AN INVESTIGATION OF THE UNITED STATES AIRLINE PILOT LABOUR SUPPLY

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ABSTRACT

Over the next 20 years, the United States airline industry is expected to hire in excess of 95,000 pilots. This hiring will be the result of new aircraft growth, pilot retirements, and pilot attrition from the industry for reasons other than retirement. In addition, government regulations may also cause an increase in the number of new pilots required. Given this increased demand, will there be enough new pilots to ensure a long-term and continuous supply? The purpose of this research is to examine the supply and demand for US airline pilots. Several new considerations are having an impact on future supply and demand of airline pilots including cost of training, growth, retirement, regulatory changes, and slowing supply of military pilots. The methodology provides an empirical analysis of the pilot labor supply in the US. A multivariate regression model was developed to forecast demand. To explore supply, a variety of data sources have been included and a survey was implemented. The results of the study indicate that the US airline industry will experience a shortage of approximately 35,000 pilots for the 2013 to 2031 time period. The impact of the shortage on regional and major airlines is examined. Possible solutions are discussed.

Keywords: Pilot supply forecast, international pilot hiring, pilot shortage, cost of flight training, major airline hiring

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1. INTRODUCTION

The United States airline industry is estimated to contribute $1.3 trillion to the national economy, 5.2% to the country's Gross Domestic Product (GDP), and around 376,000 jobs to the nation's workforce (FAA, August 2011). The industry faces many dynamic and well-documented challenges, including high fuel prices, occasionally contemptuous labor disputes, and sensitivity to general economic conditions. While these issues may be well-known, obtaining adequate staffing levels amongst employee groups has been the source of both historical and recent speculation. Specifically, the availability of properly trained and qualified pilots has garnered recent interest.

Will the United States airline industry have enough qualified pilots to appropriately staff its aircraft? Several recent forecast efforts have attempted to quantify both the future pilot demand as well as training capacity. When taken in their totality, every forecast indicates there will be an increased worldwide demand for commercial airline pilots. The purpose of this research initiative is to answer a simple question: will the United States experience a future pilot shortage?

Future pilot demand is generated from three different events: industry growth, retirements, and attrition for reasons other than retirement. On the supply side, future airline pilots are created from both civilian and military sources. Historically, the airline industry in the United States has generally been able to find enough qualified pilots from these two areas. Given this historically balanced relationship has existed in an equilibrium for years, what, if anything, has changed?

Current retirement data indicates that over 45,000 pilots will retire from major airlines over the next 20 years. Given there are currently an estimated 18,000 regional pilots, it doesn't take an elaborate mathematical analysis to conclude that unless a large number of new pilots enter the workforce in the coming years, the industry faces a critical shortage.

The situation appears to have been complicated by the introduction of several new rules. In particular, Congress passed Public Law 111-216 which mandates, among other requirements, that pilots who operate at an airline would be required to have 1,500 hours (2010). In addition, the Federal Aviation Administration has also instituted new flight-time and duty-time rules. It is important to note the purpose of this study is not to evaluate the efficacy of any newly-mandated rules or laws; rather, the purpose is to evaluate their effects, if any, on the pilot supply.

In the media there has been much written and debated about the possible pending pilot shortage (Kaufman, 2012, Carey, Nicas, Pastzor, 2102, O'Connor, 2012). It begs the question, what is meant by "pilot shortage?" Does pilot shortage refer to a situation where the lack of available qualified pilots results in operational disruptions such as changes in schedule or reduction of flights? Using this definition, the last pilot shortage occurred in the 1960s (Carey, Nicas, Pastzor, 2012). In this era it was noted that thousands of hours of flights by major airlines had to be cancelled and operations adjusted due to the unavailability of qualified pilots to hire (Simmons, 1969). There are indications this is occurring again now. In the Fall of 2013, Great Lakes Airlines in the US Midwest, has cancelled nearly two dozen flights, attributing the cause to lack of pilots (eTN, 2013)

Or, does pilot shortage mean a lowering of hiring requirements to dip in to the next wave of applicants who, of course, still meet FAA requirements but are not at the top of the flight experience hierarchy? There is evidence to support this was the case at the regional carriers in the most recent hiring wave of 2007 and 2008. Atlantic Southeast Airlines lowered its hiring minimums twice in six months during that period. At that carrier, average hours of pilots in new hire classes dropped from 1,200 total time with 200 hours of multi-engine time to 800 hours total time and 50 hours of multi-engine time. (Lunan, 2007, Robertson, 2009)

Another consideration is that the industry may be facing a hiring wave versus an actual pilot shortage. Numerous hiring waves have existed in the past. Key periods of hiring include the mid to late 60s, 1990 and into 1991, late 90s into 2001, and the 2006 to 2008 time frame (Simmons, 1969: FAPA 2012). Ultimately, these waves came to a grinding halt due to circumstances in the operating environment, which reduced the demand for pilots. Often these circumstances are beyond the control of the operators. For example, one can argue that key factors leading to the decline of hiring waves include economic factors such as the price of oil and the state of the economy; political events such as the Gulf War and Iraq War; natural disasters such as hurricanes and tsunamis; and aviation events such as the attacks of 9/11. Major aviation accidents and other aviation factors such as safety concerns and regulatory changes also may play a role. Of course these events cannot be examined individually but often occur simultaneously creating a perfect storm to slow the demand for pilots.

Numerous factors appear to be coming together that will create a significant demand resulting in a hiring wave at the least and possibly a shortage of qualified pilots. The current pilot workforce is experiencing a wave of retirements as the 2007 Fair Treatment and Experienced Pilots Act is now impacting many pilots reaching age 65. Costs for aviation training are on the rise. Regulatory changes in the areas of fatigue related work rules and changing qualifications for airline first officers will increase the need for pilots. International aviation is growing quickly and may result in the hiring of pilots from the US (Jones, 2011). The military supply of pilots has slowed (Lynch, 2012). Those who are trained in the military are staying in the military longer (Jones, 2013).

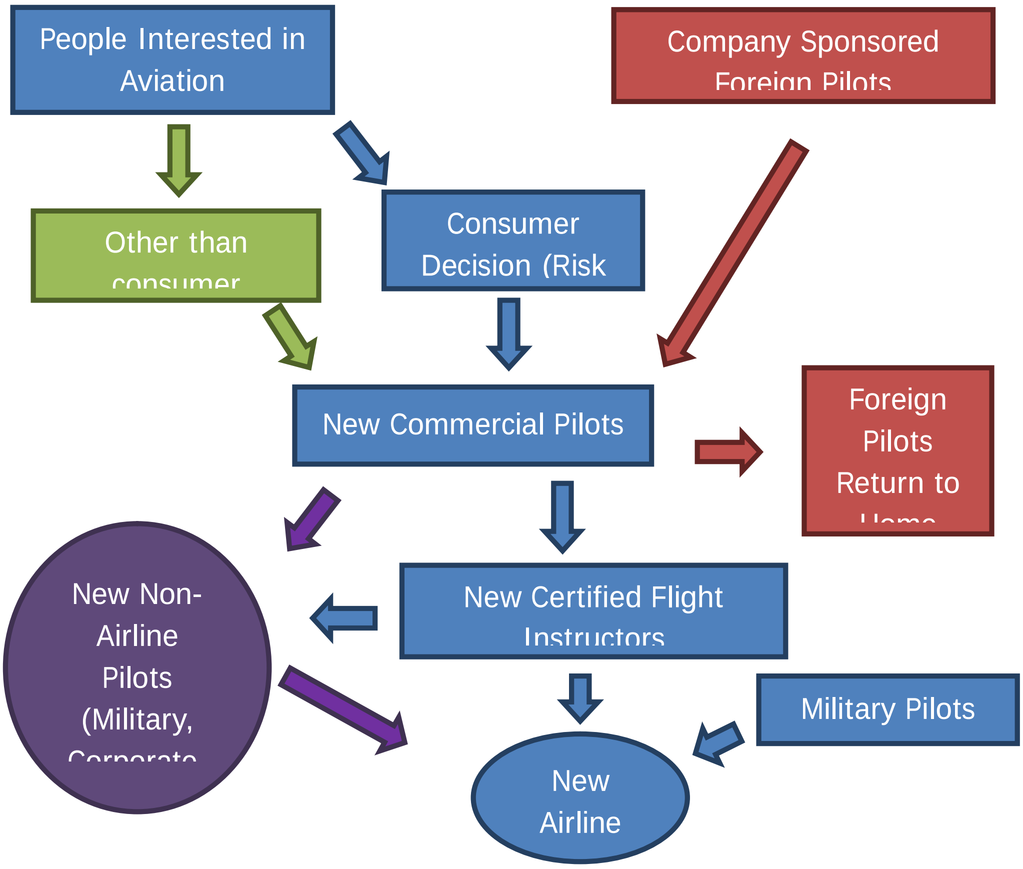
Clearly, an empirical analysis of the United States future pilot labor supply is warranted. If there are future conditions which could lead to pilot shortages, the nation's economic conditions could be negatively impacted. Given the reach of the industry, the impact could be serious and cause widespread negative disruptions throughout the country.

This forecast assumes that when there are short-term disruptions in the supply of new pilots, the industry and regulators will not react. Of course, this is unlikely, as scarcity of required labor will most certainly cause individual airlines to react, and could cause a reexamination of the current regulatory environment. Some examples of this reaction from an industry view could include signing bonuses, scholarships for flight training, pathway programs which outline a clear path to a major airline job, and/or increased wages. It is important to note that, at present, no correlation has been found linking these factors to new pilots, but unless the pilot labor market follows fundamentals which are different from other industries, there likely is a relationship yet to be identified. It should also be noted that the airlines may find they have limited ability to react monetarily given they may be constrained by their current operational and market dynamics. The regulators could have a role to play and react by lessening some barriers in obtaining pilot certification. Any of these above measures would likely change the following analysis. Accordingly, this forecast should be viewed as a hypothetical, or a “what-if,” which details the effects of the continuation of current market forces without mitigation.

2. SUPPLY-SIDE: BACKGROUND

There are three pilot certificates that allow for employability — Commercial, Airline Transport Pilot (ATP), and Certified Flight Instructor (CFI). A pilot holding one of these certification levels is able to be compensated for operating aircraft. As of August 2, 2013, pilots who are employed at part 121 air carriers are required to hold an ATP certificate. Current requirements needed to obtain the ATP will likely require several years of academic instruction and flight training. Figure 1 depicts the basic flow pilots follow on their way to the airlines.

Figure 1: Flow of Pilots to the Airlines



When examining the historical number of pilots holding each type of certificate, trends can be seen. Because the FAA tracks all active pilots—those that hold a current medical certificate—an actual census can be examined (FAA, 2012). Figures 2, 3, and 4 depict historical numbers of active CFI, commercial, and ATP certificates along with newly created pilots on a yearly basis, respectively. The typical path to the airlines for a civilian-trained pilot involves several steps. Most pilots begin with obtaining a private pilot certificate and then advance to a commercial certificate with a multi-engine rating. Most of these pilots also obtain a CFI which allows for them to obtain an entry-level flight position wherein they can obtain more flight time and experience. As part of this research project, over 1,600 collegiate aviators were surveyed as part of a Career Aspirations Survey (CAS) regarding their long-term career plans. The results indicated that only 53.67% of CFI certificate holders have a long-term career plan of working at the airlines. While this variable has not been tracked longitudinally and only represents a snapshot of current opinion, it belies the notion that the vast majority of aspiring or recently-earned CFIs seek long-term major airline jobs.

Figure 2: Historical CFI Population

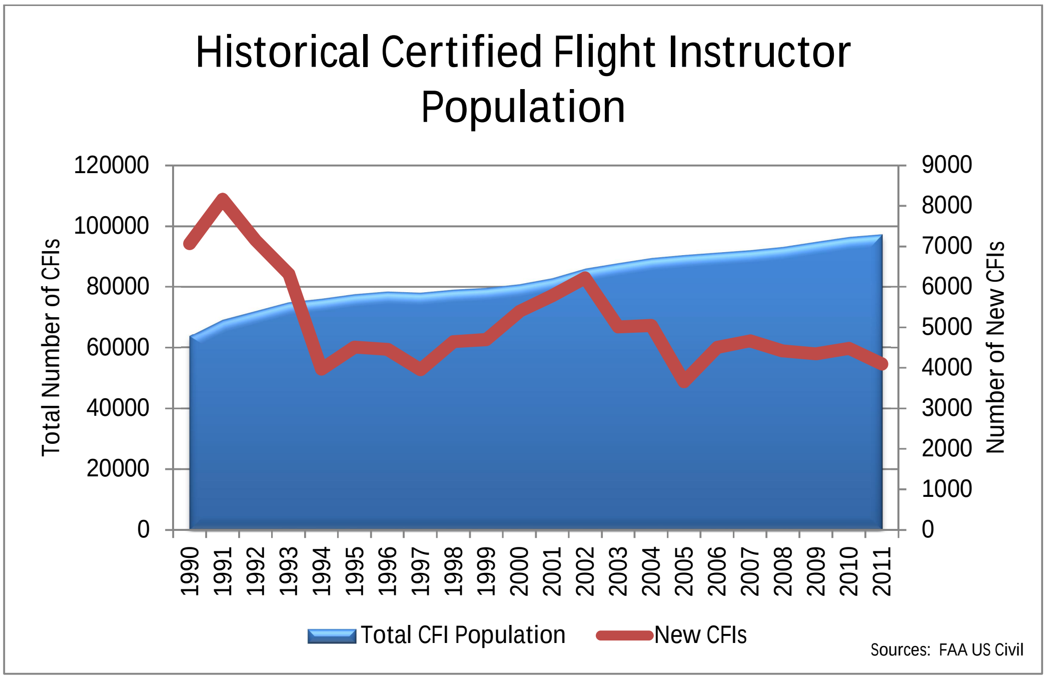


Figure 3: Historical Commercial Pilot Population

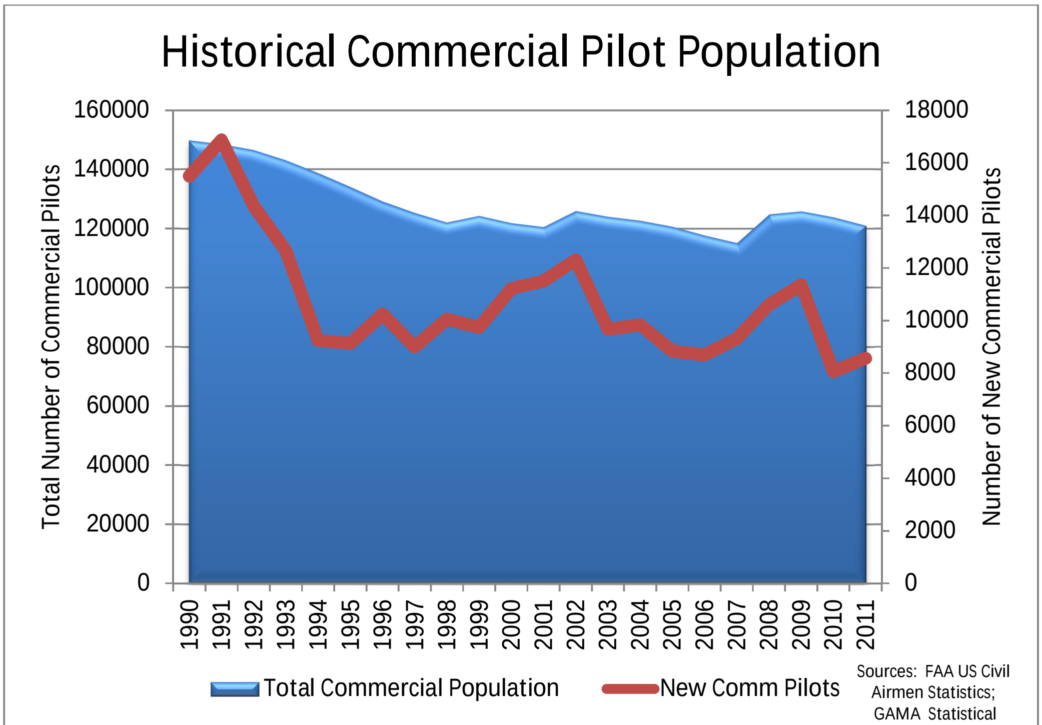
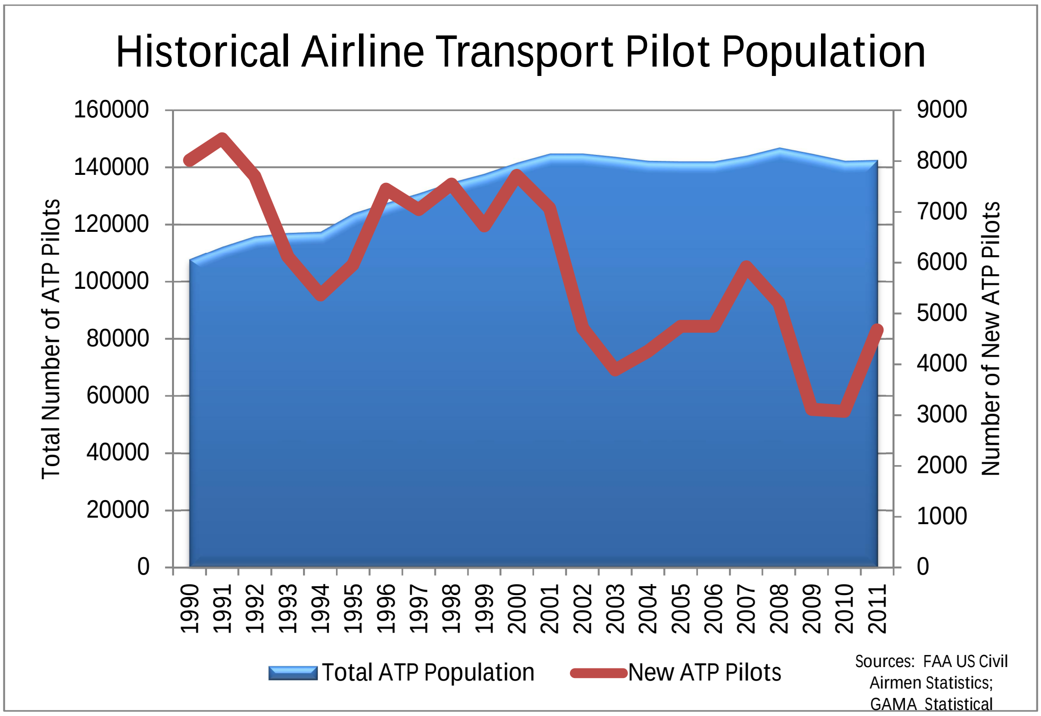


Figure 4: Historical ATP Population



3. THE FORECAST MODEL

3.1 Determination of the Outcome Variable

One complicated aspect involved with predicting the future airline pilot labor supply is identifying an appropriate outcome variable. In previous years, the number of new commercial pilots seemed to be a plausible candidate as a commercial certificate represented the basic unit of employability. The use of new commercial pilots is no longer a viable variable due to the following reasons:

1. An ATP certificate is now required to become employed at an airline.
2. A large number of foreign pilots are now training in the United States. These pilots will obtain their commercial certificates yet have no intention of working as commercial pilots in the United States.

Because of Public Law 111-216, an ATP certificate is required to be employed at an airline. Accordingly, pilots will have to accumulate enough flight time to become eligible to obtain this certification. According to data collected in the 2010 Pilot Source Study, 85.2% of civilian-trained ATP pilots hired at the airlines held a CFI certificate at some point in their career (Smith et al, 2010). It is important to note this percentage has occurred prior to the enacting of the Public Law; accordingly, given the increased hour requirements needed in the future, even more pilots seeking employment at airlines will likely have to obtain CFI certification. This theme was further identified qualitatively in the CAS.

There has been a sharp increase in the training of foreign pilots in the United States. Using data supplied by the FAA's certification branch, in 2004, for every 4.80 pilots with United States citizenship training for their commercial pilot certificate, there was one foreign pilot training in the United States. In 2012, that ratio changed to 1.19 to 1 (1.19 U.S. pilots for every one foreign pilot). This data is encapsulated in Figure 5, which depicts the number of pilots, based upon citizenship, completing the commercial pilot written/knowledge tests by year. For the periods from 2009-2011, the percentage of commercial written tests completed by foreign pilots has hovered above 40%. In 2012, this percentage jumps to around 45%. The number of pilots completing their commercial written is significantly correlated to new commercial pilots the following year, $R^2 = .52$, $F(1,7) = 7.67$, $p = .03$.

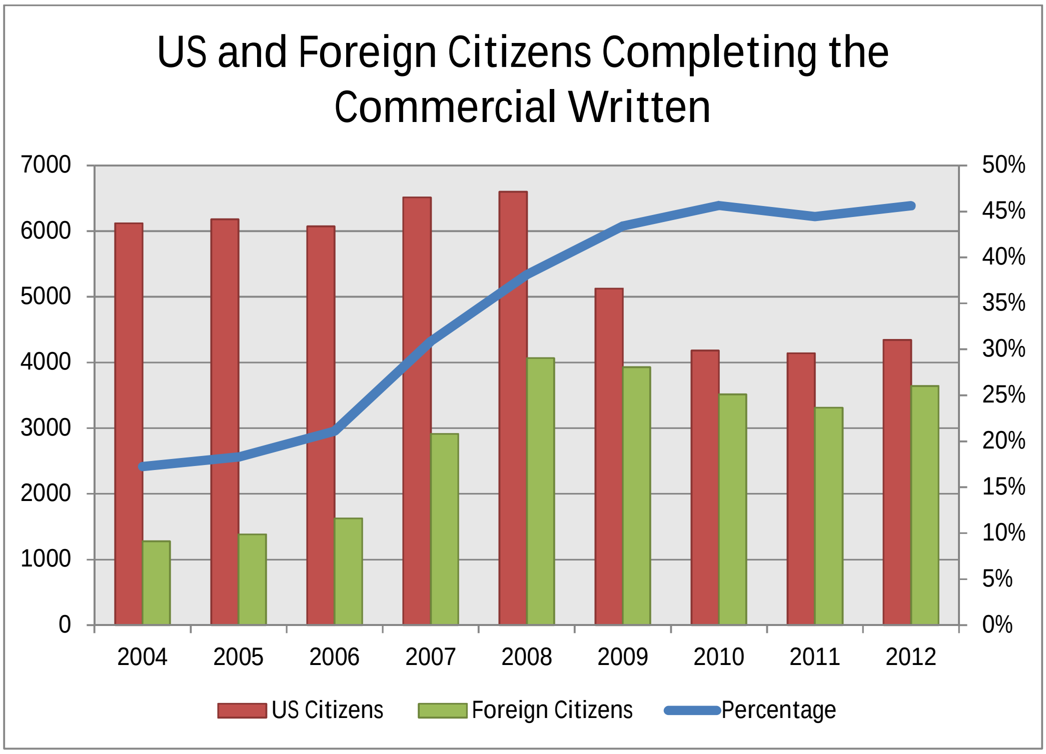
The authors of this study note that the training of foreign pilots in the United States is not a negative happening; moreover, these pilots provide for opportunities for United States CFIs to obtain flight experience. In addition, from an economic point of view, this training represents a national export-surplus. In terms of impact to using new commercial pilots as an outcome variable for a pilot supply study however, given their proportion of impact to new commercial pilot numbers, the presence of foreign-training confounds the use of commercial pilots as an outcome variable.
For the aforementioned reasons, this study uses the creation of new CFIs as the outcome variable. This outcome variable recognizes that the vast majority of civilian ATPs (presently over 85%) have been a flight instructor at some point in the career and that this percentage will increase given the new ATP-airline requirements. This outcome variable also successfully deals with the confounding issue of foreign-pilot training, as a relatively small number of foreign-trained pilots will require or seek CFI certification in the United States.[2]

Another important aspect considered when selecting newly created CFIs (NCFI) is that it can take several years from the time a pilot starts their initial training until they achieve CFI certification. Further complicating this fact is that while the NCFI data is tracked by the year, some pilots can complete their CFI training in a year, and

[2] According to recent CFI written test data, from 2004 to 2012, an average of 10.68% of CFI written examinations were completed by foreign pilots.

some may take several years[3]. This part of the variable is difficult to track and measure. Because of this difficulty, the determination of length of time it takes to obtain certification can be determined using a *post hoc* determination of model fit. This *post hoc* method will be discussed in further detail, but through multiple model builds, the largest significant R^2 values were found when the outcome variable included a mixture of new CFIs of 5% in two years, 25% in three years, and 70% in four years. This study uses this "mixture" as a weighted yearly average and is used as the outcome variable in this study.

Figure 5: Commercial Pilot Written Examinations by Citizenship



3.2 Determination of Predictor Variables

When attempting to predict the future supply of airline pilots in the United States, there are several candidate predictor variables, which could be descriptive. In 2009, researchers at the University of North Dakota attempted to identify useful predictors. Among the list of potential predictor variables included: starting pay at regional airlines, high school student interest in aviation careers, prestige of being an airline pilot, job satisfaction of being an airline pilot, the cost of flight training, hiring at the

[3] Some pilots may train in a collegiate environment where it can take 3-4 years on average to obtain CFI certification, and some pilots might achieve CFI certification from an *ab initio* environment.

airlines, and hiring at major airlines.

Several of these potential data sources were eliminated because there was no useful historical data source. The historical data is needed to determine whether there is a predictive correlation between newly created CFIs and the metrics of the predictive variable. Some predictor variables had valid historical data, but no correlational relationship between newly created CFIs was demonstrable. Table 1 lists the potential predictor variable, potential data sources, and the disposition for use as a predictor.

Table 1: Candidate Predictor Variables, Data Sources, and Disposition

Candidate Predictor	Potential Data Source(s)	Disposition
Starting pay at regional airlines	Airlinepilotcentral.com; UND Contracts Database	No relationship found
High school student interest in aviation careers	National Research Center for College and University Admissions (NRCCUA)	No relationship found
Prestige of being an airline pilot	General Social Survey (GSS); Gallup	No meaningful historical data source found
Job satisfaction of being an airline pilot	General Social Survey (GSS)	No meaningful historical data source found
Cost of flight training	Aircraft Owners and Pilots Association (AOPA); University Aviation Association (UAA)	Relationship found in model
Hiring at major airlines	Future and Active Pilot Advisors (FAPA)	Relationship found in model

From the predictors in Table 1, two variables showed relationships with the future creation of CFIs. The first variable is Major Airline Hiring (MAH). Figure 6, generated from data gathered from Future and Active Pilot Advisors (FAPA), shows historical hiring at major airlines. FAPA's data starts in 1989 and continues through present day. Table 2 lists the major airlines tracked by FAPA. Many of these carriers have merged or ceased to exist, but still prove useful when examining the efficacy of MAH as a predictor.

A regression was conducted with MAH versus NCFI. A significant relationship was found, $\beta = .78$, $t(18) = 5.06$, $p < .001$. MAH also explained a significant proportion of variance in NCFI, *adj.* $R^2 = .60$, $F(1, 17) = 25.60$, $p < .001$. Figure 7 depicts the regression scatterplot of this relationship. The regression is expressed as Y = .42X + 3789.87, where Y = NCFI and X = MAH.

Figure 6: Historical Hiring of Pilots at Major Airlines

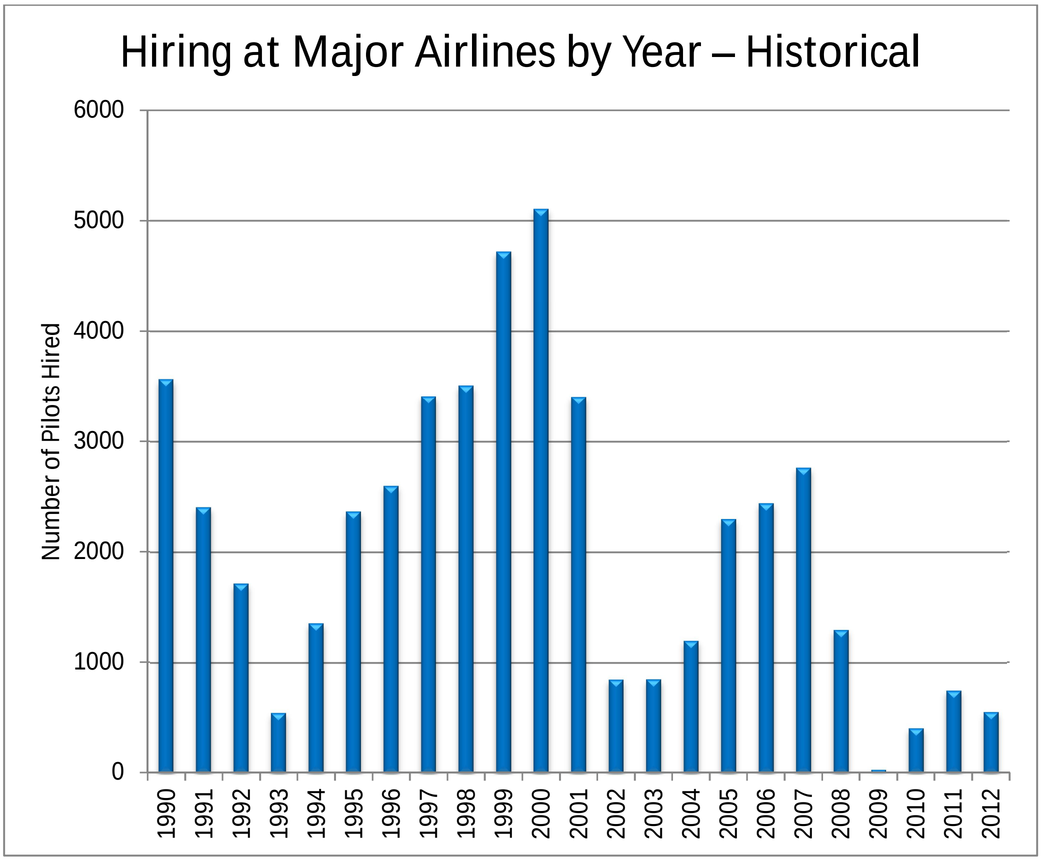


Table 2: Major Airlines Tracked by FAPA

Major Airlines Tracked by FAPA	
ABX Air	FedEx
AirTran Airways	JetBlue
Alaska Airlines	Northwest
America West	Southwest Airlines
American Airlines	United Airlines
ATA	UPS
Continental Airlines	US Airways
Delta Air Lines	

The other predictor variable from Table 1 which indicated a relationship with NCFI is Cost of Flight Training (CFT). Using data collected from the University Aviation Association (UAA) member schools, the average cost of private pilot certification (initial flight training) was $4,270 in 1990 (adjusted to 2012 dollars) and rose to $9,476 in 2012. This cost is just for the initial certification. Figure 8 depicts the historical CFT adjusted for inflation along with the percent change in cost year-over-year. It should be noted that data was collected by the UAA in 4-5 year periods, and intermediate points were straight-line interpolated. From 1990 to present, inflation, as measured by the Consumer Price Index (CPI) and tracked by the Bureau of Labor Statistics (BLS), grew at a 2.8% annual rate. CFT grew an average of 3.9% during that same period, which demonstrates that CFT is growing faster than inflation.

Figure 7: MAH vs. NCFI

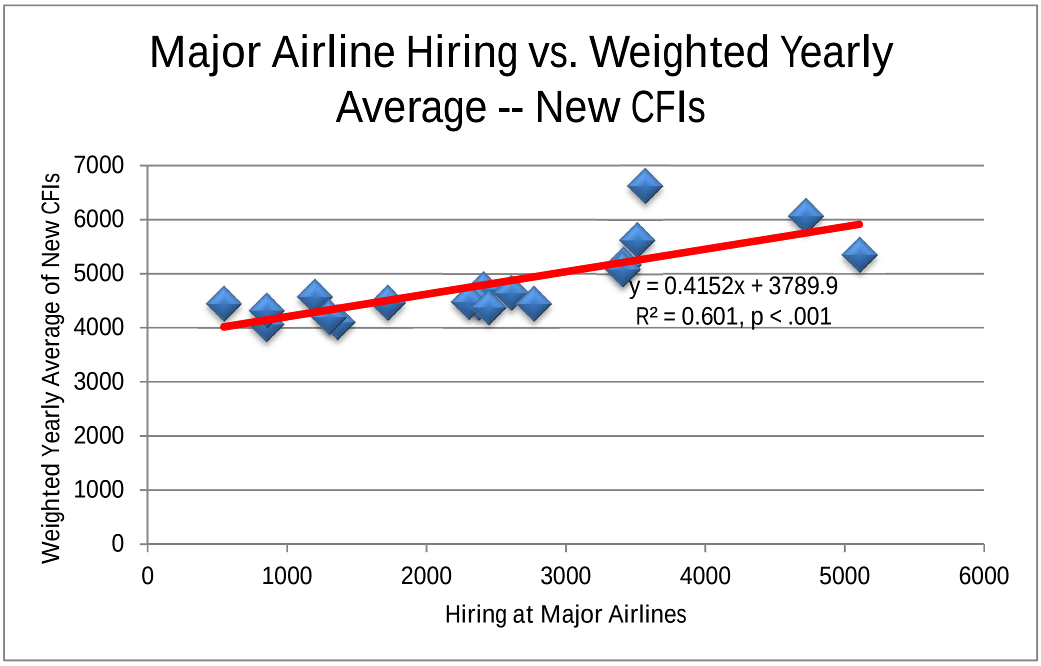
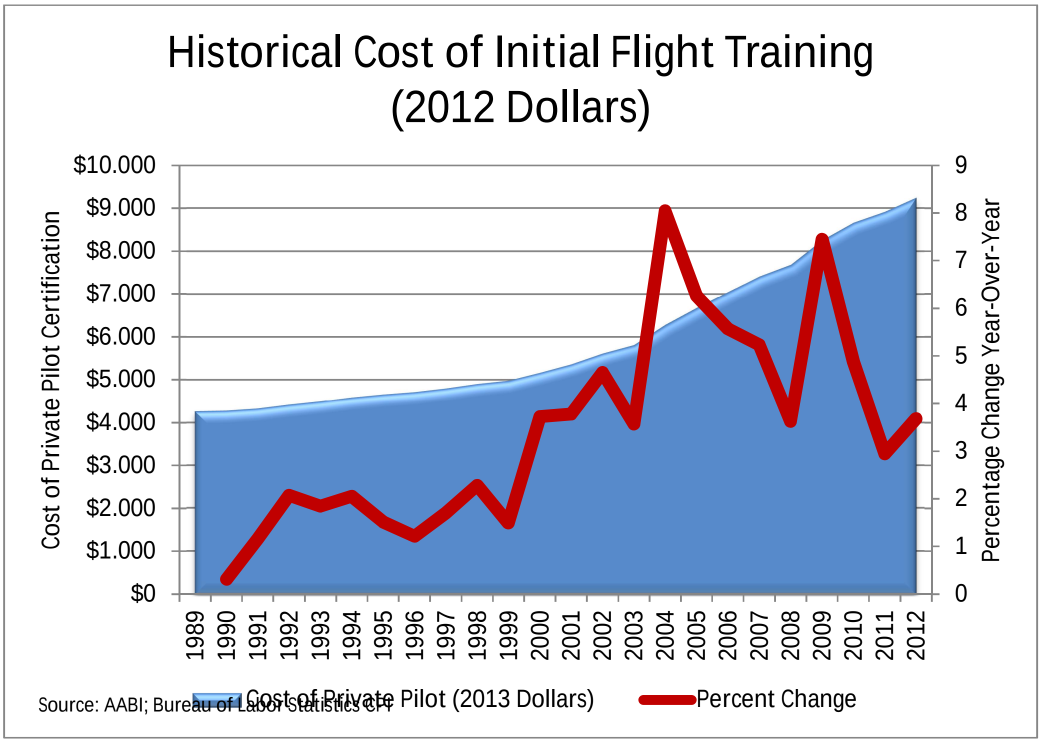


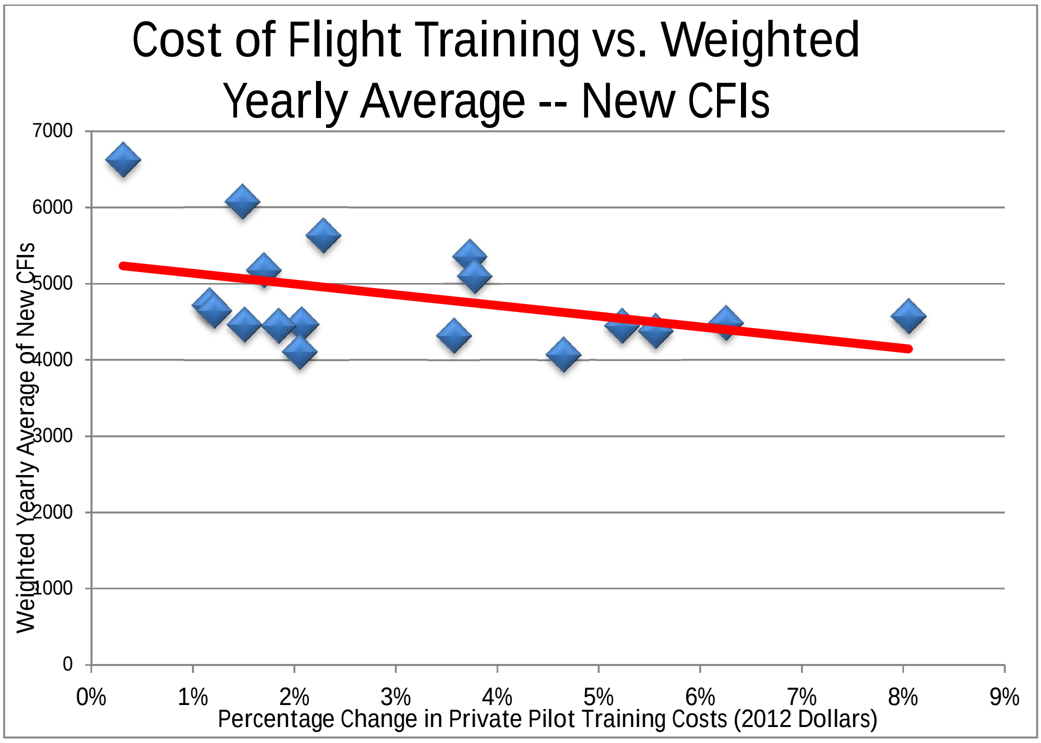
Figure 8: Historical CFT



A regression was conducted with CFT versus NCFI. A significant relationship was not found, β = -.43, $t(18)$ = -1.95.06, p = .068. CFT did not singularly explain a significant proportion of variance in NCFI, *adj.* R^2 = .18, $F(1, 17)$ = 3.81, p = .068.

Figure 9 depicts the regression scatterplot of these two variables. While the regression for CFT was not significant, its p value of .068 makes it a candidate for use in a multivariate regression model. This variable can also be measured for moderation effects, if any, on MAH.

Figure 9: CFT vs. NCFI



3.3 Building the Multivariate Model

Because MAH was singularly significant, and because CFT approached significance, a multivariate model may appropriately be able to better explain the overall relationship, if any, between all three variables (MAH, CFT, and NCFI). In addition, the relationship can be probed for interactive effects between the predictors to possibly increase the predictive power of the model.

Interactive regression involving multiple variables is similar to a factorial Analysis of Variance (ANOVA), except the continuous nature of the predictor variables can be maintained. One issue that sometimes surfaces in interactive regression is the problem of multicollinearity — a condition where one or more predictor variables are highly correlated with the interactive term. As indicated in several texts on the subject (Jaccard & Turrisi, 2003; Franzese & Kam, 2007; among others), the problem of multicollinearity is avoided by centering the predictors. Centering is accomplished by transforming each variable by subtracting the actual score from its distribution mean.

Another way to envision an interactive model is to examine whether one predictor moderates another predictor's overall effect on the outcome variable. In this case, MAH was seen as singularly significant. An interesting question is: does CFT moderate MAH's effect on NCFI?

One limitation of the data set is the sample size is limited to 19. This is due to data only being available on an annual basis and only from 1990 onward. The limited size is further narrowed because NCFI is spread out over four years (2013 - 4 years = 2009). The limited sample size also precluded other statistical techniques such as Vector Auto Regression (VAR), which may have also been helpful in demonstrating a relationship. Of course, a limited sample size affects the power of the model. Having an n=19 equates to only being able to detect large effect sizes. An *a priori* power analysis indicated that a sample size of 19 had a reasonable expectation of detecting an effect size of around .8.

A simultaneous stepwise multivariate regression was conducted with three predictors, MAH, CFT, and MAH * CFT (interaction of MAH and CFT) and a single outcome variable, NCFI. MAH, CFT, and the interaction of MAH and CFT significantly predicted NCFI, adjusted $R^2 = .774$, $F(3, 15) = 21.55$, $p < .001$. In addition, each of the three predictors indicated individual significance: MAH, $\beta = .58$, $t(18) = 4.74$, $p < .001$; CFT, $\beta = -.25$, $t(18) = 12.16$, $p = .003$; MAH*CFT, $\beta = -.42$, $t(18) = -3.52$, $p = .047$ (Figure 10).

The regression equation is given by:

$$Y = .31X - 84.60Z - .14XZ + 4593.78$$

Where:

y = Future Certified Flight Instructors over the next 3 years;

x = Number of pilots hired at major airlines;

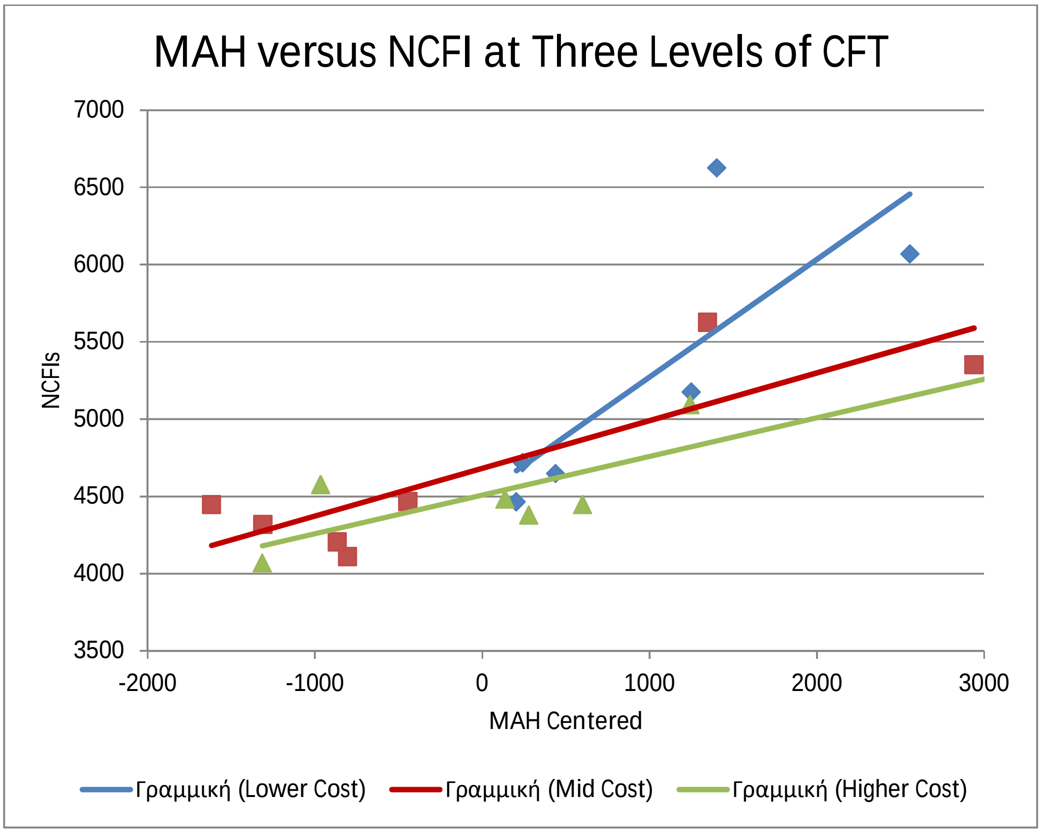
z = Percent change in cost of obtaining Private Pilot certification (adjusted for inflation).

Figure 10: Coefficients and Significance of Individual Predictors

	β	t	p
MAH	.58	4.74	.001
CFT	-.25	12.16	.003
MAH * CFT	-.42	-3.52	.047

In order to examine the moderation effect of CFT on MAH, Figure 11 depicts the various slopes of MAH regressed against NCFI at three different levels of CFT. The interactive effect is demonstrated by the differing slopes across the levels of CFT. From these slopes, CFT moderates MAH by increasing NCFI at a faster rate than at the two higher CFT levels.

Figure 11: MAH versus NCFI at Three Levels of CFT



Due to the centering of all predictor variables, multicollinearity was avoided in the regression as indicated by all tolerances (MAH at.84, CFT at .90, MAH * CFT at .93) being greater than .1 and all Variable Inflation Factors (VIFs) near 1 (MAH at 1.19, CFT at 1.07, MAH * CFT at 1.11). In addition, the lowest eigenvalue noted is .56 which further indicates avoidance of multicollinearity issues.

While this model predicts that for every pilot hired at a major airline there is .31 new CFIs created over the next 4 years. In addition, for every percent increase in the cost of initial flight training, there is a loss of 84.6 new CFIs over the next 4 years. According to Tracz (1992), causation can be demonstrated if three elements are present: temporal order, existence of correlation, and control of other causes. Given the significance of the model, the large overall R^2 value, and the temporal nature (MAH and CFT occur years before NCFI), this model may demonstrate causation.

It is possible the MAH variable is behaving in an exogenous capacity and is masking a more latent underlying relationship. For example, MAH could actually represent the higher wages and/or work rules associated with employment at a major airline. While this could be construed as a "substitution effect," the underlying premise remains. Whether MAH is a surrogate for increased wages or not, the model demonstrates a stimulation of new pilots whenever hiring occurs at major airlines. The impact of whether this is part of a larger substitution effect will more likely influence overall industry reaction and mitigation initiatives, rather than the identified relationship itself. Although the available dataset is limited by annualized data, a possible measurement of the impact (if any) of concessionary and growth labour contracts at MAH carriers could be examined to determine if MAH was impacted. If so, the substitution effect concept would become stronger and deserving of more investigation.

Given causation and the prevailing substitution accommodation of MAH (if necessary), this model demonstrates that 77.4% of people considering entering the aviation industry make a consumer decision. At its core, this decision is based upon a risk-reward paradigm. The risk is encapsulated by CFT (due to the fact that most people have to self-fund their own training). The reward is represented by MAH. In essence, a potential future commercial pilot evaluates the cost they will incur (risk) against the potential for getting hired at a major airline (reward).

4. DEMAND SIDE: USING THE MODEL TO FORECAST FUTURE SUPPLY

In order to determine the future number of NCFI going forward, a separate forecast must be made for the two predictors—MAH and CFT. Future MAH is dependent upon three factors: growth of an airline, pilot retirements, and attrition for reasons other than retirement. Figure 12 outlines the flow of staffing on the demand-side.

4.1 Future Hiring at Major Airlines

For every airline operating aircraft, there is a corresponding staffing ratio of required pilots. For example, at American Airlines, they operate 618 aircraft and have 8,481 pilots (airlinepilotcentral.com, 2013); this yields a staffing ratio of 13.72 pilots per aircraft. These staffing ratios can be determined for each airline. Table 3 lists each of the airlines that comprise MAH (or their consolidated surviving carriers) and their corresponding staffing ratios. The aggregated weighted staffing ratio for all the passenger MAH carriers is 14.44 and for the MAH cargo carriers 12.37.

Figure 12: Outline of Pilot-Staffing Needs.

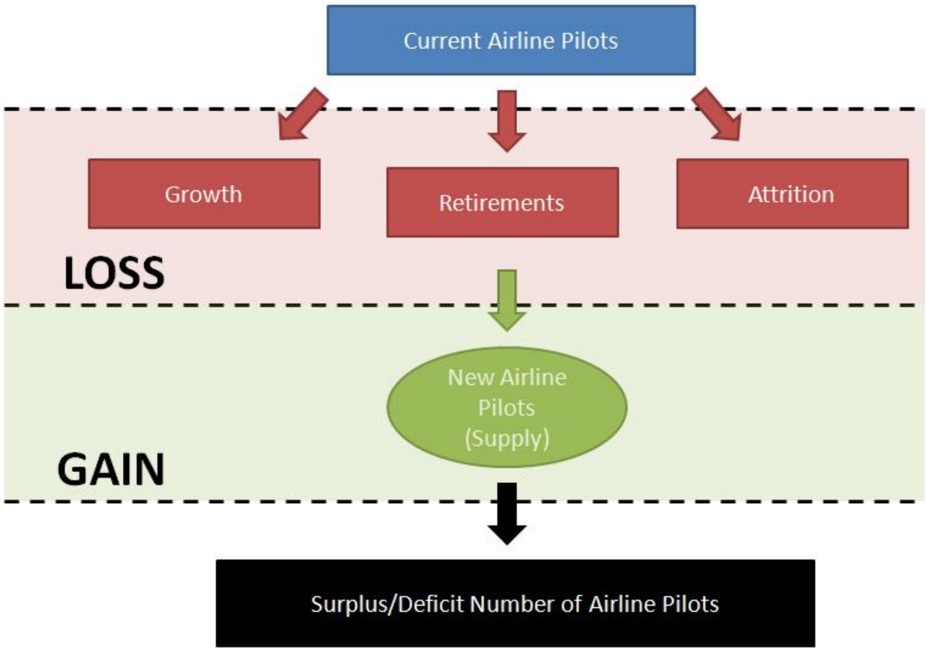
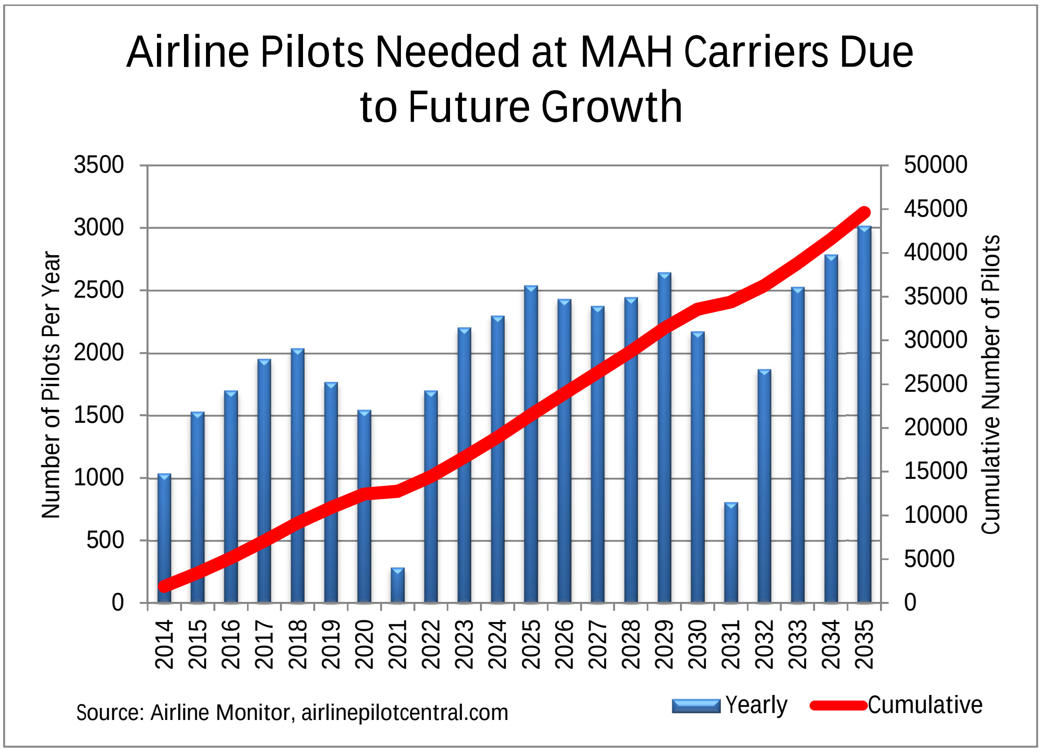


Table 3: Staffing Ratios for MAH Carriers.

	Number Pilots	Number Aircraft	Ratio
Alaska	1472	120	12.26667
American	8481	618	13.72330
Delta	11770	720	16.34722
United	11005	705	15.60993
US Airways	5085	346	14.69653
AirTran	1526	129	11.82946
JetBlue	2377	180	13.20556
Southwest	6327	565	11.19823
ABX	460	35	13.14286
FedEx	4541	351	12.93732
UPS	2573	229	11.23581

The number of new pilots needed for growth can be calculated by multiplying the weighted staffing ratios by the number of future aircraft. There are a few forecasts that predict the future number of airline-utilized aircraft. The FAA publishes a publicly-available annual forecast which projects the number of aircraft expected to be in service several years into the future. The Airline Monitor is a commercially-available aircraft forecast used by financial companies and other businesses reliant upon forecast information for strategic planning purposes. Given that the Airline Monitor has more of a business focus, this study made an *a priori* determination to utilize this forecast for future aircraft growth. Figure 13 indicates the number of pilots who will be needed by the MAH carriers.

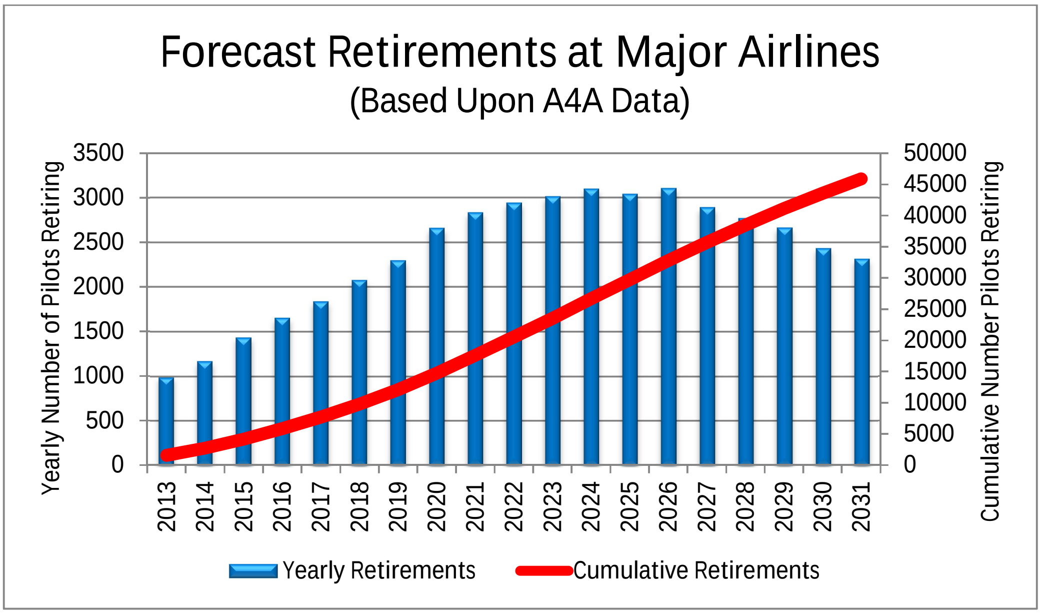
Figure 13: Pilots Needed at MAH Carriers due to Growth



Retirements at major airlines are easily predictable given that all airline pilots must retire by the time they reach 65 years of age. Not all pilots make it to the age of 65 because they become medically disqualified prior to reaching that age. It is unclear what percentage of pilots actually make it to age 65, so this forecast makes the assumption that all pilots make it to full retirement age. Figure 14 indicates projected retirements at the major airlines from 2013 to 2031.

Airline pilots may leave their professions for reasons other than retirement. Examples of this attrition could include loss of medical certification, separation from employment (furloughs, voluntary layoffs, terminations, etc.), or a personal decision to change careers. Determining this rate historically is difficult. An examination of the entire population of both commercial pilot and ATP certificate holders adjusted for new pilots created and retirements can help determine this level in retrospect. The problem with this approach is the combined population of commercial pilot and ATP certificate holders are obviously not all major airline pilots. Using the data from Table 3, the population of the major airline pilots (MAH carriers used) is 55,617.

Figure 14: Forecast Retirements at Major Airlines



This figure can be used as a numerator over the combined commercial pilot and ATP certificate holders (263,376) as a denominator. This metric, calculated at 21.12%, was used as a percentage estimate of the number of pilots who fly for major airlines. Figure 15 indicates a historical year-by-year calculation of attrition for reasons other than retirement at the major airlines. The historical average attrition rate at the major airlines was calculated to be 1.52%.

Figure 15: Historical Rate of Attrition for Reasons Other than Retirement

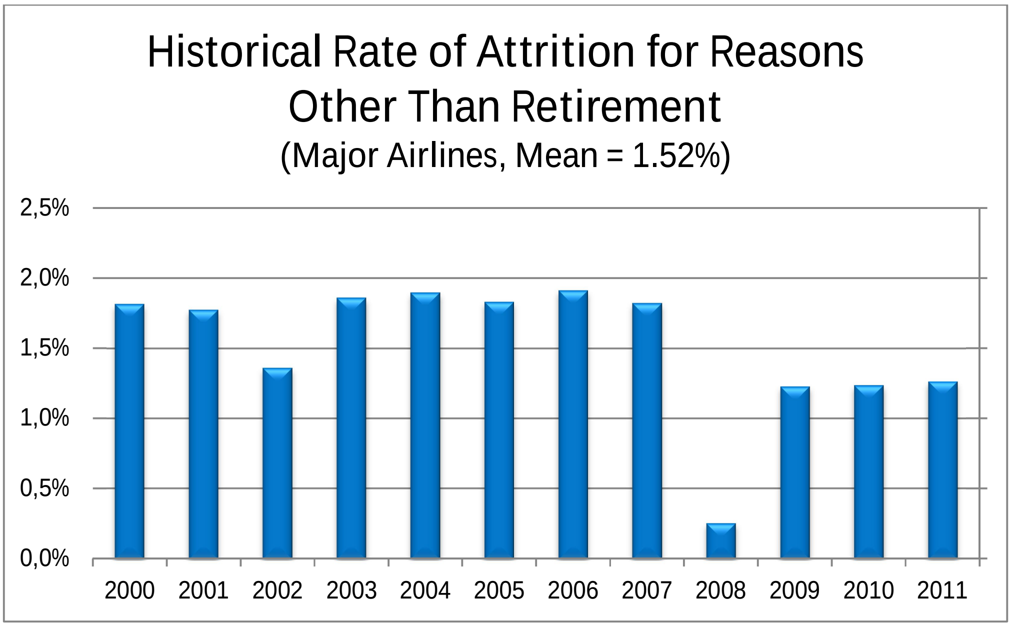
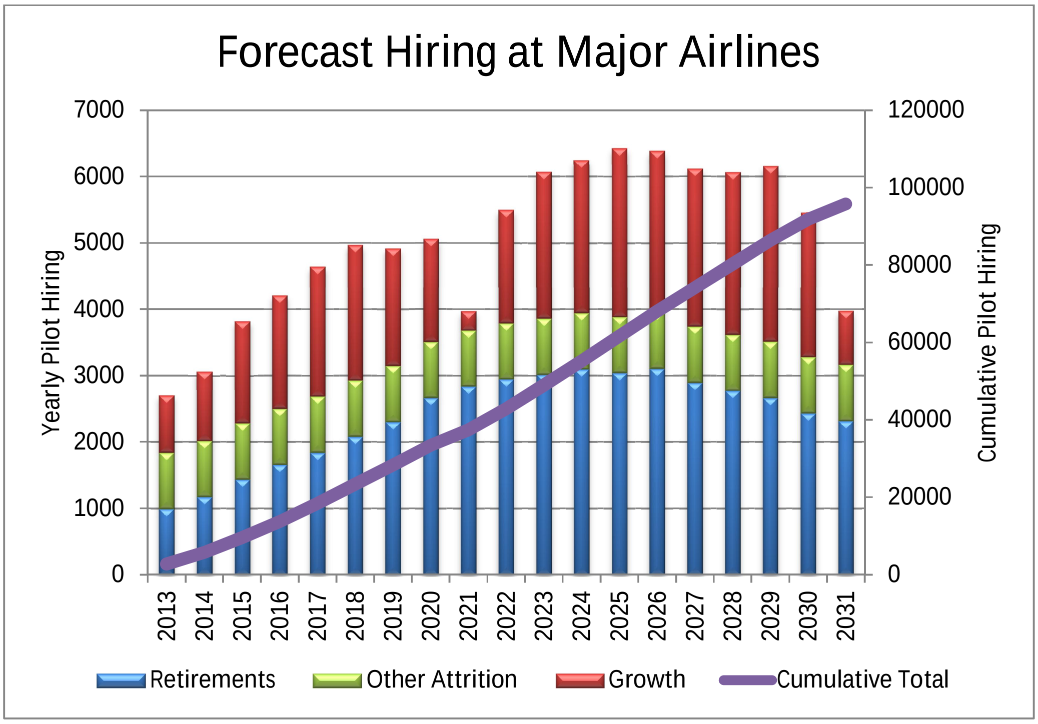


Figure 16 depicts the forecast hiring at major airlines. These figures were derived from the sum of new pilots needed for growth (Figure 12), new pilots needed because of retirements (Figure 14), and using the historical other attrition rate of 1.52% (Figure 15). In the period from 2013 through the end of 2031 it is predicted that major airlines will hire 95,790 pilots.

Figure 16: Forecast Hiring at Major Airlines



4.2 Future Cost of Flight Training

Forecasting the future cost of flight training in terms of year-over-year percent cost change (CFT) presents a new set of challenges. Figure 8 depicted the historical percent changes. Given the involvement of multiple macroeconomic influences, a time-series methodology is appropriate. Due to the lack of seasonality, a simple Holt exponential smoothing algorithm is appropriate and was applied.[4] Figure 17 depicts the future cost forecast using this method, MAPE = 37.4, Stationary R^2 = .73.

4.3 Forecasting NCFI

Using the data from Figures 16 and 17 and applying the regression model going forward, a year-by-year calculation can be made which forecasts the number of new CFIs. Once this calculation is determined, 53.67% of the NCFI are considered potential candidates for airline employment due to findings in the previously mentioned CAS. In addition, due to the new requirements to obtain an ATP

[4] Several models were built using IBM's SPSS model builder. The model that led to the lowest MAPE was selected.

certificate prior to operating as a pilot at an airline, a CFI will not become available for airline employment for a period of time. While the length of time needed for a CFI to achieve ATP minimums will vary, a period of two years[5] was used in this study. Figure 18 indicates newly available pilots for airline hiring.

Figure 17: Historical and Forecast Change in Flight Costs

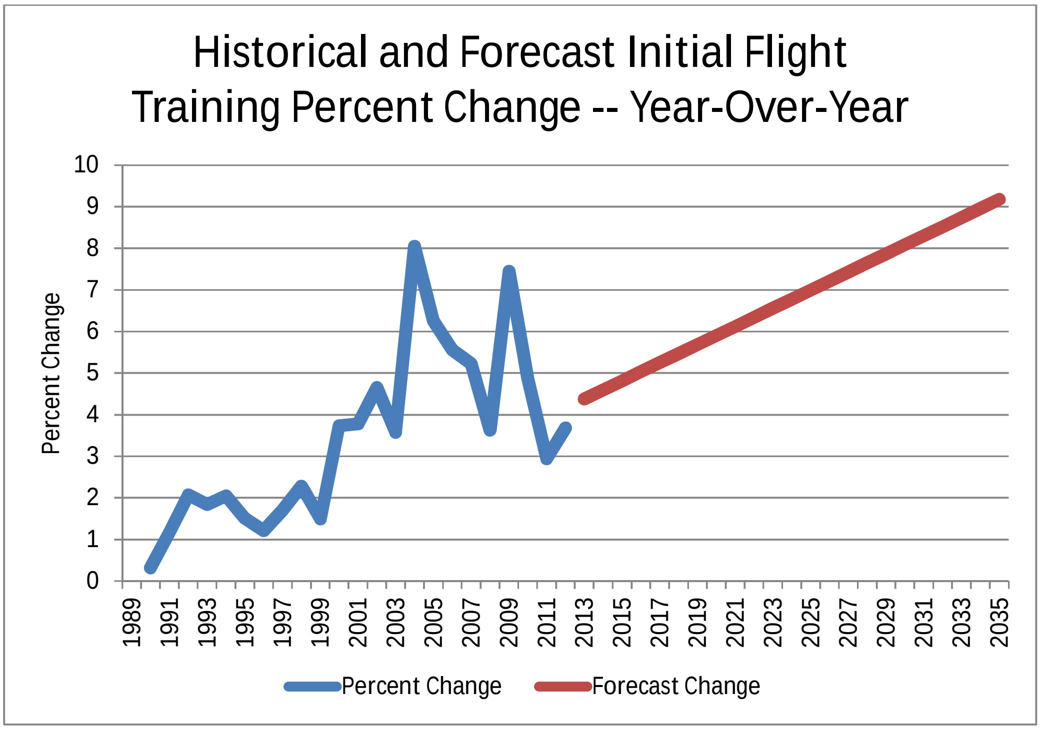
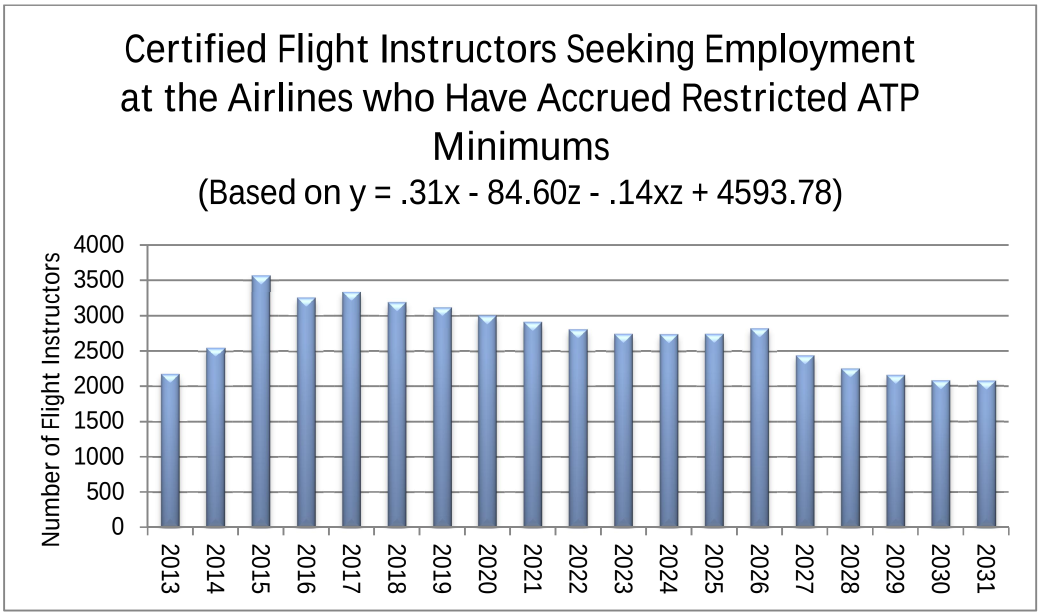


Figure 18: Newly Available Pilots for Airline Hiring



[5] Two years was selected simply because the FOQ NPRM recently published by the FAA outlined some restricted ATP minimums.

One additional supply of pilots available for hire at airlines is the military. The number of retiring military pilots will change based upon several factors, including sequestration and/or changing military missions. United Airlines recently completed a study of future available military pilots from all branches (2013). While variation in the yearly supply of military pilots is inevitable, a calculation of an annually-averaged 1,244 military pilots will be hired by major airlines during the forecast period. This number could be affected by diminishing military pilot populations as defense budgets are reduced, the increase in the UAS military pilot population that would not be eligible for airline pilot hiring, and the effect of stop-loss orders by the Department of Defense if military pilot populations moves to an unacceptable attrition rate.

5. QUANTIFYING THE SHORTAGE

A simple year-by-year calculation can be conducted which simply compares the available new pilots to the pilots leaving the industry. A simple equation for this calculation is given as:

$$\text{Surplus/Shortage} = (R+OA+G) - (M+I)$$

R=Retirements; OA =Other Attrition; G=Pilots Needed for Growth; M=New Military Pilots; I=Available and Qualified CFIs;

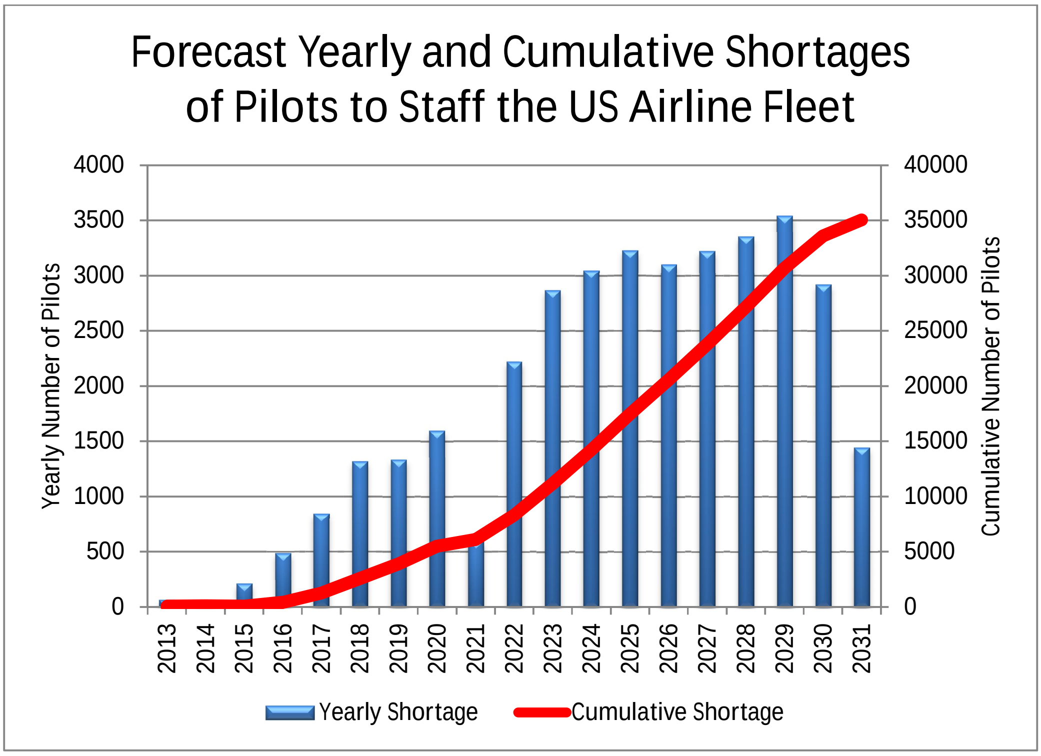
Figure 19 depicts the year-by-year and cumulative forecast shortages for airline pilots in the United States. For the years 2013 to 2031, there is a forecasted 35,059 pilot shortage. It should be noted that all forecasts lose accuracy over longer periods of time simply due to changing macro conditions. In the case of this forecast, no reaction by the industry or regulators is taken into account.

5.1 Factors not Considered by this Forecast

This study does not take into account three major issues affecting US airline pilot supply, i.e. increased staffing requirements for the newer flight time/duty time requirements for Part 121 operations; foreign hiring of US pilots, and any further career aspiration changes as a result of Public Law 111-216.

The effects of the new flight time/duty time requirements are not fully understood at this time. The new rules will most likely affect the major mainline air carriers to a lesser degree than the regional air carriers due to the differences in the contractual work rules with their pilot groups. Anecdotally, due to several conversations with operations managers for various airlines, many of them have not yet determined its full impact; many are in the midst of making that determination. Some data does exist. Two regional air carriers projected increased pilot staffing by 7% due to the new flight time/duty time regulations. One major carrier expected it would need to increase its pilot staffing requirements by 2.7% to 3.1% in order to handle the increase of the reserve contingencies of their flight operation schedule due to the new regulations. While these data points may be of interest, there currently is no aggregated quantifiable metric that will allow for the measurement of the impact, if any, of the new flight-time/duty-time on the overall industry. That being said, in almost all scenarios, the implementation of these new rules will likely require additional staffing not contemplated in the forecast above.

Figure 19: Forecast Yearly and Cumulative Shortages of Pilots to Staff the US Airline Fleet



How foreign hiring will continue to affect US airline pilot supply is also unclear. Over the past decade many US pilots have left their country to fly for foreign air carriers because of increased worldwide demand for pilots. Given the coming ATP requirements in the US, will new, lower-time pilots leave the country in order to circumvent Public Law 111-216? According to the CAS, when asked the question from the study's survey, 'How likely are you to relocate to another country if flight time requirements were lower for second-in-command?" 796 individuals answered 'likely' or 'very likely' to do so, out of a total of 1340 respondents. This represents 59.4%. In another related question, "If a non-US airline opened up a base in the US, how likely would you consider a career at that airline?", 1016 individuals out of 1342 (or 75.7%) indicated they were 'likely' or 'very likely' to consider that situation. Both of these responses indicate a willingness to work abroad if the employment opportunities are more positive for younger pilots entering the industry today.

The final issue is not taking into consideration the affects of Public Law 111-216 concerning the perception of younger people's attitudes towards their career aspirations as US airline pilots. Again, from the survey that was recently completed, 1410 respondents answered the question of how the new ATP requirement and 1500 hours to fly as a first officers had affected their career aspirations, 112 (7.9%) indicated it had changed their mind about pursuing a career with airlines due to the proposed rule change. Another 469 (33.2%) indicated they were starting to think twice about a career with the airlines based on the proposed rule changes. Based on the survey, a small population (7.9%) of up and coming pilots have elected not to pursue the airlines as a career. The group that is starting to think twice is much larger and could have a significant negative impact on US airlines pilot supply if they also move away from an airline career.

Each of these factors, flight time/duty time regulations, foreign hiring of US pilots, and Public Law 111-216 could impact the labor supply by increasing the shortage. Additional research to explore this impact would enhance the literature on pilot supply issues.

6. CONCLUSION

It is clear from the data that the United States faces a shortage of airline pilots. The current forecast calls for a shortage of over 35,000 pilots in the US between 2013 and 2031. While shortages have been predicted from time to time, this particular shortage forecast is based upon factors not previously experienced. These factors include the following:

1. New pilots who may enter the profession make a consumer decision based upon cost of flight training and the potential to obtain employment at major airlines. The cost of flight training is increasing which will negatively impact the future pilot supply.
2. Major airline retirements are accelerating and will accelerate in the future.

3. Growth will continue within the airline industry.
4. Only a small majority of CFIs intend to work for the airlines as a long term career aspiration.
5. The requirement of obtaining an ATP prior to operating as a line pilot at an air carrier is negatively impacting the pilot labor supply, and may further negatively impact the pilots supply further in the future.

Other factors not specifically considered by this forecast:
1. The impact of the new flight-time/duty-time rules.
2. Foreign carriers may decide to aggressively compete and employ lower-time entry-level pilots.

From the data, it appears that the larger major carriers will likely not experience any shortage in the next five to seven years. However, the same cannot be said for the regional carriers. It is likely that the regional carriers will experience large-scale shortages, and that a relatively small population of newly-available and qualified pilots will have ample opportunities to obtain employment as the regional airlines compete for employees. Regarding this competition for employees, the regional airlines will likely become aggressive in their recruiting tactics. Today, some regional airlines are already offering "signing bonuses" and "gateway" programs to help attract new pilots.

7. IMPACT

Most airlines in this country operate the majority of their flights via a hub-and-spoke model. Passengers fly into the hub and then transfer to another flight that will carry them to their final (spoke) destination. Successful hubs rely on service from both mainline as well as the regional carriers.

Atlanta's Hartsfield Jackson International Airport, is the world's largest airport when measured by aircraft movements and passengers (Airports Council International, 2012). It also serves as the largest hub for Delta Air Lines and will be an important hub for Southwest, as it continues to implement its merger with AirTran.

Nearly one in three aircraft departures out of Atlanta are operated by regional airlines (Regional Airline Association, 2012). At Chicago's O'Hare International Airport, a hub airport for both American and United Airlines, over 64% of departures are operated by a regional carrier (Regional Airline Association, 2012). Regional flights allow carriers to support existing domestic and international service. Without regional airline flights, many markets would not receive the same level of service (or any service) as they do today.

The importance of the regional airlines in providing air service throughout the country cannot be understated. Regional airlines serve 681 airports throughout the United States. About 70% of those airports, 476 airports in total, are served exclusively by regional airlines. This means that in the event that regional airlines have to reduce service due to the inability to hire qualified pilots, many communities will see a reduction in air service. Assuming a constant or increase in demand, airfares in many of those cities would rise.

In order to appreciate the potential consequence of this situation, one can examine the economic impact that a loss of airline service would have on the city of Abilene, Texas and its airport. Abilene is a city with a population of nearly 120,000 people (U.S. Census Bureau, 2013). The Abilene Regional Airport has scheduled airline service provided by one carrier, American Eagle Airlines. A review of the February, 2013 flight schedule shows that Eagle operates seven round-trip daily flights and one additional flight scheduled for every day except on Saturday to Dallas Ft. Worth International Airport (City of Abilene, 2013).

The vast majority of passengers flying out of Abilene are connecting onto another flight in Dallas to go to another destination. The average fare for passengers flying out of Abilene during the third quarter of 2012 was $521[6] (Bureau of Transportation Statistics, 2013). This relatively high fare is most likely due to the fact that only one carrier provides service to Abilene. In the event that American Eagle was to reduce service due to its inability to find qualified pilots to support its scheduled flying, it would have to reduce service to various cities. Abilene could experience a reduction in service, which would very likely result in an increase in fares due to the fact that there are less seats available for sale. This may deter some passengers from flying which can lead to a reduction in economic activity at the airport.

[6] Provided by the Bureau of Transportation Statistics, Airline Origin & Destination Survey. Average fares are based on domestic itinerary fares, round-trip or one-way for which no return is purchased. Fares are based on the total ticket value which consists of the price charged by the airlines plus any additional taxes and fees levied by an outside entity at the time of purchase. Fares include only the price paid at the time of the ticket purchase and do not include other fees, such as baggage fees, paid at the airport or onboard the aircraft. Averages do not include frequent-flyer or 'zero fares' or a few abnormally high reported fares. Airports* ranked by U.S. originating domestic passengers in 2011.

Airline service can be an important revenue stream at many airports and their communities. In addition to transporting passengers, airline service supports the movement of air cargo and jobs at the airport (CDM Smith, 2010). With the so-called 1500 hour rule, many airports-both large and small-may face a reduction in air service over the next several years, if airlines are unable to find a sufficient number of qualified pilots to fly their planes.

In 2010, the University of North Texas' Center for Economic Development and Research published some data on the economic impact of airport related activity in Abilene (University of North Texas Center for Economic Development and Research, 2011). The study highlighted the importance that commercial, general aviation and military operations have on the airport (University of North Texas Center for Economic Development and Research, 2011). The report stated that commercial and general aviation activities at the airport generated over $148 million in economic activity (University of North Texas Center for Economic Development and Research, 2011).

Again, in the event that the airport were to see a reduction in air service due to American Eagle's inability to find a sufficient number of pilots, cities like Abilene could see a reduction in air service. The airport would also experience a reduction in economic activity.

8. POTENTIAL SOLUTIONS

In the face of the upcoming pilot supply disruptions and shortages, the industry must seek solutions; otherwise, the effects can be catastrophic both on multiple local levels as well as the national economy. There are two areas which the data suggest might provide the most relief:

1. Given the consumer decision made by potential pilots, the industry should focus on both the risk (CFT) and reward (MAH) variables. This concentration should focus on reducing of costs related to flight training, such as paid scholarships or funding in return for future employment; or, providing a clear pathway to the major airlines from early pilot training, such as a gateway program which outlines a career progression culminating in major airline employment.
2. The industry should focus their efforts on recruiting and attracting CFIs who have no intention of obtaining employment in the airline industry. The data currently suggests that around 47% of CFIs fall into this category and have no

intention of becoming airline pilots in the long-term. If these pilots can be attracted to the airline industry, the effects of the shortage could be mitigated.

9. FINAL REMARKS

In the face of forecasting and the errors associated with forecasting methodology, one fact is certain: as time passes, the industry will know for sure if previous forecasts were accurate. Unfortunately, given that it takes several years for a pilot to enter the airline pilot labor supply, the industry cannot afford to "wait and see" if there will be enough pilots in the future. Accordingly, the industry must make its best efforts to forecast and mitigate, if necessary, any future shortages. These efforts should begin now and in earnest. The likely result of inadequate staffing will be the reduction of flying in smaller-communities and other markets served by regional airlines. The overall effect could also cause harm and disruption to the entire airline industry. Given the far reach of the airline industry and its effect on the national economy, this threat should be taken seriously, and mitigations should be enacted in an attempt to circumvent this potential hardship.

Acknowledgements

In the Summer of 2012, the industry formed a stakeholders group which sought to analyze the current state of the airline pilot labor supply. From this stakeholders group, a subgroup of collegiate aviation researchers formed and endeavored to help provide a scientific foundation to this process. This group could not have completed their work without assistance. In particular, the industry helped form the underlying research questions examined by this study, as well as provide detailed data to help facilitate the analysis. The authors of this study wish to acknowledge the contributions of many people representing the airline industry. The authors wish to specifically thank the following people:

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