The effect of airline mergers on on-time performance

Master thesis

Caroline Werger

Student number 371295

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Abstract

This study analyzed the effect of mergers in the airline industry on on-time performance. The importance of this study is reflected by the on-going discussion relating to whether airline mergers are disadvantageous to consumers. Data provided by the US government is used to compare the frequency and length of flight delays before and after a merger. The statistical analyses show that on-time performance becomes worse after a merger. However, when looking at mergers independently, we can conclude that the effect of mergers on on-time performance is not the same for every merger studied.

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Chapter 1: Introduction

The merger between American Airlines and US Airways has been all over the news in 2013. The plans for the two airlines to merge caused a lot of turmoil, taking into account the significant size of the two airlines and the impact of a proposed merger. While some encouraged it or were confident that the merger was the only way forward for the airline industry, others criticized the plans and feared the consequences of this major move, which would mean that 80% of the passengers transferred domestically would be in hands of the largest 4 airlines in the United States. (PwC, 2014) This merger was, however, not unique. Over the last decades, many airlines have merged. Whenever two (large) airlines announce their intentions to merge, the discussion whether airline mergers should be allowed by the authorities becomes a vivid discussion in the United States. The fear that an airline merger will have a negative impact on consumers is an argument often heard in these discussions. Besides the effect on fares, a worsening of service quality is frequently feared. Service is an important aspect in the airline industry, as it is one of the most important decision drivers for consumers (Ramdas & Williams, 2008). Service quality is for a large part reflected in on-time performance, which is the quality of an airlines performance regarding the frequency and magnitude of flight delays and cancellations.

Because of the importance of on-time performance and the frequent occurence of airline mergers, the question whether these mergers affect on-time performance is very relevant nowadays. If airline mergers do not worsen the on-time performance of airlines, it could be an important driver in the decision whether to allow a merger between two airlines. In this study, we focus on airlines in the United States. The airline industry in the US is deregulated and therefore home to many airline mergers. Data from 10 airlines, made available by the US government, will be used to answer the question whether mergers between these airlines influence on-time performance.

An overview of the existing literature is given, followed by an outline of the airlines' motives to merge and the possible consequences of these mergers. This allows us to create a model in which we control for other factors influencing mergers and flight delays, such as the level of competition and airline size. We will use data on flight delays to compare the frequency and magnitude of delays of selected airlines before and after a merger to understand the impact a merger has on on-time performance. If the results show that the frequency and magnitude of flight delays increase or decrease after two airlines have merged, then we can conclude that airline mergers do have an impact on on-time performance. A comparison between on-time performance in the first year after a merger took place and the years after this will also be made to see if a newly merged airline produces different on-time performance statistics.

The thesis will continue as following: chapter 2 will outline the motives for airlines to merge, while chapter 3 explains the consequences of these mergers. Chapter 4 continues with the concept of on-time performance. The various ways in which mergers can influence on-time performance are outlined in chapter 5. The data we used for the model and the model itself are presented in chapter 6. And then finally, the results of the analysis are presented in chapter 7 and the thesis is concluded in chapter 8.

Chapter 2: Merger motives

The US airline industry used to be heavily regulated. Before 1978, the government decided fares, routes and other operational aspects. This meant that airlines were not able to optimize their operations to be as efficient as possible and to respond to external circumstances. (Winston, 1998) During this time, the opinion of many was that the airline industry should stay regulated; competition in the airline industry would not be possible. However, others, such as Winston (1998) have argued that the market will work most efficiently when there is no governmental intervention, this will lead to a long-term equilibrium with enough competition and airlines will operate at their most efficient frontier, as the market will eliminate all inefficient airlines. Incumbent airlines will need to continuously improve by innovating and investing to be able to compete with other airlines. (Winston, 1998) After the airline industry in the United States was finally deregulated in 1978, a favorable environment for mergers was created (Carbaugh & Ghosh, 2010). There are several motives for airlines to merge with one another. The most common reasons are explained in this chapter.

2.1 Financial synergies

Airline mergers are often driven by financial synergies. According to Hansson, Neilson & Belin (2001) the fact that most airlines are reporting losses and large budget cuts means that the airline industry is in a challenging situation. The emergence of low cost airlines, which accounted for up to 25% of the airline industry in 2010 (Carbaugh & Ghosh, 2010) in the last few decades had put pressure on national airlines, as both business and economy passengers have become more price sensitive and consequently are not always willing to pay a lot for more or better service. (Teichert, Shehu & von Wartburg, 2008) But above this, most pressure was put upon the airline industry by the high and volatile fuel prices. Fuel prices are the largest single component of airline costs, and these costs have been rising for years. According to the Department of Transportation (2012), more than 50 passenger and cargo airlines in the United States have filed for bankruptcy since 2000. Carbaugh & Ghosh (2010) found that the major mergers that took place in the last decade were indeed primary driven by financial reasons and have allowed for a reduction in operating costs. For instance the merger between Continental and United Airlines; the primary reason for the merger was financial and by merging, the airlines were able to reduce costs up to $1.2 billion a year. (Carbaugh & Ghosh, 2010) As Liang

(2013) argues, reduced costs after a merger are often the result of efficiency gains and lower unit costs because of economies of scale, scope and density.

Economies of scale are common in the airline industry, as the airline industry is characterized by having very high fixed costs. (Jara-Diaz & Basso, 2003) Because of these economies of scale, larger airlines have a cost advantage over smaller airlines. The use of a hub-and-spoke network can contribute to economies of scale through consolidation of air traffic flows, as centralizing operations at airports reduces costs. (Carlsson & Jia, 2013) After a merger, there are an increased number of flights carried through the primary hub. (Bilotkach, Fageda & Flores-Fillol, 2012) According to Bailey & Williams (1988), “if a firm achieves a higher degree of control at a hub airport, its financial stability will improve.” The more intensive use of airport facilities can also reduce costs substantially after a merger. According to Jara-Diaz & Basso (2003), economies of scope are the most important cost advantages in the airline industry. They arise primarily when an airline offers several interconnected routes; each route can be identified as a separate market. Therefore, airlines operating several routes serve different markets and can use their resources in all production lines, or routes, and thereby they are able to flexibly adjust their schedule to actual demand. (Vermooten, 2004) Economies of scope also arise when airlines offer ancillary services. For example, some low cost airlines offer car hire, hotel bookings and travel insurance. (Vasigh, Fleming & Tacker, 2009) Economies of density in the airline industry exist when the marginal costs of carrying an extra passenger decline when traffic on the route increases. (Brueckner & Spiller, 1994) This happens when an airline adds capacity (extra flights or seats) on an existing route, and thereby improves utilization of capacity. (Vermooten, 2004) When capacity on one route is increased, the gains in economies of density can be observed as a reduction in costs per passenger on the whole network. (Brueckner & Spiller, 1994)

However, there are studies that show that there are no economies of scale, scope or density in the airline industry. Caves, Christensen & Tretheway (1984) argue that economies of scale can only be found at very specific routes, but not for regional or network airlines in general. They illustrate this by pointing out that local airlines are able to compete with the larger network airlines, and if economies of scale were present they would have had too much cost disadvantages to be able to do so.

2.2 Growth

Company growth can also be aimed at for reasons other than scale and/or scope economies. As Roll (1986) argues, people do not always make rational decisions and this can influence merger decisions by managers. This can take two forms. In the first, managers aim for a large company, because a large company brings additional personal benefits for a manager, such as the fact that managers for a large company get paid more, have a higher status, or the size of the company fosters risk diversification. In the second case, managers overestimate themselves, believing that they can turn the target company in a more profitable company than it is in reality. Because of this, they are likely to suffer from the winners curse and to pay too much in case of an acquisition or merger. (DePamphilis, 2008) Many merger decisions have been affected by hubris (Roll, 1986) and this causes mergers not always to be efficient. Furthermore, managers interest in these scenarios conflict with the interests of shareholders, as they aim at profit maximization and a merger influenced by hubris will possibly not result in profit maximization.

2.3 Rationalization and expanding network

Rationalization of production can also be an incentive for merging. Only flights on the most profitable routes will be offered to increase efficiency, flights on less profitable routes are eliminated. Furthermore, by combining the demand on a particular route, the same frequency can be maintained while using larger aircraft, which is more efficient. Flying frequently is important, as customers are not only driven by tickets prices, but also value a flight schedule with several flight time options. This allows them to find a flight close to their desired departure time. (Richard, 2002) Also, because some routes were not carried out before the merger because of a lack of demand, the combined demand from the two airlines might create the opportunity to start a new route and thus expand activities into new markets.

Expanding to new markets is important, as Oum, Zhang & Zhang (1995) mention that airlines do not necessarily compete with routes but rather with networks. A network industry drives on network externalities. This means that the more extensive the network is, the more value it has to customers. This is confirmed by Dennis (2005), who argues that the vast majority of passengers simply want transport from A to B, and are not very interested in other aspects. Because of the high fixed costs in the airline industry, having a sufficient number of passengers should be of high priority to the airline. This makes geographical expansion an attractive option for growth. Merging with an airline which is already active in another region, compared to opening up new routes into this area is advantageous because of the competitive advantage given to the airline in terms of brand name and knowledge.

2.4 Resources

As airlines are large consumers of the resources they use, such as fuel and ground services, they are able to negotiate and obtain quantity discounts. Especially for fuel prices, which account for a large part of the high costs for airlines (Vasigh, Fleming & Tacker, 2009), a reduction on price can lower total costs substantially. Airlines that operate a large number of flights from an airport and thus have a high concentration on that airport, have a much better negotiating position than airlines that only operate a few flights. Additionally, large airlines usually have a competitive advantage in hiring employees and staff training.

Thus, mergers between airlines are mostly driven by financial reasons, but are also instrumental in expanding their network and entering more markets. Therefore, they are attractive to airlines. However, due to the Clayton Act of 1914, which states that mergers and acquisitions are not to be allowed if they are anti-competitive and harmful to consumers, mergers are still subject to approval by antitrust authorities. The next section will continue with the consequences of airline mergers.

Chapter 3: Consequences of mergers

The previous section summarized the most important reasons why airlines merge. The airline industry is characterized as having a relatively small amount of large airlines, so a merger between two airlines will have a significant impact. In the following chapter the most common consequences of airlines mergers are explained.

3.1 Internal consequences

An airline merger requires substantial change within the airline, as management, employees and divisions of the two airlines need to be integrated to become one new airline. Both the number of employees and the number of managers increase and this will make communication within the company more complicated. The more specialization within a firm, the higher the need for good coordination, because the company will not function efficiently if all departments work independently. (Kapas, 2006) Worse communication has a negative effect on coordination, as communication allows for effective coordination. (Kleinbaum, Stuart & Tushman, 2008) This is confirmed by Weber (2002), who argues that both group size and the growth process have a significant effect on a group's ability to coordinate; slow growth will lead to better coordination because the growth process has allowed the company to adapt gradually to the new situation. However, growth is not slow in the case of two merging firms. Therefore, we can expect that a merged, and thus larger, company has a worse coordination, and consequently would be able to reduce costs when communication and coordination are improved. A less than optimal coordination is a problem because in the airline industry, smooth operations cannot be realized without functional communication and good coordination. Because airlines usually run on very strict time schedules, coordinating processes as tightly as possible is essential to avoid flight delay and cancellations. Also, monitoring operations is more complex for a large airline. With a good coordination system, business opportunities will be discovered and exploited much easier. (Kapas, 2006)

A merger can affect job satisfaction, as management might be very reserved in informing employees prior to the merger and this can decrease employees' motivation. Problems with airlines' seniority listing have posed problems before, for example after the American Airlines & Trans World Airlines merger. Seniority listings are very important in the airline industry, as the seniority list determines which pilots fly a particular route, and are also closely linked to wages.[1] In the American Airlines & Trans World Airlines merger process, agreements about the seniority listings were made where American Airlines pilots were favored over Trans World Airlines pilots. This resulted in a lot of controversy, combined with decreased morality among employees, which caused operations to be affected. Dissatisfaction among employees is a threat, as this can lead to a lack of effort to provide quality. (Testa, 2001) However, other studies show that job satisfaction can increase after a merger. A larger company offers more opportunities for promotion and more status. Graves (1981) argues that employees are often more satisfied after a merger because their tasks are extended and more diversified.

Competitive inertia occurs when a firm does not display much activity towards altering its position relative to its competitors. (Miller & Chen, 1994) Managers can be discouraged to make an effort to improve operations when competition is reduced. When an airline does not see competitors as a threat, it will continue to deliver the same service, even if consumers regard it as below standard.

Corporate culture clashes are common during mergers. This occurs when the two merging firms have a different strategy, operating routines or other fundamental differences. Of course, some difference in corporate culture is desired, as this will allow for diffusion of knowledge (Roller, Stennek & Verboven, 2000), but if the differences are too large, it will be difficult to create a common language. (Ramaswamy, 1997) Prior to a merger, the two companies often fail to acknowledge these potential problems and this might lead to higher costs than anticipated and a non-successful merger. This has, for instance, happened with the merger between USAir and Piedmont Aviation. The value of USAir dropped $2.15 billion after the merger, due to differences in corporate culture which were not acknowledged beforehand. (Carbaugh & Ghosh, 2010)

[1] Source: http://fapa.aero/content.asp?ID=69&Gateway=Industry

3.2 External consequences

Apart from the consequences that affect the airline internally, the market will also be affected. The airline industry is a highly concentrated market, which means that a merger will reduce the number of competitors significantly. As the Department of Transportation (DOT) stated in 2012; "The recent series of significant airline mergers has reduced the number of airlines serving the bulk of the domestic passenger market from 10 in 2000 to 5 in 2012, which has dramatically consolidated control of the industry." (DOT, 2012) This lead to one of the biggest concerns regarding mergers; the reduction of the number of players in the industry might lead to a monopoly or a near-monopoly on some routes. The airline industry is an industry with a tendency towards a natural economy or oligopoly. This is due to the homogeneity of the product, high fixed costs, growth through mergers (the industry is saturated) and economies of scale, scope and density. Less competition means that customers will have fewer options and airlines get more market power. Besides the competitive advantage the incumbent airlines will have, a concentrated market will also discourage new airlines to enter the market. (Borenstein, 1989) According to many, this gives airlines too much control and this situation should be avoided. This is especially true for airports on routes that are only served by one airline or airports that are only served by one or a few airlines. Airport dominance brings natural advantages to airlines. For example, a frequent flyer program will be much more attractive for local customers when an airline has a large market share of routes from that particular airport. (Brueckner & Spiller, 1994)

However, a decrease in competitors is not always a disadvantage, as the reduction of the number of competitors might create opportunities for new entrants. Even though barriers of entry are high, many new airlines have entered the industry in the last decade. If the incumbent airlines price their product too high, new airlines will be able to offer the same product for a much lower price and by doing this, restore the equilibrium in the market as the remaining airlines will have to adjust their prices as well. Additionally, a reduction in the number of airlines can foster competition. This happens when two medium sized airlines merge and the merged airline is able to compete with the larger airlines in the market. This is supported by Brueckner & Spiller (1994), who argue that despite the increased concentration, an increase in competition on many routes can be observed.

The effect of mergers on the hub-and-spoke network is to a large extent related to the degree of overlap in the route networks of the two merging firms. (Huschelrath & Muller, 2013) If the two networks are largely complementary, then a reduction in flights will be less common and the consumer welfare effects will be larger, as the number of destinations available to customers increases. In this case, the number of hubs will increase to be able to efficiently cover the route network. However, if the airlines' networks prior to the merger were to a large extent similar, then the number of hubs will most likely decrease after the merger. Airlines will compare their own and their competitors cost and revenue analysis to be able to choose the airports that will best function as a hub (Adler & Smilowitz, 2007). The hub-and-spoke network will be restructured and redundant hubs will lose their status as a hub. This situation is less favorable for customers, as the number of routes will not increase, but competition on the existing routes decreases.

As airlines are often similar in quality, service and schedules (they offer a homogeneous product), they will compete on fares. Economic theory would suggest that by merging two companies, market power would increase for the merged airline and the airline is able to ask a higher price. Some studies have supported this, for example Butler & Huston (1989) show that "mergers that result in major hub carriers result in more flights, but higher concentration and thus higher fares". This is confirmed by Borenstein (1989), who argues that the market power of dominant airlines raises fares above costs. However, there are also studies that show that mergers do not increase ticket prices. Liang (2013) argues that the increase in efficiency leads to lower costs for the airline and thus an opportunity to lower fares. Because the emergence of low cost airlines puts downward pressure on airlines' fares, this might create an opportunity for incumbent airlines to remain competitive.

A possible increase in airfares will partly be offset by benefits such as a more extensive route network, with more flights and fewer connections and still result in a net benefit, argue Morisson & Winston (1995). However, while the total number of flights in the network increases, flight frequencies might be cut as airlines reorganize their network and combine demand on a route to use a larger aircraft. (Luo, nd) According to Carbaugh & Ghosh (2010), a merger between two airlines who have been serving the same route before, will lead to a lower frequency of flights. Financial distress can also lead to a reduction of flights, especially on routes with a low density. (DOT, 2012) Additionally, it can also lead to the de-hubbing of redundant hubs, which can have large consequences for employment, but also affects frequent flyers and the local business community. (Luo, nd) The Essential Air Service program was founded to protect these airports from the elimination of all air traffic by prohibiting a sole airline to eliminate services to the airport without finding a replacing airline.[2] However, regulation has changed and airlines do not have to inform prior to cutting routes. (DOT, 2012) This makes small communities very vulnerable to reductions in flight frequencies. A higher frequency is valued by consumers as this will allow them to arrive closer to their preferred arrival time. (Richard, 2002) Business travelers place an even higher value on a high frequency of flights than leisure travellers do. (Borenstein, 1989)

Airline mergers have large consequences for consumers. Even though the joint outcome of the merger effects is dependent on the number of remaining competitors in the market (Brueckner, Dyer & Spiller, 1992), Richard (2002) found that mergers increased the overall welfare for customers. This is confirmed by Bailey & Liu (1995), who argue that the service improving effects of a merger outweigh the possible increases in fares when competition decreases.

The consequences of an airline merger are not minor and are evident both within the airline itself and in the nationwide airline industry. The consequences are summarized in *table 1*. The effect of mergers on consumer welfare is important, as antitrust authorities argue that a merger should, at least, not be disadvantageous to the consumer. Therefore, they partly base their approval decisions on the effect on consumer welfare. (Richard, 2002)

Communication and coordination	*Internal*
Job satisfaction	*Internal*
Cultural clashes	*Internal*
Competitive inertia	*Internal*
Reduction in competition	*External*
Frequency of flights	*External*
Number of hubs	*External*
Change in fares	*External*

Table 1. Consequences of mergers, internal and external

[2] http://www.dot.gov/policy/aviation-policy/small-community-rural-air-service/essential-air-service

The following chapter will discuss the concept of on-time performance. It will explain why it is important to register and publish flight times and how airlines can improve their on-time performance.

Chapter 4: On-time performance

As explained before, airlines do not always get permission to merge. One of the major reasons for the authorities not to grant permission is the fact that many expect that airline mergers will have a negative influence on service quality; less competition means that airlines can reduce the effort to provide a high quality of service. Especially when a few airlines decide to cut back on service quality expenses, other airlines will be able to follow them without losing too much market share. Following Mazzeo (2003) and other researchers, we use on-time performance as a proxy for service quality. On-time performance is an important part of service quality; of all complaints made by passengers to the DOT in January 2014, over 39% was related to delays and cancellations. (DOT, 2014) The following chapter will elaborate on on-time performance.

4.1 Importance of on-time performance

Flight delays are common in the US airline industry; 23.3% of all flights between 2006 and 2010 were delayed for 15 minutes or more (DOT, 2014). Delays are expensive, as they cost airlines 8.3 billion dollars in 2007, which was one of the worst years in terms of flight delays in the last decades. (Ball et al, 2010). Because of the importance of on-time performance of flights, a lot of emphasis is placed on it by airlines, but also by the government. All United States registered airlines that have more than 1% of the total market share in the domestic market are obligated to report their on-time performance statistics to the Department of Transportation (DOT). Some airlines, that have less than 1% of the market share in the US, report their on-time performance voluntarily. Since the DOT publishes the on-time performance records, transparency to the consumer is increased; it gives consumers the opportunity to select an airline based on its on-time performance. Delays are one of the most common annoyances among passengers and among others, the on-time performance of an airline is critical when consumers choose an airline to fly with (Ramdas & Williams, 2008). With access to the internet, consumers are now able to easily compare flights and on-time performance from all airlines at once. According to Suzuki (2000), passengers who have experienced delays are more likely to switch airline in the future. Therefore, as an attempt to gain more market share, or at least retain their market share, airlines should try to improve their on-time performance. Flight delays can be caused by several factors. The most common factors will be outlined in the next section.

4.2 Causes of delays

Weather accounts for approximately 75% of all delays in the United States. (Rosenberger, Schaefer, Goldsman, Johnson, Kleywegt & Nemhauser, 2002) These delays are costly, as Robinson (1989) argues weather related causes are responsible for up to 165,000 minutes a year in delays. Weather causes delays when it is extreme, especially with fog and thunderstorms (Robinson, 1989). The DOT defines a delay caused by bad weather as the situation in which the operations at the airport are slowed down, yet it is still possible for aircraft to land and depart. In case of bad weather, air traffic control (ATC) often requires more time between flights to ensure safe landing or take-off procedures, thus a reduction in the number of flights that can depart and arrive. The effect of weather on airlines also differs depending on the region the airline serves; some routes and airport are more affected by the weather than others. For example, Hawaiian Airlines has been among the best performing airlines in the United States regarding delays[3], but this can possibly be attributed to the fact that the weather conditions at their major hub, Honolulu International Airport, are better than average. Days with fog, snow hazards or tropical storms are less common than in most other regions of the United States. The airport also processes significantly less traffic than congested airports like, for instance, Atlanta do[4]. On the other hand, Alaska Airlines also performs well in the on-time performance charts[1], even though this airline serves a number of airports which are often plagued by snow hazards and other delay-causing weather, such as Anchorage International Airport.

The degree to which weather disrupts air travel is also subject to the season in which the flight takes place. According to Rupp, Owens & Plumly (2001), spring and fall have the best on-time performance while winter and summer have more delays. In the summer This is attributable to the increase in the number of passengers in the summer due to tourism, while bad weather is primarily the reason in winter. Weather cannot be controlled for by the airline, and is an obstacle to all airlines active at the airport.

[3] http://www.transtats.bts.gov/carriers.asp

[4] http://www.transtats.bts.gov/airports.asp

However, airlines can react differently to bad weather circumstances and therefore the magnitude of the impact of weather on delays can differ per airline.

According to Brueckner (2002), traffic exceeding airport capacity is the second largest cause of delays. Delays increase non-linear when an airport approaches its capacity constraint; extra traffic when the constraint is met will result in large delays. (Ball et al, 2010) Congestion leads to delays when too many airplanes are to depart, but also when there are not enough gates available or when not enough ground staff is available to keep up with demand for their services. Congestion on the runway or gates can be solved by increasing the capacity of an airport. However this is not always a viable option as expansions are costly and will also have (environmental) externalities. Therefore, airport expansion is only a long-term option. As supply of capacity on the airport cannot be increased, demand for capacity should decrease. Congestion based pricing of landing fees or measures to reduce the incentives to overschedule flights can reduce the number of flights and thus also congestion. (Ball et al, 2010) Congestion is not necessarily a permanent issue, it also occurs when capacity is temporarily reduced. For instance during extreme weather or a security incident. Furthermore, congestion does not only appear at the airport but also in the air, as ATC can only handle a particular number of flights. Additional traffic might be put on hold until ATC is able to handle the flight.

Another important source of delays is an interruption in operations, which can be caused by many factors. For instance security issues, both in the terminal building and in the airplane itself can cause severe delays. Security issues cannot be ignored and need to be resolved, even if this will cause one or more flights to be delayed. When passengers check-in but do not show up at the gate, luggage has to be removed from the airplane. Furthermore, screening processes for both passengers and crew are more extensive and require more time these days. Especially after September 11th, 2001, many airports have temporarily been closed due to security issues. (Rupp, Holmes & DeSimone, 2003). Technical failures are also known as a common cause of delays.[5] Airplanes are complex and therefore prone to technical problems or break-downs. Fixing technical problems can require a large amount of time, especially when the airplane is not at the hub, but at

[5] Exact numbers are not known, as the DOT shields airlines from harmful publicity by not releasing the number of delays caused by technical failures.

another airport with less possibilities to repair. Apart from the reasons mentioned here, many other operational issues can delay a flight.

When a flight is delayed due to one of the reasons above, it can affect the on-time performance of other flights, as the next flight which is scheduled to use the aircraft might be delayed as a result. Similarly, the crew of this delayed flight might be needed on a subsequent flight, which will then also be delayed. In other cases the airline will hold for transferring passengers to be able to make their connecting flight, as both the cost of their missed connection to the airline and the inconvenience to the passenger might be larger than the cost of a delayed subsequent flight. The problem of additional delays caused by late arriving aircraft is fostered by the existence of hub-and-spoke systems, which almost all airlines in the US use. (Coughlin, Cohen & Kahn, 2002) For example, a snow hazard in one state can cause flights at the other side of the country to be delayed. To be able to maximize profits, airlines have tight schedules with short turnaround times to use aircraft and crew most efficiently. This makes them vulnerable to even the shortest delays, as a tight schedule will not leave space for unexpected events.

4.3 Improving on-time performance

For airlines there is a tradeoff between on-time performance and costs. Airlines are able to reduce delays if they spend more on preventive measures. While airlines are not able to control some of the causes of delay, such as weather, they are able to lower the number of delays.

The first way of doing this is by padding the flight times. Extra time is added in anticipation of a longer flight time than calculated based on distance. A study by Mazzeo (2003) shows that flights out of hubs tend to have a longer than normal scheduled flight time, while flights arriving into hubs have not. The larger the hub size, the longer the extra scheduled time. (Mayer & Sinai, 2002) This is most likely due to the uncertainty of a tight schedule on a crowded and congested airport. By allowing a longer scheduled flight time on flights out of the hub, operational delays can be avoided. The extra time hub airlines schedule on their flights to and from hubs varies between 47 to 56 minutes. (Mayer & Sinai, 2002) While some may perceive this as “cheating”, as this will improve the on-time performance statistics, it is more likely about adopting a more realistic schedule; some routes simply require more time, disregarding the flight distance. Padding is mostly done on routes prone to delays; the most congested routes, or on routes which include an origin or destination airport with a lot of traffic. However, schedule padding is not always beneficial. Fewer flights a day can be scheduled; when a flight arrived on time, it will stand on the ground not being used for longer than necessary. Thus, airlines have to find the best tradeoff between scheduling extra time, and thereby reducing delays, and a higher utilization of the airplane.

Another way to improve the on-time performance is by anticipating on interruptions and acting proactively to minimize delays. For example, if weather forecasts signal a snow hazard coming, the airline can prematurely cancel flights. By doing this, a larger pool of sources (such as crew and ATC) can be used to make sure the remaining flights minimize delays. Cancelled flights do cost the airline a large amount of money, as passengers need to be rebooked on to other flights, which often causes capacity problems. However, the total amount of passengers affected by the bad weather will be smaller. Similar to cancelling flights in anticipation of severe weather, an airlines' proactive policy can also decrease the number of delays caused by mechanical failures. Regular check-ups and maintenance will detect potential problems in an early stage and avoid many unexpected technical problems that delay flights. Furthermore, having spare aircraft can avoid a further snowball effect when a technical problem keeps an aircraft on the ground. But these preventive measures are costly and airlines will not always be able or willing to adapt these measures to improve their on-time performance.

Decreasing the frequency and magnitude of delays is also possible by avoiding particular airports and peak hours. As explained before, airlines are often not able to avoid congestion on airports and the related delays. However, they do have the option of choosing less crowded airports or to fly outside of peak hours. According to Bonnefoy & Hansman (2004), delays are much less common at secondary airports, which are often used by low cost airlines. This is mostly due to shorter taxi times and less congestion on these airports. This is most likely one of the reasons why some low cost airlines manage to have a better than average on-time performance.

This chapter explained the most common causes of flight delays. These causes are to a large extent related. For instance, bad weather can cause congestion, while a flight delay at one airport can cause a delay at another airport simultaneously. Airlines are not able to avoid all flight delays. Some delay causes are external and airlines cannot avoid these delays completely, such as extreme weather. Congestion on airports is partly external (when the airline is not the only user of the airport) and can be avoided by flying into other, less congested, airports. Finally, some delays are caused by inefficiencies in operations, and with investment or changing operation structure, these can be avoided. Most importantly, every airline has its own way of coping with delays, and is also subject to different circumstances. Therefore, every airline will develop its own policy to deal with on-time performance.

Chapter 5: Effects of mergers on on-time performance

In the third chapter, the consequences of mergers are explained. An airline merger has both internal and external effects on airlines. These consequences might also influence the on-time performance of airlines, which is one of the reasons why airline mergers are subject to approval by antitrust authorities. In this section, the effects of airline mergers on on-time performance are explained. How can airline mergers affect the airlines' on-time performance?

5.1 Hubs

When two airlines merge, the hub and spoke networks of both airlines are transformed into one new network. In some mergers, hubs are closed and more flights are scheduled for the remaining hubs. This leads to an increased pressure on these airports, with a lot of extra traffic. For other mergers, new hubs will be opened besides already existing hubs because the hub-and-spoke network is reorganized or the merger expands the route network to new areas. A merger will consequently influence the number of hubs being used. An increase in the number of hubs gives airlines an incentive to improve on-time performance. When an aircraft arrives late, there is a substantial chance that it will delay the subsequent flight for which the aircraft and crew are needed. By improving the on-time performance on flights departing to the hub, delays can be avoided. This argument is confirmed by Mazzeo (2003), who finds that performance in an airlines' own hub is better than average, especially for flights arriving at a hub. The hub airlines' flights out of a hub also have a better than average on-time performance, but this effect is slightly weaker compared to flights arriving at the hub. However, Deshpande & Arikan (2012) find that the number of passengers on the flight who have to make a connection does not positively influence the scheduled on-time arrival probability. Contrary to the results found by Mazzeo (2003), Rupp, Owens & Plumly (2001) find that flights originating at hubs have more frequent delays than other flights. However, for flights arriving into hubs, no significant difference can be found. They argue that the reason why flights departing a hub are often late, despite the longer turn-around times at hubs, may lie in the fact that at hubs, services such as cleaning and small maintenance take place. These services might cost more time, but are also more unpredictable in terms of time needed. (Rupp, Owens & Plumly, 2001) More delays on flights arriving at and departing from hubs is observed by Mayer & Sinai (2002), who show that flights originating from a hub require on average 7,2 minutes extra, compared to non-hub flights, while flights arriving to a hub require 4,5 minutes extra. The delays are increasing with hub size. A hub airline will most likely bundle its flights to make connections as short and smooth as possible, but this means that most flights will be scheduled for peak hours. (Mayer & Sinai, 2002) In addition, once they are a dominant airline at an airport, airlines might want to focus on increasing the number of destinations flown from this airport to fully exploit the advantages of a hub-and-spoke network. Hub airlines themselves bear the costs of an increased number of flights, as they will face a more congested airport and thus more delays. (Mayer & Sinai, 2002) The airline will make a tradeoff between additional destinations (and thus growth) and increased delays. A similar tradeoff is needed for clustering all the flights around peak hours. The increased benefits to the passenger (better connecting flights), should outweigh the additional delay costs that may come with flying during these peak hours. Thus, an increased amount of traffic on hubs will cause congestion and this might result in longer and more frequent delays at hub airports.

5.2 Competition

As discussed in chapter three, when two airlines merge, the number of competitors on the routes will be affected. There are several routes in the United States that are only served by one or a few airlines. After a merger, the number of competitors on these routes might even decline further. According to Rupp, Owens & Plumly (2001), routes that are served by one or two airlines have on average a better on-time performance than routes that are served by more than two airlines. They explain this difference by schedule differentiation on less competitive routes; on these routes, flights are often more spread throughout the day and not clustered around peak hours, which tends to be a major cause of delays. However, this contradicts the result of the study of Mazzeo (2003), who argues that delays are more frequent and longer on less competitive routes. Deshpande & Arikan (2012) confirm this, as the result of their study shows that when an airlines' market share on a route increases, the scheduled on-time arrival probability decreases. Because of the market power these airlines have, they can afford to provide a lower quality of service, and thus have longer delays. The lack of alternatives for the passenger means that he has to accept the delays. This gives the airline a possibility to focus on improving the on-time performance on other routes, which are more competitive. When there is more competition on a route, an airline might want to invest in delay prevention, as the costs to prevent delays will likely be less than the cost of customers switching to other airlines. (Mazzeo, 2003)

5.3 Frequency

A merger between two airlines might lead to a change in the frequency of flights. Douglas and Miller (1974) show that higher flight frequency decreases flight delays. The load factor will be higher as demand is combined, but the airline will be able to offer flights more spread out over the day, and thus avoiding peak hours. On the other hand, according to Rupp, Owens & Plumly (2001), delays are the lowest when an airline has one or two flights a day on a particular route. With more flights on a day, average delays will increase. They argue that this is because airlines generally intend to minimize consumer inconvenience as much as possible. With more flights on a day, there are more alternatives for passengers who need to be transferred to another flight due to a delay or cancellation. Thus, on a route where the airlines only has one or two flights a day scheduled, having a delayed or cancelled flight causes a lot of inconvenience and should be avoided. The effect of frequency on on-time performance is reciprocal; airlines might be motivated to reduce frequency at delay prone airports to improve their overall on-time performance. (Pai, 2010)

5.4 Airline size

It can be assumed that a large airline has a better on-time performance than smaller airlines, as a large airline has more opportunities to substitute aircraft and crew when there is a disruption in operations. This is supported for by Mazzeo (2003), who argues that airlines aim to maximize firm-wide profit, and thus will allocate resources in a way that on-time performance can be improved. On the other hand, coordination and communication in a large organization can be tougher because of the centralization of decision making, which might result in a slower decision making process in case of operational problems. For instance, problems occurring at an airport might have to be reported through several layers of corporate structure before a final decision can be made. This requires a needless amount of time and leaves space for miscommunication along the process. Bhat (1993) likewise argues that the probability of a delay increases with airline size. Large airlines usually have more flights flying into congested airports, as the hub-and-spoke system concentrates flights onto some airports. Furthermore, large airlines generally serve a larger geographical network, and therefore use larger airplanes than smaller airlines. These airplanes have more passengers on board than smaller airplanes. Higher load factors increases delays, as the boarding and deplaning process will require more time. (Ramdas & Williams, 2008) This is confirmed by Mazzeo (2003), whose study indicates that an increase in the number of seats on a flight increases delays. This causes inconvenience as this means that when a flight operated by a large aircraft is delayed, a large number of passengers are affected by this at once.

5.5 Congestion

After the restructuring of the network, as explained in chapter three, the hub-and-spoke network will change and more flights will arrive and depart from the remaining hub airports. Congestion will become a problem when the capacity constraints on these airports are reached. While airport expansion is possible on the long-term, the effects of the additional traffic are often felt by the airport and all the airlines using the airport. Thus, after a merger, it is not only the merging airline which might experience extra delays due to the increased traffic on its most used airports, but also other users of the airport, to which this is an externality they cannot control. (Moss & Mitchell, 2012) Due to the increased level of traffic, delays can increase for both the merging airlines and the other airlines present at the airport.

To conclude, there are several possible ways in which an airline merger can affect the on-time performance of airlines. Increased pressure at hub airports can cause congestion, while at the same time flying to a hub airport would motivate airlines to minimize delays. The increase in market share and the related decrease in competition might present an incentive to lessen the effort to provide a good on-time performance, but it can also lead to more scheduling differentiation. Similarly, with a higher frequency of flights, flights will be more spread out over the day. When frequency is low, it is expected that airlines try to avoid delays to minimize inconvenience to passengers. These factors, which can influence on-time performance, are summarized in *table 2*.

Independent variables	
Competitors	Number of competitors
	Monopoly
Frequency	On route
	Total frequency
Hubs	Concentration on airport
Congestion	Flights per hour
Airline size	Passengers on route
	Total number of passengers
Flight time	Scheduled flight time
	Actual flight time

Table 2. Determinants of on-time performance

In the next chapter the data is described and the variables used to build the model are presented.

Chapter 6: Data

In this chapter the data and the methods for building the model are discussed. The first section will elaborate on the data, the second section presents the variables and the model to be used is presented in the third section.

6.1 Data

In this study, we use data from the United States airline industry. The main reason for this is the fact that the United States airline industry is deregulated and therefore a favorable environment for mergers. Another reason is the availability of data on on-time performance. As mentioned in chapter four, the US government requires airlines with more than 1% of the domestic scheduled passenger revenues to report on on-time performance for all domestic flights. The reporting is also required for flights that are cancelled or diverted. The data includes, among other things, flight number, origin and destination airport, scheduled departing and arriving time and actual departing and arrival time. For the scheduled and actual arriving and departing times, the times of arriving at and departing from the gate are used as a reference point. The data is made available to the public through the DOT's website.[6]

The data we use is from the period January 1993 to April 2013. The FAA (Federal Aviation Administration) has on-time performance data available throughout these years. It is a period in which several mergers took place. Because this data set covers data from more than 20 years, we can investigate the effect of several mergers on on-time performance with this dataset.

We do not use data from all airlines active during the period 1993 and 2013. We make a selection because the total amount of mergers during this time is large and includes several mergers between small airlines. Only the ten largest airlines that were active in 1993 are used in this study. The reason for this is that a merger between large airlines has a significant effect on market share and competition in the airline industry, while the consequences of a merger between two smaller airlines might go unnoticed. Additionally, the large sample size of the ten largest airlines means that the outcome of the model will be more accurate. The 10 largest airlines in the United States in 1993, and consequently the airlines used in this study, can be found in *table 3*.

[6] http://transtats.bts.gov

	Airline	IATA-code	Number of passengers in 1993
1	Delta Airlines	DL	81,373,803
2	American Airlines	AA	70,477,857
3	United Airlines	UA	60,600,225
4	US Airways	US	54,277,594
5	Southwest Airlines	WN	43,238,487
6	Northwest Airlines	NW	38,222,160
7	Continental Airlines	CO	34,899,021
8	Trans World Airlines	TW	18,164,870
9	America West Airlines	HP	15,623,698
10	Alaska Airlines	AS	7,008,314

Table 3. Largest airlines in 1993

In this group of 10 airlines, 5 mergers have taken place between 1993 and 2013, involving 8 of the 10 airlines in the sample. Two airlines, Southwest Airlines and Alaska Airlines, have not merged during this time, and can be used as a control group. From the group of 10 airlines that operated in 1993, 5 airlines still operate in 2013. These are American Airlines, United Airlines, Southwest Airlines, Alaska Airlines and Delta Airlines. The largest number of flight statistics are reported by Southwest (18.1%), while Trans World Airlines contributes the smallest number of flights (2.5%). A schematic overview of the sample airlines and the mergers is given in *figure 1*, while a short overview of the mergers is given below.

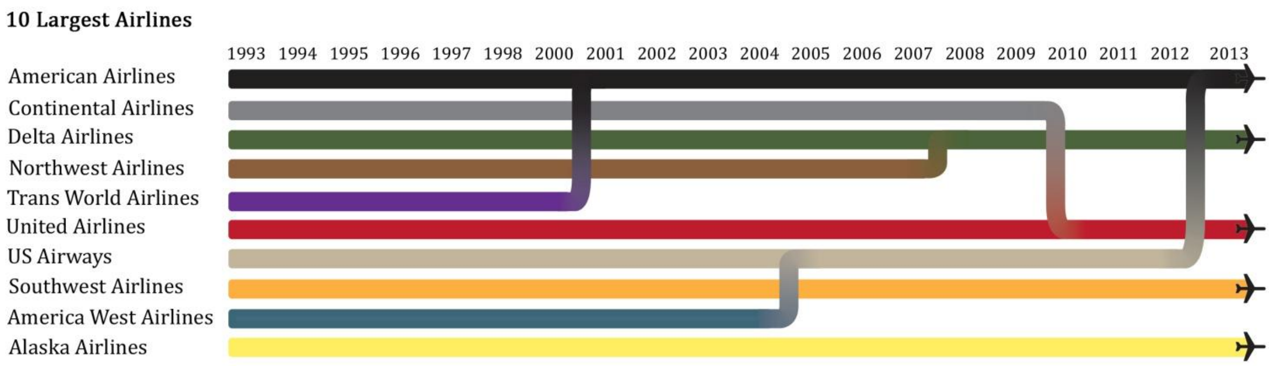

Figure 1. Schematic overview of mergers

American Airlines and Trans World Airlines merged in 2001. The merger followed a financially difficult time for Trans World Airlines. The last flight under the Trans World Airlines name was operated on December 1st, 2001. The airline continued using the American Airlines brand name.

Four years later, in 2005, America West Airlines and US Airways started negotiations as part of a restructuring process due to America West Airlines' bankruptcy. This would eventually, later in 2005, lead to the merger between the two airlines. America West Airlines bought the, by that time bankrupt, US Airways. The merged airline continued operations as US Airways.

Delta Airlines and Northwest Airlines announced a merger in 2008. Operations under one single operation certificate commenced in 2009. The new airline, using the Delta Airlines name, became the largest airline in the world at that moment.

When Continental Airlines and United Airlines started to talk about a possible merger in 2008, this was rumored to be a reaction to the merger of Delta Airlines and Northwest Airlines. Since this merger made the new Delta Airlines a large and powerful company, both airlines felt the need to strengthen their own position. The two airlines agreed upon the merger specifics in 2010. The United Airlines name would be used in combination with Continental Airlines' logo.

American Airlines and US Airways merged in 2013. However, we will not use this merger in the study, as the on-time performance statistics from before and after the merger are compared. As American Airlines and US Airways only commenced their joint operations in 2013, there is no (or little) data available for the time period after the merger. Therefore, we will not take this merger into account in this study.

All routes that are being served by our sample airlines are considered. This is because since deregulation, airlines are free to enter any market they want to. Even though the airlines do not serve all airports in the United States, they at least have the opportunity to do so. (Carlton, Landes & Posner, 1980) Thus, potential competition should also be taken into account. Some studies have used a route market definition, though this method neglects cross-elasticity of supply between the markets. (Carlton, Landes & Posner, 1980) Operations on one route are linked to operations on other routes; late arriving flights impact subsequent flights and airlines distribute their resources among routes in the most efficient way. (see chapter four).

To summarize, we use data from selected United States airlines from 1993 to 2013. The airlines we use were the 10 largest airlines in 1993 for which data is available. In our sample, 4 mergers occurred, involving 8 airlines. Two airlines were not involved in a merger during this period. The variables which are going to be used in the model are presented in the following section.

6.2 Variables

Table 2 in chapter 5 summarizes the factors which are expected to influence on-time performance. In this section, the variables to represent these factors are chosen.

We want to measure airlines' on-time performance. To do this, we can use several variables. For arrival delay, we use 3 variables; the first one measures the share of flights that arrive 15 minutes late or more, the second one the length of the arrival delay in minutes and the third the average deviation from the scheduled arrival time. While the first variable basically measures how many flights were delayed, the second one measures the magnitude of the delays. The variable for the deviation from the scheduled arrival time does not only measure late arriving flights, but also includes early arriving flights; the value can be negative when a flight arrives before its scheduled arrival time. There are also three variables measuring departure delays. Similar to the variables for arrival delays, the first measures the share of flights with a departure delay of more than 15 minutes. The second variable measures the departure delays in minutes, and the last one measures the deviation from the scheduled departure time in minutes. All of these six variables represent the time of departure and arrival at the gate. Finally, a variable is added which measures the share of flights that were cancelled. These 7 variables will be used as dependent variables; the model will be run 7 separate times and the results will be analyzed.

Dummies were created to indicate the time of the 4 mergers. The value of the dummy is 0 in the months before the merger and 1 in the months after the merger. Additionally, a dummy is created that includes all of the four mergers. Because mergers are often settled on paper before they are actually operational, we used the date in which the FAA issues a single operating certificate for the merger.[7] (*table 4*) From this day on, the airlines officially operate as one airline. This day is not always directly after the official date, for example in the case of the merger between America West Airlines and US Airways. The day on which the single operating certificate was issued was

[7] The dates are gathered from 'Airlines for America'. This institution states that official government organizations in the US do not provide official records from merger dates. Their data is gathered from information made publicly by airlines. (www.airlines.org)

approximately two years after the deal was signed by both airlines. Because we want to measure the effect of the merger, we measure from the day the operations are actually merged.

Airline	Airline	Date	Start of merged operations
American Airlines	Trans World Airlines	April 9th, 2001	January 2002
America West Airlines	US Airways	September 27th, 2005	October 2007
Delta Airlines	Northwest Airlines	December 31st, 2009	January 2010
United Airlines	Continental Airlines	October 1st, 2010	December 2011

Table 4. Merger dates (retrieved from www.airlines.org)

According to the literature, one of the most important indicators for on-time performance is the level of competition. This is discussed in chapter 5. We use the Herfindahl index[8] to measure the level of competition on the route. A second variable indicates the number of airlines in the total market. Additionally, a variable that defines whether a route is a monopoly is added. Adding a dummy variable for monopoly means that we can capture the non-linear effect of the number of competitors on on-time performance; the change between 0 and 1 competitors is larger than, for example, a change from 5 to 6 competitors. (Prince & Simon, 2009)

Frequency of flights is another indicator discussed in chapter 5. Two variables measure the frequency of flights, one from the origin airport and the other from the destination airport. A variable is added to measure an airlines' total frequency of flights over all routes. As explained in chapter 5, frequency of flights can affect on-time performance; when frequency is high, flights are usually more spread out over the day, resulting in fewer delays. On the other hand, when frequency is high, airlines will be less motivated to operate with minimal delays, as passengers can be transferred to other flights during the day if necessary. We measure both the frequency on a route and the frequency in the total market.

Airline size is expected to have an effect on on-time performance. To measure airline size, we use a variable measuring the total number of passengers carried on a route.

[8] The Herfindahl(-Hirschman)-index measures concentration in a market. A value close to 0 indicates a myriad of small firms that all have a small market share, while a value of 1 indicates a monopoly.

A change in the number of hubs is also a consequence of mergers which is expected to influence on-time performance. Recalling from chapter 5, this is, among other factors, because airlines aim to minimize delays at hubs as this will affect connecting passengers and because of the congestion due to the concentration around peak hours. To indicate a hub, we use the Herfindahl index on airports. Ideally, we would use a variable which indicates precisely whether an airport is a hub or not. Unfortunately, defining whether an airport is a hub is complex and therefore not feasible in this study. Using the Herfindahl Index, we can approximately identify airports as hubs. The closer the value is to one, the fewer airlines operate from or to the airport. Therefore, two variables are used, one measuring the Herfindahl index at the origin airport and the other one measuring the Herfindahl index at the destination airport.

Due to the hub-and-spoke networks airlines use, a merger will increase the pressure on hub airports. We therefore use variables to measure the level of congestion. A variable indicates the number of flights arriving and departing from an airport, both origin and destination, in the same hour. In addition, we use a variable measuring the departures from the origin airport and the arrivals at the destination airport, as these are the traffic flows that will affect the relevant flight (as indicated by the variable *id)* the most.

A variable measuring the scheduled flight time is added to the model to be able to control for schedule padding. As explained in chapter 4, padding is a common practice in the airline industry. By extending the flight times in anticipation of delays, the calculated flight time on a route can differ from airline to airline. Airlines with a longer scheduled flight time might have less registered delays. Additionally, by running the regression using the variables that measure departure delays, we can measure the effect on the departure delay. Departure delays are not affected by schedule padding. However, they are not the best way to measure on-time performance, as airlines often have the possibility during the flight to recover from a departure delay. Also, passengers are usually not concerned about a departure delay, only the arrival time is relevant to them.

To summarize, *table 5* lists all the variables and their minimum value, maximal value, mean and standard deviation.

Dependent variables	Min	Max	Mean	St. dev.
Share of flights arriving more than 15 min. late	0	1	0.1958	0.1254
Arrival delay in minutes	0	1191	11.2060	8.7712
Deviation from scheduled arriving time in minutes	-80	1191	5.7454	10.5739
Share of flights departing more than 15 min. late	0	1	0.1630	0.1130
Departure delay in minutes	0	1203	9.7776	8.6923
Deviation from scheduled departing time in minutes	-76	1203	8.0691	9.1389
Share of flights cancelled flights	0	1	0.0156	0.0339
Herfindahl index on route	0	1	0.7112	0.2710
Monopoly	0	1	0.3762	0.4844
Herfindahl index on origin airport	0.0579	1	0.2638	0.1643
Herfindahl index on destination airport	0.0579	1	0.2638	0.1643
Frequency from origin airport	1	451	87.7353	40.5058
Frequency from destination airport	1	451	88.3881	40.4835
Frequency per airline over all routes	6786	103168	57691.49	22429.31
Flights arriving & departing at airp./hour (average)	1	400.0361	20.870	14.5765
Departures from origin airport (all airlines)	1	43042	11582.98	9456.249
Arrivals at destination airport (all airlines)	1	43029	11589.57	9434.144
Number of passengers carried on route	1	110067	10270.6	10272.89
Scheduled flight time in minutes	1	665	148.6645	83.1128
Merger (all mergers)	0	1	0.0847	0.2784
Merger American Airlines and Trans World Airlines	0	1	0.6979	0.4592
Merger America West Airlines and US Airways	0	1	0.5261	0.4993
Merger Delta Airlines and Northwest Airlines	0	1	0.4657	0.4988
Merger United Airlines and Continental Airlines	0	1	0.4163	0.4929

Table 5. Variables and descriptive statistics

The next section will introduce the model that is best suited to investigate the effect of mergers on on-time performance and explains why this model was chosen.

6.3 Choice of model

The data gathered from the DOT is referred to as panel data; it consists of observations reported by airlines over a series of time. The variable *id,* which is the panel variable, makes a distinction between route and airline. Thus, a flight from JFK to ORD operated by Delta has a different value for *id* than a flight from JFK to ORD operated by American Airlines. Similarly, a flight on the same route and with the same airline but with origin ORD and destination JFK also has a different value for id. Thus, observations are done separately for all routes. This is because routes can be seen as separate markets; the market share of an airline might be large on one route and at the same time small on another route. Apart from that, not all airlines operate on all routes.

The most important advantage of panel data is the combination of cross-sectional analysis and time-series analysis, as a much larger dataset can be used than with one dimensional datasets and this creates more sample variability. There are a few disadvantages of panel data. A common disadvantage is the problem of unbalanced data. Looking at the nature of our data, airlines are obliged to report their on-time statistics to the DOT[9], so there will be no missing data because of a lack of motivation from the airlines' side. However, after two airlines merge and one of the two ceases to exist, one of the two airlines will stop reporting in its own name. Fortunately, Stata is able to handle unbalanced datasets.

The two main models for panel data are the fixed effects model and the random effects model. In the fixed effects model the variable that estimates the individual specific effects might be correlated with the explanatory variables, while the random effects model does not allow a relation between the individual-specific effects variable and the explanatory variables. Thus, by including the individual-specific effects in the model, the effect of other factors, such as competition or congestion, can be estimated while controlling for airline specific effects. The fixed effects model uses a within estimator, which measures the change within units, not between the units. The model implies that differences across groups can be captured in differences in the constant term. (Wooldridge, 2010) This is appropriate for our study, as we want to measure what the effect of mergers is over time, not to what extent a merger has different effects on the individual airlines or routes. We expect that the data contains many airline specific effects which we cannot control for. By using the fixed effects model, these effects are captured in the model.

To find out whether the fixed effects model is indeed a better fit for our study than the random effects model, we use the Hausman test. The test is executed after both the random effects model and the fixed effects model are estimated. The test can be found in *appendix A*. The outcome leads us to reject the hypothesis; the result shows that the appropriate model to use is indeed the fixed effect model. This is in line with the expectations regarding the design of the data and study.

[9] Not all airlines in the United States are obligated to report their on-time statistics, but the airlines we use in the analysis all have a market share of 1% or higher and are thus obligated to report on-time statistics.

Because of the risk of autocorrelation among the variables, we use a modified Wald test to test this. Autocorrelation appears when two independent variables are related, besides both being related to the dependent variable. The modified Wald test gives a p-value of 0.0000, with which we reject the hypothesis that there is no autocorrelation. Thus, some of our independent variables are (to some extent) related. To find which variables are related, we plot a correlation matrix containing all of our independent variables (*appendix C*). There is correlation between some of the variables, but these are all control variables. Therefore, they do not influence our variables of interest, the dummy mergers.

Additionally, we test for heteroskedasticity using the *xttest3,* see *appendix B*. The outcome is that the model is affected by heteroskedasticity. This means that the errors are correlated with the variables they are explaining and are not normally distributed. To correct for this, robust standard errors are used in the model.

To conclude, we selected the variables we are going to use in the model. The model is a fixed effects model with robust standard errors. In the next section, the results of the analysis will be discussed.

Chapter 7: Analysis

Previous literature shows both signs of improved on-time performance as well as worsened on-time performance after a merger; there is no clear consensus about the magnitude and direction of the effect of airline mergers on on-time performance.

This leads to the following hypothesis:

A merger between airlines influences on-time performance.

The following regression will be used to test the hypothesis:

$$Y_{i,t} = X_{i,t}\,\beta + f_i + \varepsilon_{i,t}$$

where the dependent variables will be indicated as $X_{i,t}$.

7.1 Results

The results of the analysis with the dummy including all of the four mergers can be found in *table 6*. The model is run 7 times, each time with a different dependent variable. Eight coefficients are not significant, out of two of the seven coefficients for the merger variable. After this, four dummies were created to represent each of the four mergers. The regressions are rerun with these four dummy variables. The results of the model can be found in *table 6*. Most of the coefficients are significant, only 14 out of the 112 coefficients are not. The R^2 values vary from 0.4 to 0.48, indicating that between 40% and 48% of the variance in the data can be explained by the models.

First, we will have a look at the control variables. We see that the coefficients are generally very small. The reason for this is the unit of measurement of the independent variables. If the units of measurement were larger, the coefficients would also be larger. However, this does not change the relationship between the variables; the effect of the variables on on-time performance is the same. Similarly, the R^2 and significance of the variables are independent of the unit of measurement used.

	Arr. delay of > 15 min.in %	Arr. delay in minutes	Deviation from arr. time in min.	Dep. delay of > 15 min. in %	Dep. delay in minutes	Deviation from dep. time	Share of cancelled flights
Herfindahl on route/1000	**-18.59 (2.90)**	**-908.19 (173.98)**	**-773.64 (218.70)**	**-9.82 (2.75)**	**-619.36 (175.99)**	**-508.03 (192.77)**	**6.30 (0.73)**
Monopoly (dummy)/1000	**1.85 (0.86)**	**127.83 (53.34)**	98.15 (67.33)	**4.06 (0.81)**	**252.90 (52.17)**	**276.39 (56.49)**	**-1.30 (0.24)**
Herfindahl index destination airport/1000	**17.36 (5.16)**	**2047.63 (286.65)**	**2884.88 (360.95)**	**18.88 (4.80)**	**1541.43 (296.75)**	**2197.14 (324.60)**	**4.71 (1.23)**
Herfindahl index on origin airport/1000	**19.32 (5.35)**	**2066.30 (302.78)**	**2422.11 (372.19)**	**44.99 (5.00)**	**2801.52 (296.59)**	**2855.77 (313.48)**	**5.65 (1.23)**
Frequency on flights from origin airport/1000	**-0.15 (0.01)**	**-10.31 (0.75)**	**-13.58 (0.97)**	**-0.15 (0.01)**	**-8.97 (0.72)**	**-12.73 (0.79)**	**-0.03 (0.004)**
Frequency on flights from destination airport/1000	**-0.22 (0.01)**	**-14.98 (0.74)**	**-17.55 (0.93)**	**-0.22 (0.01)**	**-13.38 (0.65)**	**-15.35 (0.70)**	**-0.03 (0.003)**
Frequency of airlines' flights on all routes/1000000	**0.40 (0.04)**	0.03 (2.53)	**9.09 (3.14)**	**0.20 (0.04)**	**11.8 (2.54)**	**20.2 (2.71)**	**-0.05 (0.01)**
Average of traffic on airport in one hour/10000	**-0.57 (0.06)**	**-21.04 (4.44)**	**-27.77 (5.48)**	**-0.74 (0.06)**	**-39.11 (3.84)**	**-42.74 (3.97)**	**0.14 (0.03)**
Total departures from origin airport/100000	**0.11 (0.02)**	**7.34 (1.34)**	**12.85 (1.60)**	**0.05 (0.02)**	2.01 (1.32)	**5.35 (1.38)**	**-0.05 (0.01)**
Total arrivals on destination airport/100000	**0.07 (0.02)**	**8.05 (1.18)**	**11.31 (1.46)**	**-0.04 (0.02)**	-2.51 (1.16)	-1.11 (1.25)	**-0.05 (0.01)**
Number of passengers carried on route/100000	**0.10 (0.01)**	**5.88 (0.58)**	**9.04 (0.71)**	**0.14 (0.01)**	**7.10 (0.54)**	**9.22 (0.58)**	**-0.03 (0.01)**
Scheduled flight time in minutes/1000	**-2.78 (0.07)**	**-120.02 (4.22)**	**-345.00 (5.73)**	0.02 (0.05)	**13.93 (4.13)**	**11.65 (4.32)**	**0.13 (0.02)**
Merger dummy/100	-0.27 (0.192)	**57.37 (11.72)**	24.78 (14.89)	**1.34 (0.20)**	**82.78 (12.60)**	**77.27 (14.02)**	**0.13 (0.05)**

Table 6. Regression results. Standard errors in parentheses. Significant results (at 5% level) are in bold.

	Arr. delay of > 15 min.in %	Arr. delay in minutes	Dev. from arr. time in min.	Dep. delay of > 15 min. in %	Dep. delay in minutes	Deviation from dep. time	Share of cancelled flights
Herfindahl on route/1000	**-18.99 (2.8)**	**-962.65 (168.6)**	**-835.72 (211.7)**	**-11.44 (2.6)**	**-715.67 (166.2)**	**-604.71 (181.1)**	**6.35 (0.7)**
Monopoly (dummy)/1000	0.48 (0.9)	47.98 (52.3)	-4.40 (65.8)	**2.00 (0.8)**	**133.54 (49.9)**	**142.28 (54.00)**	**-1.26 (0.2)**
Herfindahl index destination airport/1000	9.41 (5.1)	**1421.50 (287.2)**	**2110.79 (364.3)**	0.82 (4.6)	496.65 (285.7)	**1035.19 (315.00)**	**5.37 (1.3)**
Herfindahl index on origin airport/1000	**11.44 (5.2)**	**1443.53 (294.7)**	**1652.32 (369.8)**	**27.00 (4.7)**	**1761.15 (279.7)**	**1698.31 (306.9)**	**6.32 (1.3)**
Frequency on flights from origin airport/1000	**-0.15 (0.01)**	**-10.05 (0.747)**	**-13.24 (0.98)**	**-0.14 (0.01)**	**-8.37 (0.71)**	**-19.95 (0.77)**	**-0.04 (0.003)**
Frequency on flights from destination airport/1000	**-0.21 (0.01)**	**-14.69 (0.74)**	**-17.18 (0.95)**	**-0.21 (0.01)**	**-12.76 (0.65)**	**-14.54 (0.70)**	**-0.04 (0.003)**
Frequency of airlines' flights on all routes/1000000	**0.56 (0.04)**	3.16 (2.55)	**13.10 (3.14)**	**0.26 (0.04)**	**15.90 (2.53)**	**24.20 (2.70)**	**-0.04 (0.01)**
Average of traffic on airport in one hour/10000	**-0.30 (0.06)**	-6.82 (4.45)	-9.70 (5.62)	**-0.41 (0.05)**	**-19.48 (3.56)**	**-22.30 (3.70)**	**0.14 (0.02)**
Total departures from origin airport/100000	**0.14 (0.02)**	**9.28 (1.3)**	**15.28 (1.54)**	**0.10 (0.02)**	**4.91 (1.22)**	**8.42 (1.27)**	**-0.05 (0.01)**
Total arrivals on destination airport/100000	**0.10 (0.02)**	**10.01 (1.16)**	**13.75 (1.43)**	0.01 (0.02)	**2.67 (1.1)**	1.98 (1.18)	**-0.05 (0.01)**
Number of passengers carried on route/100000	**0.10 (0.01)**	**5.79 (0.58)**	**8.93 (0.71)**	**0.14 (0.01)**	**6.99 (0.53)**	**9.15 (0.58)**	**-0.03 (0.01)**
Scheduled flight time in minutes/1000	**-2.68 (0.06)**	**-115.35 (4.20)**	**-339.02 (5.72)**	**0.11 (0.51)**	**19.42 (40.48)**	**16.79 (41.83)**	**1.30 (0.15)**
Merger between American Airlines & Trans World Airlines/100	**1.44 (0.23)**	**163.35 (15.17)**	**157.51 (17.82)**	**3.98 (0.23)**	**239.31 (16.07)**	**242.51 (17.32)**	0.09 (0.09)
Merger between America West Airlines & US Airways/100	**-1.97 (0.35)**	**-110.88 (20.12)**	**-182.09 (28.20)**	**-4.09 (0.36)**	**-225.18 (19.90)**	**-280.24 (22.21)**	**0.42 (0.09)**
Merger between Delta Airlines & Northwest Airlines/100	**-3.94 (0.26)**	**-96.15 (14.84)**	**-178.58 (20.70)**	**-1.58 (0.23)**	**-94.85 (14.40)**	**-105.41 (15.82)**	0.03 (0.06)
Merger between United Airlines & Continental Airlines/100	**3.45 (0.36)**	**226.82 (23.26)**	**263.73 (32.67)**	**6.22 (0.32)**	**344.51 (21.32)**	**436.25 (23.00)**	-0.13 (0.11)

Table 7. Regression results. Standard errors in parentheses. Significant results (at 5% level) are in bold.

7.2 Control variables

Noteworthy is the coefficient of the variable measuring the average of flights arriving and departing from origin and destination airport in one hour. This variable has a negative coefficient in all models, except for the share of cancelled flights. However, not all results are significant. The negative coefficients imply that an increase in the average amount of traffic departing and arriving in an hour will lead to a decrease in the frequency and magnitude of delays. If the flights are more concentrated around particular hours, then delays will decrease. This is counterintuitive, as congestion is thought to be one of the main causes of delays. A possible explanation for this would be the fact that large airports, which process a large amount of traffic every hour, are better organized than their smaller counterparts.

The other control variables show coefficients in the direction we expected them to, based on the literature review. For instance, the variables measuring the Herfindahl index on the routes has a negative coefficient, meaning that the less competition on the route, the lower the delays. Additionally, the variable indicating whether a route is a monopoly is positive, as the more a route tends towards being served by only one airline, the longer and more frequent delays will occur. Thus, delays seem to occur less frequent and are shorter when the number of competitors decreases. However, when a route becomes a monopoly, delays increase again. The Herfindahl index on airports yields a positive coefficient. Thus, the smaller the number of airlines active at an airport, the higher the delays. The variables measuring departures from the origin airport and arrivals in the destination airport have a positive coefficient. This is also in line with the expectations, as more traffic means that there will be more and lengthier delays. The variable describing the frequency on all routes (per airline) shows a positive value. The positive relation indicates the complexity of a larger airline; coordination and communication are more challenging when the frequency of flights is high. The average frequency of a flight on a particular route has a negative coefficient; with a higher frequency of flights there are fewer delays. A higher frequency will allow the airlines to offer the flights more spread out over the day, thereby avoiding peak hours. The number of passengers on a route has a positive relation with delays. A large number of passengers means more complex boarding and thus more delays.

Scheduled flight time has a negative effect on arrival delays, and a positive effect on departure delays. The reasoning behind this is that for arrival delays, the longer the flight, the more time there is to recover from a departure delay while in the air. Despite this, a longer flight is most likely served by a larger airplane, which means a lengthier boarding process and therefore higher departure delays, as discussed in chapter five.

The variables of interest, the dummies that identify the mergers, are discussed below.

7.3 Dummy variables

The results of the analysis with the dummy that includes all mergers can be found in table 6. The variable that measures the share of arrival delays and the variable for deviation from scheduled arrival time are not significant. The variable for the length of arrival delays in minutes indicates a 0.57 minute increase in delays. The share of departure delays increases by 1.34%, while the length of the delays increases by 0.83 minute. The deviation from scheduled departure time increases with 0.77 minute. Finally, the share of cancelled flights increases with 0.13%.

Next, the dummies representing each of the four mergers are looked at individually.

The first variable measures the share of departure delays of more than 15 minutes. Two of the mergers, the merger between America West Airlines & US Airways and Delta Airlines & Northwest Airlines yield a negative coefficient, implying that after these mergers closed, the share of departure delays decreased, with 4.1% for America West Airlines & US Airways and 1.6% for Delta Airlines & Northwest Airlines. On the other hand, the mergers between American Airlines & Trans World Airlines and United Airlines & Continental Airlines resulted in a larger share of departure delays, with respectively 4% and 6.2%.

The variable measuring the length of departure delays tells us that the length of the departure delays decreased after the America West Airlines & US Airways, with 2.25 minute, and the Delta Airlines & Northwest Airlines mergers, with 1 minute. For the American Airlines & Trans World Airlines merger the length increased with 2.4 minute and the increase was 3.4 minute for the United Airlines & Continental Airlines merger.

The deviation from the scheduled departure time has a similar contradictory result. For both the merger between America West Airlines & US Airways and Delta Airlines &

Northwest Airlines the deviation decreased after the merger, with 2.8 minute for the former and 1.1 minute for the latter. This can be explained by the decrease in the length of the departure delays and/or in an increase in flights that departed earlier than their scheduled departure time. For American Airlines & Trans World Airlines, the increase in deviation from scheduled departing time was 2.4 minute and for United Airlines & Continental Airlines this was 4.4 minute, which is in line with the increase in the length of departure delays.

The share of flights that arrived more than 15 minutes late is also measured. The negative coefficients for two of the mergers tell us that, similar to the share of late departing flights, less flights were delayed for more than 15 minutes after the mergers closed; delays decreased with 2% after the America West Airlines & US Airways merger and with 3.9% for the Delta Airlines & Northwest Airlines merger. On the other hand, the other two mergers yield positive results, an increase of 1.4% for American Airlines & Trans World Airlines and 3.5% for United Airlines & Continental Airlines.

Looking at the length of the arrival delays, we see that the effect is similar. The length of the delays increased after the American Airlines & US Airways and United Airlines & Continental Airlines merger, with respectively 1.6 minute and 2.3 minute, but declined after the America West Airlines & US Airways and Delta Airlines & Northwest Airlines mergers, with respectively 1.1 minute and 1 minute.

The deviation from scheduled arriving time decreased for the America West Airlines & US Airways merger with 1.8 minute and with 1 minute for the Delta Airlines & Northwest Airlines merger, and increased for American Airlines & Trans World Airlines with 1.6 minutes and for United Airlines & Continental Airlines with 2.6 minutes. Thus, with a smaller deviation, the flight delays were less severe or more flights arrived early. This is consistent with the results above, where is indicated that the length of the delays decreased after the America West Airlines & US Airways and Delta Airlines & Northwest Airlines merger. On the other hand, for the American Airlines & Trans World Airlines and United Airlines & Continental Airlines mergers, the increase in deviation is mostly composed of an increase in the length of delays.

At last, the shares of cancelled flights were measured. The coefficient for the mergers between American Airlines & Trans World Airlines, Delta Airlines & Northwest Airlines and United Airlines & Continental Airlines mergers are not significant. After the America West & US Airways merger, the share of cancelled flights increased with 0.42%.

To conclude, the fact that the coefficients are significant tells us that mergers do have an effect on on-time performance. However, due to the changing direction of the coefficients for the four mergers, we cannot (yet) conclude whether this change is positive or negative. In the next section we will have a more extensive look at the years after the merger.

7.4 First year after the merger

As explained in chapter 3, airline mergers are very complicated processes. Agreements have to be reached, the interests of all stakeholders need to be protected and very detailed plans are made before the integration of the airlines can start. However, the airline merger history shows that many unexpected issues might arise after a merger, which makes it difficult to stick to airline integration plans as scheduled. When unexpected events or problems occur during or after the merger process, the focus on on-time performance can be lost and this might result in more and longer delays.

It seems therefore reasonable to assume that airlines need some time to work on these problems after a merger, before operations run smoothly again and they can focus on on-time performance. This can result in a period directly after the merger in which on-time performance declines. The time needed to recover from this and to improve on-time performance statistics differs, depending on the problems that arise and the speed with which they can be solved, but can range from months to even years.

To be able to draw conclusions about this assumption, we created another set of dummies which represent the year after the merger took place; the dummies have value 1 for the 12 months after the merger, and value 0 for any other month. Four other dummy variables represent year 2 and consecutive years after each merger. The results can be found in *table8*.

	Arr. delay of > 15 min.in % (year 1)	Arr. delay of > 15 min.in % (year 2 +)	Arr. delay in minutes (year 1)	Arr. delay in minutes (year 2 +)	Dev. from arr. time in min. (year 1)	Dev. from arr. time in min. (year 2 +)
Merger American Airlines & Trans World Airlines/100	**-1.87 (0.25)**	**1.96 (0.24)**	**-36.34 (14.99)**	**194.78 (16.33)**	**-145.34 (21.32)**	**205.68 (19.04)**
Merger America West Airlines & US Airways/100	**-3.26 (0.38)**	**-1.56 (0.37)**	**-215.60 (22.2)**	**-79.40 (21.25)**	**-386.22 (31.41)**	**-122.24 (29.76)**
Merger Delta Airlines & Northwest Airlines/100	**0.67 (0.31)**	**-5.70 (0.27)**	**205.82 (17.17)**	**-210.17 (15.41)**	**274.62 (24.67)**	**-346.25 (21.42)**
Merger United Airlines & Continental Airlines/100	**3.78 (0.40)**	0.66 (0.36)	**246.94 (26.08)**	**52.96 (22.80)**	**299.69 (36.51)**	-4.65 (35.84)

	Dep. delay of > 15 min. in % (year 1)	Dep. delay of > 15 min. in % (year 2 +)	Dep. delay in minutes (year 1)	Dep. delay in minutes (year 2 +)	Deviation from dep. Time (year 1)	Deviation from dep. Time (year 2 +)	Share of cancelled flights (year 1)	Share of cancelled flights (year 2 +)
Merger American Airlines & Trans World Airlines/100	0.14 (0.24)	**4.59 (0.25)**	25.41 (14.36)	**272.85 (17.18)**	-27.96 (15.90)	**284.95 (18.51)**	**-0.36 (0.08)**	0.16 (0.09)
Merger America West Airlines & US Airways/100	**-4.15 (0.34)**	**-3.98 (0.38)**	**-239.87 (20.72)**	**-216.36 (21.12)**	**-258.51 (23.40)**	**-279.32 (23.36)**	0.09 (0.09)	**0.51 (0.09)**
Merger Delta Airlines & Northwest Airlines/100	**1.77 (0.28)**	**-2.89 (0.24)**	**150.66 (16.58)**	**-191.29 (14.93)**	**166.95 (18.63)**	**-214.27 (16.33)**	**0.90 (0.08)**	**-0.30 (0.06)**
Merger United Airlines & Continental Airlines/100	**6.74 (0.34)**	**3.20 (3.55)**	**371.74 (22.89)**	**155.19 (23.91)**	**469.54 (24.62)**	**209.89 (26.18)**	-0.14 (0.11)	**-0.40 (0.12)**

Table 8. Regression results. Standard errors in parentheses. Significant results (at 5% level) are in bold.

The merger between American Airlines & Trans World Airlines shows a negative coefficient, implying that in the first year after the merger, delays decreased with 2%. However, in the subsequent years, delays increased with 2%. For America West & US Airways, the share of arrival delays decreased with 3% in the first year after the merger, but decreased with 2% in the years after this. Thus, similar to the merger between American Airlines & Trans World Airlines, on-time performance improved more in the year after the merger than it did in the second and subsequent years. The arrival delay in the first year after the merger between Delta Airlines & Northwest Airlines increased with 1%, while arrival delays decreased with 6% in the years after the merger. This confirms the assumption that on-time performance is worse in the first year after the merger. This is also the case for the United Airlines & Continental Airlines merger; the share of arrival delays increases with 4% in the first year, and with 1% in the other years after the merger. Thus, the first year sees the largest increase in delays, while the delays in the years after are higher than before the merger, but not as high as in the first year.

For two of the four mergers the assumption holds that on-time performance is worse in the first year after the merger. For the other two mergers, we see a different result; on-time performance is better in the first year after the merger than it is after this. Based on these results, we cannot conclude that airlines generally have a worse on-time performance in the first year after the merger.

7.5 Discussion

The analysis shows that two of the mergers improved on-time performance, while the other two mergers worsened on-time performance. Additionally, for two of the four mergers in this study a decline in on-time performance in the first year was observed, while on-time performance was better in the first year after the two other mergers. The following section will discuss possible explanations for these inconsistent results.

The merger between Delta Airlines & Northwest Airlines is considered as relatively successful[10]. There are a few possible explanations for this. First of all, the route networks of the two airlines were largely complementary; direct competition only

[10] http://www.nytimes.com/2011/05/19/business/19air.html?pagewanted=all&_r=0

occurred on 12 of 1000 routes before the merger.[11] Secondly, the two airlines were already cooperating to some extent, as the airlines even had some codesharing agreements on a number of routes, and were part of the same airline alliance. (Brown & Gayle, 2009) Also, according to Kaufman (2013), the corporate cultures in the two companies were similar, which made integration between the two cultures easier. On top of this, both airlines had previously been involved in mergers and were able to learn from their previous mistakes. For Northwest Airlines this had been the merger with Republic Airlines (1986), where the merger was followed by years of really bad service, according to Kaufman (2013). They were also able to learn from the problems with seniority listings that, for example, struck the merger between American Airlines & Trans World Airlines. In an attempt to avoid similar problems, they constructed agreements for the seniority listing which both parties agreed to before the merger was sealed[11]. Other employment issues were also carefully considered and taken care of, as they understood the precondition of satisfied employees to a successful merger[12]. What Delta Airlines and Northwest Airlines also comprehended well, was the time needed to integrate the two airlines. The merged Delta Airlines planned a time period of 12-24 months for the two airlines to integrate completely[13]. This time was needed to integrate the two airlines and to be able to shift the focus on on-time performance again. This is illustrated by the fact that initially delays increased, while after the first year, a decrease in frequency and length of delays was observed.

The merger between America West Airlines & US Airways also resulted in better on-time performance. Similar to the Delta Airlines & Northwest Airlines merger, the America West & US Airways merger had complementary route networks. Before the two airlines merged, they served two different parts of the country; America West Airlines was active in the western part, while US Airways mainly served the east coast. This meant that there was little overlap; the merger mainly extended the route network. Delays started to decrease in the first year after the merger, and continued to decrease in the years after this but not as substantially as it did in the first year.

Delays increased after the merger between United Airlines and Continental Airlines. The airline had many problems with the integration of its reservation systems. These

[11] http://news.delta.com/index.php?s=20295&item=122507
[12] http://news.delta.com/index.php?s=20295&item=122507
[13] http://news.delta.com/index.php?s=20295&item=122588

problems continued to exist over the next three years and probably still affect operations and the airlines' on-time performance[14]. Additionally, the corporate culture of the two airlines differed largely, which is generally thought to make the merger process more difficult. Continental Airlines had been known for its good customer service before the merger, while United Airlines had a poor reputation for customer service. (Kaufman, 2013) It was therefore feared by many that the combined airline would provide a worse service quality than Continental Airlines passengers were used to. According to the NY times[15], the merged United Airlines set the targets for integration too high. They expected to be totally merged within 2 years. This is most likely an unrealistic term for a merger process and will discourage employees when targets turn out to be infeasible. On top of this, similar to the merger between American Airlines & Trans World Airlines, the integration of the seniority listings did not go without trouble. It took the airline a long time before agreement was reached about the seniority listings. This is in line with the conclusion that delays increased considerably in the first year after the merger.

Similar to the situation after the United Airlines & Continental Airlines merger, the merger between American Airlines & Trans World Airlines led to a worse on-time performance. The American Airlines & Trans World merger had problems with the integration of the seniority listings of the two airlines; it even led to the creation of the McCaskill-Bond, which required merging airlines to integrate seniority listings in a "fair and equitable manner"[16]. Additionally, the merger took place shortly before 9/11. 9/11 had a huge impact on the entire airline industry and might have made integration tougher. Many jobs have been lost due to the large decline in demand for air travel and this has possibly affected employee morale within the airline. All airlines in the United States have been affected by the aftermath of 9/11, but for an airline in a merger process, consequences of these events might have been more harmful than for other airlines. Section 7.4 outlined the fact that even though on-time performance worsened in the years after the merger, it temporarily increased in the first year after the merger. While the other mergers integrated the two airlines into a new merged airline, the

[14] http://www.forbes.com/sites/tedreed/2014/04/22/jetblue-and-delta-lead-while-united-lags-in-customer-satisfaction-survey/
[15] http://www.nytimes.com/2012/11/29/business/united-is-struggling-two-years-after-its-merger-with-continental.html?pagewanted=all&_r=0
[16] http://www.forbes.com/2008/01/28/airline-mergers-congress-oped-cx_esp_0129airlines.html

merged American Airlines decided to drop most of the Trans World Airlines. For example, St Louis airport was almost immediately de-hubbed, most aircraft were retired and a large share of the Trans World Airlines employees was fired. This made integration in the beginning easier, as the merger process mainly consisted of using the Trans World Airlines assets to support American Airlines, instead of actually merging two airlines, including processes and routes. This is possibly an explanation of why delays decreased in the first year, but increased in the years after.

When we take the four studied mergers as an example, we might propose that the similarity in corporate culture between two airlines and the fact that their route networks are not overlapping makes a merger potentially successful. Besides that, the approach to the merger, including the initiative to tackle employment issues early and a gradual and slow process to integrate the two airlines might contribute to a successful merger in terms of on-time performance. On the other hand, problems with seniority listings that were not solved before the mergers and failure to integrate operational systems successfully seem to have been major causes of deficient mergers in the past.

Chapter 8: Conclusion

8.1 Conclusion

To conclude, if we look at the difference in on-time performance before and after mergers, we see that following a merger, on-time performance becomes worse. Both the frequency and the length of delays increase. However, if we look at the four mergers individually, we see that even though the overall effect is positive, this does not hold for all mergers. In fact, two of the four mergers in this study, the mergers between Delta Airlines & Northwest Airlines and America West Airlines & US Airways, were followed by an improvement in on-time performance. The mergers between American Airlines & Trans World Airlines and between United Airlines and Continental Airlines resulted in more frequent and longer delays. This is in line with the expectations based on the literature review, where was indicated that there are both reasons to believe that mergers improve on-time performance, as arguments that point towards an increase in delays. This inconsistency could be explained by the fact that mergers are very complex; the merger process, including strategies and agreements, and airline specifics of the merging airlines are possibly an important factor in the degree of successful integration of two merging airlines. Thus, looking at the four mergers at once, we can conclude that it causes delays to increase. However, when looking at the four mergers specifically, we can argue that there are a lot more factors to take into account than we were able to control for in this study; such as internal issues with coordination and integration as discussed in chapter 3. The fact that for 2 of the 4 mergers analyzed, on-time performance was worse in the year after the merger than it was in other years supports the argument that on-time performance might be challenged even more when the merger is still in process. The common fear that mergers increase delays is largely legitimate, based on this study. However, in order for authorities to make sound decisions regarding airline merger approvals, more detailed analyses need to be made in order to anticipate on consequences affecting on-time performance.

8.2 Limitations

An important limitation to the study was the imprecise dates of mergers. While mergers are closed on a particular day, the actual date that the operations are merged, that is, that the airline operates as one airline, is not easy to determine. This is partly because changes are implemented gradually; it is therefore difficult to define when two airlines are merged. In this study, we used the merger dates as they were announced by the concerning airlines, despite the progress in the merging process at this date. By defining a more precise actual merger date, more accurate results could be obtained.

Another limitation is the time span of the mergers. Because all of the mergers took place between 2001 and 2012, and the last two even in the last five years, the results might be biased because of the few months of data available after the merger. For example, the United Airlines & Continental Airlines merger took place in December 2011, while the data is available until April 2013. Thus, the before period contains data from 227 months, while the period after the merger is only 17 months. If the same study is done in a couple of years, with data from 2013 on, the results might be different.

This study only investigated 4 mergers. To get a better view of the effect of mergers on on-time performance, more mergers might need to be considered. However, there are no more large airline mergers in the United States, so to expand the study, mergers between small airlines or mergers in other countries need to be considered, which will change the design of the study.

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Appendix A

Hausman test

```
Note: the rank of the differenced variance matrix (12) does not equal the number of coefficients
        being tested (16); be sure this is what you expect, or there may be problems computing the
        test.  Examine the output of your estimators for anything unexpected and possibly consider
        scaling your variables so that the coefficients are on a similar scale.
```

	Coefficients (b) fixed	(B) random	(b-B) Difference	sqrt(diag(V_b-V_B)) S.E.
herf_route	-.0069367	-.004664	-.0022727	.0000767
monopoly	-.0019579	-.0014538	-.0005042	.
herf_o_airp	.0051219	.0019701	.0031517	.0003033
herf_d_airp	-.0069234	-.0115331	.0046097	.0003021
frequency_o	-.0003867	-.0003792	-7.58e-06	4.70e-07
frequency_d	-.0004632	-.0004458	-.0000173	4.97e-07
carr_depar~s	4.59e-07	4.98e-07	-3.95e-08	2.62e-09
avg_airp_f~r	.0000847	.0000602	.0000244	.
o_airp_dep	2.91e-06	2.68e-06	2.30e-07	2.15e-08
d_airp_arr	2.17e-06	1.80e-06	3.70e-07	2.16e-08
route_pax	1.94e-06	1.99e-06	-4.59e-08	4.11e-09
crs_elapse~e	-.0024228	-.0008498	-.001573	.0000177
aa_twa_d	-.0230367	-.0254657	.002429	.0000407
hp_us_d	.0128913	.0077759	.0051153	.0000462
dl_nw_d	-.0297279	-.0302149	.000487	.
ua_co_d	-.0202594	-.0201444	-.000115	.

```
                         b = consistent under Ho and Ha; obtained from xtreg
          B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                 chi2(12) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =     8038.73
                Prob>chi2 =      0.0000
                (V_b-V_B is not positive definite)
```

Appendix B

Xttest3

Modified Wald test for groupwise heteroskedasticity in fixed effect regression model

H0: sigma(i)^2 = sigma^2 for all i

chi2 (9562) = 3.4e+35

Prob>chi2 =   0.0000

Appendix C

	1	2	3	4	5	6	7	8	9	10	11	12
1	1											
2	0.8456	1										
3	0.2341	0.2293	1									
4	0.2335	0.2261	0.1576	1								
5	-0.0088	-0.0233	0.1824	-0.0347	1							
6	-0.0063	-0.0172	-0.0341	0.1835	0.1701	1						
7	0.1052	0.1004	0.0296	0.0301	0.1714	0.1716	1					
8	-0.2950	-0.2545	-0.0349	-0.1861	0.3232	-0.1718	-0.0475	1				
9	-0.2928	-0.2451	-0.1857	-0.0343	-0.1699	0.3215	-0.0472	-0.1740	1			
10	-0.1303	-0.1633	-0.0206	-0.0194	0.3540	0.3510	0.0543	0.2564	0.2586	1		
11	-0.2769	-0.2361	-0.0663	-0.0667	0.1255	0.1169	-0.0049	0.4331	0.4345	0.2745	1	
12	0.0336	0.0606	-0.1852	-0.1757	-0.1441	-0.1369	-0.0857	0.1682	0.1734	-0.408	0.1520	1

Correlation matrix independent variables

1 = Herfindahl on route, 2= monopoly, 3= Herfindahl origin airport, 4= Herfindahl destination airport, 5= Frequency origin airport, 6= Frequency destination airport, 7= Frequency all routes, 8= Departures origin airport, 9= Arrivals destination airport, 10= Passengers on route, 11= Average traffic/hour, 12= Scheduled flight time