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Uncertainty, Flexibility, and Market Entry

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Abstract

In this paper I study the relationship between demand variation and entry. Specifi cally, I investigate how this relationship is moderated by firm-speci c flexibility. As flexible firms can cope more easily with uncertainty, I hypothesize that these firms are more likely to enter markets with greater levels of demand variation. I use the airline industry as the empirical setting of my study. Particular routes show signi cant variance in demand which makes the expected outcome uncertain for the potential entrant. Also, airlines diff er with regard to their fleet composition which is used to operationalize flexibility. My results indicate that unpredictability has a positive e ffect on the likelihood of entry. This is because firms looking for growth opportunities need variation in demand. I find that the risky decision to enter an unpredictable market is positively moderated by flexibility, i.e., fi rms are more likely to enter if their individual flexibility is large relative to the uncertainty of the market. The significance of this interaction eff ect, however, depends on the predicted likelihood of entry.

Jelcodes:C10,L10

Uncertainty, Flexibility, and Market Entry[a]

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Abstract

In this paper I study the relationship between demand variation and entry. Specifically, I investigate how this relationship is moderated by firm-specific flexibility. Demand variation, represented by amplitude, frequency and unpredictability of demand change, has been shown to affect entry decisions of firms. I hypothesize that demand variation reduces entry but that a firm's ability to cope with this uncertainty moderates this relationship. Using the airline industry as the empirical setting, the results indicate that, while amplitude and change frequency have a negative effect, unpredictability has a positive effect on the likelihood of entry. This is because firms looking for growth opportunities need variation in demand. Further, I find that firms prefer to hedge their risky entry decision, i.e., they are more likely to enter if their individual flexibility is large relative to the unpredictability of the market. The significance of this interaction effect, however, depends on the predicted likelihood of entry.

Keywords: Market Entry, Flexibility, Uncertainty, Airline Industry
JEL-Codes: C10, L10, L13, L93

[a]Preliminary and incomplete. Please do not quote or cite!

1 Introduction

In this paper, I explore how the entry decisions of firms are driven by market uncertainty and firm-specific flexibility. Specifically, I study the effect of a firm's flexibility relative to the level of uncertainty in the new market. Here, the focus is on uncertainty arising from variation in demand. Much of the literature on entry focuses on mode of entry (e.g., Chang and Rosenzweig, 2001; Fuentelsaz et al., 2002; Lee and Liebermann, 2010; Mitchell, 2006; Robinson et al., 1992; Sharma, 1998), timing of the entry decision (e.g., Dowell and Swaminathan, 2006; Joshi et al., 2009; Shen and Villas-Boas, 2010), and how the entrant's resources and capabilities affect its post-entry performance (e.g., Bayus and Agarwal, 2007; Helfat and Lieberman, 2002; Klepper and Simons, 2000; Lee, 2008; Qian et al., 2012; Schoenecker and Cooper, 1998). Other contributions find that uncertainty has a negative effect on likelihood of entry (Delacroix and Swaminathan, 1991; Dowell and Killaly, 2009) or that changes in uncertainty are the main driver of exit (Anderson and Tushman, 2001). However, within this field of research, heterogeneity in the level of firm flexibility is ignored. And yet there is a large stream of literature arguing that flexible firms are more capable of handling uncertainty (Dreyer and Gronhaug, 2004; Fiegenbaum and Karnani, 2006; Gerwin, 1993; Lee and Makhija, 2009; Pacheco-De-Almeida et al., 2008).

The decision to enter a new market depends on many factors, including how profitably the firm can operate in this market and whether the new market offers an opportunity for growth. Using historical data, the firm tries to forecast demand. Although all markets are subject to some seasonal fluctuation, some markets are systematically more uncertain when it comes to future demand level, e.g., because they are more sensitive to the business cycle. Thus, when historical data show that a market is particularly unpredictable, entering it is associated with significant uncertainty. This is because formulating exact expectations about the optimal output level is difficult. Deviations in both directions are critical. If demand is higher than expected, the firm could have sold more and incurs significant opportunity costs. If demand is lower, the firm cannot sell the produced output and incurs a loss.

Flexibility is of pivotal importance if the potential new market is characterized by an unpredictable demand level. In deciding whether to enter a new market, a firm must evaluate whether it is sufficiently flexible to cope with this uncertainty. An inflexible firm entering a volatile market experiences significant challenges when demand drops unexpectedly because the firm cannot adjust its production level fast enough to balance output and demand.

This paper's major contribution is its joint consideration of the two dimensions—flexibility and entry under uncertainty—in testing firm entry behavior. To conduct the empirical test, I characterize the dimensions of uncertainty across a set of markets over time and then estimate how a firm's flexibility drives entry decisions. Note, however, that

even though I observe individual firms entry decisions, the goal of the study is not to identify who will enter markets; rather, I want to understand how firm characteristics in combination with market conditions affect the likelihood of entry.

The empirical context of this study is the airline industry. A carrier's flexibility is based on the latitude of seating configurations in the fleet. An airline wants to fly the smallest possible aircraft that will still hold all the booked passengers, thus saving fuel expenses and landing fees as both of these correlate with plane size. Having a diversified fleet implies having more sizes of aircraft from which to choose, which, in turn, allows an airline to react quickly to changes in demand as it can use a larger/smaller aircraft if demand increases/decreases on a particular route. This is commonly referred to as demand-driven dispatch (Berge and Hopperstad, 1993). Higher flexibility, however, is accompanied by higher maintenance and personnel training expenses. Thus, there is a trade-off between cost efficiency and the ability to cope with uncertain markets.

To test my theory, I use data from the Bureau of Transport Statistics covering U.S. domestic flights between 1993 and 2010. I observe the entry decisions of 25 airlines into 800 domestic markets. This industry is particularly well suited for the analysis as markets can be clearly defined by airport pairs (following Berry, 1992) and, even more important, potential entrants do not need to develop any additional skills or resources for the new market. This allows me to isolate the effects of flexibility, demand variation, and their interplay on a firm's entry decision. Following Dowell and Killaly (2009), demand variation is operationalized using the constructs amplitude, frequency and unpredictability of demand changes proposed by Wholey and Brittain (1989). My results suggest that greater demand variation reduces the likelihood of entry. Interestingly, the results indicate that unpredictability of demand variation has a positive effect on the likelihood of entry. This is consistent with the argument that, when considering entry into new markets, firms search for growth opportunities. If last period revenue would be a perfect predictor of next period revenue, demand would be flat and thus of little interest for growth-oriented airlines. However, airlines seem to hedge their risky entry decisions, as indicated by the interaction between unpredictability and flexibility. The positive effect suggests that airlines have a higher likelihood of entering a market if their flexibility is high relative to market-specific unpredictability. The significance of this interaction effect, however, depends on the predicted likelihood of entry. This implies that the ratio does not add much to the likelihood of entry if the firm is certain to enter a market. Put differently, only if a firm is doubtful about an entry decision then this ratio can tip the scales.

In addition to providing empirical evidence for the relationship between uncertainty and entry, my results contribute to our understanding of market entry (Chang, 1995; Greve, 2000; Guilln, 2002; Haveman, 1993; Haveman and Nonnemaker, 2000; Henisz and Delios, 2001; Martin et al., 1998). I build on work that considers the moderating effect of firm-specific attributes on the relationship between uncertainty and market entry (Dowell and Killaly, 2009; Wu and Knott, 2006). My results show that flexibility not

only increases the likelihood of entry but also moderates the effect of uncertainty. Thus, my findings contribute to our understanding of the relevance of flexibility (Dreyer and Gronhaug, 2004; Fiegenbaum and Karnani, 2006).

The remainder of this paper is structured as follows. Section 2 introduces the theoretical mechanism; Section 3 describes the empirical context of the study. Data, variables, and descriptives are presented in Section 4. Section 5 explains the methodology, followed by presentation of the results and several robustness checks. Section 6 concludes and proposes directions for future research.

2 Theoretical Mechanism

2.1 Flexibility and Uncertainty

It is frequently argued that firms face a tradeoff between efficiency and flexibility, chiefly because the two business models have different organizational and operational requirements (Ebben and Johnson, 2005; Jansen et al., 2009; Raisch et al., 2009). Stigler (1939) raised this discussion by arguing that the technology needed to operate at low cost is completely different from that required to meet changing demand.

Economies of scale are an important driver of efficiency. Firms concentrating on one particular product quickly achieve process experience and thus improve their performance, a trajectory referred to in the organizational learning literature as the "learning curve" (Fang, 2012; Zangwill and Kantor, 1998). Moreover, the efficient firm not only saves on labor costs, but also on procurement. As a result, the efficient firm is inflexible with regard to processes and procurement but can offer its products at a competitive price. This strategy can be deliberately chosen; but also, as firms age and grow, more structure is employed which favors efficiency (Eisenhardt et al., 2010).

On the other hand, firms can choose to be flexible. This type of firm employs several production technologies so as to be able to react quickly to environmental changes. There are many types of flexibility such as market flexibility (Pacheco-De-Almeida et al., 2008; Ward et al., 1995), production flexibility (Sanchez, 1995; Swamidass and Newell, 1987), product flexibility (Ettlie and Penner-Hahn, 1994), process flexibility (Upton, 1997), or design flexibility (Krishnan and Bhattacharya, 2002; Suarez et al., 1996)[1]; in this context, however, flexibility is meant to be volume flexibility, which allows the firm to react to changes in demand. Volume flexibility is characterized by the shape of a firm's cost function. The average cost of producing a good is non-monotonic in its output. Average costs, due to fixed costs, decrease in output until the output optimum is reached. Beyond this point average costs increase again because the production needs to be expanded which is costly. Flexible firms have a flat cost function which means that deviations from the optimal output are not as costly for them as for efficient firms. For inflexible firms, any deviation from the optimal output leads to a steep increase in average costs. However,

[1]For a detailed review on the strategic aspects of flexibility, see Gerwin, 1993

the inflexible but cost-efficient firms can produce their optimal output at lower costs (for a more detailed illustration, see Fiegenbaum and Karnani, 2006).

Flexibility is an advantage if the firm is likely going to need to deviate from the optimal output level, which will be the case if the market is uncertain (Lee and Makhija, 2009), i.e., there is a significant degree of variation in demand (Dreyer and Gronhaug, 2004). Flexible firms can react quickly to changes in demand and adjust their output level. At the same time, cost-efficient firms maintain their output level as adjustments are too costly. Usually, these firms have an edge over flexible firms in stable environments. However, it is argued that flexible firms outperform cost-efficient firms in uncertain environments (Fiegenbaum and Karnani, 2006). With regard to entry, flexible firms can choose from a broader set of possible markets, whereas the inflexible firm has a more limited option. Therefore, inflexible firms should only choose markets characterized by a level of demand variation with which they can cope. As this is only a small subsample of all available markets, their ex-ante likelihood of entering any market should be lower.

Hypothesis 1. *The greater a firm's flexibility, the more likely it is to enter a market.*

2.2 Uncertainty and Firm Entry

In general, uncertainty is hazardous for firms, but it is likely to be especially problematic for firms considering entry into a new market. Uncertainty over future states of the market makes it difficult to forecast demand. Therefore, firms run a high risk of committing to an entry which might eventually fail to pay off. The sources of this uncertainty are various including technological (Anderson and Tushman, 2001), political (Henisz and Delios, 2001), price- (Dixit, 1989), and demand related (Delacroix and Swaminathan, 1991; Dowell and Killaly, 2009). Although the authors study different industries, their findings are throughout similar. In these above-mentioned studies, the authors show that entry into a new market is less likely if policy uncertainty is higher in the potential host country (Henisz and Delios, 2001) or if past outcomes are relatively less useful in predicting future demand (Delacroix and Swaminathan, 1991; Dowell and Killaly, 2009). Looking at it from a different angle, changes in demand and technological uncertainty have been found to affect firm survival rates (Freeman and Hannan, 1983; Tushman and Anderson, 2001).

This study is concerned with entry decisions when there is uncertainty over future demand (Perrakis and Warskett, 1983). Firms try to identify and enter profitable markets for which they anticipate demand growth (Gruber et al., 2008; Shen and Villas-Boas, 2010). And yet, uncertainty makes it more difficult to anticipate demand development. Uncertainty can have various facets which is why many scholars argue that it should not be understood as a one-dimensional concept (Dess and Beard, 1984; Freeman and Hannan, 1983; Wholey and Brittain, 1989). Re-analyzing the data from Freeman and Hannan (1983), Wholey and Brittain (1989) conclude that environmental uncertainty can be characterized along the three dimensions amplitude, frequency and unpredictability of demand

changes. The recent contribution by Dowell and Killaly (2009) uses these constructs to analyze firm entry behavior and argue that greater levels of resource variation should deter firms from entering a particular market. Although managers are unlikely to measure amplitude or unpredictability of demand change, the proposed dimensions do reflect constructs to which managers attend (Dowell and Killaly, 2009, p.71).

Hypothesis 2. *The greater the uncertainty (amplitude, frequency, and unpredictability of change) in a particular market, the lower the probability that a firm will enter that market.*

This study follows Dowell and Killaly (2009) in arguing that demand, while certainly not the only relevant dimension, is a key criterion for firms considering entry into new markets. This is because firms make investments when entering new markets and are concerned about their return. However, when markets show variation in demand, the return is uncertain for the firm. Intuitively, one would expect that firms will be reluctant to enter markets if they are unsure that returns will be high enough to recoup investments. I further agree with Dowell and Killaly that firms are not affected by uncertainty uniformly. However, Dowell and Killaly use firm entry experience as a moderating factor; this paper is concerned with the potentially moderating effect of flexibility.

2.3 Flexibility and Entry into Markets with Uncertainty

Previous studies show that uncertainty has a negative impact on entry. However, most studies (for exceptions see Dowell and Killaly, 2009; Wu and Knott, 2006) fail to account for firm heterogeneity. The implicit assumption in previous studies of this relationship is that all firms are equally deterred by uncertainty. This is a too strong and apparently even wrong assumption according to Dowell and Killaly (2009) as well as Wu and Knott (2006). Using the U.S. telecommunication industry, the former find that uncertainty matters more for firms with more entry experience. Looking at entrepreneurial market entry, Wu and Knott (2006) demonstrate that entrepreneurs are more likely to enter an uncertain market if the level of their ability uncertainty is comparable to the level of market uncertainty.

As argued above, flexibility is a more viable strategy in turbulent and volatile markets. Hence, I expect that a particular level of uncertainty is not perceived as equally threatening by all firms. That is, some firms are more flexible and can handle a higher level of uncertainty in the potential new market: their flexibility allows them react to changing demand in a quick and inexpensive manner. Therefore, rather than the absolute level of uncertainty, I expect, similarly to Wu and Knott (2006), that entry decisions are driven by the ratio of firm-specific flexibility and market-specific uncertainty. Consider a market with low variation in demand and a second one with high fluctuation. A firm with low flexibility and one with high flexibility should have the same likelihood of entering the market with

low and high uncertainty respectively. This is because their degree of flexibility is in each case comparable to the degree of demand uncertainty. Looking only at the high uncertainty market, the entry decision seems less risky for the flexible firm than for the inflexible firm as its flexibility-uncertainty-ratio is higher.

Hypothesis 3. *The greater a firm's flexibility, the less will uncertainty decrease a firm's likelihood of entry in a market.*

3 Data and Variables

3.1 Data Sources

My main data come from the T100 Dataset, which is collected by the Bureau of Transport Statistics, a part of the Research and Innovative Technology Administration. The dataset provides monthly data on domestic flights between January 1993 and December 2010 for 25 U.S. carriers and reports monthly aggregated numbers of scheduled and realized departures. This information is available for every airline-route-aircraft-combination.

My definition of markets and carriers follows Berry (1992), Borenstein (1989), and Ciliberto and Tamer (2009). A market is defined as the connection between two airports, irrespective of the direction of the flight. It is sometimes argued, however, that most airline competition is at the city level. That is, for a customer departing from New York, it is mostly irrelevant whether the flight departs from La Guardia or from John F. Kennedy Airport. A different market definition is used as a robustness check.

In addition, I draw data from the Airline Origin and Destination Survey (DB1B). This is a 10% random sample of all tickets for domestic flights in the United States. The survey reports the carrier, route, distance flown, and, most importantly, ticket price. These data are used to calculate an indicator of route attractiveness by averaging ticket prices across all carriers for a particular route in a given month and dividing it by the distance. The exact calculation is reported below.

3.2 Variables

3.2.1 Entry

My hypotheses concern the impact of flexibility and uncertainty on firms' likelihood of entering a new market. Airline entry decisions are operationalized similarly to the method used in other work on this topic (Berry, 1992). Entry into a new market is defined to occur if a given airline offers service on this route and has not operated this particular airport pair market within the last three months. Since demand for flights is highly seasonal, it is especially important to look at whether the airline operated in this market at the same time a year ago. Some airlines operate certain airport pairs only for a limited time each year, a circumstance that, if not appropriately accounted for, could yield wrong estimates for entry decisions. This is further discussed in the section on robustness checks.

Moreover, only entries are considered where the carrier has operated the route for a minimum of two consecutive months. Occasionally, an airline will have a few flights in a particular month and none in the following. These cases typically reflect weather-related diversions rather than scheduled service (Joskow et al., 1994 p. 459). Such operations could be seen as small-scale entries but generally would not reflect actual entry decisions.

3.2.2 Flexibility

An airline's flexibility increases with the number of types of aircraft it operates, because each usually will have a different number of seats, meaning that adjusting capacity to demand is feasible. The T100 Dataset provides monthly data on passengers and departures at an airline/route/aircraft type-level. This way, the capacity of a particular aircraft type can be inferred from the number of total seats and the number of performed departures (both of which are aggregated on a monthly level).

While the number of distinct aircraft types does give a first indication of flexibility, it does not take into consideration that two airlines with two different plane types might not be equally flexible. For example, an airline could have two different aircrafts that each hold 100 passengers. Another airline could also have only two types of planes, but one holds 100 passengers, the other 300. The second carrier will be much better able to cope with shifts in demand and yet a naïve approach to flexibility would report it as having the same degree of flexibility as the first airline. A measure of flexibility needs to account for the fact that airlines choose seat configurations, such as:

$$Flexibility_j = \left[\sum_{i=1}^{n} (Capacity_{i+1} - Capacity_i)^2 \right] * (n-1) \tag{1}$$

This formula uses differences in seat configurations—*Capacity*—between aircraft types. Aircrafts are sorted by their capacity, with the smallest plane being $i = 1$. The sum of squared capacity differences is multiplied by $n - 1$.

It could be argued that the measure of flexibility is endogenous. Although it is true that airlines choose their own flexibility, they usually do so only once—at the time of their founding. Airlines choose either to be cost efficient, i.e., a low-cost carrier, or flexible. In the former case, only a few types of aircraft are purchased to save on both acquisition and maintenance costs. The result of this business model choice is low flexibility. Firms do not change their business model (at least not in this sample) and are not expected to purchase new aircraft types in anticipation of a risky entry decision. Figure 3 illustrates this point. Both carriers represented in the figure show only minor variation in their average fleet composition. Indeed, Southwest Airlines (lower line) had no changes in flexibility for eight years. Also, Northwest, a full-service provider, continually employs the same business model that privileges flexibility over efficiency. Therefore, the measure of flexibility can be considered as exogenous for the sample period. I touch on this issue in the section on robustness checks.

Insert Figure 3 here

3.2.3 Market Uncertainty

Following Dowell and Killaly (2009), market uncertainty is modeled along three dimensions: amplitude, frequency, and unpredictability of changes in demand (Wholey and Brittain, 1989). These three variables are calculated as follows using the time series of monthly passengers for a particular route.

Amplitude is calculated by dividing the difference between the maximum and minimum traffic over the preceding five years by the average traffic, thus indicating the width of the demand distribution. Larger amplitude means that actual demand in this market can be either really high or really low. Low amplitude implies a narrow window and hence lower uncertainty over future demand.

To measure unpredictability of demand variation I regress total passengers in month m of year t in market j on passengers in month m of previous years. By regressing on the same month, I eliminate seasonal effects within the market that would distort the estimates. Each regression is performed using a five-year time frame. The R^2 of the regression is higher, the better previous-period demand can explain current-period demand. Thus, unpredictability of demand variation is equal to $(1 - R^2)$ for that market and month.

To construct a measure of frequency of demand change, I count the number of times that the trend in a market's passenger growth reverses course (i.e., changed from increasing to decreasing passenger count or vice versa). Again, a five-year time-frame is used to calculate this measure. However, the underlying data are highly seasonal, which would result in a tremendous upward bias. To account for this, passenger data are de-seasonalized using a Hodrick-Prescott filter. The smoothed passenger count reports the actual trend changes more precisely.

Operationalizing the uncertainty measures this way assumes that airlines use five years' worth of data to forecast demand for the potential new market, which may or may not be accurate. Also questions remain with regard to discount rates of information. Reasonably, demand 10 years ago is not as good a predictor for future demand as last-year demand. Therefore, demand of earlier periods is probably discounted by the firm when forecasting demand for the new market. I touch upon this point in the section on robustness checks.

3.2.4 Interaction Effects

My central argument is that different firms perceive the same market differently. This is because some firms are more flexible and can therefore cope with a higher level of uncertainty. The likelihood of entry should be driven by the ratio of firm-specific flexibility and market-specific uncertainty. By combining firm characteristics with market characteris-

tics, this measure is intended to reflect how safe a particular entry is considered to be by a particular firm. It is calculated as follows:

$$\frac{Flexibility_{i,t}}{Uncertainty_{j,t}} \tag{2}$$

where $Uncertainty$ is one of three measures amplitude, frequency, or unpredictability of demand variation. High values, meaning that the firm is flexible and the market is rather predictable, indicate that the firm's entry decision is relatively safe.

This form of interaction requires some transformation of the uncertainty measures. Since the interaction must be a multiplication, even though I need a division, I have to invert the uncertainty measures. Hence the main effects are taken into the regression as $Amplitude^{-1}$, $ChangeFrequency^{-1}$, and $Unpredictability^{-1}$. This way the interaction of, e.g.,

$$Flexibility_{i,t} * \frac{1}{Unpredictability_{j,t}} \tag{3}$$

yields the desired measure of how safe a particular market is perceived to be by the individual firm. The interpretation of the main effects simply changes from "Effect of higher amplitude" to "Effect of lower amplitude", "Effect of higher change frequency" to "Effect of lower change frequency", and from "Unpredictability" to "Predictability".

3.2.5 Controls

First, the model controls for route attractiveness, measured as average price per flown kilometer. An airline prefers to enter a market that will be profitable. If competition is fierce, average price per kilometer is likely to be low. Since the firm ultimately wants to make a profit, I expect price per kilometer to be a key factor in the decision-making process.

My controls also include airport presence as previous papers have found this to have a significant effect on entry (Berry, 1992). Airlines which own slots at one of the two endpoints can more easily operate a new route out of this airport. Airport presence is a dummy that takes the value 1 if the carrier has been active at one of the two endpoints of the new route in the last month.

As entry considerations are driven by competitive dynamics, the model controls for market competitiveness. This is measured as a Herfindahl-Hirschman Index (HHI), which is the sum over the squared market shares. Routes with the maximum HHI of 1 are considered a monopoly, whereas low values indicate fierce competition.

Larger firms might also be more likely to enter since they have more resources than do smaller firms. Also, they might be less risk averse, which would directly impact the likelihood of entry. I account for this by controlling for the log of full-time equivalents employed at the firm.

Carrier-fixed effects are used so as to capture all time-constant carrier-specific effects such as strategic orientation and business model. To control for unobserved time effects, I use month-fixed and year-fixed effects. All market controls are lagged by three months.

4 Estimation and Results

4.1 Analysis

I observe the monthly entry decisions of 25 U.S. carriers from 1993 to 2010. The event of interest is whether an airline started providing service on a new domestic route. As previously stated, entry into a particular market is defined to occur if the status of an airline switches from inactive during previous months to active in the focal period. The indicator for "activeness" can be either zero or one for every airline/market/date combination: one if the airline operated in this market during this month, zero otherwise. Airlines can decide to enter into one, multiple, or no new markets each month. Also, airlines decide to exit markets during the 17 years. If the airline, after a period of absence, returns to the market, such is considered an entry as long as the entry criteria set out in Section 4.2.1 are satisfied. Post-entry observations are dropped as long as the carrier operates in the new market. Keeping these observations would bias the results. This is because the model would interpret consecutive periods of "activeness", which are coded as 1, as new entries into the market. Accordingly I only keep observations of markets in which airlines are not yet active or entered during the respective period.

Modeling firm entry into a market presents an estimation challenge. Like Dowell and Killaly (2009), I investigate the likelihood of firm i entering into market j over time. Whereas most other studies look at firms entering a single market, my data suffer from non-independence, that is, a firm's decision to enter a particular market at time t is not independent of entering the other 799 markets (Havemann and Nonnemaker, 2000; Korn and Baum, 1999). The firm has limited resources that have to be distributed carefully. Following Dowell and Killaly (2009) I estimate the model using the method of generalized estimation equations (GEE) developed by Liang and Zeger (1986). The principal benefit of this model is that it allows me to make adjustments for the nonindependence of the errors across markets for the same firm. The method requires the distribution of the outcome variable, the link function connecting the covariates to the outcome and a correlation structure of the errors to be specified. I choose a binomial distribution and the logit link function. Moreover, an exchangeable error structure is specified which means that all observations of a firm are correlated in a given month with no difference in the correlation across markets for a firm.

By using the GEE estimator, I seek to identify the effects of flexibility, demand variation, and their interaction on an airline's entry decision. My baseline specification is:

$$Pr(Entry_{i,j,t}) = \alpha_0 + Flexibility_{i,t} + D_{j,t} + Flexibility_{i,t} * D_{j,t} + \mathbf{X} + \sum_{m=1}^{12} \beta_m dm + \sum_{y=1993}^{2010} \beta_y dy + u_i + \epsilon_{i,j,t} \quad (4)$$

where the vector $D_{j,t}$ contains the inverted demand variation measures (Lower Amplitude, Lower Change Frequency, and Predictability of Demand) and $\mathbf{X}$ includes the control variables—market competitiveness, route attractiveness, firm size and airport presence—while dm and dy stand for the month and year fixed effects respectively. In addition to the standard error term $\epsilon_{i,j,t}$, the use of carrier-fixed effects includes a carrier-specific time-constant heterogeneity term u_i.

This estimation is particularly robust as the combination of GEE estimation with within-firm market correlated errors and a number of variables controlling for firm and market characteristics is well suited for the spatial autocorrelation that likely exists in my data. The standard errors are calculated using the sandwich estimator (Huber, 1967; White, 1980).

4.2 Results

Descriptive statistics and correlations are reported in Tables 1 and 2, respectively. A few of the descriptive statistics are worth noting. First, the number of observations is lower than one would expect because airlines join and drop out of the panel. Second, the minimum value of flexibility is zero, which is observed whenever airlines operate only one type of aircraft. This situation, by definition, characterizes the perfectly inflexible firm. Third, while the mean unpredictability is 0.56, the maximum value is 1. This implies that for particular markets, previous-period passenger counts could not explain any of the variation in the following periods. This is true for four markets and for a maximum of only three months.

Insert Table 1 and 2 here

Table 3 presents the results for the GEE estimation which are marginal effects evaluated at the mean. Hypothesis 2 is tested in Model (1) of Table 3 by introducing the measures of demand variation. Two of the three measures support the hypothesis. The results show that lower amplitude and lower change frequency increase the likelihood of entry. The effect of predictability is negative, indicating that airlines prefer to enter markets whose future demand is more difficult to predict. At a first glance, this is a counterintuitive result; however, it is consistent with the idea that firms search for growth opportunities when expanding into new markets. In growing markets, previous-periods demand is not a good predictor of future demand. Unpredictability of demand is high if current demand

deviates substantially from previous periods regardless of the direction. Jointly, the three dimensions of demand variation are significant at the $p < 0.000$ level ($\chi^2(3)$=88.83). Overall, I find reasonable support for H2 as greater demand variation in a market deters entry into it.

Insert Table 3 here

The coefficients of the control variables are in the expected direction and are stable across the models in this table, with one exception. Market concentration is negative and significant which would indicate that airlines prefer to enter fiercely competitive markets. However, this might just be picking up the size effect of the route. A single airline can usually satisfy demand on small routes, whereas busy routes between two large cities can sustain multiple airlines. The latter case results in less market concentration but provides a better environment for entry. This finding is consistent with those of Martin et al. (1998) who suggest that higher levels of market density provide information about market attractiveness.

The measure of flexibility is included in Model (2) of Table 3. The effect is positive and significant ($p < 0.01$). This finding supports Hypothesis 1 as more flexible firms have a higher likelihood of entering a new market. Model (3) includes the interactions between flexibility and the three measures of demand variation. The results provide some support for Hypothesis 3. The interactions with amplitude and change frequency are insignificant; however, the interaction of flexibility and unpredictability is positive and significant. That indicates that airlines have a higher likelihood of entering a particular market if their individual flexibility is relatively high compared to the unpredictability of the new market. Although the results show that airlines prefer to enter unpredictable markets, this particular finding shows that airlines prefer to hedge their risky entry decisions. In the event of unpredictability going in the wrong direction, i.e., demand decreases instead of increasing, their flexibility allows them to react quickly. Further, as amplitude to some extent measures a market's exposure to seasonality, the insignificant interaction effect is plausible. Since seasonal variation is predictable, the carrier can plan its schedule accordingly without the need for flexibility.

However, there is an econometric issue with the results of the interaction terms. As the moderating variable is itself a marginal effect, the direction and statistical significance of the interaction coefficient is not reliable (Hoetker, 2007). This is because the equation for the moderating effect is non-linear as its value depends on all other values of the variables in the model. Intuitively, the true interaction effect might vary with the predicted probability, e.g., it is significant only when the probability of entry is low. Therefore, the effect of the interaction in a logit model is tested by examining the sign (positive or negative) and statistical significance of the values of *Flexibility*'s marginal effect on the

relationship between *Unpredictability* and *Entry* over all sample values of the model variables (Wiersema and Bowen, 2009). The test yields a mean of the true interaction effect (flexibility over unpredictability) of 1.47e-6 and a z-statistic of 1.70 which means the true interaction effect is positive and significant at the 10% level. The result is illustrated in Figure 4 and reveals an interesting implication. The true effect of the flexibility to unpredictability ratio decreases as the predicted probability of entering a market increases. Being flexible relative to market unpredictability matters most if the firm is uncertain whether it should enter the market. Put differently, if a firm is certain to enter a market in the first place, the ratio does not add much to the probability of entry.

Insert Figure 4 here

4.3 Robustness Checks

The results show that demand variation partly deters entry and that flexibility moderates this effect. The following section discusses several robustness checks undertaken to increase confidence in these results.

The findings are robust against the omission of the two major U.S. airports, different operationalizations of the entry variable and the time horizons used to calculate the uncertainty measures. Further, the analyzed time frame and the measurement of flexibility does not influence the results.

Also, it could be argued that competition does not occur at the airport level but at the city level. In this case, operating the route between New York and Boston out of La Guardia or out of John F. Kennedy Airport would make no difference to the airline. Since there are some cities in the sample with multiple airports, markets are redefined as the connection between two cities (still irrespective of the direction). The regression yields results qualitatively similar to those of the preferred regression.

As discussed above, flexibility is highly correlated with choice of business model. That is, airlines that choose to be low-cost carriers also choose to purchase only a few different types of aircraft so as to save on maintenance costs. On the one hand, this argument is crucial for the analysis as it punctuates the exogeneity of the flexibility measure. On the other hand, it could be argued that the results are simply picking up the effect of the business model. To rule out this alternative explanation, an additional regression is performed that uses only those airlines considered to be full-service providers. The results show that flexibility still has a positive effect on entry. Also, the coefficients of the interaction terms are qualitatively similar to the preferred regression. This indicates that the effect I find in my analysis exceeds the pure effect of the business model decision.

Nevertheless, my findings could be driven by the size of the carrier. Additionally to controlling for firm size in terms of full time equivalents, two additional regressions are

performed using split samples. The total sample is divided into two so that the first part contains all the large carriers, such as American Airlines, Continental Airlines, Delta, Northwest, Southwest and United. The second part contains the smaller airlines, including Frontier Airlines, Spirit Airlines, and Air Wisconsin, to name a few. The results show that the findings still hold for the subgroups of small and large airlines.

My central argument is that firms prefer to enter markets if their own flexibility is high relative to market uncertainty. However, it could be argued that even though a market is volatile, it is still steadily increasing in its overall demand. Hence an airline tracking market development might select only markets with an upward trend in demand. As a consequence, the findings would suggest that firms enter volatile markets whereas, in reality, they are simply choosing markets with a clear upward movement. The model includes the additional control $MarketDevelopment$, which is the growth rate in deseasonalized passengers over the previous year, lagged by three months. As the results show, the coefficient for $MarketDevelopment$ is positive which means that airlines prefer markets in which demand is increasing. However, the coefficient is insignificant, which, in combination with the persistently positive and significant coefficient for the flexibility over unpredictability ratio, strengthens the argument that it is the interaction of flexibility and unpredictability that matters for firms when considering entry into new markets.

The majority of airlines have realized the benefits of leasing aircraft instead of buying them. Currently, roughly one in three aircraft operated by U.S. carriers is leased. It seems plausible, even though this would run counter to the rationale of efficiency, that airlines could easily increase their flexibility by leasing different types of aircraft. Although firms are not expected to strategically lease new airplanes so as to have the appropriate flexibility to enter a particular market, this alternative explanation needs to be addressed. Unfortunately, the data do not distinguish between bought and leased aircraft; however, the following approach shows that the leasing-airplanes explanation is invalid. Suppose airlines strategically leased aircrafts so as to enter a particular market in which flexibility is necessary. In such a case, the observed fleet variety should increase in advance of entry. Using the same dataset, I calculate the difference in fleet variety, measured as the number of distinct aircraft types, as follows:

$$Difference_{i,t} = FleetVariety_{i,t} - FleetVariety_{i,t-6} \tag{5}$$

where i denotes the airline and t the date measured in months. A high value of $Difference_{i,t}$ would indicate an increase in the carrier's fleet diversification. I still cannot disentangle whether this difference is due to purchasing or leasing, but this issue can be ignored at this point as I seek to show that airlines do not strategically alter their fleet constellation for market entry. The data report entry decisions (coded as 0 for none and as 1 for one or more entries) and the difference between this-month fleet variety versus that of six months before for every airline and every month over the 17 years. Correlating $Entry_{i,t}$ and $Difference_{i,t}$ reveals a weak, negative and even insignificant relationship of

-0.02 (p=0.171). A more econometrically stringent test of this relationship is performed using a fixed-effects panel estimator. Using four different specifications (with and without firm, month and year fixed effects), I test whether a significant change in fleet variety is followed by entry into a new market. This argument would be supported by positive and significant estimates, but I find exclusively insignificant effects. Moreover, the coefficients are negative, which further allays concerns. Clearly, this test cannot claim causality, but it goes some way toward supporting the argument that fleet variety is not strategically altered to overcome uncertainty of a new market.

5 Discussion and Conclusion

The success of market entry is always uncertain, and a great deal of this uncertainty (and thus risk) revolves around demand and variations therein. The main problem arising from this kind of uncertainty is that firms have to make investments, i.e. decide on their capacity, in anticipation of a given level of demand. Higher uncertainty over this level increases the probability that the firm's predictions will be wrong. As a consequence, the firm over- or underinvests and incurs opportunity costs or a loss respectively. However, this scenario is only applicable in the case of an inflexible firm. A firm with sufficient flexibility can adjust its capacity along with events, which prevents it from either losing money or incurring opportunity costs.

If uncertainty over future demand is a problem for firms, higher unpredictability should reduce the likelihood of market entry. Also, as argued above, firms for which the flexibility to uncertainty ratio is high should not be deterred as much as firms that have a lower ratio, and it is this issue that is investigated in this paper. Using the airline industry as my empirical setting, I analyze whether a carrier is more likely to open up a new route when its own flexibility is relatively high compared to the uncertainty of the new market. Using a large dataset of entry decisions made between 1993 and 2010, my results suggest that greater demand variation in markets reduces the likelihood of entry. Interestingly, the results indicate that firms prefer unpredictable markets. While counterintuitive at first, this is consistent with the argument that firms, when considering entry into new markets, search for growth opportunities. If last-period revenue is a perfect predictor of next period revenue, demand is flat and an airline looking to grow would probably avoid this particular market.

However, my results show that airlines hedge their risky entry decision, as indicated by the interaction between flexibility and unpredictability. In the event that demand goes down instead of up, the airline can still leverage its flexibility to reduce its exposure. This lends support to the hypothesis that firms are more likely to enter a particular market if their individual flexibility is large enough to cope with the unpredictability of demand in the new market. Flexibility seems to be less helpful for the dimensions of amplitude and change frequency. In the case of the former, this might be explained by airlines foreseeing

seasonal patterns of demand which is partially captured in the measure of amplitude. In the long run, carriers can adjust their frequency and therefore do not have to balance demand and capacity with flexibility. The results further suggest that the interaction effect is only statistically significant when the predicted probability of entry is low. Specifically, this implies that the ratio of flexibility over unpredictability only plays a decisive role as long as the airline is uncertain about the entry decision.

My findings contribute to our understanding of market entry. Although, the analysis focuses on domestic expansion with the same service, it reveals some basic mechanisms that should drive entry decisions of other industries or entry types, too. Any firm contemplating entry into new geographic or product markets needs to verify whether it has the resources to cope with the uncertainty of the entry decision. My analysis shows that demand variation does indeed influence firm entry decisions and that firm-specific characteristics moderate the effect of uncertainty on the likelihood of entry.

Furthermore, the findings can be generalized to various other settings. Flexibility is an important driver for entry into uncertain markets whose output cannot be stored, such as the airline industry, where capacity for a particular flight cannot be sold after the aircraft has taken off. Whenever storage of produced output is unfeasible, a potential entrant must be flexible enough in its output generation to react appropriately to volatility in demand. Hence, the findings from this paper can be applied to industries such as transportation, professional services, and virtually all those whose capacity cannot be stored.

The paper has several limitations. First, my measure of route attractiveness might have a slight upward bias. Using the DB1B dataset, I cannot distinguish between booking classes, which means that by averaging across all tickets, I also include first-class tickets in my measure. Since there are some carriers, e.g., Southwest, which do not offer first class on domestic routes, the estimate for this measure might be biased. Second, I cannot observe entry profitability. Clearly, it would be interesting to see whether more flexible airlines have higher post-entry performance. However, the data do not report performance measures at a route level which makes it difficult to disentangle the impact of a particular entry.

Moreover, my argument is built on the idea that a firm's flexibility has an effect on its perception of a market. That is, a flexible firm might perceive a particular unpredictable market as less risky than an inflexible firm would. However, I cannot conclusively state that firms' perceptions of the same environment differ as I do not measure it.

The model presented in this paper could be enhanced in several ways. First, it would be interesting to see if the results hold in different industries. Entry into new markets in the airline industry does not require the firm to acquire new resources or skills. Also, airlines sell the same product to potentially the same customers regardless of the market. This characteristic made the airline industry particularly suitable for my analysis as I could isolate the effect of uncertainty and flexibility; however, the same characteristic makes it questionable to what extent my results hold for other industries. Most firms entering new

markets are confronted with different customers, either due to geographical differences or product characteristics. Therefore, using entry data from different industries might be worth studying.

Second, firms enter new markets only if they expect to make a reasonable profit. This study, however, can show only that flexible airlines do indeed enter more risky markets. Future research could look into post-entry performance to investigate whether flexible airlines perform better than inflexible ones after entry into the same risky market. Theory would suggest that flexible airlines can react to changes in demand. Using smaller planes saves costs and ultimately should result in higher profits. Such studies would also contribute to the literature on the relationship between flexibility and firm performance (Jack and Raturi, 2002; Worren et al., 2002).

Third, as shown by Anderson and Tushman (2001), exit rates are significantly driven by changes in demand uncertainty. A future study could explore whether inflexible firms are more sensitive to changes in uncertainty and prefer to exit a market more quickly than flexible firms. If firms exit a market when the change in uncertainty exceeds their flexibility, we should be able to observe flexible firms staying longer in a market.

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Appendix

Table 1: Summary Statistics

Variables	N	Mean	Std.Dev.	Min	Max
Entry	3,040,602	0.008	0.090	0	1
Flexibility	3,040,602	2.999	7.372	0	47.73
Amplitude	2,610,174	0.865	0.373	0.226	6.75
Change Frequency	2,610,174	2.286	1.356	0	13
Unpredictability	2,610,174	0.560	0.237	0.003	1
Firm Size (log)	3,040,602	8.578	1.677	1.791	11.51
Market Concentration	3,040,602	0.770	0.244	0.140	1
Route Attractiveness	3,040,602	0.272	0.371	0.01	50.34

Table 2: Correlation Table

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1) Entry	1.000							
(2) Flexibility	0.057	1.000						
(3) Amplitude	-0.006	0.01	1.000					
(4) Change Frequency	-0.006	-0.006	0.045	1.000				
(5) Unpredictability	0.009	-0.004	-0.013	0.028	1.000			
(6) Firm Size (log)	0.078	0.490	0.000	0.004	0.005	1.000		
(7) Market Concentration	-0.016	0.059	-0.004	0.070	-0.037	0.007	1.000	
(8) Route Attractiveness	0.009	-0.015	-0.047	0.000	0.076	0.010	-0.058	1.000

Table 3: Preferred Regression

	(1)	(2)	(3)	(4)
	Dependent Variable: Entry			
Lower Amplitude	0.000521***	0.000499***	0.000482***	0.000431***
	(0.000114)	(0.000116)	(0.000134)	(0.000110)
Lower Change Frequency	0.000770***	0.000748***	0.000880***	0.000731***
	(0.000215)	(0.000219)	(0.000261)	(0.000221)
Predictability	-0.361e-5***	-0.371e-5***	-0.512e-5***	-0.430e-5***
	(8.69e-7)	(8.81e-7)	(1.06e-6)	(8.84e-7)
Flexibility		0.0908***	0.0820***	0.0687***
		(0.00584)	(0.0145)	(0.0124)
Flexibility / Amplitude			0.00228	-0.000293
			(0.00914)	(0.00766)
Flexibility / Change Frequency			-0.0172	-0.0132
			(0.0178)	(0.0152)
Flexibility / Unpredictability			0.000175**	0.000139**
			(6.84e-5)	(5.76e-5)
Market Attractiveness	0.000160***	0.000164***	0.000165***	0.000138***
	(4.84e-5)	(4.96e-5)	(4.96e-5)	(4.22e-5)
Market Concentration	-0.00204***	-0.00206***	-0.00204***	-0.00175***
	(0.000220)	(0.000223)	(0.000223)	(0.000186)
Airport Presence	0.00259***	0.00260***	0.00260***	0.00197***
	(0.000116)	(0.000118)	(0.000118)	(9.61e-5)
Firm Size	0.00331***	0.00298***	0.00298***	0.00271***
	(5.85e-5)	(6.61e-5)	(6.60e-5)	(0.000166)
Month FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Carrier FE	NO	NO	NO	YES
N of obs	2,911,411	2,911,411	2,911,411	2,911,411
Model Degrees of Freedom	34	35	38	62
Wald χ^2	6126.3	6736.9	6763.9	7721.4

Note: Reported coefficients are marginal effects evaluated at the mean. For dummy variables dy/dx represents the discrete change from 0 to 1. Robust standard errors in brackets. * p<0.1, ** p<0.05, *** p<0.01

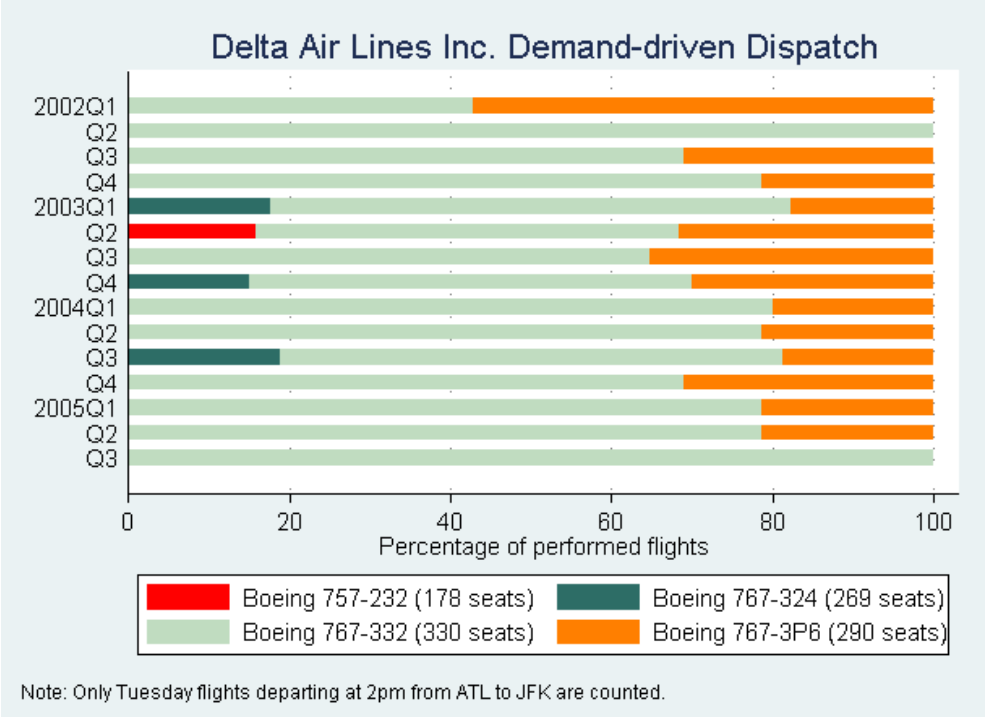


Figure 1: Demand-driven Dispatch for Delta Air Lines

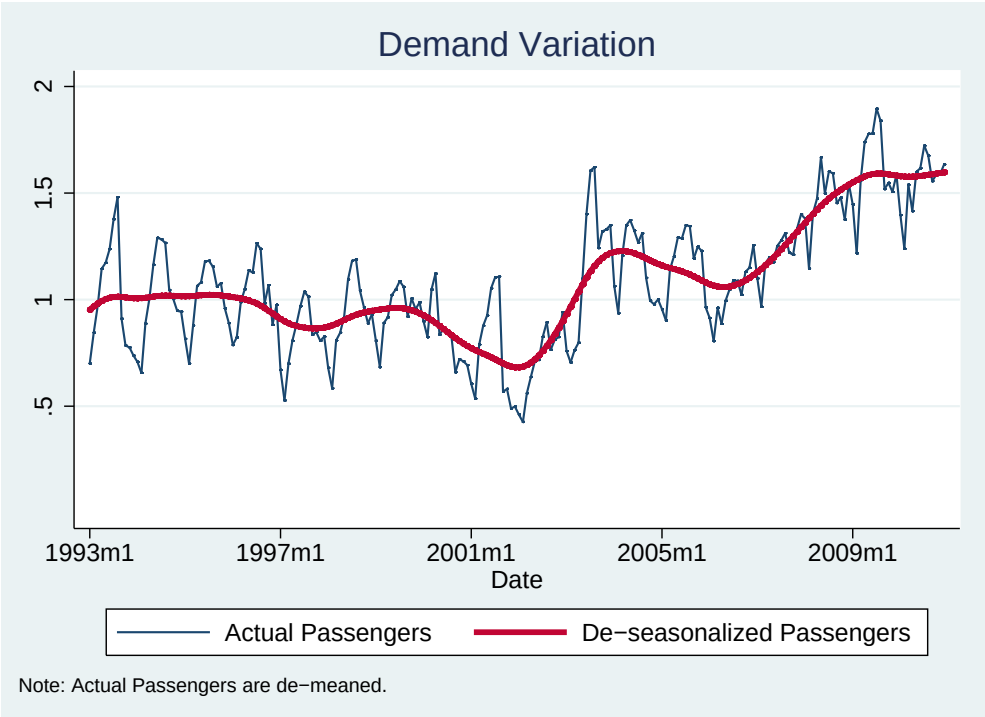
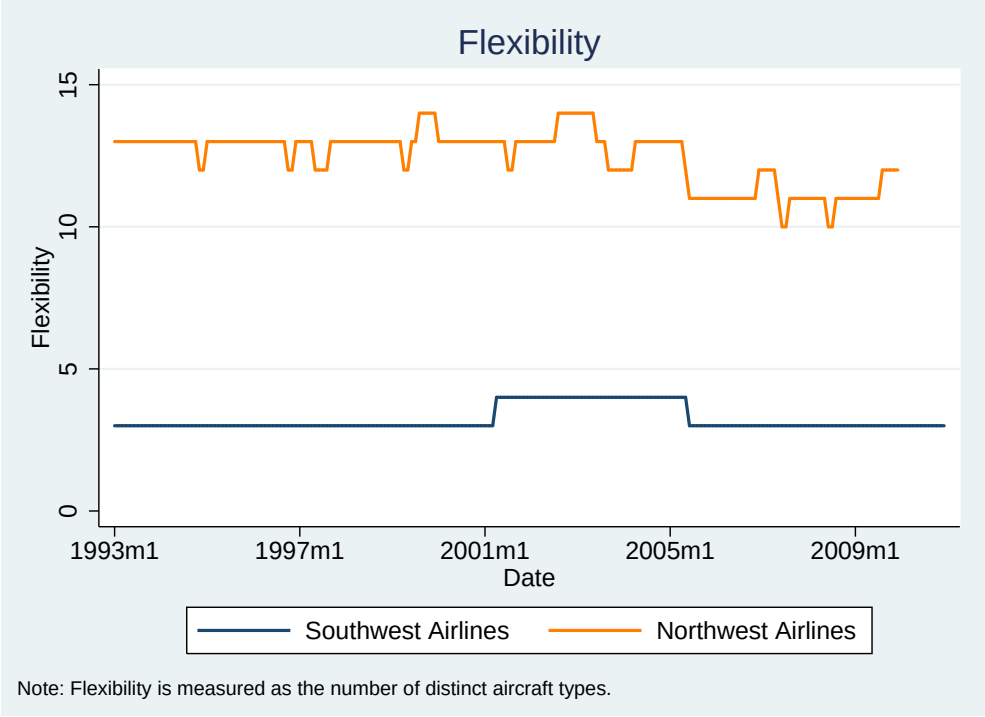


Figure 2: Demand Variation for the route between Atlanta (ATL) and New York (JFK)



Note: Flexibility is measured as the number of distinct aircraft types.

Figure 3: Flexibility

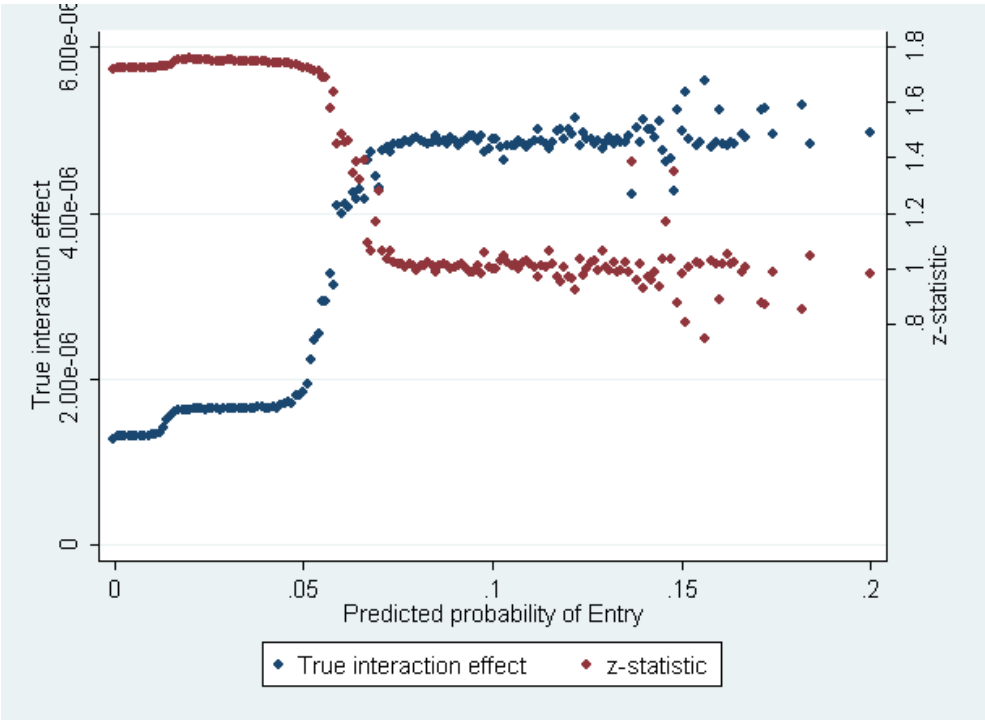


Figure 4: True Interaction Effect