substitutes for each other than for connecting itineraries, and vice versa; and ρ_A, which indexes the extent to which itineraries with the same endpoint airports tend to be closer substitutes for each other than for other itineraries in the market. Parameter ρ_0 is bounded between zero and one, and each of the others is bounded between zero and ρ_0. Each parameter is inversely related to the relative strength of within-group substitution. For example, if ρ_D equals ρ_0 (its upper bound), a direct itinerary is no closer a substitute for another direct itinerary than it is for a connecting itinerary, all else equal. As ρ_D approaches zero (its lower bound), there is no substitution between direct and connecting itineraries. The simple nested logit model corresponds to the special case in which $\rho_A = \rho_D = \rho_0$.

If each consumer purchases the product that maximizes her utility, product *j*'s share of potential market sales can be expressed as a function of the prices and characteristics of all products in the market.[16] Note that the shares are defined as relative to potential market sales rather than actual market sales. This allows for some fraction of potential consumers to choose the outside good and for this fraction (the share of the outside good) to vary with changes in the prices or characteristics of the available products. As a result, the aggregate demand for air travel is not assumed to be perfectly inelastic. The total market potential for each city-pair is assumed to be equal to the geometric mean of the populations of the two endpoint cities.[17,18] Intuitively, estimation then consists of finding the parameters that most closely match the predicted market shares with the observed sales of each product.

The last step before estimation is to identify reasonable instruments in order to account for potential correlation between the observed and unobserved characteristics. In this application, not only price but also flight fre-

[16] The analytical solution for the market share function in the generalized extreme value (GEV) model is given in the Appendix.

[17] Experimentation indicated that allowing the market potential to be proportional to the population, rather than equal to it, would not have a significant effect on the results.

[18] An alternative to defining the potential market size on the basis of population is to assume (or estimate) a value for the aggregate elasticity. For any set of parameter values, this aggregate elasticity implies a particular size of the potential market. This approach is suggested by Werden and Froeb (1994) in the context of the simple logit model. The method I use here is suggested by Berry (1994) and has been widely used in the subsequent literature. The elasticity method may be more appropriate in applications in which the econometrician is more confident in the estimated aggregate elasticity than in the accuracy of the assumed relationship between the market potential and population. A detailed comparison of the two methods has not, to my knowledge, been attempted and is beyond the scope of the present paper.

quency and airport presence are likely to be endogenous. The basic identifying assumption that I use to construct a set of instruments is that each airline's overall network structure is exogenous. That is, the set of routes served by each airline is assumed to be independent of the unobserved component of utility (ν). This is admittedly a strong assumption but is analogous to the standard assumption in the literature on discrete-choice demand estimation (for example, Berry, Levinsohn, and Pakes 1995), that variation in the set of available products across markets and over time is exogenous.

To construct instruments for flight frequency and airport presence, I exploit the overlap between itineraries in different markets. In particular, the number of flights on a segment will generally increase with the number of distinct itineraries that include the segment and with the average population of the endpoint cities across all itineraries that include the segment. The intuition here is that an airline will tend to operate more flights on a segment that flows into a major hub where connections to many different endpoints will be available. An airline's presence at an airport will increase with the total number of itineraries offered by the airline out of the airport and will decrease with the total number of itineraries offered by rival airlines. Similarly, it will increase with the fraction of the airline's itineraries that are direct and decrease with the fraction of rivals' itineraries that are direct. Again, this is simply a way of measuring the "hubness" of the airport. Finally, to construct instruments for price, I use the number of products and the means of product characteristics within markets and for products with similar characteristics, following Bresnahan, Stern, and Trajtenberg (1997).[19] The intuition behind the expected correlation between these instruments and price is that, in the absence of perfectly collusive conduct, price will tend to fall with an increase in the number of alternative products, the number of relatively close substitutes, or the attractiveness of those alternatives' characteristics. Once this set of instruments has been constructed, estimation follows Berry's (1994) procedure.

B. Firm Conduct and Marginal Cost

With the estimated parameters of the demand function in hand, an assumption about firm conduct is sufficient to allow marginal costs to be recovered. The standard approach in the literature on merger simulation is to assume static Nash-Bertrand conduct: firms choose prices noncooperatively to maximize a short-run profit function. The widespread use of this assumption is partly due to its mathematical tractability and partly due to the belief that dynamic behaviors, such as tacit collusion, are more difficult to sustain when products are differentiated. For the purposes of evaluating how

[19] Since some of the available product characteristics are themselves endogenous (flight frequency and airport presence), I instead use the means of their corresponding instruments.

standard practices perform in a particular application, I maintain the assumption of static Bertrand conduct in the computations that follow. In interpreting the results, however, I will consider the possibility that the observed price changes actually reflect changes in conduct or errors in the estimated markup due to misspecified conduct. Explicitly incorporating into the model alternative assumptions about firm behavior, such as quantity setting (Cournot) and collusive conduct, and attempting to identify mergers' effect on conduct would be interesting areas for future research but are beyond the scope of this paper.

Given the assumption of static Bertrand conduct, the first-order conditions for firms' profit maximization decision make it possible to solve for marginal cost. For product *j*,

$$q_j + \sum_{k \in S_j} (p_k - c_k) \frac{\partial q_k}{\partial p_j} = 0, \tag{3}$$

where *p*, *q*, and *c* are prices, quantities, and marginal costs, respectively, and S_j is the set of all products produced by the same firm as product *j*. Price and quantity are observed in the data, and the derivatives of the demand function can be computed from the estimated demand function. For a market with *N* products, this yields a system of *N* linear equations, which can easily be solved for *c*:

$$c = p + \Delta^{-1} q, \tag{4}$$

where Δ is an $N \times N$ matrix such that $\Delta_{jk} = \partial q_k / \partial p_j$ if $k \in S_j$, and zero otherwise.

Note that marginal costs are essentially computed as a residual: the difference between observed prices (p) and estimated markups ($-\Delta^{-1}q$). Just as the unobserved product quality, ξ, measures the component of consumer utility that is unaccounted for by observed characteristics, the marginal cost, *c*, represents the component of price that is unaccounted for by the estimated markup. Because the estimated markup relies heavily on the assumption of static Bertrand conduct, it may be more appropriate here to refer to *c* as the supply-side residual rather than as marginal cost, in order to remain agnostic a priori about whether the changes in *c* implied by the model represent actual changes in cost or whether they simply reflect prediction errors due to misspecified conduct.

C. Postmerger Prediction

The final stage of merger simulation is to use the recovered marginal costs and demand estimates to predict the postmerger equilibrium prices. The role of the ownership set, S_j, in a firm's first-order conditions (equation [3]) is particularly important here. Rather than maximize the profits associated with each product individually, a profit-maximizing multiproduct firm will take into account the fact that some of the sales lost to a price increase will be diverted to its other products and hence will not represent a loss in overall profits. After a merger, as more substitute products enter a single firm's portfolio (that is, as the set S_j expands to include the acquired products), the firm's incentive to keep prices low to avoid losing sales to rivals will diminish. Hence, the standard way of simulating a merger is simply to change the ownership set in each market while holding the set of products and all of their characteristics (including ξ and c) constant. In this way, a merger is modeled as equivalent to a bilateral collusive arrangement between the merging firms (a point noted by Baker and Bresnahan 1985). For each market, the first-order conditions given in equation (3), together with the estimated demand function, define a system of nonlinear equations in price.[20] Standard numerical methods allow this system to be solved for the postmerger equilibrium prices.

III. Estimated Demand Elasticities

The data used here are drawn primarily from the Department of Transportation's (DOT's) Origin and Destination (O&D) survey, a quarterly 10 percent sample of all tickets sold by domestic U.S. airlines each quarter. Information on flight frequency is from the DOT's Service Segment Databank. For demand estimation, I use all 4 quarters from 1985, predating the five mergers studied here. The sample is restricted to round-trip coach-class travel between a set of 131 major U.S. airports, with at most one connection in each direction. A market is defined as a directional city-pair, where airports are grouped into cities according to Census Bureau definitions of metropolitan statistical areas (MSAs). City-pair markets with fewer than 50 passengers in any quarter are removed from the data, as are observations with fewer than five passengers or with extremely low or high prices. Also, I remove itineraries with a connection that cannot plausibly be a simple layover[21] and routes where a reporting airline does not report at least five flights during the quarter.[22]

Table 1 reports the estimated parameters from the two demand models: the simple nested logit model with a nest for the outside good and the more flexible GEV model. Several points are worth noting. First, all parameters in both models are highly significant with the expected sign, and the elements of ρ satisfy the necessary restrictions ($0 < \rho_h \leq \rho_0 \leq 1$, $h = A, D$). Second,

[20] Unlike solving for c when price is known, as described in the previous section, solving for price when c is known requires nonlinear methods because price enters into the (nonlinear) demand function, while c does not.

[21] For example, New York–Los Angeles–Boston is not a reasonable option for travelers in the New York–Boston market.

[22] The Service Segment data from this time period do not include flight frequency for the smallest or newest airlines. In these cases, I use an imputed estimate of flight frequency based on other observables.

TABLE 1

Estimated Demand Parameters

	Nested Logit		GEV	
ln P	−2.54	(.34)	−1.66	(.20)
ln Flights	.968	(.057)	.685	(.044)
ln AptP	.0958	(.0088)	.0663	(.0061)
Direct	2.22	(.12)	1.60	(.10)
ln Miles	−.748	(.083)	−.575	(.060)
ρ_0	.595	(.037)	.557	(.035)
ρ_A	ρ_0		.380	(.027)
ρ_D	ρ_0		.478	(.032)

Note.—Demand estimates are based on 42,613 airline-itinerary-quarter observations from 1985. Figures in parentheses are standard errors, robust to heteroskedasticity and within-market autocorrelation. GEV = generalized extreme value.

the restrictions of the nested logit ($\rho_A = \rho_D = \rho_0$) are easily rejected, which indicates the importance of allowing for closer substitution between itineraries with similar characteristics. Because the nested logit model is rejected, the comparison (later in the paper) between the postmerger predictions of the two models is not motivated by a desire to choose which is a more accurate representation of consumer demand: this is already possible using only premerger data. Rather, the comparison is intended to illustrate the effect on prediction of using a less accurate demand model.

One way to check that these estimated demand parameters are reasonable is to consider the implied aggregate demand elasticity. A convenient feature of this class of models is that the aggregate elasticity in any market is especially simple to compute:

$$\left| \frac{\partial\left(\sum_{j\neq 0} q_j(\lambda \boldsymbol{p})\right)}{\partial \lambda} \frac{1}{\sum_{j\neq 0} q_j(\lambda \boldsymbol{p})} \right|_{\lambda=1} = \beta_p s_0,$$

where s_0 is the outside good's share of the potential market and $\boldsymbol{p}$ is a vector of all prices in the market.[23] Because the outside good's share is generally close to one,[24] β_p approximately equals the aggregate elasticity for most markets. This highlights one significant difference between the nested logit

[23] Werden and Froeb (1994) derive this relationship for the simple logit model (their expression is slightly different because they use a utility function that is linear in price, not loglinear), and it is straightforward to extend it to the nested logit. Comparable analytical results for the GEV model are considerably more complicated, but the relationship can be verified numerically.

[24] The outside good's share will usually be close to one when we define the market size as proportional to market population, with the choice of the constant of proportionality constrained by the requirement that total market sales not exceed total market potential (that is, the outside good's share is never negative). This is a result of the highly skewed distribution of the ratio of market sales to market population.

TABLE 2

AVERAGE ESTIMATED OWN- AND CROSS-PRICE ELASTICITIES

	Number of Products	Average Own-Price Elasticities		Number of Pairs	Average Cross-Price Elasticities	
		Nested Logit	GEV		Nested Logit	GEV
Northwest-Republic	818	−3.8	−3.2	1,148	.44	.57
TWA-Ozark	479	−3.7	−3.2	588	.49	.67
Continental–People Express	797	−4.0	−3.4	1,348	.25	.29
Delta-Western	116	−4.0	−3.6	178	.23	.30
USAir-Piedmont	843	−3.9	−3.3	1,624	.30	.36

NOTE.—Own-price elasticities were calculated for each product offered by one of the merging carriers in an overlap market during each quarter of the premerger period. Cross-price elasticities were calculated for each competing pair of products offered by the merging carriers in an overlap market during each quarter of the premerger period. Reported figures are unweighted means across all calculated elasticities, for each estimated demand model. GEV = generalized extreme value.

and GEV results: the nested logit estimates ($\beta_p = -2.54$) imply a considerably more elastic aggregate demand than the GEV estimates ($\beta_p = -1.66$). A comparison with other research on demand elasticity in the airline industry suggests that the GEV estimate is more accurate. For example, using estimates from Oum, Gillen, and Noble (1986), Brander and Zhang (1990, p. 571) calibrate a model of airline competition using a base-case elasticity of −1.6 and argue that values of −1.2 to −2.0 "probably cover the reasonable range." Hence, the formal rejection of the nested logit model against the alternative of the GEV is consistent with prior beliefs about the aggregate demand elasticity.[25]

The more relevant quantities for merger simulation, however, are the individual product elasticities. The own-price elasticity of the demand curve facing an individual product indicates the extent to which consumers are willing to switch to alternatives after a marginal price increase and hence measures the overall competition faced by that product. The cross-price elasticity between two products in the same market measures how well the products substitute for each other. Intuitively, the anticompetitive effect of a merger will tend to increase with the degree of substitution between the products of the merging firms.

Table 2 summarizes the own- and cross-price elasticities implied by the demand estimates, for markets in which the merging firms competed with each other prior to the merger. Comparing the results from the two models, we see that the GEV model consistently implies smaller own-price elasticities (in absolute value) but larger cross-price elasticities than the nested logit model. In other words, under the GEV model, when a product's price in-

[25] Morrison and Winston (1996) assume a baseline elasticity of −.7, with reasonable range of −.5 to −1.0. Thus, the GEV results reported here can be interpreted as supporting Brander and Zhang's (1990) assumption that demand for air travel tends to be more elastic.

creases marginally, fewer of its consumers are driven away, but a larger share of those diverted consumers choose other flights rather than leave the market entirely. This is consistent with the GEV model's implying a lower aggregate elasticity, as noted above. The nested logit's smaller cross-price elasticities suggest that that model will tend to underpredict the postmerger price changes.

Comparing the results across mergers, we see that the cross-price elasticities for competing products offered by Northwest and Republic or by TWA and Ozark are notably higher than the cross-price elasticities for products offered by other pairs of merging carriers. This is a direct consequence of the fact that the Northwest-Republic and TWA-Ozark mergers involved carriers with one or more shared hubs. Operating out of a common hub, the merging carriers in these two cases were more likely to offer overlapping nonstop service in the same city-pair markets, which suggests that their services were often particularly close substitutes for each other, just as indicated by the estimated cross-price elasticities. As a result, the postmerger price increases predicted by merger simulation will tend to be higher for these two mergers.

While the estimated elasticities contain valuable information about the extent of competition between the merging firms, simple averages and other summary statistics do not always yield a straightforward interpretation. It may be more useful to summarize the information from the estimated demand elasticities in a way that captures the full expected effect of the merger on pricing incentives. This is precisely what is accomplished through merger simulation. As noted by Baker and Rubinfeld (1999, p. 415), when merger simulation does not involve predicting changes in cost or conduct, it essentially amounts to "transforming the demand elasticities into a more informative metric."

IV. Predicted and Observed Postmerger Price Changes

For the purposes of this paper, I focus on the set of markets where the two merging airlines faced significant competition from each other prior to the merger (overlap markets). This focus on markets with premerger overlap is not based on a presumption that the mergers' effects in other markets were negligible. A merger may have effects on prices in other markets if the cost structure or overall service quality of the combined firm is altered, if merger-induced changes in the route networks facilitate collusive conduct (for example, by increasing multimarket contact), or if firms' pricing decisions involve dynamic considerations, such as entry deterrence, that may be influenced by the merger.[26] The standard methods of merger simulation, how-

[26] The potential for merger-induced changes in costs to affect nonoverlap markets is illustrated by Brueckner, Dyer, and Spiller's (1992) study of the Northwest-Republic and TWA-Ozark mergers. These authors predict significant price decreases in markets where only one of the

ever, capture only those price changes that stem from a loss of within-market competition. For this reason, focusing exclusively on overlap markets is appropriate for the purposes of evaluating the performance of these methods, even though it would not generally be appropriate as a means of evaluating the aggregate effect of the merger.

For each of the five mergers of interest, I define the set of overlap markets as those city-pairs where both carriers provided service during all 4 quarters of 1985, excluding any markets where the merger would be considered "unlikely to have adverse competitive consequences" under the 1992 *Horizontal Merger Guidelines* (U.S. Department of Justice and the Federal Trade Commission 1997, p. 16).[27] The markets excluded under this criterion are generally those where at least one of the merging airlines has less than 5 percent market share. The number of overlap markets identified in this way ranges from 11 for the Delta-Western merger to 78 for the Northwest-Republic merger.

For each of these overlap markets, I use the demand estimates from the nested logit and GEV models, along with data from the premerger period (defined here as calendar year 1985), to calculate predicted postmerger prices using the simulation methodology described above. As a basis for comparison, I also calculate predicted postmerger prices using a simple linear model. In particular, I regress log price on concentration (using the Herfindahl-Hirschman Index [HHI]), with controls for route distance and whether the itinerary is direct and with fixed effects for each quarter. To account for endogeneity in concentration, I estimate the model using the two-stage least squares method, with the number of airlines in the market as an instrument for HHI.[28] Predicted prices can then be calculated from the change in concentration implied by the premerger market shares of the merging firms. This approach is conceptually problematic, since extrapolating from an empirical relationship between price and concentration implicitly relies on strong assumptions about the underlying supply function. Nonetheless, the predictions from the simple linear model can serve as a useful benchmark against which to compare the predictions from the more computationally demanding simulation approach.

A more important benchmark is the pattern of outcomes that are actually observed in the postmerger data. Accordingly, I measure the average passenger-weighted fare for each of the overlap markets for each merger

merging firms offered service prior to the merger, due to postmerger economies of traffic density.

[27] A market satisfies this condition if the postmerger Herfindahl-Hirschman Index (HHI) is less than 1,000, if the postmerger HHI is less than 1,800 and the change in the HHI is less than 100, or if the change in the HHI is less than 50. For the purposes of computing the HHI, I use market shares based on revenues, although very similar results are obtained with passenger shares.

[28] I have also estimated the model using the ordinary least squares method. A Hausman specification test allows the ordinary least squares estimates to be rejected against the alternative of two-stage least squares estimates at any level of significance.

TABLE 3

Average Observed and Predicted Price Changes in Overlap Markets: 1985 versus First Year Post Merger

	Number of Overlap Markets	Observed Relative Price Change (%)	Predicted Price Change (%)		
			Nested Logit	GEV	Linear Regression
Northwest-Republic	78	7.2 (.8)	7.0 (.5)	19.8 (1.9)	21.6 (1.5)
TWA-Ozark	50	16.0 (2.3)	7.2 (.6)	20.8 (2.5)	21.5 (1.8)
Continental–People Express	67	29.4 (3.6)	3.4 (.3)	6.4 (.6)	9.8 (1.1)
Delta-Western	11	11.8 (4.6)	3.3 (1.0)	7.6 (3.1)	7.2 (2.7)
USAir-Piedmont	60	20.3 (2.6)	4.5 (.6)	12.7 (2.2)	15.7 (1.9)

Note.—Figures reported are unweighted means. Standard errors for the mean (assuming normality) are reported in parentheses. These reported standard errors do not take into account the variance of the estimated demand parameters but are simply computed from the empirical variation across markets in the predicted prices. As a result, the degree of statistical precision is somewhat overstated, although I expect this effect to be small, given the relatively high precision of the estimated demand parameters. GEV = generalized extreme value.

during the first full year after the operations of the merged firms were fully integrated (the postmerger period). Some portion of the price change between the premerger and postmerger periods is properly attributed to causes other than the merger, such as overall inflation, fluctuations in the prices of fuel and other inputs, and changes in aggregate demand. In order to remove this type of variation and more accurately measure the component of the price change that is due to the merger, I calculate a relative price change for each market, defined as the difference between the observed percentage price change and an average industry-wide percentage price change, conditional on route distance, across all markets in the data.[29]

Table 3 summarizes the observed and predicted price changes for each of the five mergers. Several points are worth noting. First, the average observed relative price increases are both statistically and economically significant.[30]

[29] Formally, the average industry-wide percentage price change conditional on route distance is calculated for each market as the percentage difference between the predicted value from a univariate loglinear regression of price on distance using premerger data and the predicted value from a similar regression using postmerger data. This approach allows macroeconomic changes (such as fuel price changes) to be netted out from the measured effect of the merger, even when such macroeconomic changes have different effects on airfares depending on the route distance.

[30] Previous studies looking at one or more of these mergers have produced widely varying estimates of their price effects. See, for example, Borenstein (1990), Werden, Joskow, and Johnson (1991), Kim and Singal (1993), and Mechanic (2002). Most of these studies focus only on the Northwest-Republic and TWA-Ozark mergers. My estimate of the Northwest-Republic price effect is broadly consistent with this prior research, but I find a notably higher price increase associated with the TWA-Ozark merger. This divergence, as well as the wide variation in prior estimates, suggests that the estimated price effects are fairly sensitive to seemingly minor differences in how they are calculated (for example, which markets and time periods are selected, how industry-wide effects are controlled for, and how the raw data are

Particularly striking is the large (~30 percent) price increase following the Continental–People Express merger. This is consistent with the hypothesis that financially distressed carriers, such as People Express (and its subsidiary Frontier Airlines), have a tendency to charge unsustainably low prices.[31]

Second, the GEV demand estimates imply significantly greater predicted price increases than do the nested logit estimates. This is exactly as expected on the basis of the larger estimated cross-price elasticities obtained from the GEV model, but the magnitude of the difference is not immediately obvious from looking at the elasticities alone. In Table 2, the average cross-price elasticities for the GEV model are generally between 20 and 40 percent greater than those for the nested logit model. By contrast, the average predicted prices for the GEV model are generally between two and three times as great as those for the nested logit model.

Third, the simple linear regression model implies price changes that are surprisingly similar to the price changes implied by full simulation with the GEV demand estimates. This suggests that, for this industry and time period, the empirical relationship between price and concentration appears to be closely related to the increase in unilateral pricing power that is identified through formal simulation.

Finally, there are generally significant differences between the average observed price changes and the average predicted price changes.[32] The two exceptions are the TWA-Ozark and Delta-Western mergers, where the differences between the average observed and predicted price changes are modest relative to the variance around those averages.[33] For the other three cases, however, the differences are clearly significant. For Northwest-Republic, simulation with the GEV model substantially overstates the observed price effects, while for Continental–People Express and USAir-Piedmont, simulation understates the effects. These findings suggest that, at least for these three mergers, the change in unilateral pricing incentives was not the only important component of the overall effect of the merger on prices. In the next section, in order to determine what other components may also have been important and to assess their relative importance, I incorporate evidence from post-merger data into the estimated structural model.

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cleaned to eliminate coding errors, outliers, and other anomalies). Accordingly, the results reported here, as well as those in the earlier studies, should be interpreted with caution.

[31] Busse (2002) finds evidence that between 1985 and 1992, airlines in worse financial condition were more likely to start fare wars.

[32] From this point in the paper forward, the predicted price changes that I discuss are those obtained with the GEV demand model.

[33] For example, in the case of TWA-Ozark, the average predicted price change is 21 percent, with a standard error of 2.5, so the prediction is (barely) within 2 standard errors of the average observed price change, 16 percent. A similar analysis applies to the Delta-Western merger. This comparison of averages indicates that there is little evidence of systematic bias in the predictions for these two mergers but does not imply that the predicted price change for any individual market is necessarily close to the observed price change in that market.

V. Accounting for the Differences between the Predicted and Observed Price Changes

The availability of postmerger data, combined with the estimated demand model and the assumed model of firm conduct, allows the observed postmerger price change to be decomposed into its component effects. That is, by incorporating postmerger data into the model, I measure the impact on prices of several specific postmerger changes in the marketplace. In particular, I consider four categories of such changes whose combined impact accounts for the entire observed postmerger price change. The first is the loss of competition associated with the changed incentives of the merged firm: while the two firms initially set prices to maximize their individual profits, the merged firm will set those same prices to maximize the combined pool of profits. The impact of this loss of competition is precisely what is measured by the merger simulations described in the previous section.

The second category of postmerger changes consists of all changes that can be directly observed in the postmerger data (other than price and quantity). In particular, this includes any changes in the set of products that are available in each market, such as changes caused by entry or exit, and any changes in the nonprice observed variables that enter the demand function and vary over time (flight frequency and airport presence). The third category consists of unobserved changes in demand, such as changes in service quality or other unobserved product characteristics. In the notation of the model, this is the demand-side residual, ξ. Postmerger values of ξ can be recovered from the demand model using postmerger data on price, quantity, and other observables. Given the observed postmerger prices, I solve for the value of ξ for each product that equates the observed postmerger quantities with the quantities predicted by the demand model.

Finally, the fourth category consists of unobserved supply-side changes. Under the assumption of static Bertrand conduct, this simply amounts to a change in marginal cost. More generally, this component of the observed price change would include the effect of any changes in firm conduct or any prediction errors due to misspecification of the model. In the notation of the model, this is the supply-side residual, c. Postmerger values of c can be recovered from postmerger data in the same way that the premerger values were recovered to perform the original simulations: given the estimated demand elasticities, I find the value of c for each product so that the observed prices are consistent with static Bertrand-Nash equilibrium.

To measure the impact of each component on prices, I use the estimated model to solve for the equilibrium prices under various counterfactual assumptions about what does and does not change after the merger. Standard merger simulation is simply a special case of this, where all variables (except price and quantity), including ξ and c, are held fixed at premerger levels, while the first-order conditions for profit maximization are changed to reflect

TABLE 4

ESTIMATED AVERAGE COMPONENT PRICE EFFECTS IN OVERLAP MARKETS

	Estimated Component Price Effect (%)				Total Price Effect (%)
	Loss of Competition	Observed Changes	Unobserved Demand-Side Changes (ξ)	Unobserved Supply-Side Changes (c)	
Northwest-Republic	19.8	−1.4	.9	−10.1	7.2
TWA-Ozark	20.8	−2.2	−.8	−1.0	16.0
Continental–People Express	6.4	.7	.2	20.5	29.4
Delta-Western	7.6	−1.5	−.5	6.0	11.8
USAir-Piedmont	12.7	2.0	−1.9	6.7	20.3

NOTE.—Figures reported are unweighted means for the estimated price effects across each of the overlap markets. The estimated effect of the loss of competition is the predicted price change from the merger simulation with the generalized extreme value model, as reported in Table 3. Observed changes include changes in the set of available products and the demand-side effects of changes in flight frequency and airport presence. The remaining unexplained portion of the total price effect is decomposed into demand-side and supply-side components by finding the values that make the observed postmerger prices and quantities consistent with equilibrium in the estimated model of demand and supply. The total price effect is the observed price change reported in Table 3. All price effects are calculated relative to industry averages conditional on route distance.

the postmerger ownership structure. Solving for the equilibrium prices under these assumptions yields the predictions reported in the previous section, which can be interpreted as a measure of the price impact of the first component, the loss of competition between the merging firms.

To measure the impact of the next component, the changes in observed demand variables and the set of available products, I solve for the equilibrium prices under the postmerger ownership structure, with postmerger values of the observed variables, while holding the unobservables, ξ and c, fixed at premerger levels. The difference between these predicted prices and the predictions from the previous merger simulations can be interpreted as a measure of the price impact of the changes in observed demand variables and the set of available products. Similarly, to measure the impact of unobserved changes in demand, ξ, I solve for the equilibrium prices under the postmerger ownership structure, with postmerger values of both observed and unobserved demand variables and with premerger values of c. The incremental change in predicted prices can then be interpreted as a measure of the price impact of unobserved changes in demand. Finally, the contribution of the unobserved supply-side changes is, by construction, equal to the remaining unexplained portion of the observed price change.

Table 4 reports the estimated average price effect of each component and the total price effect observed in the postmerger data.[34] The first column is simply the predicted price change from the merger simulation using pre-

[34] Because the price effects are reported as percentages, the individual component effects do not add up arithmetically to the total effect. Rather, they "add up" multiplicatively. For example, looking at the last row of the table, $1.127 \times 1.020 \times .981 \times 1.067 = 1.203$.

merger data, while the last column reports the average price effect that was observed in the postmerger data. The three columns in the middle show the relative importance of the other three components. The key point to note from these results is that, for almost every merger, the unobserved supply-side changes account for most of the difference between the observed and predicted price effects.

For the Northwest-Republic case, the substantial overprediction is almost entirely accounted for by a large reduction in supply-side residual. One possible interpretation is that the merger generated substantial efficiencies, which led to marginal cost reductions sufficiently large to pass through a 10 percent fare decrease. This interpretation, however, is inconsistent with contemporaneous anecdotal evidence regarding the costs Northwest incurred to integrate two unionized labor forces.[35] A more plausible interpretation is that some degree of tacit coordination between Northwest and Republic existed prior to merger. Under this scenario, merger simulation overpredicts the price effect because the Bertrand oligopoly model overstates the extent of premerger competition. This interpretation, although formally outside of the model, is consistent with the finding that the unexplained component of the price effect was driven largely by supply-side changes. By contrast, the evidence rejects the hypothesis that demand-side changes, such as reductions in service quality, or postmerger entry by rivals played a significant role in restraining Northwest's postmerger fare increases.[36]

The case of the TWA-Ozark merger is the one exception to the general finding regarding the importance of unobserved supply-side effects. In contrast to the other cases, observed changes account for most of the prediction error. Inspection of the data shows that TWA experienced modest levels of postmerger entry by rival carriers and reductions in its own flight frequency in overlap markets, to a greater extent than for the other mergers. Both of these changes are consistent with a modest fare-reducing effect of demand-side observables, as indicated in the results. It does, however, create a puzzle: while the demand-side effect of frequency reductions is to put downward pressure on prices, the same reductions would be expected to have a supply-side effect putting upward pressure on prices by lowering the firm's capacity constraint. This would be expected to appear in the results as an increase in the effect of changes in the supply-side residual, c, but in fact, no such increase is evident. Possible explanations for this include the possibilities that postmerger efficiencies offset this effect or that, again, some degree of tacit coordination existed premerger.

[35] See, for example, *New York Times* (1987, p. B5). "Since the merger, . . . Northwest has spent more than $232 million to increase wages and buy back [employee-owned] stock."

[36] It should be noted that the only postmerger effects considered in this paper are those that occurred within the first year after the merger was completed. To the extent that competitive responses such as entry took longer to occur, their effects would not be captured in my results.

In the case of the Continental–People Express merger, large increases in the supply-side residual account for nearly all of the substantial underprediction. Under the assumption of static Bertrand conduct, this would imply extraordinarily large postmerger inefficiencies: marginal cost increases passed through to yield a 20 percent price increase. Inefficiencies of this magnitude seem intuitively implausible, which suggests that a change in firm conduct played an important role in the observed price increases. A natural interpretation is that People Express simply behaved as a maverick, with a pricing strategy focused on short-run profit maximization, while Continental moved toward a strategy of coordinated pricing after the merger. A somewhat richer interpretation would allow for the possibility that as a carrier in financial distress, People Express (and its equally distressed subsidiary Frontier Airlines) may have been pricing below the short-run profit-maximizing level in order to raise cash to meet immediate financial obligations.[37] Finally, reversing the direction of causality between financial distress and aggressive pricing conduct, it may be that People Express became financially distressed simply because its managers adopted an unsustainable and ultimately unprofitable business strategy of charging extremely low fares.[38]

Finally, in the last two cases, the Delta-Western and the USAir-Piedmont mergers, the underprediction is again largely accounted for by increases in the supply-side unobservables. In comparison with the effects of the Continental–People Express merger, these supply-side effects were relatively modest. Given prior evidence on the large costs of labor force integration following these mergers, particularly USAir-Piedmont (see Kole and Lehn 2000), these results are consistent with plausible postmerger inefficiencies. Alternatively, the results are also consistent with a coordinated effects outcome in which the merger facilitated increasingly collusive conduct among the remaining market participants.

The unifying theme in this analysis is that the oligopoly model used here (and in nearly all other merger simulations) does not allow one to distinguish among several plausible hypotheses explaining the observed pattern of postmerger price effects. While this leaves a great deal of uncertainty about precisely what accounts for these effects, the results are nonetheless informative about what does not account for them, at least not to a significant degree. In particular, it appears that postmerger entry and exit and the

[37] This interpretation is consistent with an equilibrium in which there is a lag between the time revenue is earned (the ticket sale) and the time costs are incurred (the flight operation). With a sufficiently high rate of discounting the future, as would be expected from a near-bankrupt firm facing an immediate financial obligation, it may be rational for the firm to maximize revenues rather than profits.

[38] This interpretation implies that the premerger period was in fact a period of disequilibrium during which one of the players in the market was not maximizing its profits. The market returned to equilibrium in the way economic theory would predict: by making the non-profit-maximizing agent go bankrupt.

demand-side effects of changes in flight frequency and airport presence played a relatively minor role in determining the impact of these mergers on prices. In short, the results suggest that in order to assess the likely effects of airline mergers on consumer welfare, an important focus should be on understanding the role of costs and firm conduct. While merger simulation can be useful in understanding the effect of a merger on unilateral pricing incentives, such methods are likely to yield unsatisfactory predictions of a merger's overall effect, at least in the context of the airline industry, unless richer models of firm conduct are incorporated into the methodology.

VI. Conclusion

Standard merger simulation methods measure a potentially important component of the effect of a merger on prices: the effect of the change in ownership on unilateral pricing incentives. To the extent that other factors also play an important role in determining postmerger outcomes, these methods should not be expected to provide an accurate forecast. The evidence reported in this paper suggests that in the airline industry consolidation of the 1980s, supply-side effects, such as changes in marginal costs or deviations from the assumed model of firm conduct, were a particularly important factor in postmerger price increases. While the model does not allow me to distinguish empirically between the effects of cost and conduct, I find it implausible that the results were driven largely by cost changes. As a result, I conclude that deviations from the assumed model of firm conduct play an important role in accounting for the differences between the predicted and observed price changes. This conclusion suggests that the predictive performance of merger simulation would benefit from future research aimed at incorporating more flexible models of firm conduct into the methodology.

APPENDIX

Market Share Function

The market share equation for the GEV model is given by the expression below. This is a generalization of Bresnahan, Stern, and Trajtenberg's (1997) principles of differentiation (PD) GEV model, with an upper-level nest for the outside good and two PD-type groupings nested within it. If $\rho_0 = 1$, so that the upper-level nest drops out, the model is equivalent to Bresnahan, Stern, and Trajtenberg's PD-GEV model:

$$s_j = \left\{ \frac{a \times \exp(\delta_j/\rho_{\mathrm{A}})}{\left[\sum_{j' \in A_j} \exp(\delta_{j'}/\rho_{\mathrm{A}})\right]^{1-\rho_{\mathrm{A}}/\rho_0}} + \frac{(1-a) \times \exp(\delta_j/\rho_{\mathrm{D}})}{\left[\sum_{j' \in D_j} \exp(\delta_{j'}/\rho_{\mathrm{D}})\right]^{1-\rho_{\mathrm{D}}/\rho_0}} \right\}$$
$$\times \frac{\left\{a \sum_A \left[\sum_{j' \in A} \exp(\delta_{j'}/\rho_{\mathrm{A}})\right]^{\rho_{\mathrm{A}}/\rho_0} + (1-a) \sum_D \left[\sum_{j' \in D} \exp(\delta_{j'}/\rho_{\mathrm{D}})\right]^{\rho_{\mathrm{D}}/\rho_0}\right\}^{-(1-\rho_0)}}{1 + \left\{a \sum_A \left[\sum_{j' \in A} \exp(\delta_{j'}/\rho_{\mathrm{A}})\right]^{\rho_{\mathrm{A}}/\rho_0} + (1-a) \sum_D \left[\sum_{j' \in D} \exp(\delta_{j'}/\rho_{\mathrm{D}})\right]^{\rho_{\mathrm{D}}/\rho_0}\right\}^{\rho_0}},$$

where $0 < \rho_{\mathrm{A}} \leq \rho_0 \leq 1$, $0 < \rho_{\mathrm{D}} \leq \rho_0 \leq 1$, and $a = (\rho_0 - \rho_{\mathrm{A}})/(2\rho_0 - \rho_{\mathrm{A}} - \rho_{\mathrm{D}})$.

References

Armantier, Oliver, and Oliver Richard. 2005. "Domestic Airline Alliances and Consumer Welfare." EAG Working Paper No. 05-4. U.S. Department of Justice, Washington, D.C.

Baker, Jonathan B. 1997. "Contemporary Empirical Merger Analysis." *George Mason Law Review* 5:347–61.

Baker, Jonathan B,, and Timothy F. Bresnahan. 1985. "The Gains from Merger or Collusion in Product-Differentiated Industries." *Journal of Industrial Economics* 33:427–44.

Baker, Jonathan B., and Daniel L. Rubinfeld. 1999. "Empirical Methods in Antitrust Litigation: Review and Critique." *American Law and Economics Review* 1:386–435.

Berry, Steven T. 1994. "Estimating Discrete-Choice Models of Product Differentiation." *Rand Journal of Economics* 25:242–62.

Berry, Steven T., James Levinsohn, and Ariel Pakes. 1995. "Automobile Prices in Market Equilibrium." *Econometrica* 63:841–90.

Borenstein, Severin. 1990. "Airline Mergers, Airport Dominance, and Market Power." *American Economic Review* 80:400–404.

———. 1991. "The Dominant-Firm Advantage in Multiproduct Industries: Evidence from the U.S. Airlines." *Quarterly Journal of Economics* 106:1237–66.

Brander, James A., and Anming Zhang. 1990. "Market Conduct in the Airline Industry: An Empirical Investigation." *Rand Journal of Economics* 21:567–83.

Bresnahan, Timothy F., Scott Stern, and Manuel Trajtenberg. 1997. "Market Segmentation and the Sources of Rents from Innovation: Personal Computers in the Late 1980s." *Rand Journal of Economics* 28:S17–S44.

Brueckner, Jan K., Nichola J. Dyer, and Pablo T. Spiller. 1992. "Fare Determination in Airline Hub-and-Spoke Networks." *Rand Journal of Economics* 23:309–33.

Busse, Meghan. 2002. "Firm Financial Condition and Airline Price Wars." *Rand Journal of Economics* 33:298–318.

Dube, Jean-Pierre. 2004. "Product Differentiation and Mergers in the Carbonated Soft Drink Industry." Working paper. University of Chicago, Chicago.

Hartmann, Monica E. 2001. "Airline Safety: A Study of Consumer Learning." Working paper. University of St. Thomas, St. Paul, Minn.

Hausman, Jerry, Gregory Leonard, and J. Douglas Zona. 1994. "Competitive Analysis with Differentiated Products." *Annales d'Economie et de Statistique* 34:159–80.

Kim, E. Han, and Vijay Singal. 1993. "Mergers and Market Power: Evidence from the U.S. Airline Industry." *American Economic Review* 83:549–69.

Kole, Stacey R., and Kenneth Lehn. 2000. "Workforce Integration and the

Dissipation of Value in Mergers: The Case of USAir's Acquisition of Piedmont Aviation." Pp. 239–86 in *Mergers and Productivity*, edited by Steven N. Kaplan. Chicago: University of Chicago Press.

Mechanic, Sara N. 2002. "The Efficacy of the Simulation Method for Predicting the Price Effects of Mergers: The Case of the 1986 Northwest-Republic Merger." Ph.D. dissertation. Johns Hopkins University, Department of Economics.

Morrison, Steven A., and Clifford Winston. 1996. "Causes and Consequences of Airline Fare Wars." *Brookings Papers on Economic Activity, Microeconomics*, pp. 85–131.

Nevo, Aviv. 2000. "Mergers with Differentiated Products: The Case of the Ready-to-Eat Cereal Industry." *Rand Journal of Economics* 31:395–421.

New York Times. 1987. "Problems Nag Airline since Merger." August 17.

Oum, Tae, David W. Gillen, and S. E. Noble. 1986. "Demand for Fareclass and Pricing in Airline Markets." *Logistics and Transportation Review* 22: 195–222.

U.S. Department of Justice and the Federal Trade Commission. 1997. *Horizontal Merger Guidelines*. Rev. ed. Washington, D.C.: Government Printing Office. http://www.usdoj.gov/atr/public/guidelines/hmg.pdf.

Werden, Gregory J., and Luke M. Froeb. 1994. "The Effects of Mergers in Differentiated Products Industries: Logit Demand and Merger Policy." *Journal of Law, Economics, and Organization* 10:407–26.

Werden, Gregory J., Luke M. Froeb, and David T. Scheffman. 2004. "A Daubert Discipline for Merger Simulation." *Antitrust* 18:89–95.

Werden, Gregory J., Andrew S. Joskow, and Richard L. Johnson. 1991. "The Effects of Mergers on Price and Output: Two Case Studies from the Airline Industry." *Managerial and Decision Economics* 12:341–52.