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Acquisition of Competition: The Impact of Alaska Airlines Acquisition of Virgin America on the Entry Dynamics of West Coast Routes

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Abstract

This paper investigates whether the acquisition of Virgin America by Alaska Airlines in April 2016 managed to change the expected entry for West Coast routes. By deploying an ordered probit model, the report was able to predict an optimal number of carriers per route, which when compared to and subtracted from the actual number of carriers, would indicate whether entry or exit choice was warranted. The idea is that if there are more predicted carriers than actual carriers, the route is underexploited, and new players will enter the route until it is no longer economically viable. To better examine these findings, probit models were deployed. Theoretical frameworks would suggest that the expected entry on Virgin America's routes would increase post-acquisition, the findings however display a generally negative trend, indicating more towards airline exit. This effect is most accentuated on "merged" routes, meaning those Virgin and Alaska flew on. While expected entry on routes is higher in the post merger period, than in the integration period when Virgin was still flying under its own brand, the general trend still indicates expected exit.

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1. Introduction

1.1. Overview

After many months of negotiations and a bidding war, Virgin America's board of directors finally agreed to a $4 billion acquisition bid from the Alaska Air Group (Alaska Air Group, 2016). The airline flew under its own brand for 2 more years, being fully integrated into the Alaska Airlines operations in April 2018 (Rosen, 2018). Virgin America appeared on the market in the 2000's and was a low cost carrier (LCC) that tried to add emphasis on entertainment and service quality, providing many free amenities such as touch-screen displays or Wi-Fi, when it was uncommon for LCCs to do so (Rosen, 2018). Over time, the San Francisco headquartered Virgin America managed to establish a loyal customer base, primarily focusing on West Coast routes, with their main hub being SFO, in San Francisco, and their secondary hub being LAX, in Los-Angeles (Alaska Air Group, 2016). Being headquartered in Seattle, meant that after the acquisition, Alaska became the only large West Coast based airline, and the 5th biggest domestic airline (Alaska Air Group, 2016).

Although not officially disclosed, many market analysts believe that Alaska Air Group made moves to acquire Virgin America in part to retain leadership on West Coast routes. There are several reasons that would explain this. Firstly, when examining entry dynamics prior to the acquisition, it could be seen that there was significant competition with many new players entering routes historically served by Alaska, with the likes of Delta and Jetblue making expansions to the region. Furthermore, many LCCs such as Southwest and Virgin were driving further competition with lower fare prices. Considering anti-trust regulations, and the high competition on these routes, it is unlikely that airlines would collude on price, meaning limiting competition would be a viable alternative. Secondly, the speculation that the purchase was done to limit competition can be somewhat proven by the economics of Virgin's operations. To ensure economies of scale Alaska exclusively operated 737 Boeings, lowering costs with bulk purchases of fleets and parts and having highly specialized maintenance staff. Virgin on the other hand had a small and leased fleet of Airbus planes, and almost all of their onground infrastructure was leased. On the other hand, Virgin had a strong brand name, and geographical presence in California, with SFO and LAX hubs, which Alaska inherited. This posed significant strategic benefits because by April 2016 LAX and SFO respectively were the biggest destinations from the Seattle-Tacoma International Airport (SEA).

1.2. Hypothesis and Research Structure

This paper utilizes the theoretical framework presented in the Bresnahan and Reiss (1991) paper, but applying it to the West Coast airline market, a region systematically underexplored in academic circles relative to other areas such as the South or the East Coast of the United States. The regional coverage of Alaska's and Virgin's coastal routes will help provide valuable insight into the competitive market landscape and help review whether acquisitions of regional competitors will favorably influence entry dynamics. Bresnahan and Reiss (1991) stipulate that economic parameters will influence the extent to which markets will be concentrated. On the basis of this theoretical assertion, it is possible to create formulas which measure the saturation of markets, helping evaluate whether entry or exit are warranted, with the idea being that entry is lucrative when the market is undersaturated. Bresnahan and Reiss (1991) present the following formula, the basis of which forms the nucleus for the hypothesis of this paper:

$$\Pi_N = S(Y, \lambda)V_N(Z, W, \alpha, \beta) - F_N(W, \gamma) + \epsilon$$

Where N is the number of firms, Π_N= Profit, V_N= Variable cost, F_N= Fixed cost, S = Market size

Subsequently, Bresnahan and Reiss (1991) reason that firm entry can be expected while $\Pi_N \geq 0$, with more firms in the market decreasing the individual firm profit of each firm. The economic attractiveness of a route can be driven by the market size (S), for example the population and GDP of a destination, but also fixed costs F_N, which can be measured by the distance related costs between locations, for example petrol costs multiplied by the distance. With the acquisition, Alaska Airlines expanded to routes in California, increasing their market size (S), and decreased the number of players (N) on the overall market. Furthermore, by inheriting SFO and LAX hubs, they should hypothetically decrease their fixed costs (F_N), considering the now shorter distances Alaska would cover to reach other Californian routes, considering that prior to the acquisition, their hubs were only in Seattle (SEA) and Portland (PDX), respectively. By April 2016, the top destinations from PDX based on passengers were SEA, LAX and SFO. For SEA, LAX and SFO were number 1 and 2 destinations respectively, with PDX being 7th. Considering such interconnectedness between these airports and Alaska's hubs, and given the firm's historical regional presence, it is understandable why Alaska was growing concerned with competitor expansion in the region and decided to enhance their market influence. On the other hand, decreasing the number of players (N) theoretically should increase the market lucrativeness for these routes, considering there are less players now competing for the same market share. Considering the many densely populated major metropolitan hubs within the vicinity of the West Coast, it is reasonable to assume many agents would be interested in growing their market presence in such a location. Thus, taking these contrasting viewpoints into account, leads to the research question of this paper:

"How did the Alaska Airlines acquisition of Virgin America influence entry dynamics for routes on the West Coast?"

The hypothesis posited by this paper is based on the economic assertions that Alaska's acquisition of Virgin America will decrease the number of players on the market, increasing the predicted entry attractiveness. The basis for this hypothesis stems from the notion that prior to the acquisition, the market was oversaturated, with many players entering, which potentially was part of the reason for the acquisition. Hence it is reasonable to assume that the time point after the acquisition occurred, would be precisely when there is the highest number of carriers per route, with periods before seeing fewer total unique carriers per route. Hence, it is reasonable to assume that entry becomes more lucrative after the integration of Virgin America into the Alaska Airlines operations. Thus the hypothesis of the paper is the following:

Hypothesis*: Entry will become lucrative once the number of actual carriers decreases on a route, meaning entry dynamics will change once Virgin is incorporated into the Alaska Air group operations in April 2018.*

To successfully test the hypothesis, this paper will incorporate a tripartite econometric analysis, for the time periods prior to the acquisition announcement, during the integration period when Virgin flew under its own brand name, and after the integration. Considering the acquisition occurred in April 2016, and the integration occurred 2 years later in April 2018, the time periods this report will be considering are April 2015, year before the acquisition, as a control group, April 2017 a year into the integration, as the integration period, and April 2019, a year after the integration, as the post merger period. The analysis will look at expected entry for the 3 time periods, with the idea being that for April 2019, the expected entry for routes that Virgin flew on would be more lucrative relative to April 2015 or April 2017. The hypothesis will be supported in the event that expected entry becomes more lucrative post-integration. Furthermore, expected entry is expected to be stronger on merged routes, meaning those routes that Virgin America flew on.

1.3. Relevance, Contribution

This research is of relevance for several reasons. Firstly, the aviation sector is the backbone of economic growth, ensuring business connectivity through travel and trade. Hence, better understanding the processes behind the industry could help economists make more accurate industry assessments and help policy-makers implement efficient and welfare maximizing legislation. Secondly, entry dynamics are highly relevant to the field of economics because it helps understand market development to a greater extent, allowing us to see how new companies can influence market processes such as pricing, innovation and competition. This itself is important because it can advance the field of economics, potentially be transferred to other industries, which could lead to better policy being passed, promoting positive economic conditions, with more efficient resource allocation and greater consumer welfare and prosperity. Lastly, the aviation sector in many ways follows an oligopolistic market structure, hence by reviewing route specific behavior of firms will help advance the study of entry in oligopolistic markets. Considering the predisposition of oligopolistic markets being susceptible to collusive tendencies, researching these market structures is of interest to relevant governing bodies responsible for upholding and ensuring consumer protection.

Much of the literature on entry dynamics in the airline industry commonly considers topics such as market structure influence on entry or the competition between LCCs and legacy carriers. Furthermore, it tends to look at these topics from a wider macro perspective, usually reviewing the matter for the industry as a whole. Unlike traditional literature on this topic, this paper incorporates both macroeconomic insights by looking at specific West Coast routes, as well as microeconomic insights, reviewing specifically Virgin and Alaska serviced destinations. Furthermore, while not inherently related to the evaluation of M&A success, studying the acquisition impact on entry dynamics can act as a proxy for evaluating M&A success, acting as a new contribution to the study of post-merger synergy evaluation, much of which only incorporates financial data to measure performance.

2. Literature review

The American commercial aviation sector consists of LCC and legacy carrier airlines. LCCs tend to compete on the basis of low fare prices, usually catering to a specific customer segment and geographic region (Slovin, 1991). Legacy carriers on the other hand tend to have more established offerings, with greater cabin selections (e.g., economy, business class, first class), amenities and cover wider geographies providing both domestic as well as international flights (Slovin, 1991). Furthermore, legacy carriers foster stronger international alliances and primarily utilize the “hub-and-spoke” models, relying heavily on large airports and centralized hubs while LCCs tend to follow the “point-to-point” model, with city to city flights without connections, usually from smaller airports (Slovin, 1991). Despite significant disparity in operational structures, LCCs and legacy carriers do not always operate in mutually exclusive domains, as for most domestic routes LCCs and legacy carriers compete for route dominance (Slovin, 1991).

Prior to the 1970s, aviation was a premium method of transportation and the industry was dominated by established players who entered the market around the 1920s and 1930s, when commercial flying started to become a serious industry. It is around this time period that carriers such as Delta, United, American, Alaska were founded. The modern market dynamics of the aviation industry can be traced to a series of legislations passed in the late 1970’s. Most relevant of which was the “Airline Deregulation Act" passed in 1978, aimed at enhancing entry and competition amongst airlines. Subsequently, the industry focus began shifting from premium to economy flying, with the market experiencing changing routes and pricing structures, marking the beginning for LCCs. This is where the origin of the "legacy carrier" comes from, terming all airlines prior to the Deregulation Act as "legacy carriers".

By the 1990s deregulation led to changing entry dynamics where significant industry entry and competition meant LCCs were growing in market share and relevance. Changing entry dynamics meant legacy carriers had to adapt to new market realities. Windle and Dresner (1999) examined one such scenario, examining flight data of Delta and an LLC called Valujet, for the years of 1993 to 1996, to Atlanta, both as a final destination and as a stop-over for further flights. The authors computed that on routes where Delta directly competed with Valujet, fare prices decreased on average by 10%, which they stipulated was a method of staying competitively relevant (Windle and Dresner, 1999). This finding closely resonates with the views of Dresener et al. (1996) paper, which found that fare prices on routes decreased after an LCC called Southwest would enter markets. In a similar manner, Morrison and Winston (1995) paper looked at LCC exit, specifically that of Southwest and American West, finding fare prices rising by almost 9% for the former, and close to 3% for the latter, within the 5 year period following route exit. On the other hand, Windle and Dresner (1999) did not find any statistical significant proof that fare prices rose on routes where LCCs were absent, citing that potentially more reasons would influence the decision to adjust fare prices.

Budd et al. (2014) reviewed entry dynamics of European LCCs for the years of 1996 to 2012, and identified significant evidence suggesting first mover advantages with respect to route dominance, citing that airlines that entered routes earlier established greater economies of scale, had substantially lower costs and were more likely to retain control. On the other hand, Budd et al. (2014) find that airlines that entered later faced substantially harsher entry conditions, with the airline's likelihood of exit being far higher. Despite this, Budd et al. (2014) argued that overall LCCs failure to survive occurred more frequently due to a combination of other factors, such as having a limited fleet size, changing business models, usually in attempts to shift towards more "premium" business offerings, as well as late-mover disadvantages.

Entry dynamics are not only influenced by airlines competing for market share, but also by macroeconomic conditions and market structures. Chi and Baek (2013) paper reviewed the relationship between economic growth and the demand for aviation transportation, and found a statistically relevant and positive relationship between economic growth and the expansion of aviation providers. Similarly, Lohman and Vianna (2016) deduced that demand drives not only entry but also exit decisions, finding that demand was a large reason for airlines to scale back departures or leave the route completely.

Market dynamics of the airline industry are complex, with many changing behaviors and relationships depending on the geographies, market structure and market contact. This means that when studying market outcomes, the results would not always follow the traditional hypothesis blueprint. One good example of this would be fare prices. Dresener et. al (1996) reviewed how Southwest's entry to the Cleveland and Chicago routes from the BWI airport in Baltimore influenced prices for said routes, and found that fare prices did not only decrease from the BWI airport, but for all nearby airports within the vicinity of BWI, fare prices decreased for these routes. On the other hand, Evans and Kessides (1994) reviewed 1,000 domestic American routes, and found that airlines that had multimarket contact were far less likely to lower fare prices for any one specific route.

Mergers and acquisitions in the airline industry can have varied effects on the market. Hüschelrath and Müller (2014) looked at the short and long run impact of the 2008 merger of Northwest and Delta. By applying a fixed effects regression model, the paper managed to consider short and long term effects on the fares, citing short run spikes in prices on merged routes, with a lower yet stable fare growth seen in the long run (Hüschelrath & Müller, 2014). The authors stipulate that the low long run fare growth, on par with industry competitors, is reasonable grounds to conclude consumer welfare was not significantly affected by the merger (Hüschelrath & Müller, 2014). Werden et. al (1991) findings greatly differ, on the other hand, citing two cases when a merger impacted route coverage and fare prices significantly. Werden et. al (1991) paper considered two 1986 mergers, first one being between Northwest and Republic, and the second one being between TWA and Ozark. Werden et. al (1991) cited substantial fare on the Northwest and Republic merged routes, as well as a decrease in the frequency of flights on these routes, the TWA and Ozark merger also resulted in substantial coverage drop, but only saw minor fare increases in the long run. Brueckner and Pels (2004) paper considered the effects that the KLM and Air France merger had on their profitability, the overall fares, and consumer welfare. The paper notes growing fares and stronger profitability in the post merger period at the expense of decreased consumer welfare, stemming from growth in ticket prices and decreased market competition on European routes (Brueckner & Pels, 2004).

3. Data, Methodology, Variables

3.1. Data

The dataset of this paper is an amalgamation of flight, economic and weather related data from several Federal Bureaus. The carrier and aviation data is collected from the Bureau of Transportation Statistics (BTS). Flight data was filtered in a manner such that only data points of relevance to the aims of this report were left, meaning only data pertaining to commercial airlines and relevant origin states of California, Oregon, Washington were left, omitting cargo and private charter airlines from the dataset. Secondly, filtering for 40 or more seats and 5 or more performed departures was done to remove incidental flights and any remaining non commercial airlines from the dataset, so as to not obfuscate the developments of entry dynamics between 2015 and 2019 which the report seeks to examine. After the filtering, the data was sorted per origin airport, where numerical variables distance, seats, passengers. Due to the nature of the acquisition, the dataset pinpointed the origin airports to the hubs of the 2 airlines, PDX, SEA, SFO, LAX. Destinations reachable from the origin airports, have specific parameters relevant to the investigation, such as the GDP per capita or population of the county/metropolitan area the airport is in (county data used for main analysis, metropolitan data is used for the robustness check). For this reason, the dataset uses the population and GDP data from the Bureau of Economic Activity (BEA) and the Federal Reserve Economic Data (FRED). For the origin airport, variables such the GDP or population or origin airport are being omitted from the model, because all 4 origin airports are of similar size with similar GDP per capita, population, economic impact, and annual visitors. The average monthly climate in Fahrenheit for April will also be used, taken from the National Weather Service (NWS). This led to the final of 1215 observations, with equal amounts of destinations from the 4 airports, for the time periods of

April 2015, April 2017, and April 2019. The descriptive statistics for the dataset are the following:

Table 1: Descriptive statistics of the carriers number and the variables used for ordered probit

Variable	**Obs**	**Mean**	**Std. dev.**	**Min**	**Max**
Seats	1215	84,835.08	34,091.83	25,308	188,914
Passengers	1215	71,340.27	29,282.37	18,599	153,487
Distance	1215	627.30	222.25	122	1050
GDPCapita	1215	96,361.91	32,179.43	30,994	235,235
Population	1215	2,140,531.38	994,588.80	749,014.00	10,100,000
Climate	1215	58.27	5.33	47.00	75.00

Table 1 displays the descriptive statistics of the dataset, comprising 1215 observations, for April 2015, April 2017 and April 2019, with routes from PDX, SEA, SFO and LAX airports. These descriptive statistics summarize the variables, which are respective to the destinations from the 4 origin airports. GDP per capita is measured in US dollars. Population, Seats and passengers are all numerical measures of people. Distance is measured in miles, referring to the distance between the origin airport and destination.

3.2. Methodology

This paper utilizes two regressions. The first regression will be an ordered probit applied on the variables mentioned in table 1. The ordered probit regression will be used to predict an "optimal" number of carriers per route. The second step in the analysis will be using the "optimal" carrier number and subtracting it from the actual carrier number, denoted as "Carriers" in table 3. The idea is that if there are more predicted carriers than actual carriers on a route, then it means a route is underexploited and entry is expected, with new players rushing in to fill up the market gap. This second step will result in a large second dataset, the descriptive statistics for which are summarized in table 3. The second regression will be used on this dataset. The second regression will be a probit model, used to see how the entry or exit predictions behave and differ in relation to binary and dummy variables such as the time period or airport. For the probit regressions, the sign of the coefficients can be interpreted as the effect of the variable on expected entry, with positive coefficients indicating a positive effect on likelihood of "expected entry" on a route, and so conversely the negative coefficients could be interpreted as a higher likelihood on "expected exit". Based on this, the hypothesis is "expected entry" would be higher for the post merger period in April 2019, than for the control period of April 2015 or Integration period of April 2017.

For the second regression, the data will be considered together through a "pooled" probit and separately, in two separate probits, first one looking at "existing routes" from PDX and SEA airports, and the second one looking at "inherited routes" from SFO and LAX airports. The reason for this is because the former were hub airports of Alaska prior to the acquisition, while the latter were Virgins hubs. Nonetheless, the data processing and econometric approach to both sections will be the same.

To ensure that the analysis is valid and statistically reasonable, 2 robustness checks will be performed. The first robustness check will be based on the same fundamental principles, but focused on the "seats" as a means of deducing entry or exit. The second robustness check will be incorporating metropolitan based data rather than county based data.

3.2.1. First Regression - Ordered Probit

The dataset will be used for an ordered probit function, which will calculate and predict the "optimal" amount carriers per route based on the variables present in the dataset. This predicted number of carriers will be then subtracted from the actual unique carriers per route, where a positive discrepancy will signal entry as the route is undersaturated and airline entry is warranted, and in the event of a negative discrepancy, exit is warranted. These routes will be from 4 possible West Coast origin airports, from which all domestic destinations will be considered because ordered probit requires a sufficient quantity of data per category in order to ensure reliable data findings. Firstly, the market size will be approximated by the population and GDP per capita metrics of the destination route, while the distance between the airport and the destination will represent the fixed costs associated with geographical distances. The weather will also be considered because of its effect on costs. With bad weather the operational costs of airlines increase, because weather can cause wear and tear which would require maintenance and repair costs, furthermore it would consume more fuel due to increased drag or detours, and the fees that airlines concur with delays such as more crew fees. For this reason, the coefficient for weather will be positive, with the idea being that warmer weather is associated with better weather and hence lower costs, which influences the profitability of a route. Weather data is the average temperature for the month of April, for the destination city, measured in Fahrenheit. Hence, taking these variables into account, the ordered probit model will hold the following structure:

$$Predicted\ Carriers_{o,d,t} = \beta_0 + \beta_1 \times ln(Population_{d,t}) + \beta_2 \times ln(GDPCapita_{d,t}) + \beta_3 \times Distance_{o,d} + \beta_4 \times Weather_{d,t} + \epsilon_{o,d,t}$$

In the formula above, the index “t” refers to the time period (April 2015, April 2017 or April 2019), “o” refers to the origin, “d” refers to the destination, “o,d” refers to data regarding both the origin and destination. For example $ln(Population_{d,t})$ is the natural log of the population of the destination location at a specific time. The economic variable $ln(GDPCapita_{d,t})$ follows the same principle, with the variable being a natural log of the GDP per capita of the destination location at a specific time. While $Distance_{o,d}$ is the distance between the origin airport and the destination, there is no “t” due to the distance not changing. The variable $Weather_{d,t}$ refers to the average temperature for the destination city, for some time period of April, in Fahrenheit. “Predicted Carriers” is an ordered categorical variable, which predicts the amount of unique careers on a route. Both the population and the GDP per capita data was transformed into the natural log form, giving the variables $ln(Population_{d,t})$ and $ln(GDPCapita_{d,t})$, done in order to ensure a better model fit. Doing this will reduce data skewness, and ensure better linearization which is beneficial since economic variables tend to have multiplicative rather than additive tendencies, in which case natural logarithms can help linearize the data and reduce data informalities. Lastly, this will help mitigate and control diminishing marginal effects, which is useful for economic data, for example this will help control for the effects of an additional thousand dollars, the effect of which will be far stronger for a relatively poorer location such as Palm Springs than it would be for a rich location such as San Jose. The ordered probit model will estimate the coefficients β_0 - β_4 will be estimated, which will be used to predict the optimal carriers per route.

Considering the research aims of the report, only routes originating from PDX, SEA, SFO, LAX airports will be of interest. This means only the 3 states of California, Oregon and Washington, will be considered for origin airports, and while at times Hawaii and Alaska also fall under the West-Coast classification, this report will omit them. The time periods this report will be considering are for the months of April 2015, April 2017 and April 2019. The control group will be April 2015, as this was the pre-acquisition period. April 2017 is the "Integration Period" of the acquisition, as Virgin America was still flying under its own brand and in the process of being integrated into Alaska's operations. April 2019 is the "Post Merger" period, a year after Virgin America was fully incorporated into Alaska's operations.

3.2.2. Second Regression - Probit

The next step of the analysis is to calculate the "ExpectedEntry" dependent variable, and use a probit model to analyze how different variables influence it. "ExpectedEntry" is the dependent variable of the model, binary in its nature, the value 1 in this context represents the decision to "Enter" the market, while 0 conversely stands for Exit. "ExpectedEntry" is the "optimal" predicted number of carriers minus the actual number of carriers on that route, with the positive sign of difference indicating Entry, while the negative sign would indicate Exit.

A second regression is applied because it enables a more comprehensive analysis on expected carrier behavior. The first regression helped explore how specific determinants influence airline entry or exit, and helped predict the optimal number of carriers on these routes. The probit, on the other hand, enables us to see any discrepancies between actual and predicted carrier data, and relationship of variables on ExpectedEntry. Such methodology allows for a more in-depth approach to understanding the fundamental determinants of expected entry or exit. Hence, the second regression, a probit model, is the following:

$$ExpectedEntry_{i,t} = \beta_1 \times MergedRouteDummy_i + \beta_2 \times Dummy2017_t + \beta_3 \times Dummy2019_t + \beta_4 \times AirportDummySFO_i + \beta_5 \times AirportDummyLAX_i + \beta_6 \times AirportDummyPDX_i + \epsilon_i$$

The index "i" indicates route specific information, and "t" indicates time period (April 2015, April 2017 or April 2019). This model would establish what role each variable plays and would also help evaluate any potential discrepancies between merged and unmerged routes, allowing us to see whether the acquisition had an impact on entry dynamics. This 2nd model goes on to include several binary dummy variables. Dummy2017 and Dummy2019 are related to the time period of April 2017 and April 2019 respectively, using April of 2015 data as a control group. April 2015 acts as a baseline relative to which 2 independent binary variables of "Integration Period" of April 2017 and the "Post Merger" of April 2019 are measured. The Post Merger variable measures the effect of the time period after acquisition integration on the airline decision to enter or exit a route. Similarly, the MergedRouteDummy is a binary dummy variable, indicating whether it is a route that Virgin flew on, whereby the baseline for MergedRouteDummy is "No" or 0, representing unmerged routes unaffected by the acquisition. Dummy binary variables were created for PDX, SFO, LAX, SEA airports. SEA was used as a baseline, for which reason was omitted as to ensure no multicollinearity occurs. For example, when AirportDummyLAX is denoted by 1, it indicates the routes originated from that airport, similarly, the same can be said for other airport variables.

4. **Results**

This section contains the findings of the analysis. The first part of the analysis consisted of creating an ordered probit based on the variables mentioned in table 1. An ordered probit model has predictive capabilities, which was used to predict the optimal number of carriers per route. The results of the ordered probit regression can be seen in table 2. These results alongside the predictive variables are used to generate the "optimal" number of carriers per route. This data was then taken, and the 2nd step of the analysis began. The "optimal" carrier number minus the actual number of carriers on a route would give a decision about the Expected Entry, with entry or exit from the route expected. This itself led to another large dataset, which required a probit model to sort the results and make them more presentable. The descriptive statistics of the dataset for the probit models can be seen in table 3. A pooled probit model was deployed on this dataset first, seen in table 4. After this, for a more comprehensible deep dive into the intricacies of the acquisition, 2 more probit models were deployed, focusing on inherited routes and existing routes, respectively. Table 5 shows the results for entry choice on existing routes, meaning those from SEA and PDX, while Table 6 displays the results for inherited routes, meaning those originating from SFO and LAX.

4.1. Ordered Probit Model

Table 2: Ordered Probit Regression on the Predicted carriers

Predicted Carriers	**Coefficient**	**Standard Error**	**z**	**P>|z|**	**95% Confidence Interval**	
lnPopulation	0.70	0.17	4.05	< 0.001	0.36	1.04
lnGDPCapita	1.16	0.15	7.71	< 0.001	0.86	1.45
Distance	0.00	0.00	-1.10	0.27	0.00	0.00
Weather	-0.06	0.01	-9.00	< 0.001	-0.08	-0.05

Note: Number of obs = 1215. Wald chi2 (4) = 452.16. Prob>chi2 = 0.0000. Pseudo R2 = 0.1191

An ordered probit regression was performed on the dataset, with 1215 observations, to see which factors influence the number of predicted carriers. Both the natural log of GDP per capita and the population appear to be statistically significant and positive, with coefficient values of 1.16 and 0.70 respectively. The coefficients indicate that destination airports located in richer and more populated counties tend to have more predicted carriers. Distance appears to not be statistically significant, indicating that the space between the origin airport and destination does not have an impact on the number of predicted carriers. Weather has a statistically significant and negative coefficient of -0.06, indicating that rising average monthly temperatures in destination locations has negative effects on the number of predicted carriers. Overall, the Wald chi-square value of 452.16 suggests the model is generally statistically significant, with independent variables that influence the predicted carriers, the dependent variable. The p-value of the Chi2 statistic and R squared values of 0 and 0.1191 also indicate that the model has a reasonable variation in predicted carrier numbers.

After this ordered probit, using the predictor variables and the coefficients, a command was implemented to predict the "optimal" number of carriers on a route. This gave us another data set. Predicted carriers minus from the actual number of carriers will give Predicted entry choice, depending on whether this difference is positive or negative. This analysis resulted in a second dataset, the descriptive statistics of which were summarized in table 3.

4.2. Descriptive Statistics on the Variables for 2nd regression

Table 3: Descriptive Statistics on the Variables for 2nd regression

Variable	Obs	Mean	Std. Dev.	Min	Max
Carriers	1215	4.71	1.62	1	10.00
Predicted Carriers	1215	3.33	0.86	0.98	4.20
Timeperiod_num	1215	2.00	0.82	1	3
OriginAirport_num	1215	2.59	1.09	1	4
Destination_num	1215	64.57	38.22	1	133.00
Mergedroute_num	1215	1.08	0.27	0	1
ExpectedEntry	1215	1.67	0.47	0	1

Note: Carrier and Predicted Carriers are numerical variables, the rest of the variables were initially categorical variables with textual or categorical labels, but were encoded to prepare the numbers for statistical analysis. OriginAirport_num is a summary for all 4 airport dummies, Airport Dummy PDX, Airport Dummy SEA, Airport Dummy SFO, Airport Dummy LAX

4.3. Pooled Probit Model Routes

Table 4: Probit Regression Model Output

Expected Entry	Coefficient	Standard Error	z	P>|z|	95% Confidence Interval
Dummy 2019	-0.11	0.09	-1.26	0.21	-0.29, 0.06
Dummy 2017	-0.82	0.10	-8.28	< 0.001	-1.01, -0.62
Merged Route Dummy	-0.91	0.19	-4.84	< 0.001	-1.28, -0.54
Airport Dummy PDX	0.10	0.11	0.90	0.37	-0.11, 0.31
Airport Dummy SFO	0.19	0.11	1.67	0.09	-0.03, 0.41
Airport Dummy LAX	0.48	0.11	4.41	< 0.001	0.27, 0.70
constant	-0.29	0.09	-3.21	< 0.001	-0.46, -0.11

Note: SEA omitted due to collinearity. Number of observations: 1,215. LR $chi^2(6)$ = 130.03. Prob > chi^2 = 0.0000. Log likelihood = -705.54779. Pseudo R^2 = 0.0844

Table 4 is a probit regression applied on the secondary dataset, the descriptive statistics for which can be seen in table 3. Upon examining the results, several observations can be made. Firstly, when looking at entry dynamics during the Integration Period, in April 2017, denoted by the variable Dummy 2017, we see a statistically significant negative effect, with the coefficient -0.82 indicating that airline entry during the period was deterred and firms were more likely to exit rather than enter the route. This could potentially be explained by the uncertainty of other airlines during the integration period of the acquisition, as they could not build forecasts and anticipate plans while the market was changing. Merged routes, denoted by Merged Route Dummy, also exhibited a statistically relevant negative coefficient of -0.91, indicating that airlines on merged routes were over saturated, with airlines more likely to exit routes. It could however also signal that the merged routes are pursued by airlines for reasons other than economic, for example merged routes could be loss leaders, offered as a means of bringing in more customers, with new business subsidizing losses on merged routes. This could explain why the routes are being pursued strongly while the models indicate expected exit.

The Dummy 2019 variable is not statistically relevant and hence cannot be used to make any significant interpretations of the post merger period. The location of the airport on the contrary can be seen to influence the entry dynamics, however to a limited extent, with routes from LAX having a statistically significant and positive effect on entry, indicating that airlines were more likely to enter routes originating from LAX relative to SEA. It should be noted that PDX and SFO similarly examine positive coefficients, however bear no statistical significance. The positive significance of LAX could be due to the underexploited role of the airport, because it's the newest hub out of the 4 airports that had the least amount of time to develop and explore new routes. SEA and PDX were Alaska's hubs for decades. For Virgin, they started off with SFO, which was their primary hub of operations, and only scaled to LAX later on in 2011. This means that Virgin only had a few years to develop routes from this hub, before the merger, meaning relative to other hubs it was much newer.

Thus, it appears that the Dummy 2017 and Merged Route Dummy were more likely to increase probability of exit on a route, while airport choice was more likely to increase entry, with LAX being a notable example. Furthermore, the coefficients for the post merger period and the airports of PDX and SFO had positive coefficients, which could signal towards entry, however the values appear to hold no statistical significance.

4.4. Separate Probit Model for Existing Routes Results

Table 5: Probit Existing Routes

Expected Entry	**Coefficient**	**Standard Error**	**z**	**P>|z|**	**95% Confidence Interval**	
Dummy 2019	-0.36	0.13	-2.87	< 0.001	-0.61	-0.11
Dummy 2017	-0.80	0.13	-5.96	< 0.001	-1.06	-0.54
Merged Route Dummy	-0.15	0.41	-0.36	0.72	-0.94	0.65
constant	-0.17	0.09	-1.96	0.05	-0.34	0.00

Note: Number of obs = 635. LR chi2 (3) = 36.92. Prob > chi2 = 0.0000. Pseudo R2 = 0.0477

Table 5 shows the likelihood of airline entry or exit on existing routes, which in this context refer to routes from SEA and PDX airports, Alaska's primary and secondary hubs. Several observations can be reached after conducting the analysis. Firstly, it can be seen that the coefficient for the Dummy 2017 is -0.80, and is statistically significant, indicating that the likelihood of exit from the said route is significantly more likely to occur after the acquisition happened relative to the control group, the pre-acquisition period in 2015. This trend can also be observed for the Post Merger period, where the statistically significant and negative coefficient of -0.36 is spotted, indicating the time period played a role in increasing airline likelihood to leave a route, albeit to a smaller extent than during the Integration period. It appears Merged Route Dummy does not hold any statistical significance, making it hard to deduce its impact on entry dynamics. Similarly, the constant value also is not statistically significant, although it hovers very close at the significance level, with the p-value of 0.051, where the negative also indicates a negative trend. Overall, it can be seen that after the acquisition of Virgin America, entry dynamics shifted, with Expected Entry increasing in the post merger period, although the negative coefficient of Dummy 2019 still indicates a higher likelihood of exit. It could be argued that the integration period, denoted by the Dummy 2017 variable, signaled uncertainty in the market for other airlines, and that in the post-merger period, the decrease of airlines did make entry more appealing, although still not enough for expected entry to be warranted.

4.5. Separate Probit Model for Inherited Routes Results

Table 6 Probit Inherited Routes

Expected Entry	**Coefficient**	**Standard Error**	**z**	**P>|z|**	**95% Confidence Interval**	
Dummy 2019	0.16	0.13	1.21	0.23	-0.10	0.42
Dummy 2017	-0.82	0.14	-5.70	< 0.001	-1.10	-0.10
Merged Route Dummy	-1.24	0.21	-5.83	< 0.001	-1.65	-0.82
constant	-0.03	0.10	-0.30	0.77	-0.21	0.16

Note: Number of obs = 580. LR chi2 (3) = 95.32. Prob > chi2 = 0.0000. Pseudo R2 = 0.1252

For inherited routes, the likelihood of predicted entry or exit can be seen in Table 4. In this context, inherited routes refer to those from SFO and LAX airports, Virgin America's primary and secondary hubs. It appears that entry dynamics for inherited routes differ relative to existing routes, since predicted entry and exit on inherited routes does not appear to be influenced in the Post Merger Period, considering the coefficient for Dummy 2019 holds no statistical significance. Unlike for existing routes however, entry dynamics on inherited routes do appear to be strongly influenced by merged routes, with a statistically relevant Merged Route Dummy coefficient of -1.24, it indicates that likelihood was higher on merged routes from LAX and SFO airports. A similar trend is spotted for the Dummy 2017 variable, with the statistically significant coefficient of -0.82, indicating a strong airline likelihood to exit from a route. The constant is not statistically significant and hence can not be interpreted with much meaning.

4.6. Robustness Checks

The robustness checks were done following the same methodology, with the 1st robustness check being based on the number of seats instead of carriers, and the 2nd check being based on metropolitan/micropolitan data rather than on county data. The 2nd check used the economic and population data of the metropolitan area that the destination happened to be in. This meant that some locations were omitted, due to not being classified as part of any metropolitan area, leading to 1113 observations, down from 1215 used in check 1 and the main analysis.

Table 7: Pooled Probit Regression Model Output, Seats based data

Expected Entry	Coefficient	Standard Error	z	P>|z|	95% Confidence Interval	
Dummy 2019	-0.86	0.10	-8.92	< 0.001	-1.05	-0.67
Dummy 2017	-0.46	0.09	-4.91	< 0.001	-0.64	-0. 273
Merged Route Dummy	0.69	0.15	4.53	< 0.001	0.39	0.99
Airport Dummy PDX	-0.95	0.11	-8.86	< 0.001	-1.15	-0.74
Airport Dummy SFO	-1.21	0.11	-10.62	< 0.001	-1.43	-0.98
Airport Dummy LAX	-1.26	0.11	-11.08	< 0.001	-1.49	-1.04
constant	1.15	962493	11.91	< 0.001	0.96	1.34

Note: Number of obs = 1,215. LR chi2(6) = 254.55. Prob > chi2 = 0.0000. Pseudo R2 = 0.1514

Table 7 displays the robustness check based on seats, and appears to have all of statistically significant coefficients, with the general negative trend indicating higher likelihood of exit rather than entry. The Post Merger coefficient of -0.857 is smaller than that of the Dummy 2017 at -0.46, suggesting the likelihood of exit from a route is higher after Virgin Airlines was integrated into the operations of Alaska Airlines. This finding contrasts the hypothesis that entry likelihood would increase in the Post Merger period, once the amount of carriers decreases. On the other hand, the Merged Route Dummy coefficient of 0.69 appears to be positive and statistically significant, which would go in line with the hypothesis. When looking at the airports, all of them appear to have a negative impact on entry, especially for the LAX airport, with the lowest coefficient value of -1.26. Nonetheless, a positive and statistically significant constant coefficient of 1.15 does indicate a positive baseline and hints towards positive entry in absence of other variables.

Table 8: Pooled Probit Regression Model Output, Metropolitan based data

Expected Entry	Coefficient	Standard Error	z	P>|z|	95% Confidence Interval	
Dummy 2019	0.49	0.13	3.89	< 0.001	0.24	0.74
Dummy 2017	-0.69	0.10	-6.71	< 0.001	-. 890	-0.49

Merged Route Dummy	-0.20	0.17	-1.18	0.24	-. 5413	0.13
Airport Dummy PDX	0.50	0.13	3.98	< 0.001	0.25	0.74
Airport Dummy SFO	0.37	0.13	2.80	0.01	0.11	0.63
Airport Dummy LAX	0.46	0.13	3.58	< 0.001	0.21	-0.71
constant	0.67	0.10	6.40	< 0.001	0.46	0.87

Note: Number of obs =1,113. LR chi2(6) = 133.19. Prob > chi2 = 0.0000. Pseudo R2 = 0.1163

Table 8 displays the probit regression output performed on metropolitan data rather than county based data as was done in tables 2-4. The findings of this table appear to indicate a similar trend to that of table 2, although with a notably higher amount of significant coefficients, with only merged routes coefficient not being significant. Similar to table 2 airports choices have a positive impact on entry, particularly that of PDX, while the Dummy 2017 variable has a significant negative coefficient indicating higher likelihood to exit during the integration period. However unlike table 2, Dummy 2019 coefficient of 0.49 is both statistically significant and positive, indicating a higher likelihood of entry on routes after Virgin America was integrated into the operations of Alaska Airlines. The constant is statistically significant and positive, with coefficient value of 0.69, indicating a positive entry baseline, in absence of other variables.

5. Discussion, Validity, Future research

5.1. Discussion

The aims of the report were to examine the entry dynamics on the West Coast after the acquisition of Virgin America. The hypothesis predicted that expected entry will become more lucrative once the airline is integrated into Alaska's operations and the number of carriers decreases. Firstly, the hypothesis would be supported in the event ExpectedEntry becomes more likely in the post-integration period, meaning the coefficient of Dummy 2019 would have had a stronger significant effect than that of the 2017 dummy. Secondly, the hypothesis would have been supported in the event that ExpectedEntry effect is stronger on merged routes, meaning those routes that Virgin America flew on.

Regarding the time period coefficients, the hypothesis is supported, albeit partially. For example, the time coefficients for the second robustness check, which is a probit deployed on metropolitan data, fully support the hypothesis, with the coefficients in table 8 showing statistically significant coefficients of -0.69 for Dummy 2017, and 0.49 for Dummy 2019. This aligns with the hypothesis, which posited that the coefficient of Dummy 2019 would have had a stronger significant effect than that of the 2017 Dummy. For other probit models, however, the findings are somewhat more ambiguous. For example, in the probit on inherited routes in table 6, Dummy 2017 has a statistically significant coefficient of -0.82 while Dummy 2019 has a positive coefficient of 0.16, however, it is not statistically significant. Similarly for the pooled probit, seen in table 4, Dummy 2017 has a statistically significant negative coefficient of -0.82, while Dummy 2019 has a larger value, albeit still negative at -0.11, and it is again, statistically insignificant. For the probit on existing routes, shown in table 5, it appears Dummy 2019 is bigger than Dummy 2017, although they're still both negative with coefficient values of -0.80 and -0.36 respectively, still indicating higher likelihood of exit. Thus, the findings of the report appear to agree with the hypothesis, albeit not fully, as while the likelihood of exit is generally higher during the integration period than during the post-merger, the general trend of the findings nonetheless indicates more towards exit from routes. The general trend can be supported by the predominantly negative coefficient values as well as the negative constants seen across all of the probits.

The only time period finding that fully contrasted the hypothesis was for the robustness check 1, where Dummy 2017 coefficient value was -0.46 while for Dummy 2019 it was -0.86. However, arguably, this does not inherently disprove the hypothesis, but rather open up a new area of research, because this probit is based on seat data, and there could be other intricacies that might drive demand for Airplane seats, for example fare prices, or individual ad campaigns, or frequent flier programs, that could all influence ExpectedEntry based on Seats.

Regarding routes that were merged, and those that weren't, meaning those neither Virgin nor Alaska covered, the hypothesis again would reason the Merged Route Dummy coefficient would be positive, however, in the analysis the Merged Route Dummy coefficients were, contrary to the hypothesis generally either not significant or negative. For example, the coefficients of Merged

Route Dummy are negative and statistically insignificant for the pooled probit in table 4, the existing routes probit in table 5, and the second robustness check in table 8. For inherited routes in table 6, the coefficient of -1.24 is significant. The “inherited routes” refers to routes originating from SFO and LAX airports. In the first robustness check, the coefficient is positive and statistically significant, as can be seen in table 7, which would go in line with the hypothesis, however, the robustness check deploys seat data, rather than carrier data.

The location of the airport also appears to influence expected entry, however to a limited extent. The findings of the pooled probit, show that the Airport Dummy LAX is significant and positive, with a coefficient value of 0.48, while other dummies appear to be statistically insignificant. LAX airport had a statistically significant and positive effect on entry, indicating that airlines were more likely to enter routes originating from LAX relative to SEA. Positive effect of LAX on ExpectedEntry could potentially stem from the underexploited role of the airport, as it's the newest hub out of the 4 airports, which had the least amount of time to develop and explore new routes. The 2nd robustness check also appears to show statistically significant and positive coefficients for all airports, biggest one being Airport Dummy PDX with a coefficient value of 0.50, followed by LAX with 0.46 and then SFO with 0.37. On the other hand, the first robustness check appears to contradict the findings, showing a negative and statistically significant impact of all airport dummies on ExpectedEntry.

Thus, as the hypothesis would predict, entry dynamics became more lucrative once the number of carriers decreased, however, contrary to the hypothesis, was still not lucrative enough to warrantExpectedEntry. Furthermore, merged routes either did not hold any statistical significance or indicated far stronger exit likelihood than unmerged routes, contrary to what the hypothesis would predict. Perhaps, the increased likelihood to exit on merged routes could be addressed to market conditions, rather than due to the merger itself. Firstly, out of the merged routes, most were predominantly from SFO and LAX, where many airlines were competing for routes. It could be that these exact routes triggered the decision of Alaska to buy out Virgin and minimize competition. Furthermore, it could be that the gap period after the integration period but before the post-merger period, merged routes did become more lucrative, and more airlines entered, and dynamics changed in favor of exit or likelihood. This potential issue is further addressed in section 5.2 of this paper.

When considering robustness checks, it should be noted that the coefficients of the first robustness check, based on the seats data, are generally contrary to that of the second robustness check or the probit models, based on carrier data. For example, the Merged Route Dummy coefficient, for the first robustness check, has a positive and significant coefficient, going in line with the prediction of the hypothesis. While the coefficients of Merged Route Dummy for the second robustness checks and other probits is either statistically insignificant, or negative. Similarly for airport dummies, the first robustness check has significant negative coefficients for Airport Dummy PDX, Airport Dummy SFO, Airport Dummy LAX. On the contrary, the second robustness check displays only significant and positive coefficients for the same variables. This general trend is also observed for the Dummy 2017 and Dummy 2019.

5.2. External and Internal Validity

As with any academic research, certain critiques pertaining to the internal and external validity of this paper could be made. From the perspective of internal validity, an argument about sampling and generalizability could be made. For example, this paper only considered the origin airports of PDX, SEA, SFO and LAX, so an argument could be made that entry dynamics on routes from these airports may not necessarily be generalized across other airports. However, on the other hand, the airports being investigated all happen to be amongst the biggest in the region, and in the case of PDX and SEA are by far the biggest in their respective state. Furthermore, for California, SFO and LAX happen to be the biggest airports, with only a few other large airports, such as the San Diego International Airport, not being included. Considering, neither Virgin or Alaska had hub presence in San Diego, it might have not been significantly relevant to the investigation of the acquisition impact on entry dynamics. Another limitation could be related to the assumptions of probit models, particularly those of independence between variables as well as linearity. This is because some collinearity amongst airport dummy variables was spotted, which could indicate that complex interactions could be potentially, overlooked or improperly interpreted.

When it comes to external validity, several points should be raised. Firstly, considering the dataset consists of data from 3 federal bureaus, it could be that the reliability of the data is not definitively foolproof, as there could be some data collection discrepancies, for example the data for the population or GDP data is annualized, while the weather data is the average for that month. Furthermore, the GDP data is on a county and metro level, while airports are located in one specific city, however counties tend to be good proxies for airports, as they tend to service a broader segment of region, outside of just the vicinity of the city. Secondly, when examining the scope that the parameters cover, it could be argued they might be overlooking other factors that might be influencing airline entry or exit. For example, the report considers 3 time periods, April 2015, April 2017 and April 2019, however it could be that other factors are being overlooked that may have occurred between the time gaps of the variables. Similarly for airports, other parameters could be influencing dynamics of entry to the said airport, for example newly passed regulation, limiting expansions of the airport. Lastly, along these lines, some variables could have been overlooked and not included in the investigation, for example perhaps the industry as whole could have been exposed to new regulation or supply shocks such as growing fuel prices or consumer demand drops.

5.3. Future research

Future research could involve expanding the scope of this specific paper to cover more markets, for example, adding Hawaii and Alaska to the investigation. Future research could also involve applying the methodology of this paper in new contexts entirely, perhaps looking at specific rivalries of airlines, and looking at their biggest routes, rather than routes originating from a specific place. Another idea could also involve a more comprehensive deep dive into market competition. The deep dive can be done on the basis of airport specific information, provided by BTS, who happen to have specific information, such as top frequented 10 routes and the market share of each airline. On this basis, a deep dive can include deploying this paper methodology on the 10 routes from that airport, or the top routes of the biggest airlines in that airport.

Considering the coefficients of robustness check 1 were contrary to other findings of the report, perhaps future research could expand on ExpectedEntry based on seats data. For example, future research could consider the airline specific intricacies that might drive demand for Airplane seats, and how that changed with respect to the Virgin America acquisition. For example perhaps fare prices, or individual ad campaigns, or frequent flier programs could all be influences on ExpectedEntry based on Seats. Lastly, the acquisition of Virgin America decreased the number of market players, and this paper examined whether this influenced market dynamics. So perhaps, for future research it could be relevant to look at other instances where market player numbers decreased, for example when airlines went bankrupt, or had to leave routes for political reasons (e.g. sanctions, regulations etc.).

6. Conclusions

The aims of this paper were to consider whether the acquisition of Virgin America influenced entry dynamics for West Coast routes, with the hypothesis being that entry likelihood would increase after the airline is integrated into Alaska's operations. The results however, indicate a somewhat convoluted outcome, with the general trend for most coefficients indicating exit rather than entry. The likelihood to exit was substantially stronger during the integration period, when Virgin was still flying under its own name, with the likelihood to exit decreasing in the post merger stage, technically suggesting that entry does become more lucrative once the number of market players decreases, however the coefficients nonetheless still indicate a negative value. For inherited routes the post merger coefficient is positive, however is not statistically significant and hence it is hard to derive reasoning from it. While the general trend line generally points towards exit, the findings do show that LAX as an airport choice played a big role in entry, with a statistically significant and positive coefficient. For routes from LAX and SFO, the opposite of the hypothesis has occurred, because when looking at merged routes, meaning routes affected by the acquisition because Virgin flew on them, the likelihood to exit was even higher than during the integration period. This means that after the acquisition the decrease in market players did not increase market lucrativeness to enter as the hypothesis would indicate. It does appear that acquisition impacted inherited and existing routes differently, as SEA and PDX route entry choice was not affected by the merged routes.

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8. Appendix

Appendix 1: Abbreviation and classification of airports,

Airport Name	**Abbreviation**	**Classification**
Seattle - Tacoma International Airport	SEA	Existing routes, hub airport for Alaska Airlines
Portland International Airport	PDX	Existing routes, hub airport for Alaska Airlines
San Francisco International Airport	SFO	Inherited routes, hub airport for Virgin America
Los Angeles International Airport	LAX	Inherited routes, hub airport for Virgin America