Airline Mergers and the Potential Entry Defense

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Abstract

Horizontal mergers may be approved if antitrust authorities believe that new entry would limit any anticompetitive effects. This argument ('the potential entry defense') has led to mergers being approved in concentrated markets in several industries, including airlines. However, entry will be both less likely and less able to constrain market power if the pre-merger entry process has already selected the best firms, for example those with better product qualities, lower marginal costs or lower fixed costs, into the market. We estimate a rich empirical entry model that allows for these types of selection using data from airline routes connecting the hub cities of the major carriers, which are usually the focus of the antitrust authorities concerns when they review airline mergers. Our results indicate that selection is important, and helps to explain the fact that airline mergers have tended to increase prices without inducing significant entry, even though most of these markets have several potential entrants and, in most cities, entry barriers are relatively low. We can also use our model to consider counterfactual mergers.

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1 Introduction

This paper explores the role of entry in constraining route-level market power after major airline mergers. In a number of cases, including several involving airlines, mergers that have significantly increased concentration in already concentrated markets have been permitted because it is believed that new entry is sufficiently easy that the merging parties would not find it profitable to significantly raise prices above pre-merger levels.acquisition of Ozark based on the argument that new entry would constrain prices (see Nannes (2000)). More recently in 2011, the Department of Justice supported its decision not to challenge the merger between Southwest and AirTran by citing the possibility of new entry by non-merging parties onto routes previously served by each of the two airlines. Similar 'potential entry defenses' have led to the approval of mergers that would have greatly increased concentration, given the pre-merger market structure, in industries as varied as supermarkets, film processing and oil services in both the United States and Europe (Bergman (2003)) and Section 9 of the 2010 *Horizontal Merger Guildelines* (2010) make clear that a merger can be approved if the authorities believe that, if the merger is anti-competitive, new entry would be *likely*, within a relatively short (1-2 year) time horizon, and *sufficient* to keep prices at or below pre-merger levels.[1]

As argued by Schmalensee (1987), one should be careful before concluding that mergers will not harm consumers because new entry seems like it should be easy. In particular, one needs to understand how attractive entry is likely to be to potential entrants who are not already in the market, and these firms may differ in systematic ways from firms who are already in the market, such as the merging parties. Unfortunately the possibility that these differences may exist has not been recognized in the existing literature dealing with mergers with entry. For example, Werden and Froeb (1998), Cabral (2003) or Spector (2003), who use static models, or Marino and Zabojnik (2006), who analyze dynamic endogenous merger formation, assume that potential entrants will have similar costs and qualities to

[1] The Guidelines argue that (p. 28) "a merger is not likely to enhance market power if entry into the market is so easy that the merged firm and its remaining rivals in the market, either, unilaterally or collectively, could not profitably raise price or otherwise reduce competition compared to the level that would prevail in the absence of the merger." A standard rule of thumb for the horizon over which such entry is considered is approximately 2 years (McDonald (2005))).

the firms that are already in the market.[2] A very simple example illustrates the effect of this type of assumption. Suppose that there are a set of symmetric potential entrants into an industry, that the nature of competition (e.g., Cournot or Bertrand- Nash) implies a unique equilibrium given a number of entrants and that the level of fixed costs implies that the unique equilibrium number of entrants is N^*. If a merger takes place between two incumbents that does not produce quality or marginal cost improvementss (synergies), it is natural to expect that after the merger another firm will enter replacing the lost competitor, so that the number of firms is once again equal to N^*, restoring the pre-merger equilibrium.

On the other hand, suppose that the initial set of potential entrants is heterogenous (e.g., they have different marginal costs or product qualities). Then most plausible entry processes are likely to result in the best firms being the ones that are more likely to enter, so that the remaining potential entrants when the merger takes place are relatively weak. If all of the remaining potential entrants have lower quality, or higher marginal or fixed costs than the incumbents, then the merger may not trigger new entry even if there are no synergies, and if they lower quality or higher marginal costs, equilibrium prices post-merger may be higher than before the merger even if new entry does restore the number of firms in the market to N^*. An alternative way of viewing the problem is that when potential entrants are weaker than incumbents, anti-competitive mergers, or ones with only small synergies, are more likely to be profitable, implying that the authorities may need to be more skeptical about the set of mergers that will be proposed when entry is selective.

The primary contribution of our paper is to develop an estimable entry model that allows for selection on at least three dimensions (product quality, marginal costs and entry/fixed costs) which can be used to analyze the effects of both observed and hypothetical mergers on consumer welfare, allowing for potential entry. Following the *Guidelines*, our estimated model can be used to assess the likelihood and sufficiency of post-merger entry. In doing so, we extend the empirical literature that tries to understand and predict the effects of

[2]Gowrisankaran (1999) also considers a computational dynamic model with endogenous mergers. In his model all potential entrants are ex-ante identical when they decide to enter so there is no explicit notion of an entry process that selects the best firms (e.g., those with better product qualities, or lower marginal or fixed costs) in the market. However, because firms' characteristics can evolve post-entry, and the firms that do best are more likely to survive (i.e., there is selection in the exit process), the potential entrants at the time that the merger takes place will tend to look weaker than the firms currently in the industry.

mergers, most of which has focused on the case where the set of non-merging competitors and products is held fixed (e.g., Nevo (2000))

Our second contribution is to provide an empirical analysis of what happens after large mergers in the airline industry, considering both prices and entry. Since deregulation a large number of mergers have been proposed and consummated. Because markets, defined as city-city or airport-airport pair routes, are often highly concentrated with the merging parties as the only competitors on a significant proportion of them, arguments about the viability of new entry have always played a role in analyzing these mergers and their potential anti-competitive effects. In most cases, route entry has been viewed as sufficiently straightforward, at least for the carriers already active at the route endpoints, that mergers have been approved despite of their effects on concentration. In other cases, the perception of higher entry barriers at congested or slot-constrained airports has led to mergers being challenged and prohibited (e.g., United-US Airways) or only approved following significant divestitures of slots that other carriers can use to enter (e.g., United-Continental or Eastern-Texas Air). However there has been relatively little explicit focus on the questions of whether potential entrants will be as effective competitors as those firms already in the market, which is surprising given that observed outcomes at the route level are rarely consistent with the idea that all firms are symmetric. We show that our model, which allows for asymmetries, which are considered by firms when they decide whether to enter, can explain two observed stylized facts about what happens after mergers, even though we estimate that entry costs tend to be quite small. First, prices on the most affected routes tend to go up, a pattern which we show holds after recent mergers, as well as those which have been the subject of previous empirical analysis (Borenstein (1990), Kim and Singal (1993), Peters (2009)). Second, entry, especially by carriers offering non-stop service, is very limited even where slot constraints are absent.

Our model consists of a two-stage game where, in the first stage, a set of carriers decide whether to enter the market and, if they enter, which type of service (direct or connecting) to offer. As both our summary statistics and estimates show connecting service is usually a poor substitute for direct service, especially on shorter routes, and allowing for this service heterogeneity is important, even though it has often been ignored in the empirical entry literature, because post-merger entry in the markets we look at has usually taken the form of connecting service. service to provide. In the second stage, the entrants compete on prices given a standard differentiated products (nested logit) demand system. Critically we allow for both firms to differ in their marginal costs and product qualities, based on both observed variables and unobserved heterogeneity, which are features that will affect the profits of other firms in the second-stage competition, as well as fixed costs. We assume that firms know both their own and competitors costs and qualities when they take their entry decisions, and it is this informational assumption, combined with heterogeneity, that leads to selection.

Our specification therefore differs in some important ways from the classic airline entry models of Berry (1992) and Ciliberto and Tamer (2009). In those papers, a firm's payoff from entering is an additively separable function of the carrier's own characteristics, competition effects, reflecting the entry decisions of other firms, and an idiosyncratic error term. In this specification, the observed or unobserved factors that affect one firm's entry decision do not affect the profitability of other firms, so that it is natural to consider them as factors only affecting entry or fixed costs. On the other hand, in the data it is clear that one needs a lot of heterogeneity in both qualities and marginal costs, which will affect the profitability of other firms, in order to explain the market shares and prices observed in the data. Allowing for heterogeneity in qualities or marginal costs also allows us to explain observed entry patterns without necessarily estimating implausibly high levels of unobserved heterogeneity in fixed or entry costs (for example, one might expect carriers to have similar costs of acquiring additional gate capacity), as has often be found in the empirical entry literature. We also avoid making the assumption that unobserved heterogeneity in qualities or marginal costs are unknown at the time when entry decisions are taken (e.g., Eizenberg (2011)), an assumption that limits the scope for there to be selective entry.

We estimate our model using price, quantity and entry decision data for the second quarter of each year (2004-2008) for markets that connect the hubs of the major carriers. We focus on these markets because they have been the focus of concern in recent airline merger cases. For example, all of the markets identified in the Government Accoutability Office (2010) report on the United-Continental merger as being of most concern linked a United hub with a Continental hub (e.g., Denver and Houston's George Bush Intercontinental), because usually the two hub carriers have a dominant position on the route, so that mergers would tend to result in situations close to monopoly based on pre-merger market shares. On the other hand, as almost all carriers serve the endpoints of these markets, which is usually how the set of potential entrants who could enter in the short-run are identified in airline markets, one might expect that new entry would provide a constraint on post-merger market power if the potential entrants and the incumbent carriers were approximately symmetric. These markets are therefore very natural ones to think about the types of asymmetry/heterogeneity and selection that our model allows for.[3]

Estimating a combined entry-and-competition model that allows for wide-ranging carrier heterogeneity leads to us using a new estimation methodology. In particular, we build off our earlier and on-going work estimating models of selective entry into first and second price auctions (Bhattacharya, Roberts, and Sweeting (2012); Roberts and Sweeting (2011, 2012)) by using a method of simulated moments estimator where importance sampling is used to calculate the moments (a method proposed by Ackerberg (2009)). In practice what this means is that we solve a very large number of games for different parameters (in our case, different quality and cost draws for each of the potential entrants once) and then re-weight the outcomes of these games to calculate the simulated moments when estimating the parameters of the distributions from which the qualities and costs are drawn. Without this type of approach estimation of a model with a large number of potential entrants (we allow up to 9 by aggregating smaller carriers), multiple product type choices (direct, connecting) and a fully specified model of post-entry competition (required to do interesting counterfactuals) would not be feasible.[4]

[3]This is not to claim that there are no drawbacks to considering this limited pool of markets. For example, Berry and Tamer (2006) discuss how variation in the number of potential entrants can play an important role in the identification of the parameters in entry models, and previous work such as Berry (1992) and Ciliberto and Tamer (2009) has used a much broader cross-section of medium and large markets, with much more variation in the number of potential entrants. In our case, the presence of all of the major carriers at almost every hub limits this type of variation. However, we still have variation in market size, and some variation in the presence of low cost carriers such as Southwest, which has only recently started to enter many hub airports. We discuss identification in Section 4.1 below.

[4]Ellickson and Misra (2012) consider a two-step selection correction method for estimating a discrete choice game with selection using outcome data. However, as they note, the viability of this method depends on the outcome equations, such as the grocery store revenue equation that they specify, being a simple linear function. In contrast, Nash equilibrium prices and market shares in a model with differentiated products and standard forms of demand, such as logit, will not be linear.

While we believe that our model significantly extends the literature on empirical entry models and our understanding of airline mergers, we also acknowledge some of the limitations of our model. First, like most of the existing literature, we do not have an explicit model of airlines' network choice, focusing instead on entry at the route level, conditioning on how much presence airlines have at the endpoints. As a result one should interpret the estimate cost coefficients, and especially the effects of airport presence on fixed costs, as partly reflecting how network considerations affect choices. One might be concerned that the hub-hub markets that we look at play a more important role in airlines networks than other routes so that this would be an even greater simplification for us than other authors. But the data indicate that this is not the case. For example, on average, 60% of people traveling on planes between hub airports are on journeys that only include this segment, which is almost exactly the same as on other routes.[5]

Second, the model that we consider is static rather than dynamic. Including the types of persistent asymmetry that we are interested in within a dynamic model is an important direction for future research, but, while a simplification, we believe that a static model is appropriate given the focus of merger policy in the immediate period (usually up to 2 years) following the merger's consummation. During this period of time, for example, the basic hub configurations of the carriers are likely to remain similar, even if in the long-run the merger leads to some cities losing hub status. We interpret our results as being complementary to the analysis of Benkard, Bodoh-Creed, and Lazarev (2010) who model dynamics, but using simpler assumptions about firms' post-merger behavior and. T without trying to model the types of selection that we are interested in.

Third, and perhaps most importantly, we model carriers as choosing prices in the second stage game rather than capacities or flight frequencies, which are likely to be valued by customers. This reflects our need to have a second stage game that has a unique solution (guaranteed by our assumptions on demand) which can be found quickly in order to make

[5]For people traveling domestically, the large number of destinations that can be reached from each hub often precludes the need to travel indirectly via another hub. On the other hand, people may travel to another airline's hub in order to travel on their preferred carrier (for example, someone who was flying from Madison, WI to New York might choose to fly via Chicago if they were a United frequent flyer (before the United/Continental merger) and so would have traveled from Chicago to New York, one of the routes in our data), and hub-hub routes do play an important role in airlines international networks, as they may only serve international destinations from a subset of their hubs.

estimation of the whole game tractable.[6]

Finally, our model only considers one particular type of way that potential entry may constrain pricing. In particular, the 'entry-then-price competition' structure of our model implies that having a large set of potential entrants with possibly low entry costs will only constrain prices if entry actually occurs. In contrast, the older contestability literature suggested that the existence of the potential entrants could constrain pricing even without actual entry. While the airline industry was seen as a plausible example of contestability in the period immediately following deregulation, it has now been discredited as an accurate description of the way that airline markets work (Borenstein and Rose (2011)).[7] On the other hand, regressions of prices on the number of actual and potential competitors do tend to indicate that prices are lower when there are more potential, as well as actual, entrants (Kwoka and Shumilkina (2010), which also contains many references to the older literature). This is consistent with the type of carrier heterogeneity-selection model that we consider as when there are more potential entrants, it is likely that some will be very efficient, leading to lower equilibrium prices when they enter.

The paper proceeds as follows. Section 2 details the model. Section 3 describes the data used to estimate the model, and presents evidence on what happened to prices and entry on hub-hub routes after the Delta-Northwest (2008) and United-Continental (2010) mergers. Section 4 describes our estimation method and discusses identification. Section 5 presents some initial estimates and discusses some simple counterfactuals that illustrate the extent and effects of selection on post-merger predictions. Section 6 concludes.

[6] The implementation presented below also requires us to have a unique solution in the entry stage as well, leading us to consider a sequential entry game where the researcher knows the order (or at least the probabilistic function that determines the order). It is easy, however, to consider alternative entry orders, and it is also possible to use an approach, akin to the one used in Ciliberto and Tamer (2009), where the researcher is agnostic about the order, resulting in estimated bounds on the parameters.

[7] Former Antitrust Division Assistant Attorney General, Joel Klein addressed this issue in a recent speech stating that the contestable market theory "simply does not conform to the facts in a post-deregulation world consisting of hub airports." See Statement Concerning Antitrust Issues in the Airline Industry of former Assistant Attorney General Antitrust Division, Joel I. Klein, Before The Committee on Commerce, Science, and Transportation, ("Klein Statement") presented on July 27, 2000, at 25.

2 Model

We model a two-stage entry game. A market is a directional city-pair or airport-pair so that, for example, the round-trip route Boston-Charlotte-Boston is a different market from Charlotte-Boston-Charlotte.[8] In the first stage, each carrier choose whether to enter and what type of service to provide, with three options: {no entry, enter with direct service, enter with connecting service}.[9] We assume that each carrier only chooses one of these options, so that a carrier choosing to offer direct service does not offer connecting service. This is a simplification but it is not unreasonable in our markets as if a carrier is counted as offering direct service, over 91% of passengers who choose that carrier fly direct.[10] In the second stage, the entrants compete by setting prices in a Bertrand Nash equilibrium.

A key feature of our model is that we allow for considerable observed and unobserved heterogeneity in costs and product qualities across carriers and markets. This increases the flexibility of our model, allowing us to explain why carriers serving the same route have quite different prices and market shares, and it also facilitates the estimation procedure described below.

Demand. We consider a simple one-level nested logit discrete choice demand structure where the nests are 'fly' and 'no fly'. i's utility from choosing a carrier j offering non-stop service is

$$u_{ijm}^{nonstop} = \mu_{jm} - \alpha_m p_{jm} + \zeta_i^{FLY} + (1 - \lambda_m)\varepsilon_{ijm}$$

where $\mu_{jm} \sim N(X_{jm}^{\mu}\beta_{\mu,\tau(j)}, \sigma_{\mu,\tau(j),m}^2)$, which is what we will call 'carrier quality on a route' and X_{jm}^{μ} contains carrier dummies, route characteristics[11] (such as distance and a mea-

[8] The correct definition of the market is often debated in airline markets, and could plausibly differ across cities. The results below are based on city-pairs, but we are in the process of estimating a model based on airport-pair markets. The use of directional pairs is intended to allow for the fact that carriers are likely to have more market power over passengers originating at their hubs. In future work we intend to allow for pricing decisions to be different in each direction, while allowing that the entry decision is a joint decision on both routes. Currently we simply try to adjust the standard errors for the correlation in the entry decisions.

[9] From the DB1B data, direct service could involve a stop but not a change of planes. However, we only count a carrier as offering direct service if it has some non-stop flights.

[10] The exceptions come when a carrier begins or ends direct service during a quarter, or for long routes out of airports such as Washington National where there are constraints on how many direct flights can be made to cities beyond a certain geographic distance from the origin.

[11] Ideally we would include route fixed effects to control for demand differences across routes. To keep the number of parameters manageable, our current specifications include route characteristics, some controls for historical passenger flows and some dummies to control for major origin and destination cities.

sure of tourist activity) and measures of carrier presence at the origin[12], so that consumers may prefer to travel on the dominant local carrier (e.g., because of frequent-flyer benefits). $\tau(j)$denotes the type of carrier j, 'legacy' or 'low cost'. We allow for this type of heterogeneity in the parameters because low cost carriers, of which Southwest is the clearest example, typically offer different amenities to passengers, as well as having different cost structures and, at least in Southwest's case, a different type of network structure.[13] λ_m is the nesting parameter and ε_{ijm} is the standard logit error. The price coefficient, α_m, and the nesting parameter can also vary across markets, and they are assumed to be distributed according to log-normal and truncated (at zero) normal distributions respectively (e.g., $\alpha_m \sim \text{LogN}(X^{\alpha}_{jm}\beta_{\alpha,\tau(j)}, \sigma^2_{\alpha,\tau(j),m})$).[14] i's utility from choosing indirect service on carrier j equals $u^{nonstop}_{ijm} - \psi_{jm}$ where ψ_{jm} is a penalty ($\psi_{jm} \sim TRN(X^{\psi}_{jm}\beta_{\psi,\tau(j)}, \sigma^2_{\psi,\tau(j),m})$), where the mean is a function of route distance. This formulation allows us to impose that consumers prefer non-stop service given equal prices.

Costs. Each carrier has a linear per-passenger marginal cost for each type of service, drawn from carrier-type and service-type specific distributions ($c^s_{jm} \sim TRN(X^c_{jm}\beta_{c,\tau(j)}, \sigma^2_{c,\tau(j),m})$) where means depend on route characteristics such as distance, carrier-route characteristics such as mean origin and destination presence and time-varying fuel prices. Fixed costs are drawn from carrier-type and service-type specific distributions ($F^s_{jm} \sim TRN(X^F_{jm}\beta_{F,\tau(j)}, \sigma^2_{F,\tau(j),m})$). X^F_{jm} includes factors such as slot or gate constraints, which affect some of the hubs in our sample, and which are likely to affect the fixed costs of adding routes.

Sequential Entry and Informational Assumptions. The entry game is structured so that carriers choose sequentially. In our initial specification the carriers with the highest average presence at the endpoints move first, and we assume complete information about all quality and cost draws. The sequential structure, together with our demand and cost assumptions, ensures that the game has a unique, pure-strategy equilibrium (Mizuno (2003) proves the uniqueness of the Bertrand Nash price equilibrium for a nested logit model where each firm only has a single product). The information assumption allows for entrants to be selected

[12]Presence of carrier j in city c is defined as $\frac{\text{number of other cities served by } j \text{ out of } c}{\text{number of other cities served by any carrier out of } c}$.

[13]Southwest does not officially have hubs, although it does have focus airports, such as Chicago Midway, Baltimore-Washington International and Las Vegas from which it serves a large proportion of its destinations.

[14]We allow, for example, for these coefficients to have different means for long and short routes, as consumers may be much more likely to substitute to car or train transportation on short routes.

on observed and unobserved variation in qualities and marginal costs, as well as fixed costs, and it is motivated by the fact that the firms that we define as potential entrants are large, sophisticated firms, already operating at both endpoints. These firms should have good information about how well suited other carriers are to the route.[15]

3 Data and Evidence on the Effects of Mergers on Prices and Entry

Our data sources are the publicly available Department of Transportation Origin and Destination Survey (DB1B) and Domestic Segment (T-100) database. The DB1B database is a 10% sample of all passenger itineraries updated quarterly that includes coupon-specific information, such as the operating carrier, origin and destination airports, number of passengers, prorated market fare, number of market coupons, market miles flown, carrier change indicators and distance, for domestic itineraries. T-100 is a monthly census of all domestic flights broken down by air carrier and origin and destination airports. In this section we describe our variable definitions and summary statistics for the data that we use to estimate the model, and also some stylized facts about what happened after two large, recent mergers: Delta/Northwest (2008) and United/Continental (2010).

3.1 Sample and Variable Definitions for Estimation Dataset

To estimate our model we use data from the second quarter for the years 2004 to 2008.[16] In order to facilitate estimation, we limit ourselves to considering the entry decisions of nine carriers.[17] American (AA), Continental (CO), Delta (DL), Northwest (NW), United (UA),

[15] The ideal model would probably also allow for some aggregate demand or cost shock to be realized after entry decisions had been taken. However, allowing for these shocks would significatly increase an already large computational burden.

[16] We choose only one quarter per year because, for our merger analysis, we are not so interested in seasonal variation in whether routes are served, although this is less important for our hub-hub sample. During our data the second quarter has the highest number of passengers flying.

[17] By estimating only a linear profit equation with carriers making only binary {not enter, enter} and symmetric competition effects, Berry (1992) avoids aggregation. However, Ciliberto and Tamer (2009), who allow for asymmetric competition effects and less restrictive equilibrium selection assumptions, aggregate to six carriers.

USAirways (US) and Southwest (WN) are modeled as individual carriers. Of these, the first six are 'legacy' carriers, with Southwest as 'low cost'. The carrier is defined by the 'ticketing carrier' in the DB1B data, so passengers carried by regional affiliates (such as American Eagle or a United Express flight operated by Air Wisconsin) count as if they were carried by the associated larger carrier. Service by all other carriers are aggregated into an 'Other Legacy' carrier (e.g., Alaska Airlines) and an 'Other LCC' carrier (e.g., Frontier, JetBlue).

To define entry, quantities and prices, we use domestic, round trip, economy class tickets with fares ranging from \$50 to \$2000. If a carrier carriers at least 15 DB1B passengers (so approximately 150 passengers quarterly) on the route by a particular type of service, the carrier is potentially defined as having entered that type of service. When the carrier carries at least 15 passengers both direct and connecting, we choose the type of service that carried the most passengers, which in almost all cases is direct, although we only allow for a carrier to be counted as direct if it does offer some non-stop flights during the quarter (based on T-100). The number of passengers and the price (calculated as the average of the prices paid by the DB1B passengers) are calculated only using the type of service that we count the carrier as offering (i.e., if the carrier offers direct service, only passengers traveling direct as used). A carrier is counted as a potential entrant if it serves any route out of each of the endpoints.

We will allow for city presence to affect both perceived quality and costs, reflecting the fact that carriers with a hub or focus city at an endpoint are usually believed to command fare premia (Borenstein (1989)) and to also have a different cost structure to other carriers. A carrier's city presence is defined as the number of destinations that it serves direct from the city (defined as offering at least one flight per day in the quarter based on T-100) as a proportion of the total number of destinations served by all carriers. We assume that it is the carrier's presence at the origin that affects demand, but that it is the average presence at the origin and destination that affect costs. We can use similar measures to define airport presence when looking at airport-airport markets. City-city markets differ from airport-airport markets in that we aggregate the following nearby airports: Kennedy, Newark, LaGuardia in New York City; O'Hare and Midway in Chicago; Hobby and Bush Intercontinental in Houston; Love Field and Dallas-Fort Worth in Dallas; SFO, San Jose and

Oakland in San Francisco; Dulles, Reagan and Baltimore-Washington in Washington DC.

The airport presence measures are also used to define the hubs for carriers, and we use this to identify the cities in the sample (a similar approach will be used to identify the airport-airport hub markets). Our initial approach is to say that a carrier has a hub in a given city if (a) the carrier has at least 10% city presence or the carrier serves at least 20 destinations and (b) the city has at least 40 destinations associated with it. However, this produced a few results that were inconsistent with where people typically believe that hubs are so we make the following changes: AA does not have a hub in San Francisco, CO has a hub in Cleveland, DL has a hub in Salt Lake City and US Airways has hubs in Pittsburgh (during our data), Phoenix and New York. In order to have a balanced panel we only consider places that can be counted as hubs for at least one of the carriers in every year. This leaves us with the 24 hub cities: Atlanta, Boston, Charlotte, Chicago, Cincinnati, Cleveland, Dallas, Denver, Detriot, Houston, Los Angeles, Memphis, Miami, Minneapolis, Nashville, New York, Orlando, Philadelphia, Phoenix, Pittsburgh, San Franscisco, Salt Lake City, St. Louis and Washington DC.

There are 552 directional routes between these hub cities. However, we exclude some routes based on two additional criteria. First, some cities are so close together (e.g., Philadelphia and Washington DC, or New York and Philadelphia) that there is very little air service, and most travelers would travel by car or train. Specifically, we drop routes where the cities are less than 200 miles apart (in doing so, we drop pairs like Boston-New York and New York-Washington DC where quite a lot of people do fly). Second, we drop some pairs because the combined market shares of carriers who are in the market are extremely high or extremely low. This is true of many pairs when we define market size as being proportional to arithmetic or geometric average population, as typically used in the literature. Instead we define market size as the predicted value from an OLS regression of the (log of) total passengers in a market in a year on the (logs of) total traffic into the destination city, total traffic out of the origin city and non-stop round-trip distance between the two cities.[18] We then drop observations for those markets where the combined market shares of the carriers

[18] Interactions among these variables were tried but added very little explanatory power.

Table 1: Summary Statistics for 2004-2008 Hub-to-Hub (City-City) Sample

Variable	Obs	Mean	Std Deviation	10th Percentile	90th Percentile
Potential Entrants					
Legacy	2,365	6.89	0.31	6	7
LCC	2,365	1.55	0.50	1	2
Entrants					
Direct	2,365	2.15	1.15	1	4
Connecting	2,365	2.57	1.65	0	5
Hub Status	21,285	0.25	0.44	0	1
if fly direct	5,086	0.62	0.48	0	1
Mean Fare					
Direct	5,086	$373.51	$119.26	$238.14	$538.04
Connecting	6,090	$365.96	$87.87	$260.72	$480.64
Market Share					
Direct	5,086	12.1%	8.3%	2.9%	23.9%
Connecting	6,090	1.6%	2.4%	0.2%	3.5%

is less than 5% or greater than 80% in any of the quarters.[19] These restrictions leave us with 473 city-pair markets.

Summary statistics.

Table 1 provides summary statistics. Because our markets are made up of hub cities, almost all of the carriers, and especially the legacy carriers, count as potential entrants on each route. The situation for Southwest is rather different, as it did not serve Atlanta, Boston, Charlotte, Cincinnati, Denver, New York, Memphis, Minneapolis or Pittsburgh in 2004, although it entered Denver and Pittsburgh during the sample. However, while there are many potential entrants, on average only two carriers serve each market with direct service, with over 60% of carriers that fly direct having a hub at one (or both) of the endpoints of the routes that they serve. 69 of the market-quarters have no direct service, and on 30% of markets there is one direct carrier. Only 12% of the observations have four or more direct carriers, and almost all of these link the biggest cities such as New York and Los Angeles. However, if we looked at airport-airport markets some of these big city routes would also look very concentrated (for direct service) as many of the carriers primarily serve only one

[19]Most of the markets with very small combined market shares are pairs of smaller cities (e.g., Nashville-Cincinnati). The pairs with very high market shares include New York-Miami.

Table 2: Market Structure by Market Size and Non-Stop Distance Terciles

		Mkt Size Tercile		
Direct Entrants		Small	Medium	Large
	Short	1.2	2.1	3.2
Distance Tercile	Medium	1.4	2.2	3.0
	Long	1.2	2.1	3.0
Connecting Entrants				
	Short	1.9	1.4	1.4
Distance Tercile	Medium	2.5	2.4	2.6
	Long	3.1	3.7	4.0

of the airports in each city.

On average, 2.6 additional carriers offer connecting service, but the small market shares of connecting carriers, relative to direct ones, indicates that for many consumers connecting service is a poor substitute to direct service, even though the average prices of the two types of service are similar.

A further reason for distinguishing between direct and connecting service can be seen in Table 2, which shows the number of direct and connecting carriers in each market size and route non-stop distance tercile combination. For direct service, we see what one would expect to see unless there are large economies or diseconomies of distance (and remember that very short markets have been excluded), as the number of carriers supported in equilibrium increases monotonically with market size, with distance not appearing to have a significant effect. This clear pattern has not been observed in earlier research, such as Ciliberto and Tamer (2009), where direct and connecting service have not been distinguished. The reason why can be seen in the lower part of the table: the number of connecting carriers varies primarily with route distance, which presumably reflects the fact that passengers are more willing to pay the fixed cost of making a connection on trips that are already long, as well as there probably being a greater number of substitute connections that do not involve the passenger going too far off the non-stop route. On the other hand, it does not vary much with market size, suggesting that the fixed costs of entering connecting service do not play a key role in determining this aspect of market structure.

3.2 The Effects of the Delta/Northwest and United/Continental Mergers

A body of research has examined the price effects of mergers that took place in the US airline industry in the decade following deregulation, when mergers were rarely challenged and there was rapid consolidation. Borenstein (1990), Kim and Singal (1993) and Peters (2009), amongst others, provide evidence that mergers resulted in significant price increases (by the merging carriers) on the routes where both of the merging parties competed prior to the merger. For example, the five mergers (Northwest/Republic, TWA/Ozark, Continental/People Express, Delta/Western, US Air/Piedmont) considered by Peters resulted in price increases of between 7% and 30% . In this section we provide some evidence that the recent Delta/Northwest and United/Continental mergers also resulted in price increases, and also resulted in relatively little entry.

To perform the analysis we form a quarterly panel of price data from the third quarter of 2007 until the third quarter of 2010 (inclusive). For the purposes of this analysis we define markets as directional airport-pairs, and we only consider direct service, so that our price measure is the average price paid by those flying direct round-trips (excluding fares less than \$50 and more than \$2000). Rather than just analyzing routes where the carriers overlap, we consider price changes on the routes most affected by the merger based on the definition that (appears) to be used in US Government Accountability Office (2010), that route is a hub-to-hub market served by both of the merging carriers, who accounted for more than 70% of direct traffic in the quarters prior to the merger. The baseline regression specification is

$$\log(\overline{p}_{jmt}) = \beta_0 + \beta_1 * \text{POST-MERGER}_t * \text{AFFECTED ROUTE}_m + FE_t + FE_{j,m} + \varepsilon_{jmt}$$

where $\overline{p}_{jmt}$ is the average price of combined carrier j on route m (defined as a directional airport-pair) for non-stop round trip tickets at time t, FE_t are time fixed effects, $FE_{j,m}$ are carrier-route fixed effects, and β_1 is the coefficient of interest. Standard errors are clustered at the route level. As a control group we identify a set of unaffected routes, defined as routes served non-stop by one of the merging carriers with the other providing neither non-

Table 3: Prices Changes After the DL-NW/UA-CO Mergers

Dependent Variable	Control Group	Fixed Effects	DL/NW β_1	UA/CO β_1
(1) Prices of merging carriers	Merging Carriers on Unaffected Non-Stop Routes	Quarter Route	0.084 (0.029)	0.154 (0.023)
(2) Prices of merging carriers	Merging Carriers & AA, US on Unaffected Non-Stop Routes	Quarter Carrier-Route	0.069 (0.028)	0.184 (0.020)

stop nor connecting service in the whole year prior to the announcement of the merger.[20] To make interpretation easier, we drop data between the announcement and closing of the transaction.[21] Table 3 shows the estimates of β_1 from two specifications for each merger (standard errors in parentheses).

In the first specification, the regression only uses the prices set by the merging carriers and, prior to merger, $\overline{p_{jmt}}$ is the weighted average price on the merging carriers. The estimated coefficients indicate that Delta/Northwest raised non-stop prices by 8%, and United/Continental by 16%, on the affected routes relative to non-stop prices on unaffected routes. In the second specification, prices set by American (AA) and US Airways (US), two airlines that were not involved in mergers during the data, on unaffected routes are included in the control group, to make sure that these estimates do not simply reflect the merging parties cutting prices on the unaffected routes. The estimated β_1s are very similar.

While prices increase, consistent with the merger enhancing market power, very little entry is induced, suggesting that route-level entry may not be as easy as the authorities assume. On the 17 (non-directional) hub-hub routes affected by these mergers, the only new non-stop entry after the merger was by Southwest between Newark and Denver.[22] On 5 routes there was entry with connecting service (e.g., AA providing service from Houston to Denver via Dallas-Fort Worth), but, as our model allows, connecting service may be a poor

[20]These routes will include routes that are not to or from hubs, as well as hub-to-hub routes where only one carrier operates. A carrier is defined as providing connecting service if it carries 150 passengers on the route in the quarter. Throughout our work we define non-stop as meaning that there is no connection involving a scheduled change of planes, meaning that it is possible that the plane stops at an intermediate airport.

[21]When we estimate separate effects for this time period we find effects that have the same sign but are smaller than the post-merger effects.

[22]We define a carrier as entering if it provides service in multiple quarters after the transaction was closed, having not provided service in the year prior to the merger being proposed.

substitute for non-stop service.

4 Estimation Method

We need to estimate demand and the marginal and fixed cost functions, and the number of parameters is large (e.g., 59 in some of our specifications) once we allow for observed and unobserved heterogeneity. A two-stage approach is not feasible because we need to take into account selection in the entry stage to consistently estimate demand and marginal costs, while the type of nested fixed point approach used by Berry (1992) and Ciliberto and Tamer (2009), where games are re-solved for each market each time on the parameters is changed, would likely take months or possibly years to converge.[23] Instead we use an estimation approach - simulated method of moments where the predicted moments are approximated using importance sampling - that involves solving a very large number of games once, and then only re-weighting them during estimation. The advantage of this approach is that the estimation stage is relatively quick (e.g., a day or so) because it only involves calculating the product of pdfs, while the solving of the large number of games can be done in parallel on many different cores (we use as many as 600) that do not need to communicate with each other.

Details. The parameters that we want to estimate are the βs and σs, which describe the distributions of the market- or carrier-specific demand and cost parameters. In what follows we will denote the collection of these parameters by Γ. Joint estimation is required because of selection, as, for example, the expected μ_{jm} of a carrier that chooses to enter non-stop will be greater than $X^{\mu}_{jm}\beta_{\mu,\tau(j)}$.

The procedure has two stages. In the first stage, we solve a large number (S) of games for each market. This can be done in parallel on a large computing cluster. For each game s, the value of α and λ, which are market-level parameters, and values of μs, ψs, cs, Fs for each carrier (denote the collection of these draws θ_s) are drawn from an importance

[23] Neither of these papers has an explicit model of second-stage competition, but they still have to impose either a strict equilibrium selection rule and a small number of parameters (Berry) or only consider a small number of firms (Ciliberto and Tamer). Neither paper distinguishes between direct and connecting service, reducing decisions to a simple {entry, no entry} choice.

sampling density $g(\theta_s|X_m)$. The game is solved using the assumed order of entry (i.e., that the carriers move in order of their average presence at the endpoints). Information on the unique predicted equilibrium outcome (e.g., entry decisions, prices and market shares) is stored.

In the second step, the parameters Γ are estimated using a simulated method of moments estimator, where the value of each moment is calculated by re-weighting the outcomes from the first-stage games appropriately. For example, consider an outcome $f_m(\theta)$ (e.g., the number of direct entrants in market m) and a guess of the parameters $\widehat{\Gamma}$. We approximate $E[f_m(\theta)|\widehat{\Gamma}]$ using $\frac{1}{S}\sum f_{ms}(\theta_s)\frac{\phi(\theta_s|X_m,\widehat{\Gamma})}{g(\theta_s|X_m)}$ where $\phi(\theta_s|X_m,\widehat{\Gamma})$ is the value of the density for a particular draw θ_s given the observed Xs (e.g., route distance or carrier presence) and all of the parametric distributions assumed in the model, and $f_{ms}(\theta_s)$ is the relevant outcome from game s simulated in the first stage. When we change $\widehat{\Gamma}$, $E[f_m(\theta)|\widehat{\Gamma}]$ can be calculated without re-solving any games.

The moments that we seek to match are each firm's entry decisions, their market shares and prices interacted with (i) indicators for one of six market size and distance pairings (small/medium/large markets (terciles) and short/long distance (defined as round-trip distance greater than 2,000 miles)); (ii) indicators for whether the airline's presence at the origin is high/medium/low; and (iii) an indicator for whether there exist at least two other carriers with presence greater than X (X is approximately the average presence of hub carriers). For identifying market fixed effects, we also match moments of each market's average total share over the five years.[24]

Ackerberg (2009) suggests the importance sampling approach for estimating complicated static or dynamic decision problems or games. An important assumption is that the supports of the θ parameters should not depend on the parameters to be estimated. This is true in our case as we either specify unbounded supports (e.g., for qualities), natural truncated supports (e.g., non-negative marginal costs) or we impose the same arbitrary support on both the true parameter distributions and the importance sampling distributions (for example, that the nesting parameter $\lambda_m$must lie between 0.2 and 0.95, because values that are very close to 1

[24]We are just now beginning to include market fixed effects. In estimating these we are beginning by grouping markets that are 'similar' so as to avoid estimating 473 of them.

can complicate the solution of the model in some markets). Estimates using this approach are more accurate when S, the number of simulation draws, is large and the importance sample densities are similar to the 'true' densities from which the parameters are drawn. In estimating the model, we currently use $S = 200$, and plan to try $S = 1000$.[25] We also intend to use a two-step approach, where we first estimate the parameters using diffuse gs, before repeating estimation using a new set of gs formed by these initial estimates.[26]

4.1 Identification

The full parametric structure of our model and our equilibrium assumptions are imposed during estimation, but there are several sources of plausibly exogenous variation that help to identify the parameters of interest. For example, inter-temporal variation in fuel prices, interacted with route distance, together with the limited cross-market variation in the number of potential entrants and their characteristics (such as presence and whether they are low-cost) should identify the mean price coefficients in the demand system.[27] The amount of entry, conditional on a set of potential entrants, will identify the mean level of fixed costs and the effects of slot constraints. Unobserved heterogeneity in marginal costs and qualities should be identified from the joint distribution of market shares and prices, controlling for observables. For example, if qualities are heterogeneous and marginal costs are common, then equilibrium prices and market shares will be positively correlated, whereas if qualities are common and marginal costs are heterogeneous they would be negatively correlated. The distribution of fixed costs will be partly identified from how realized qualities and costs

[25] Roberts and Sweeting (2011) present Monte Carlo evidence for a Simulated Maximum Likelihood estimator. On-going Monte Carlo experiments with the airline model suggest that estimates can be unbiased using S as low as 5.

[26] In the current implementation we use importance sampling densities that have the same distributional form (e.g., truncated normal, log normal) as we assume that the true parameters have, and we tried to pick parameters for the densities that implied that the means were consistent with the estimates of demand, marginal costs and substitution patterns reported in recent airline papers such as Berry and Jia (2010), and variances large enough that all parameters that seemed plausible would have non-negative probability. The implementation of a two-step approach, with higher initial variances, should allow us to be more confident that these initial choices are not affecting our results.

[27] Implementation of the estimation method requires us to allow for unobserved heterogeneity in carrier costs and qualities and the market-demand parameters $\alpha$and λ. Based on intuitive identification arguments, identification of heterogeneity in $\alpha$and λ seems likely to be particularly reliant on functional form (at least given the limited time-dimension of our panel), although, as explained below, there are features of the data that should provide information on the heterogeneity in costs and qualities.

change as market size varies. For example, if all firms have the same fixed costs, then in small markets, which can only support one or two carriers, we would expect to see the firms with the highest qualities or lowest marginal costs as entrants, with weaker firms entering when we consider larger markets. On the other hand, if fixed costs are very heterogeneous we will be relatively more likely to see small markets served by some weaker firms, and strong competitors being amongst the additional entrants in larger markets.

4.2 Aside on Weakening the Known Move Order Assumption

Our current results assume a particular order of moves (highest average presence moves first) that is known to the econometrician. This is obviously an arbitrary assumption. There are at least two possible ways that it can be weakened. The first approach is to assume that the order of entry is probabilistic (although the exact order is known to all firms when they take their entry decisions), depending on factors such as cost, qualities and presence. In this case, it is possible to try to estimate the probabilistic function determining the order as part of estimation. The other approach is to try to be more agnostic about the entry order, either by assuming that there is a sequential order of entry but that it is unknown to the econometrician, or that there is simultaneous entry but only pure strategy equilibria are played.[28] In both cases, an estimation procedure that roughly follows Ciliberto and Tamer (2009), in the sense of constructing upper and lower bounds on the moments (still using importance sampling), can be used. We have performed Monte Carlo experiments with these approaches, constructing confidence sets using the S1 criterion for critical values described in Andrews and Soares (2010), and have found them to work well as long as the number of parameters is not too large. In fact, the bounds on each parameter tend to be quite close together because, once quality and cost heterogeneity and a specific model of competition is allowed for, it is unusual for more than one or two outcomes to be supported as different equilibria or by different orders. For the same reason, when we try to estimate

[28]Given the assumed form of competition, a pure strategy equilibrium can be shown to exist in the entry game, although mixed strategy equilibria could exist as well. As carriers have three choices there may be outcomes in the sequential game that could not be supported as pure strategy Nash equilibria in the sequential game. However, in both cases it is actually quite easy to calculate which outcomes could be supported by some order or by some set of pure strategies.

a probabilistic order of entry we find that the estimates of the factors that determine the order tend to very imprecise.

5 Preliminary Estimation Results and Implications for Merger

Table 4 presents some very preliminary estimates of the model parameters. We do no report standard errors as they need to be calculated using a bootstrap, although our experience with estimating the model on a cross-section of data indicates that most of the coefficients will be statistically significant.

The estimates imply plausible elasticities for many quantities of economic interest. For example, own price elasticities vary between -3 and -4, with route distance not having a large effect (in the cross-section our estimates imply slightly lower elasticities on longer routes). Consumers have a strong preference for non-stop service, especially on short routes. Marginal costs average $250 dollars for legacy carriers and $160 for low-cost carriers for a 500 mile route, increasing by approximately $60-70 per 1,000 miles for both carrier types. The estimated average per-quarter fixed costs are around $40,000 for direct service and $5,000-7,000 for indirect service. Consumers value origin airport presence, while it has mixed effects on fixed costs. The estimated variances of $\alpha$and λ are estimated to be small.

The estimates also imply that there is considerable unobserved heterogeneity in carrier qualities and costs, as well as some observed heterogeneity. Given the structure of our model, this implies that there will be selection. The following example gives some sense of what selection will produce in the data, and how it may affect merger counterfactuals. It is purely illustrative, and we actually present it assuming that markets are airport-pairs (see the next footnote for what happens if Houston Hobby is included in the market). It is also based on a previous set of estimates (using a 3 year panel), where origin presence was allowed to affect marginal costs.

Consider the George Bush Intercontinental (IAH) to Denver International (DEN) market. It was one of the markets directly affected by the UA/CO merger. In Q2 2008, CO (IAH hub), UA and Frontier (both DEN hubs) provided non-stop service, and no carriers provided connecting service, although there were 5 other potential entrants.[29] Table 4 presents the marginal costs and μ component of quality implied by the observed prices and quantities for entering non-stop carriers, and the mean of μ and marginal cost for non-stop service for each potential entrant based on the model parameters (i.e., where we do not condition on the observed entry decisions).[30]

The table illustrates two types of selection. First, looking at the unconditional mean qualities, the model predicts that, because of their lower presence at IAH (the presence of all carriers other than CO is quite similar but not identical), legacy carriers other than CO would be less attractive to customers and have higher marginal costs than CO. Second, relative to their unconditional means, the observed entrants have favorable quality and cost draws,consistent with there is also selection on these dimensions.[31] Both types of selection will tend to make entry less likely and less effective at constraining prices if two incumbents merge.

To see this, consider the UA/CO merger. Out of many possible assumptions, we assume that the merged firm would inherit CO's quality and cost draws given CO's dominance at IAH, while Frontier would keep its pre-merger quality and cost of non-stop service.[32] Holding entry fixed, the model predicts that the average price paid would increase by $21 or 7%. We can, of course, also use our model to examine what would happen for different types of merger synergies and to test, using post-merger data, whether there is evidence for these in the data.

Now suppose that we allow for additional entry to occur. To do this, we first compute the distribution of qualities and marginal and fixed costs for each type of service, using simulation, for the other firms conditional on the fact that they chose not to enter, given the

[29] Southwest provided non-stop service to Denver from Houston Hobby. If Hobby is included in the market, the merger is predicted to lead to smaller price increases, but also to lead to even less entry.

[30] These values are calculated based on the mean values of λ and α for the IAH-DEN market. The estimated variances of these parameters are not large, so drawing other values gives similar conclusions.

[31] It is natural to think that some of these differences might reflect route-level, rather than carrier, heterogeneity. This is one of the main reasons why we hope that our final specifications will control for more market characteristics, exploiting the panel structure of our data.

[32] The merger does not increase CO's IAH presence as CO already served all of UA's IAH routes.

Table 4: Implied Carrier Qualities and Marginal Costs for IAH to DEN (Preliminary Estimates)

Potential	Service	Mean	No. of	Non-Stop μ		Non-Stop M. Cost	
Entrants	Type	Price	Passengers	Implied	Unconditional	Implied	Unconditional
Continental CO	Non-stop	\$336.35	21,060	1.716	1.160	250.87	307.20
United UA	Non-stop	\$248.69	3,000	0.625	0.087	211.38	336.09
Frontier F9	Non-stop	\$229.34	2,530	0.447	-0.676	192.56	241.08
American AA	No entry	-	-	-	0.158	-	336.09
Delta DL	No entry	-	-	-	0.042	-	336.77
US Airways US	No entry	-	-	-	-0.245	-	336.77
Northwest NW	No entry	-	-	-	-0.327	-	336.09
Other Legacy ZZ	No entry	-	-	-	-0.887	-	338.11

implied quality and marginal cost draws of the entrants and an assumed move order of CO, UA, F9, AA, DL, US, NW and ZZ. Because they chose not to enter, these conditional quality and cost distributions will be less favorable for the non-entrants than their unconditional counterparts. We then allow the later firms to choose to enter using this order when CO and UA are merged. Given our estimates, we predict that new non-stop entry will happen with low probability (0.07), with connecting entry, which actually happened in this market (by AA), with probability 0.15. However, even when non-stop entry occurs, prices always remain above pre-merger levels because the entrants will have lower quality or higher costs than UA did prior to the merger.

If we ignored selection, we would come to different conclusions. To illustrate, suppose we assumed that the non-entrants had the same qualities for non-stop service as the implied averages of CO, UA and F9, which is similar to the assumption in the theory literature. We continue to use conditional marginal and fixed cost distributions for the non-entering firms (re-calculated so that they still do not want to enter before the merger). In this case, we would predict that at least one new carrier would enter non-stop with probability 0.45, and, if entry happens, the expected average price increase would be smaller (3%).

6 Conclusion

In this paper we develop an estimable model of airline route markets that is designed to allow us to answer the important policy question of whether new entry would constrain the exercise of market power after mergers. This question is particularly important in the hub-to-hub markets that we look at because there are usually only two carriers that provide direct service on the route, even though a lot of people travel on them. The key feature of our model is that the entry process is selective, so that the firms with better product e or lower marginal costs, as well as lower fixed costs, are more likely to enter. Allowing for quality and marginal cost asymmetry allows us to consider both the sufficiency of entry in constraining post-merger prices to be close to pre-merger levels as well as the likelihood of new entry. The Horizontal Merger Guidelines require that both likelihood and sufficiency are considered, but the existing theoretical and empirical literature, which assumes that potential entrants must be similar to incumbents, is only really appropriate for exploring the likelihood of entry, and even then is likely to be biased in favor of saying that entry will constrain post-merger market power.

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TABLE 4: Parameter Estimates from a 5 Year Panel (Preliminary)

(Std. Errors will be calculated using a bootstrap)

Carrier Qualities	
Carrier Fixed Effects	
American	-0.015
Continental	-1.030
Delta	-0.060
Northwest	-0.429
United	0.021
US Airways	-0.385
Southwest	-0.231
`Other Legacy Carrier'	-1.535
`Other Low Cost Carrier'	-1.675
Market Distance	
Legacy Carriers	0.141
Low Cost Carriers	0.206
Origin Presence	
Legacy Carriers	2.324
Low Cost Carriers	0.389
Std Deviation in Quality Draw	
Legacy Carrier * Long Route	1.030
* Short Route	0.634
Low Cost Carrier * Long Route	0.863
* Short Route	0.640
Connecting Penalty	
Constant	1.019
Distance	-0.186
Price Coefficients	
Constant	-0.731
Distance	-0.018
Variance (transformed scale parameter)	0.039
Nesting Coefficient	
Constant	0.747
Std Deviation	0.086

Marginal Cost Parameters	
Legacy, Direct Service	
Constant	2.220
Distance	0.682
Jet Fuel Price	-0.017
Std Deviation	0.934
Legacy, Connecting Service	
Constant	1.376
Distance	0.639
Jet Fuel Price	0.040
Std Deviation	1.108
Low Cost Carrier, Direct Service	
Constant	1.260
Distance	0.974
Jet Fuel Price	-0.182
Std Deviation	1.035
Low Cost Carrier, Connecting Service	
Constant	-0.011
Distance	1.237
Jet Fuel Price	-0.052
Std Deviation	1.589

Fixed Cost Parameters	
Legacy, Direct	
Constant	3.935
Distance	0.051
Presence	0.366
Slot Constraint (same for connecting)	
Standard Deviation	0.494
Legacy, Connecting	
Constant	0.752
Distance	-0.057
Presence	-0.083
Slot Constraint (same for direct)	-0.120
Standard Deviation	0.843
Low Cost, Direct	
Constant	3.832
Distance	0.131
Presence	-0.807
Slot Constraint (same for connecting)	0.170
Standard Deviation	0.453
Low Cost, Connecting	
Constant	0.376
Distance	0.049
Presence	0.202
Slot Constraint (same for direct)	0.170
Standard Deviation	0.306