IMPACT OF THREE-HOUR TARMAC DELAY RULES AND FINES ON PASSENGER TRAVEL TIME AND WELFARE

JULY 20, 2010

MARKS AVIATION

THE AIRLINE ZONE

Joshua Marks
(703) 994-0000 Phone
josh@marksaviation.com

Darryl Jenkins
(540) 364-6913 Phone
airjenkins@aol.com

KEY FINDINGS

ABSTRACT

On April 29, 2010 United States Department of Transportation rules banning taxi-out, taxi-in and diversion ground times greater than three hours became effective. These rules were the product of a decade-long debate between airlines, consumer groups and regulators over the federal role in mandating how airlines manage departures during severe weather events.

This paper outlines the background and specific of the tarmac delay rules. Using historical data of tarmac delays, the causes and patterns of extended tarmac delays are analyzed. We analyze airline responses to the tarmac delay rule and provide a case study. We review reported cancellation data for May 2010 and compare current (post-rule) trends against historical patterns. We assess public cost and benefit with particular focus on the balance between tarmac delays and cancellations. DOT had projected that public benefits exceed public costs from the tarmac delay rules, but initial results under the rule indicate that public costs have far outweighed realized benefits. The rule and enforcement strategy have created significant public harm.

This paper concludes that while 110,000 passengers a year will be spared an average of 3.26 hours of taxi-out delays, at least 200,000 passengers will be on more than 2,600 flights cancelled directly and solely to comply with tarmac delay regulations. Due to aircraft availability and network design, these 2,600 flights will drive at least another 2,600 indirect cancellations, displacing another 200,000 passengers. The total impact will be at least 5,200 flights and 400,000 passengers impacted.

In the long term, we estimate that a 4:1 ratio of direct and indirect cancellations to prevented delays will result. For every three-hour tarmac delay prevented by the rule, two flights will be directly cancelled and another two flights indirectly cancelled. In the short term, profound uncertainty about enforcement of the rule has driven a significantly higher cancellation ratio. Airlines are cancelling flights that would not otherwise be impacted to avoid prohibitive and disproportionate fines. Because tarmac-related cancellations peak during the summer months, when airline load factors are the highest, finding new seats for displaced passengers is challenging. For passengers on cancelled flights, re-booking time is significant. The net cost to public welfare from the DOT rules approaches $4 billion, discounted over a 20 year period.

We conclude that DOT's tarmac rules and punitive fine threats have driven significant cancellations and public costs far in excess of quantifiable benefits. A transparent, rational fine structure, publicly available and disclosed, will reduce cancellations resulting from airlines' extreme risk-aversion and minimize the public costs. The underlying tarmac delay rules, particularly those related to weather-driven taxi-out delays, should be re-examined by regulators, legislators and consumers to determine if the trade-offs inherent are in the public interest.

KEY FINDINGS

Passenger Impact

1. Tarmac delay rules have public benefits: at least 110,000 passengers a year will not be confined on aircraft longer than three hours. Over 500,000 passengers on flights delayed more than 2 hours will receive food and water.[1]

2. Tarmac delay rules have significant public costs: Flight cancellations have increased. The punitive fine structure threatened by DOT, at more than 200x the revenue on a given flight, has caused extremely risk-averse behavior by airlines.

3. In the long run, based on comprehensive research, modeling and operational interviews, we estimate that an incremental 2,600 flights annually will be directly cancelled to avoid violations of the tarmac rule, forcing over 200,000 passengers to wait an average of 17 or more hours for alternative flights. At least another 2,600 flights will be cancelled indirectly as airlines cancel follow-on flights that would have used the impacted aircraft. In the long term, we estimate a 4:1 total ratio of flight cancellations to prevented tarmac delays.

4. This 4:1 ratio implies a public cost between $3.5 and $3.9 billion over 20 years.

5. In the short term we expect the cancellation ratio to be significantly higher than 4:1 as uncertainty about fines has driven risk-averse operating decisions. Based on May 2010 operational results, the ratio of cancelled flights to prevented tarmac delays is higher than 4:1. The Secretary of Transportation has threatened "strong enforcement" of the rule; airlines have taken commensurate steps to manage risk to punitive and prohibitive fines.

The Rule

1. Tarmac delay rules impose a tarmac time limit of three hours. DOT has threatened fines of up to $27,500 per passenger. This is disproportionate to revenue.

2. Three-hour limits have significantly greater impact on passenger costs than do four-hour limits. DOT confirmed that a four-hour limit would have greater public benefit.[2] The three-hour limit appears to have been chosen under pressure from Congress and consumer groups, not based on public benefit maximization.

3. Uncertainty about enforcement has driven severely risk-averse behavior by airlines. Flights now return to the gate significantly before the three-hour cutoff to avoid fine risk. Operational data from May 2010 demonstrate significant increases in returns to gate and cancellations of flights that pass two hours of tarmac time. Aircraft are diverted away from impacted airports. Flights are pre-cancelled or cancelled before boarding to open gate capacity.

---

[1] DOT Regulatory Impact Analysis, p40
[2] DOT Regulatory Impact Analysis, p60 (Final Rule vs. Alt 1)

KEY FINDINGS

Tarmac Delays

1. Most tarmac delays are caused by limited gate availability and airspace capacity during severe weather events. (See Page 22)

2. Causal weather events are unpredictable, are prolonged (2-3 hours at minimum) and impact both airports and surrounding airspace. (Pages 27, 31)

3. Taxi-in, taxi-out and diversion tarmac delays have different impact on consumers. Taxi-out delays (91%) benefit consumers by resulting in a completed flight. Diversions (9%) are due to severe weather and occur for safety reasons. Taxi-in delays (1%) are rare and indicate a breakdown in airline operations. (Page 19)

4. Taxi-out tarmac delays are clustered. In a 2 year period, more than 50% of delays occurred on just 20 days. (Page 25)

5. Tarmac delays are rare outside of the northeastern United States. (Page 28)

6. Tarmac delays are seasonal with 64% occurring in June, July and August. 72% occur during the afternoon with the highest incidence between 3pm and 6pm. These factors create significant challenges for re-booking passengers during peak summer months when tarmac-related cancellations will peak. (Pages 20, 26)

7. The clustered nature of lengthy delays prevents effective flight scheduling or gate management solutions for preventing three-hour times. Severe weather and associated ground-delay programs cause a reduction in airspace or airport capacity by 50% or more.[3] Advance cancellations are an effective strategy for winter snowstorms forecasted in advance. During the summer, last-minute cancellations and diversions can be expected in significant number to open gate capacity. (Page 37)

8. Airspace interdependency in the northeastern United States creates regional disruption when convective activity blocks the narrow departure and arrival corridors into Philadelphia and New York. Boston and Washington are often impacted when New York airspace capacity is reduced. NexGen improvements may have a significant impact on long delays by allowing aircraft to deviate from these narrow departure corridors. (Page 31)

[3] Vossen, T. and Ball, M. *Slot Trading Opportunities in Collaborative Ground Delay Programs.* Transportation Science 40(1) 29-43 (2006)

KEY FINDINGS

Case Studies

1. Risk management has driven extensive operating changes at airlines to avoid fine exposure. Flights return to gate no later than 2.5 hours after push-back except in extraordinary conditions.

2. Our gate allocation models predict that for a three-hour operating disruption at a major hub airport, 20% of flight operations will be cancelled to free gate capacity for tarmac-delayed flights.

3. During a prolonged severe weather event at Dallas Fort Worth on May 14, 2010, American Airlines and American Eagle cancelled 20.1% of flights to free gate capacity, in addition to significant diversions and gate delays. The majority of cancellations at the Dallas hub resulted in a subsequent cancellation of the return flight from the destination city.

4. The American Airlines case study confirms that the minimum follow-on cancellation ratio for modeling purposes should be 1:1. For every flight segment that cancels due to tarmac rules, a return flight must be cancelled due to aircraft availability and network flow.

5. Based on records, we estimate that 29 comparable weather events occur annually on average. These events alone will cause the cancellation of more than 5,200 flights and impact more than 400,000 people. These cancellations will cause passengers to wait a total of 6.9 million incremental hours for re-accommodation on alternative flights.

6. Our estimate reflects a 4:1 ratio versus historical tarmac delays of 3+ hours. Using our estimate of 5,200 annual cancellations, net public cost is $3.5 billion. Using DOT's baseline average (2007-2008) of 1,481 flights per year, the net public cost is $3.9 billion.

7. These public cost estimates do not include incremental diversion expenses.

KEY FINDINGS

May 2010 Results

1. Recognizing the limitations of a single month sample, May 2010 on-time statistics reported by DOT on July 8, 2010 support our 4:1 estimate.

2. Overall cancellations after the rule took effect (1.2% of scheduled flights in May 2010, or 6,716 flights) are higher compared to May 2009 (0.9%, or 4,792). Diversions increased to 1,500 flights in May 2010 from 1,201.

3. Equalized for flight operation levels, cancellations rose 41% (1,975 flights) and diversions rose 26% (310 flights). Taxi-out times greater than three hours dropped from 34 flights in May 2009 to just one flight in May 2010.

4. DOT reports that weather in May 2010 had a significantly lower impact than in May 2009 (39% of flights in May 2010 delayed due to weather vs. 47% in May 2009). Our research also demonstrates that severe weather had less of a national impact in May 2010 than May 2009.

5. Airlines engaged in an aggressive strategy to avoid fines. Of flights that taxied more than 2 hours after departure from gate, both gate returns and cancellations increased abnormally. Gate returns rose to 24.9% in May 2010 from 6.2% in May 2009. Cancellations were significantly higher (14.2% vs. 3.9%). In three key markets (Dallas, Detroit, and New York) the cancellation rate exceeded 20% (versus 5-8% year prior).

6. A minimum of 140 cancellations can be directly tied to DOT reports, versus 35 fewer taxi-out delays. Based on other cancellations not tied to weather or operational factors, the short-term impact of the rule is trending higher than 4:1.

7. The DOT rule has prevented taxi-out tarmac delays but also caused an increase in cancellations, returns to gate, and diversions that far outweigh any consumer benefits from the new rule.

KEY FINDINGS

Public Welfare

1. DOT predicted a public welfare gain of $69.1 million (over a 20 year period, discounted at 7%, with inflation) from the overall package of consumer changes of which the tarmac delay rules were a component.

2. DOT's analysis was based on a cancellation rate based on the number of flights that would have had three-hour tarmac delays. DOT assumed trivial incremental cancellations (41 flights per year) from the rule. Ramp, de-icing, diversion and other critical costs were excluded.

3. DOT excluded any follow-on cancellation estimates resulting from tarmac-related events.

4. DOT analysis is based on an aggressive assumption for passenger re-booking time after cancellations. The analysis cites a study based on load factors between 4% and 7% lower than 2010. As our research demonstrated, re-booking time is proportional to load factor, with an 18-22 hour rebooking time more accurate during summer months for afternoon and late evening cancellations.

5. Adjustments are necessary to reconcile the projected change in public welfare to current conditions. We calculate a **minimum cancellations scenario** (based on May 2010 cancellations of tarmac delayed flights with 2-3 hour taxi time, and no follow-on cancellations) and an **observed scenario** (based on 4:1 trend).

6. **Minimum Cancellations Scenario.** The original DOT welfare calculations should be corrected as follows.

    a. **Mandatory Returns to Gate.** The fine structure causes flight recall at 2.5 hours or earlier. This increases significantly the number of flights subject to cancellation. We estimate the public welfare change at negative $12.6 million (over a 20 year period).

    b. **Cancellation Re-Booking Time.** We estimate the increase in passenger re-booking time from 2009 load factors causes a public welfare change of negative $30.8 million.

    c. **DOT Welfare Restatement.** The DOT estimates should be based on the demonstrated May 2010 rate of 14.16%, not an arbitrary 2.8%. No follow-on or indirect cancellations are counted.

    d. **The net change in public welfare** from a higher cancellation rate is negative $210.3 million, for an overall impact of negative **$184.7 million**.

7. **Observed Scenario.** We now incorporate the observed 4:1 ratio, which includes follow-on cancellations. Using our observed baseline of tarmac delays in prior years, the net public welfare change is negative **$3.5 billion**. Using DOT's baseline of 1,481 flights, the net public welfare change is negative **$3.9 billion**.

KEY FINDINGS

8. These adjustments demonstrate that even in a minimum cancellations scenario, tarmac delay rules have a significant and negative impact on consumer welfare. In a scenario using observed results from May 2010, they are strongly negative.

9. We conclude the high cancellation rate observed ties to the punitive fine structure threatened by DOT, and the lack of transparency about enforcement.

10. By moderating the fine structure with fines proportional to revenue on board, in a published and transparent enforcement strategy, unnecessary cancellations and associated public harm can be reduced.

11. DOT should immediately publish an enforcement strategy for the rule, refrain from any further tarmac delay changes (including imposition of delay limits for international flights) and re-assess the public costs of tarmac delays.

LIST OF CHARTS AND TABLES

SECTION ONE: INTRODUCTION

On December 30, 2009, the United States Department of Transportation (DOT) published a set of revised aviation regulations that limited tarmac delay times to 3 hours for domestic flights. The revised regulations contained requirements to provide food and water after a two-hour tarmac delay, as well as various disclosure requirements for airlines regarding chronically delayed flights.

The new rules followed a lengthy initiative by DOT, Congress, and consumer groups to prevent incidents where passengers were held on aircraft for up to nine hours during severe weather and weather-related diversions without the option to deplane. Airlines, trade associations and some consumer groups believed the imposition of inflexible tarmac delay limits would increase flight cancellations. The Regulatory Impact Analysis issued by DOT in support of the rules concluded that marginal flight cancellations would be minimal, and that the public benefit from eliminating lengthy tarmac delays outweighed the public cost of cancellations.

DOT rules now place a three-hour limit on tarmac delays for domestic flights. Tarmac delays are defined as time that passengers are held on the aircraft before take-off or after landing without the option to deplane. International flights are not subjected to a government-mandated tarmac limit. The rules became effective on April 29, 2010.

The maximum statutory penalty for violation of the tarmac limits is $27,500 per incident. Incidents are measured on a per passenger basis. The maximum penalty is potentially $1.4 million for a regional flight with 50 passengers, $3.7 million for a narrowbody flight with 137 passengers, and more than $8 million for domestic widebody aircraft with 280 passengers.[4] The maximum fine reflects between 200 and 300 times the revenue that the airline would collect in gross revenue from the passengers on an impacted flight.[5] The fine is disproportionate to the fares paid.

As of July 1, 2010, DOT has not published specific criteria that transparently illustrate to airlines or consumers how the tarmac limits will be enforced. It is unclear whether DOT intends to seek maximum penalties for minor violations of the 3 hour rule, particularly in situations where an airline initiates a return to gate during severe weather but is unable to deplane by the 3 hour threshold. Recent comments by the Secretary of Transportation suggest that the Department will seek "strong enforcement" of the rule at the maximum levels permitted by statute.[6] Predictably, the lack of transparency has driven highly risk-averse behavior by airlines.

---

[4] Based on 50-seat regional jet (CRJ-200 or EMB-145), 137-seat Boeing 737-700 (Southwest), and 348-seat domestic 777-200 (United Air Lines). From Seatguru.com.

[5] Based on an average fare of $75 per passenger for regional flying (SkyWest Airlines, 2009 Annual Report, $2.61 billion revenue over 34.5 million passengers) and $119 per passenger for other domestic flights (Southwest Airlines, 2009 Annual Report, $10.35 billion revenue over 86.31 million revenue passengers).

[6] Secretary Ray LaHood, DOT Press Conference, 4/27/2010. Secretary LaHood said "[DOT] just leveled a $16 million fine which was the maximum fine we could level against Toyota. So I don't think anybody thinks that [DOT] is not going to have strong enforcement."

In 2009, there were a total of 8.8 million domestic flights.[7] 903 flights had a tarmac delay greater than 180 minutes (0.2%). Of those tarmac delays, 604 occurred on departure, 2 on arrival (waiting for a gate), 112 prior to a return to gate (and second departure), 110 before the flight cancelled, and 75 occurred at a diversion airport.[8]

Media and consumer attention has focused on tarmac delays after flight diversions. Consumer groups that wanted tarmac delay limits cited examples of diversion-related delays in Austin (2006) and Rochester (2009) where passengers were trapped at airports where the carrier had limited or no regular capability. In comparison, departure tarmac delays are more frequent, and more than 90% result in a completed flight with passengers at their destinations. As a result they generate comparatively little consumer anger or media attention.

Airlines and industry groups recognized that the combination of three-hour limits and punitive fines would demand risk-averse behavior that would impact many more flights than the 903 tarmac-delayed cases in 2009. Airlines changed operating procedures in 2010 to identify cases where aircraft were at risk of lengthy tarmac delays. Today, when even a slight risk of exposure is identified, airlines demand a return to the gate long before the three hour threshold, cancel a flight before push-back to free gate capacity, or divert inbound aircraft to airports not impacted by the event.

These new operating policies are inflexible. They mandate action by pilots, dispatchers and airport managers. Mandatory action begins at some carriers at 2 hours after push, and by 2.5 hours the largest US carriers return all flights to the terminal. Compared to the 604 flights in 2009 that had taxi-out times greater than 180 minutes, over 4,100 flights had taxi-out times greater than 120 minutes.[9] More flights returning to the gate drives a higher cancellation percentage as airlines free gates for passenger disembarkation.

The data show that DOT and consumer groups achieved their objective of preventing three-hour tarmac delays. The threat of “strong enforcement” at disproportionate levels has created unnecessary flight cancellations. The inherent uncertainty about fine structures and DOT enforcement strategies, ambiguous language in the final regulations, and the threat of media attention on the first violations drives extremely risk-averse behavior by airlines in making operational decisions about delayed flights. The result is clear from May 2010 operating results: flight cancellations (both pre-cancellations before departure and cancellation after pushback from gate) and diversions are both dramatically higher than comparable periods before the rule change.[10]

This paper focuses on the consumer impact of a three-hour limit on taxi time on departures when paired with an ambiguous and punitive fine structure. Our core objective is to quantify the impact of the tarmac delay rules on flight cancellations, and ultimately on the flying public.

---

[7] DOT T-100 Segment Data

[8] Department of Transportation BTS Website

[9] 4,109 flights had taxi-out times of 120-180 minutes in 2009. DOT Bureau of Transportation Statistics (BTS).

[10] For more information, see Page 53.

We provide background on the DOT regulations and the positions taken by key aviation stakeholders. We analyze historical tarmac delay patterns, reviewing why extended departure tarmac delays are intricately tied to severe weather and airspace congestion. We demonstrate that tarmac delays cannot be "scheduled" out of existence, and that network and airport factors cause airlines to cancel flights to mitigate risk of tarmac fines.

These cancellations drive significant consumer harm. Advocates of a fixed tarmac limit have expressed a clear preference for flight cancellations over tarmac delays; in the words of a major proponent, "cancellations could go up, but it's not a bad thing… The cancellations are going to prevent people from being stuck on the tarmac."[11] We discuss why these generalizations by a vocal minority of consumers ignore and shortchange the real, prolonged and tangible harm from cancellations. By modeling flight cancellations based on an analytical review of tarmac delay patterns, we demonstrate that the harm from cancellations is real – and impacts hundreds of thousands of passengers who would have completed their flights prior to the rule. In the long term, we estimate that four cancellations will result from every prevented taxi-out tarmac delay. In the short term, we demonstrate that the cancellation ratio is significantly higher than 4:1 as uncertainty about enforcement and fine levels clouds airline decision making.

Using prior research, we calculate incremental passenger harm from these cancellations. Using the framework defined by the Regulatory Impact Analysis, correcting for the impact of early returns to gate by risk-adverse airlines, long wait times for available seats after flight cancellations, and an overall flight cancellation rate based on research cited by the RIA, we demonstrate that the tarmac delay rule has a strongly negative consumer benefit that far outweighs the positive impact of other consumer protection initiatives introduced concurrently by DOT.

Finally, we demonstrate that with a transparent and reasonable fine structure in place, the negative impact of tarmac rule changes can be mitigated. Airlines must assume worst-case enforcement and penalties until proven otherwise. This drives unnecessary cancellations. If DOT introduces a fine structure that graduates the fine by the length of the delay – potentially reaching maximum penalties by the fourth or fifth hour – airlines will be more flexible in situations where aircraft taxi past two hours but are likely to depart before three hours has passed since leaving the gate.

This paper does not analyze or comment on the other passenger protections introduced concurrently by DOT, including DOT's requirements for disclosing delayed flights, serving food and water after two hours of delay, and posting information on web sites. We generally concur with the RIA analysis that these changes carry positive public benefits and should be retained.

[11] Kate Hanni, Interview with John Hughes, BusinessWeek April 27, 2010

SECTION TWO: RULEMAKING HISTORY

On December 30, 2009, DOT published measures called Enhancing Airline Passenger Protections. These revised regulations required commercial airlines to implement contingency plans for lengthy tarmac delays, respond to consumer complaints regarding tarmac delays, and post information on web sites. The final rulemaking also defined chronically delayed flights (scheduled flights that consistently operated with lengthy delays) and implemented penalties and disclosure requirements for such flights. The final rulemaking took effect on April 29, 2010.

Rule Language. The new rules regarding tarmac delays are contained in 14 CFR Part 259. They are designed to "mitigate hardships for airline passengers during lengthy tarmac delays" and to "bolster air carriers' accountability to consumers."[12] The rules apply to all certificated airlines that operate aircraft "originally designed" to have 30 or more passenger seats.

The regulation defines a tarmac delay as "the holding of an aircraft on the ground either before taking off or after landing with no opportunity for its passengers to deplane."[13] As of July 2010, tarmac delay rules apply at all airports with more than 0.25% of total annual enplanements in the United States. In 2009, there were 767.7 million passenger enplanements across the United States; all airports with more than about 2 million annual enplanements are therefore covered.[14] While smaller markets such as El Paso, Wichita, Madison, Dayton and Albany have fewer than 2 million annual enplanements, mid-tier cities such as San Antonio, Kansas City, Raleigh and Hartford are subject to tarmac delay restrictions. On June 8, 2010, the DOT subsequently proposed expanding tarmac delay rules to all essentially all airports in the United States with commercial air service.[15]

The DOT language states that for domestic flights, "the air carrier will not permit an aircraft to remain on the tarmac for more than three hours" unless there is a "safety-related or security-related reason (e.g. weather, a directive from an appropriate government agency) why the aircraft cannot leave its position on the tarmac to deplane passengers" or air traffic control advises that deplaning "would significantly disrupt airport operations."[16] The regulation does not define what constitutes "safety" or "security" related reasons, nor does it define which government agencies are "appropriate" for issuing directives *not* to deplane. This ambiguity of language has a significant impact on airline decision-making, a topic we discuss later in this paper.

---

[12] 14 CFR Part 259.1

[13] 14 CFR Part 259.3

[14] In 2008, there were 28 large hub airports and 41 medium hub airports. Large hub airports are ATL, BOS, BWI, CLT, DCA, DEN, DFW, DTW, EWR, FLL, HNL, IAD, IAH, JFK, LAS, LAX, LGA, MCO, MIA, MSP, ORD, PHL, PHX, SAN, SEA, SFO, SLC AND TPA. Medium hub airports were ABQ, ANC, AUS, BDL, BNA, BUF, BUR, CLE, CMH, CVG, DAL, HOU, IND, JAX, MCI, MDW, MEM, MHT, MKE, MSY, OAK, OGG, OKC, OMA, ONT, ORF, PBI, PDX, PIT, PVD, RDU, RNO, RSW, SAT, SDF, SJC, SJU, SMF, SNA, STL and TUS. The Department will enforce based on 2008 metrics until an update to 2009 metrics in mid-2010. (OAEP, April 28, 2010).

[15] NRPM June 8 2010

[16] 14 CFR Part 259.4(b)(1)

For international flights, the DOT rules also mandate a contingency plan, but the air carrier may set the limit for tarmac delays across its system. As with domestic flights, the airline must enact the contingency plan at all large and medium airports, allowing passengers to deplane before that limit.[17]

For all domestic and international flights, the new DOT rules mandate that the airline will provide food and water "no later than two hours" after gate push-back or after landing, that lavatory facilities will be operable at all times on the tarmac, and that medical attention will be available if needed. If an airline violates the tarmac delay rules, or related provisions for food and water, lavatory facilities and medical care, the violation will be considered an "unfair and deceptive practice" under 49 USC §41712 and subject to prosecution by DOT. The maximum aggregate fine is $27,500 for each passenger per incident.[18]

Historical background. A string of extended tarmac delays created the political and consumer pressure towards these new regulations. As Table 1 indicates, certain tarmac delays attracted significant media attention.

After major delays in 1999 resulting from winter snowstorms, the first Congressional proposals were made for a consolidated "Passenger Bill of Rights." After hearings, Congress, DOT and the Air Transport Association (ATA) agreed to allow air carriers to improve their response procedures for tarmac delays without formal legislation. On June 17, 1999, each ATA airline agreed to a customer service framework that included a provision to "meet customers' essential needs during long, on-board delays."[19]

Some carriers ultimately adopted customer service plans for major tarmac delays, but many did not. After severe tarmac delays during the winter of 2006-2007, in February 2007 Secretary of Transportation Mary Peters commissioned an Inspector General report to review tarmac delays and provide recommendations for future rulemaking. In parallel, legislators renewed their focus on passenger rights with Rep. Mike Thompson (D-CA) introducing language to limit tarmac delays to 4 hours (HR 1303). Thompson's bill did not advance past Subcommittee but raised awareness.

During the summer of 2007, the DOT Inspector General reviewed specific incidents of tarmac delays, airline customer service plans and contracts of carriage. He recommended best practices to prevent reoccurrence of tarmac delays. In a final report issued September 25, 2007, the IG recommended that DOT (1) formally define "what constitutes an 'extended period of time' for meting passengers' essential needs", (2) require airports to monitor tarmac delays, (3) investigate tarmac delays and (4) enforce commitments to avoiding delays. The IG cited a comprehensive review of airline contracts of carriage and internal policy, demonstrating that airlines had a wide range of policy for tarmac delays with deplaning standards ranging from case-by-case to 5 hours.

[17] 14 CFR Part 259.4(b)(2)

[18] 14 CFR Part 383 ($25,000 per incident) and 49 U.S.C. §46301 ($2,500 per incident)

[19] Airline Customer Service Commitment, ATA, June 1999.

Table 1: Historical Tarmac Delays with Widespread Media Coverage
Source: Public News Sites and DOT IG Report September 2007

Airline	*Date*	*Event*
American Airlines	December 29, 2006	Severe weather and tornadoes at DFW caused more than 100 diversions to regional airports, including diversions to Austin where flights took up to 9 hours to deplane.
JetBlue Airways	February 14, 2007	Unforecast ice storm stranded more than 52 flights on tarmac for up to 10 hours. JetBlue cancelled 355 flights and diverted 6 flights. There were 26 on-board delays of 4+ hours with 2,962 passengers on these flights.[20]
US Airways	August 9, 2007	Severe weather along the eastern seaboard caused tarmac delays at PHL for up to 6 hours.
Multiple Carriers	August 11, 2007	More than 17,000 passengers on 73 international flights were stranded for up to 10 hours due to computer failure by US Customs.
ExpressJet (Continental Airlines)	August 8, 2009	Aircraft diverted to Rochester, MN and arrived at 12:28am. Crew requested to deboard passengers and was refused. Passengers ultimately released at 6:00am.
Virgin Atlantic	June 22, 2010	Weather diversion, equipment failure and crew legalities prevented a fully-loaded Airbus A340 from London from departing Hartford; passengers were held on aircraft for five hours

ANPRM and Task Force. DOT responded to the IG report by introducing an Advance Notice of Proposed Rulemaking (ANPRM) on November 20, 2007,[21] and by creating the Tarmac Delay Task Force in December 2007 to develop a plan of action for reducing tarmac delays.

The ANPRM invited public comment on whether DOT should “adopt a rule to enhance passenger protections” through seven requirements: (1) to adopt contingency plans for tarmac delays and incorporate such contingency plans into contracts of carriage, (2) to respond to consumer problems related to tarmac delays, (3) to deem the operation of chronically delayed flights to be deceptive, (4) to require carriers to publish delay data on their web sites, (5) to require carriers to publish complaint data on their web sites, (6) to require on-time performance reporting by international carriers, and (7) to require carriers to audit compliance with customer service plans.

[20] According to the DOT IG, “Initial weather forecasts for JFK on February 14 predicted rain in the morning with temperatures slightly higher than 32 degrees; the weather was dramatically worse with freezing rain starting at 8:00am. JetBlue’s flights continued to arrive at the airport, although flights could not depart… thereby causing gridlock on the airport tarmac.”

[21] Federal Register, Vol. 72, No. 223, Tuesday November 20, 2007.

The ANRPM did not describe or set a federal limit for tarmac delays, allowing airlines to set their own standards. The ANPRM set four-hour tarmac delays as the threshold for analysis and reporting. The DOT received 200 total public responses during the comment period. Thirteen came from industry members (airlines, airports and other trade associations), 2 from legislators and 131 "identical or nearly identical" responses from a form letter coordinated by a vocal consumer group.[22]

Consumer groups protested that the ANPRM did not prescribe a specific tarmac limit, while airlines and industry groups attributed lengthy tarmac delays to factors outside their control including weather and air traffic control. Senators Boxer (D-CA) and Snowe (R-ME) advocated the adoption of a three-hour limit for tarmac delays.

The only airline to independently comment, Delta Air Lines, supported the principle of contingency plans for tarmac delays, calling such requirements "reasonable and necessary to ensure a carrier is prepared to react." Delta opposed a fixed tarmac limit, arguing that "operational flexibility is critical to managing extended ground delays… [a] gate return will often result in more extensive disruptions of airport operations and/or a cancellation of the flight, resulting in greater inconvenience to passengers than an additional extension of the tarmac delay."[23] The Air Transport Association took an adversarial position to DOT, arguing that airlines had already incorporated contingency plans into their operating procedures.

The 36-member Tarmac Delay Task Force was composed of representatives from the industry (including airports and airlines), consumer groups and travel distribution partners. Through 2008, the Task Force met to discuss best practices, debate the merits of defining tarmac limits and other consumer protection initiatives.

Voluntary Implementation of Tarmac Limits. Several airlines voluntarily introduced tarmac delay limits. During 2007, American, Continental, JetBlue and United all introduced fixed limits, ranging from 1 hour (for arrivals) to between 4 and 5 hours. As our analysis later in this paper demonstrates, setting a 4-5 hour limit is not arbitrary. Such thresholds incorporate factors including gate availability, passenger rebooking strategies, and the duration of severe weather events. They minimize flight cancellations while staging enough aircraft in a position to depart (when weather clears) to recover the network most efficiently, minimizing passenger disruption.

The effectiveness of these self-imposed rules for departure delays varied by carrier. Some set more stringent limits than others (See Table 2). Alaska, Northwest, and Southwest Airlines, all of which have relatively low exposure in the tarmac-delay prone northeast corridor, had significantly fewer flights with 3+ hour taxi times in 2006 than other major airlines. These carriers adopted internal limits of 2 and 3 hours, but could not accomplish a significant reduction in flights above this internal limit in 2008.

[22] Federal Register, Vol. 73, No. 236, Monday December 8 2008, 74587.
[23] Delta Air Lines, Response to ANPRM, January 28, 2008

Table 2: Airline Voluntary Tarmac Limits, Prior to New Regulations
As of September 2007 (Source: DOT Office of Inspector General)

Airline	*Definition of "Extended Period of Time" in customer service plan and/or Contract of Carriage*	*Time to Deplane as set in Customer Service Plan, Contracts of Carriage or Internal Policies*
Alaska Airlines	1.5 hours	2.0 hours for arrivals
American Airlines	2.0 hours	4.0 hours (eff. 4/10/07)
Continental Airlines	2.0 hours	4.0 hours (eff. 6/15/07)
Delta Air Lines (pre-merger)	None	None
JetBlue Airways	None	5.0 hours (eff. 2/20/07)
Northwest Airlines (pre-merger)	1.0 hours – arrivals 3.0 hours – departures	1.0 hours – arrivals 3.0 hours – departures
Southwest Airlines	2.0 hours	2.0 hours
United Air Lines	None	4.0 hours – departures, 1.5 hours – arrivals 4.0 hours – deps. (9/05/07)
US Airways (post-merger)	2.0 hours	None

In contrast, airlines with significant northeast exposure – American, Continental, United and JetBlue – set more conservative standards of 4 and 5 hours. American and United significantly reduced both the number of flights with 3+ hour delays and the number of flights over their self-imposed limits (see Table 3). Continental and JetBlue, impacted by New York-related factors discussed later in this paper, did not achieve material changes in the ratio of tarmac delays to total flight departures.

Table 3: Flights with Taxi-Out Times in Excess of Airline Limits and 3+ hours
Source: US Department of Transportation Transtats

	2007 Self-Imposed Taxi-Out Limit	*2006 flights over self-imposed limit*	*2006 flights of 3+ hours on taxi-out*	*2008 flights over self-imposed limit*	*2008 flights of 3+ hours on taxi out*
Alaska	2 hrs	27 (0.017%)	3 (0.001%)	16 (0.010%)	3 (0.001%)
Southwest	2 hrs	218 (0.02%)	24 (0.001%)	206 (0.017%)	16 (0.001%)
Northwest	3 hrs	27 (0.006%)	27 (0.01%)	31 (0.009%)	31 (0.01%)
American	4 hrs	44 (0.007%)	219 (0.03%)	22 (0.004%)	171 (0.03%)
Continental	4 hrs	12 (0.004%)	112 (0.04%)	28 (0.009%)	134 (0.04%)
United	4 hrs	39 (0.008%)	204 (0.04%)	11 (0.002%)	80 (0.02%)
JetBlue	5 hrs	3 (0.002%)	99 (0.06%)	7 (0.004%)	120 (0.06%)

By the end of 2008, many airlines had demonstrated an improvement in taxi-out delays. The Tarmac Delay Task Force was unable to agree on a fixed standard for tarmac delays, even though consumer and travel groups represented on the committee had pushed strongly for such a uniform standard. The Task Force recommended the creation of contingency plans for lengthy tarmac delays, coordination with airports, regular passenger updates during lengthy delays and the availability of food, water and restroom facilities.

Neither vocal consumer groups nor key legislators were satisfied by the Task Force actions. Airlines and certain travel industry groups supported the conclusions. With the Presidential election, the economic crisis of late 2008 and comparable improvements in tarmac delays during 2008, public attention focused onto other issues.

Notice of Proposed Rulemaking. On December 8, 2008 the DOT introduced rules for Enhancing Airline Passenger Protections.[24] The NRPM did not set maximum tarmac delay times, but introduced language to mandate contingency plans, coordination with local airport authorities, provision of food, water, and functional lavatories, and record keeping requirements. With no fixed tarmac limit defined by DOT, consumer groups turned their attention to lobbying legislators to advocate such a limit through specific language in FAA Reauthorization and parallel measures.

Express Jet Flight 2816. Political and consumer momentum towards a fixed tarmac delay limit was rejuvenated after the August 8, 2009 diversion of Express Jet Flight 2816, operated on behalf of Continental Airlines. The flight was en-route from Houston to Minneapolis when it diverted into Rochester at 12:30am due to thunderstorms at the Minneapolis airport.

The Embraer 145 regional jet with 47 passengers and 3 crewmembers parked on the tarmac at Rochester airport. The airport terminal facilities were closed. The flight could not continue because duty regulations prevented the flight crew from operating another segment that evening.

Local ground handling agents for Mesaba Airlines, a division of Northwest Airlines, refused to allow passengers to deplane into the terminal because "the airport was closed to passengers for security reasons."[25] While this claim proved incorrect (TSA regulations in fact do permit passengers to be deplaned into a sterile area and then reboarded without additional screening) the flight crew did not challenge the claim that evening, and senior management at both Continental and ExpressJet did not intervene. Conditions on board the aircraft deteriorated through the night and passengers ultimately deplaned at 6am.

Secretary of Transportation Ray LaHood took a visible role in leading the government response to the incident. Through press conferences and FastLane, the DOT blog, the Secretary expressed his "outrage" and "anger" over the incident.[26] The Secretary directed attention to the 2008 NPRM and invited further comment as DOT considered more stringent action.

The DOT investigation into the incident concluded that a lack of coordination between Mesaba, Continental Airlines (as the marketing carrier) and Express Jet (as the

[24] Federal Register, Vol. 73, No. 236, Monday December 8, 2008.

[25] DOT Blog, Secretary Ray LaHood, August 21, 2009

[26] FastLane (fastlane.dot.gov), August 21, 2009

operating carrier) caused the extended delay.[27] Neither Continental nor Express Jet had ground staff at Rochester, and Mesaba offered assistance out of courtesy, not contractual relationship. The incident highlighted a lack of planning by Express Jet in diversion planning and the handling a lengthy tarmac delay.

Political and consumer anger built. In September 2009 Sen. Boxer (D-CA) and Rep. Thompson led meetings and hearings to promote a fixed three-hour limit for tarmac delays, covering taxi-out, taxi-in and diversion-related delays under a uniform standard. Boxer and Thompson renewed legislation (S.213 and HR 674 respectively) to impose a three hour limit. With consumers and legislators unsatisfied by the general recommendations of the Task Force, pressure built on DOT to enact new rules.

Final Rule. DOT responded, stating that such action was taken "on its own initiative". On December 30, 2009, the department introduced the final language of the Enhancing Airline Passenger Protections rules. The Department imposed a three-hour limit on tarmac delays for domestic flight operations, with limited exceptions for safety, security and ATC. With respect to international flights of US carriers, DOT recognized the implications of flight cancellations on passengers, and that passenger re-accommodation after a cancelled flight could subject consumers to disproportionate harm. Accordingly, DOT allowed airlines to set their own limits for international tarmac delays, but required airlines to stick to such limits across their systems.

After publication of the Final Rule, airlines filed comments requesting exemptions and warning DOT of the cancellation impact of the new rule. Consumer groups also responded in support of the new rules. The following comments were made or filed between December 30, 2009 and April 29, 2010:

> "Rigid and inflexible application of the new tarmac delay rule would have the unintended and undesirable effect of exacerbating passenger inconvenience and disruption by forcing the cancellation of flights that could otherwise be operated" (Delta, DOT filing, March 5, 2010)
>
> "Long tarmac delays are extremely rare. They do occasionally occur, there's no question about it. But having a rule that requires us to cancel flights at three hours or suffer a fine of $27,500 per passenger is inane. And so what we do in the face of a fine like that is we're going to cancel a lot of flights… and with the [load factors] we've got today, [passengers are] not getting [to destinations] for maybe days." (Jeff Smisek, CEO of Continental, March 8, 2010).
>
> "Carriers, faced… with the prospect of incurring $27,500 per passenger in fines, will inevitably cancel flights during challenging operational situations. This new rule will drive cancellations where flights depart the gate, are not able to take off within three hours, and return to the gate. The limited departure window created by tarmac time limits… will also cause carriers to strategically cancel flights proactively." (American Airlines, DOT filing, March 12, 2010)

[27] DOT's analysis did not review an important difference between this incident and prior diversion-related delays, including the American Airlines diversions in Austin, Texas on December 29, 2006. Unlike the Austin diversions, where American served Austin and had significant ground equipment and personnel in place, the Express Jet diversion was unplanned and for safety reasons.

Consumer groups took an opposite perspective:

> "Cancellations could go up, but it's not a bad thing… the cancellations are going to prevent people from being stuck on the tarmac." (Kate Hanni, FlyersRights.org Director, April 27, 2010).
>
> "Proactive, advance cancellations are in fact needed at overscheduled airports, and communications-technologies such as text messaging are facilitating improved customer service before and during irregular operations. To the extent material and unacceptable spikes in cancellation levels do occur, it will not have been because of the new tarmac rule, it will instead have been because the underlying problem of over scheduling had not been effectively addressed." (Kevin Mitchell, Business Travel Coalition, February 2010)

Enforcement Guidance. In the months leading to the effective date of April 29, 2010, the Department of Transportation issued guidance about both the rule and proposed enforcement. On April 26, 2010, Secretary LaHood issued guidance about "strong enforcement" of the rules, drawing parallels to the Department's maximum fine strategy against Toyota. The Office of Aviation Enforcement and Proceedings issued guidance on April 28, 2010 stating:

- That the Enforcement Office "considers a number of factors in determining the civil penalty it would seek in an enforcement proceeding." The lack of specificity, combined with concurrent comments from Secretary LaHood about "strong enforcement", created concern among airlines that maximum fines would be sought for all infractions.

- That a "tarmac delay begins when passengers no longer have the option to get off of the aircraft, which usually occurs when the doors of the aircraft shut. However if an aircraft is at the gate with the doors open, and passengers are not allowed off the aircraft, the time limit would start at the point when passengers were no longer permitted to deplane." This definition creates ambiguity given that the passenger door usually remains open once the passenger load is frozen so that paperwork can be exchanged between ground personnel and the flight crew.

- That "a carrier must give passengers the opportunity to deplane at the three-hour mark. It is not sufficient for a carrier to begin the process of returning to the gate or another disembarkation point at that time." To avoid exposure to the fine, airlines must begin the return to gate well ahead of the three-hour mark.

With this guidance, the Final Rule went into effect on April 29, 2010. It contained changes to 14 CFR Parts 253, 259 and 399. The full text of 14 CFR Part 259.4, which outlines the new rules for tarmac delays, can be found in Appendix One.

Six weeks have passed since the new rules went into effect. In Section Three, this paper outlines the causes of tarmac delays and reviews the operational challenges that airlines and consumer groups debated through the rulemaking period.

From public comments and interviews with airline operations teams, we have found that each U.S. airline has taken pro-active and comprehensive action to avoid any exposure to potentially strong fines. This is rational behavior, as the multi-million dollar fine far outweighs any revenue earned from a completed flight. The threat of public prosecution by DOT, based on Secretary LaHood's "outrage" over the issue, creates additional disincentive to risk a violation.

Based on data analysis and interviews, in Section Four we have compiled a case study of how airline operating procedures have changed in practice. We review actual operating results under the new rules in Section Five. Using this case study and prior research, we project the magnitude of disruption passengers will face from flight cancellations going forward. In Section Six, we assess the Regulatory Impact Analysis, testing airline and consumer claims about the impact of the rule on real-world operations. We update assumptions based on our prior research and reported data and discuss the incentives created by punitive fines.

SECTION THREE: SYSTEM ANALYSIS OF TARMAC DELAYS

Public debate centered on a core set of assumptions and arguments by consumer groups and regulators. Those arguments can be distilled as follows:

(1) That tarmac delays on departure, arrival and diversion are inherently similar and should be measured, enforced and fined under the same regulatory structure.[28]

(2) That tarmac delays are predictable and controllable events for airlines. Airlines can choose at any time during taxi-out to return to the gate to offload passengers. The aircraft can then return to the queue for take-off. On taxi-in, the airline can choose to deplane passengers by bus or at a gate.[29]

(3) That returns to gate do not create disproportional cancellations or diversions. Crew eligibility to complete the flight, maintenance checks and other factors relevant at the first gate departure are not relevant factors thereafter.[30]

(4) That passenger welfare is higher when waiting for departing flights in airport terminals, not on board before push-back (with the passenger door open and no restrictions on deplaning) or on an extended tarmac delay.[31]

(5) That advance flight cancellations are preferable to lengthy tarmac delays. Passenger re-accommodation time is not trivial but within a reasonable period of time, passengers on cancelled flights can be routed to their final destinations.[32]

(6) That airline scheduling is the core cause of tarmac delays, and not weather and/or large-scale limitations of the air traffic control infrastructure. If airlines moderately reduced flight schedules, the traffic log-jams would be alleviated and tarmac delays would disappear.[33]

In this section, we present an in-depth review tarmac delays based on tarmac incidents from October 2008 through April 2010. Results from May 2010, the first full month after the rule took effect, are analyzed separately in Section Five.

We review the operational differences between tarmac delays on departure (waiting for an airspace or runway slot to depart, when tarmac delays occur in high frequencies at a given airport) versus the different (and comparatively rare) operational realities of diversions due to weather.

---

[28] Department of Transportation RIA (HDR), pp25-26
[29] Department of Transportation RIA (HDR) , p27
[30] Department of Transportation RIA (HDR) , p28
[31] Department of Transportation RIA (HDR) , p21
[32] Kate Hanni, FlyersRights.org, Interview with BusinessWeek
[33] Bill Mosely, DOT Spokesman

We discuss how airspace availability and weather en-route is often a greater cause of tarmac delays than airport paralysis – and why weather en-route creates confusion among passengers who see certain departures singled out for long delays while other flights depart faster.

We review how today's terminal facilities and runway capacity do not provide sufficient flexibility to prevent either tarmac delays or cancellations during severe weather – and why flight scheduling is not the culprit for extended tarmac delays. Finally, we address each of the assumptions above, discussing whether statistical data support or contradict the points made by industry stakeholders.

Data Analysis Methodology

The data reviewed in this section originate from publicly available sources, with most from the Department of Transportation's Transtats database. Since 1995, the Department has required airlines that operate more than 1% of total domestic scheduled-service revenue to file monthly operating reports that include taxi-in and taxi-out times.[34]

Starting in October 2008, these airlines were required to file comprehensive reports of flight performance data under 14 CFR Part 234 for all scheduled nonstop domestic passenger operations to or from any reportable airport, including new requirements for detailed explanations of tarmac delays and full reporting of diversions.[35] A complete roster of reportable information is contained in Table 4 below.

Table 4: Reportable Data under Part 234 for every domestic flight
Source: DOT BTS Technical Directive #19 (Revised January 25, 2010)

Basic Identifiers	*Schedule Information*	*Delay Summary*	*Diversion Summaries*
Carrier Code (2 letter)	Dep. Time, OAG	Departure Delay	Airport(s) of Diversion
Flight Number	Dep. Time, CRS	Arrival Delay	Wheels-on, diversion(s)
Departure Airport	Dep. Time, Actual	Time Difference	Wheels-off, diversion(s)
Arrival Airport	Arr. Time, OAG	Wheels-Off Time	Total time at gate, diversion(s).
Date of Flight	Arr. Time, CRS	Wheels-On Time	Longest away, diversion(s).
Day of Week	Arr. Time, Actual	Cancellation Code	
Aircraft Tail Number	OAG – Actual	Minutes per Delay Code	
	CRS – Actual	First departure, origin	
	Elapsed Time, CRS	Ground taxi time	Aircraft Tail # if substitution of equip.
	Added gate-gate time	Longest time off gate	

Because the reported data is only for the 29 largest airports, developing meaningful data requires an adjustment for non-reported flights. We scale metrics as reported by the airlines on a direct, proportional basis. This estimates the systemwide impact of delays and cancellations before and after the tarmac delay rules took effect.

[34] Reporting airlines as of January 2010 have annual domestic revenue in excess of $720 million, including AirTran, Alaska, American, American Eagle, Atlantic Southeast, Comair (USA), Continental, Delta, Frontier, Hawaiian, JetBlue, Mesa, Northwest, SkyWest, Southwest, United and US Airways. In addition, Pinnacle Airlines and Express Jet file on-time reports on a voluntary basis.

[35] Reportable airports include 29 major airports nationally, each handling in excess of 6.2 million annual passengers. Reportable airports as of January 2010 are ATL, BWI, BOS, CLT, MDW, ORD, DFW, DEN, DTW, FLL, IAH, LAS, LAX, MIA, MSP, EWR, JFK, LGA, MCO, PHL, PHX, PDX, SLC, SAN, SFO, SEA, TPA, IAD and DCA.

Our quantitative analysis in this paper builds on prior research as part of developing a Passenger Delay Model ("PDM") to estimate the passenger re-booking time required to re-accommodate passengers on cancelled flights.[36] The PDM is a comprehensive model that computes the number of passengers impacted by a given system disruption and then models how those passengers can be re-accommodated on subsequent flights. To prepare the PDM, we analyzed ten years of flight delay and cancellation data to identify industry changes that have rendered prior estimates of re-accommodation time obsolete. We estimated the number of passengers impacted by flight cancellations between 2004 and 2009. Finally, we conducted a comprehensive review of airline load factors, on an aggregate and seasonal basis, to determine how seasonality of cancellations impacts re-booking strategies. This research provides a foundation of information and passenger impact that is relevant when considering the effects of tarmac delay rules on flight operations and passenger welfare. We have incorporated and referenced our research and analysis developing the PDM.

Core Findings from Analysis

We summarize our core findings from the analytical review of historical taxi delays, cancellations and flight operations as follows.

1) Tarmac delays on taxi-in, taxi-out and diversions are caused by different factors, occur at different frequencies and have differential impact on passenger welfare.
2) Tarmac delays are highly seasonal.
3) Tarmac delays are peaky – occurring in large numbers on single days.
4) Tarmac delays are primarily afternoon events during the summer.
5) Tarmac delays are driven by severe weather that block airports and airspace.
6) Tarmac delays on taxi-out are primarily three to four hours in length, caused by weather and airspace factors that often lessen within a four-hour window.
7) Tarmac delays are concentrated at specific airports and relatively rare elsewhere.
8) Most tarmac delays end in a completed flight.
9) Airport and gate constraints force airlines to choose between cancellations and tarmac delays.
10) Flight scheduling cannot reasonably reduce exposure to tarmac delays.

[36] Marks, J. and Jenkins, D. *Modeling Passenger Re-Accommodation Time for Flight Cancellations in Airline Networks.* George Washington University Aviation Program (2010).

Detailed Analysis

<u>Tarmac delays on taxi-in, taxi-out and diversions are caused by different factors, occur at different frequencies and have differential impact on passenger welfare.</u>

There are three types of tarmac delays as reported under 14 CFR Part 234 requirements: taxi-out tarmac delays, taxi-in delays and delays at diversion airports.

Taxi-Out Tarmac Delays occur on departure, after push-back from the gate but before take-off has occurred. Taxi-out delays are caused by aircraft awaiting de-icing, by runway or taxiway congestion, or by Air Traffic Control (ATC) flow restrictions that limit the pace at which aircraft can be launched on specific departure routes. Contributing factors include thunderstorms, icing conditions, low ceilings or visibility, smoke and radar failures. The vast majority of tarmac delays that are reported occur on taxi-out. Of 1,257 reported tarmac delays between October 2008 and April 2010, 1,142 (91%) occurred on taxi-out at the point of origin, as outlined in Table 5 below.

There are two core explanations for the prevalence of taxi-out tarmac delays. First, when an aircraft pushes from the gate, that aircraft is "activated" in the ATC system and enters the queue for an airspace slot. When that queue is constrained due to weather factors, both the time that the flight is scheduled to depart and the time the aircraft is ready to taxi out determine its slot into the system. Today's ATC infrastructure does not allow en-route ATC facilities to govern when specific flights push from the gate. Instead, en-route facilities dictate acceptance rates, and local facilities move aircraft into the system.[37]

Second, as outlined below, surplus gate availability is constrained at most U.S. airports. Airlines lease the number of gates required for normal flight operations, with reasonable variance for bad weather or other delays. This means that airlines have a limited number of places to put aircraft on the ground. Because unloading, cleaning, catering, fueling and boarding an aircraft can take between 30 and 90 minutes, this gate constraint means that airlines try to push boarded flights off gate as quickly as possible to allow the next turn cycle to occur. An aircraft delayed after push-back on departure is one delay in a system; a flight waiting for a gate is not only delayed itself, but is also delaying a second departing flight that would use that aircraft.

Taxi-In Tarmac Delays occur after landing while the aircraft is awaiting a gate, airstairs or ground handling personnel to unload. Taxi-in tarmac delays since 2008 have been very rare, primarily because airline policy after 2007 has been to prioritize the unloading of flights on arrival. As Table 5 shows below, from October 2008 through April 2010, just 13 flights experienced tarmac delays on arrival, representing 1% of all

[37] Tarmac delays on departure usually occur during Ground Delay Programs (GDPs) issued by the FAA to manage reduction in airport departure or arrival capacity. Under GDP programs flights will be held at their departure point until a point in the future when the FAA identifies available airspace for that flight, or when weather conditions improve to permit departure or arrival. GDPs are relatively frequent events (1.6 per day according to Ball 2005). The base allocation of slots under GDPs is performed on a Ration-by-Schedule paradigm where airlines are allocated slots in congested airspace based on their original flight schedule. Airlines can trade those slot positions among their own roster of departures. For more information, see Vossen, T. and M. O. Ball, *Slot Trading Opportunities in Collaborative Ground Delay Programs.* Transportation Science 40(1) 29-43 (2006).

tarmac delays. As described above, airlines try to avoid tarmac delays on arrival due to gate, network and passenger factors. The few cases observed (including the most recent, US Airways flight 816 on February 15, 2010) result from severe weather including snow, ice and lightning which bars the airline from taxiing the aircraft to gate or from unloading the passengers safely. Taxi-in delays therefore tend to be uncontrollable by airlines and in most cases should meet new guidelines for "safety" exemptions.

Diversion-related tarmac delays have been visible and problematic for both consumers and airlines, although they represent less than 10% of overall tarmac delays. Diversion tarmac delays usually result from aircraft diverted to secondary or small fields due to severe weather at their primary destinations, and when fuel on board does not permit diversion to an "on-line" station with that airline's personnel and equipment. The diversion airport may not have gate space, loading and unloading equipment, or terminal infrastructure to handle passengers on board. Prior to the tarmac delay restrictions, aircraft could continue to a destination even under inclement weather without consideration to the closest "on-line" station. Under new tarmac delay rules, airlines must be confident that they can unload an aircraft in a timely manner, meaning that diversions occur earlier into airports with more favorable gate availability or weather conditions. In Section Four, we present a case study of Dallas Fort-Worth on May 14, 2010. Aircraft can be observed diverting, with attention to not overloading a single station closest to the impacted airport. This increases total travel time for passengers, but the strategy greatly reduces any exposure to extended tarmac delays.

Table 5: Summary of Reported Tarmac Delays by Phase of Flight
Source: US Department of Transportation, Reporting Carriers

	Reported Flights	*Tarmac Delays > 3 hr*	*Tarmac Delay on Departure*	*Tarmac Delay on Arrival*	*At Diversion Airport*
April 2010	529,330	4	1	0	3
March 2010	548,282	25	22	1	2
February 2010	481,988	61	59	1	1
January 2010	521,809	21	16	2	3
December 2009	529,269	35	30	0	5
November 2009	509,540	4	3	0	1
October 2009	531,799	12	12	0	0
September 2009	510,852	6	4	0	2
August 2009	568,301	70	63	0	7
July 2009	580,134	164	146	0	18
June 2009	557,594	278	254	1	23
May 2009	546,832	35	34	1	0
April 2009	537,793	81	69	0	12
March 2009	557,422	88	81	0	7
February 2009	488,410	43	43	0	0
January 2009	532,339	87	87	0	0
December 2008	544,956	187	170	7	10
November 2008	523,272	7	5	0	2
October 2008	556,205	49	43	0	6
Total	**10,156,127**	**1,257**	**1,142**	**13**	**102**
	100%	0.0124%	0.0112%	0.0001%	0.0010%

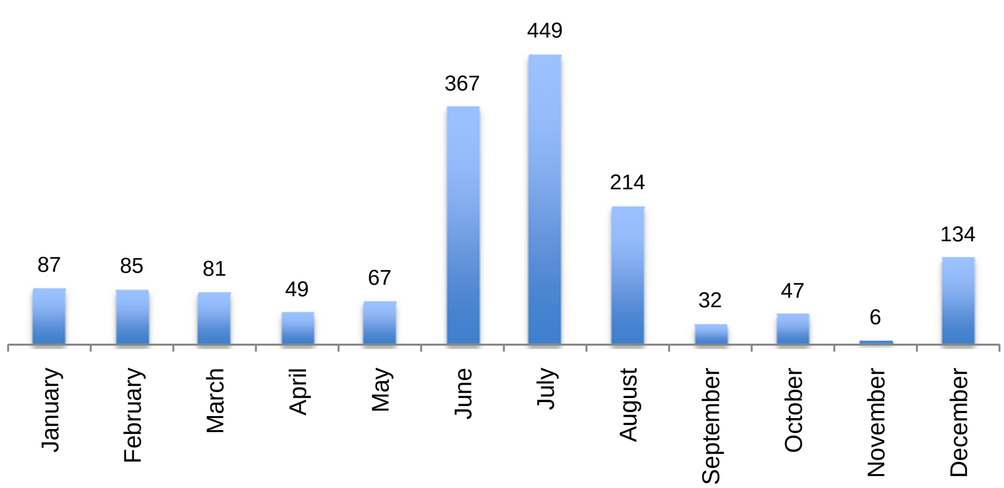
Consumer and legislative anger has focused on diversion-related tarmac delays. Of recent delays that have generated national attention, all were diversion-related events (except for the JetBlue operational melt-down of February 14, 2007, which impacted aircraft on departure and arrival, as well as diversion delays). By regulating a single solution for tarmac delays, the DOT has impacted a significantly larger pool of departure-related delays that are caused by uncontrollable factors – and where the alternative to tarmac delays, as outlined below, is cancellation of the scheduled flight.

Tarmac delays are seasonal

To assess the seasonality of tarmac delays, we compiled two full years of tarmac delay data, including the months of May 2008 through September 2008 which were reported by airlines under the old 14 CFR Part 238 standards. The reported data set did, however, contain aggregate taxi-in and taxi-out times directly comparable to data reported under the new standards.

The compiled tarmac delay data confirm that tarmac delays are highly seasonal, with 64% of tarmac delays occurring during June, July and August. Another 24% occur during the winter months of December through March. November is the quietest month.

Chart 1: 3+ Taxi-Out Tarmac Delays by Month
May 2008 to April 2010
Source: 14 CFR Part 234 filings to DOT



The core explanation for this seasonality is the unpredictability of severe summer weather. As shown in Table 7 (Page 22) tarmac delays have very high positive correlation to severe weather events, including hail and wind.

As Table 6 below illustrates, during the winter months, flight cancellations rise as airlines pre-cancel flights to avoid exposure to snowstorms, but tarmac delays are relatively minor compared to those observed during summer months. During the spring and fall months, where neither thunderstorms nor snowfall is a major concern in markets impacted by tarmac delays, on-time performance is high, cancellations relatively low and tarmac delays minimal.

During the summertime, the incidence of tarmac delays jump significantly. Pop-up and frontal thunderstorms are unpredictable, and neither the National Weather Service nor airline meteorologists can pinpoint the impact of a thunderstorm cell or squall line until several hours before the storm hits. This contrasts with winter storms, which can be predicted at least 24 hours in advance and in many cases 72-96 hours out.

During the summer, airlines do not have the planning advantage they have in the winter months. As storms roll through airports and airspace corridors, blocking departure and arrival corridors, they reduce the aggregate capacity of airspace. Flights must queue, and this causes delays. As the table below demonstrates, the incidence of long tarmac delays peak during June, July and August, while flight cancellations and (importantly for tarmac delays) diversions also rise.

Table 6: Percent of Flights Cancelled, Diverted and 3+ hour Tarmac Delay
Source: DOT Bureau of Transportation Statistics, based on reported flights for each category

	On-Time Departure	On-Time Arrival	Flights Cancelled	Flights Diverted	3+ hour tarmac time
October 2008	88.07%	86.04%	0.58%	0.16%	0.0088%
November 2008	85.92%	83.33%	0.85%	0.16%	0.0013%
December 2008	69.60%	65.34%	3.26%	0.45%	0.0343%
January 2009	80.56%	77.02%	2.33%	0.24%	0.0163%
February 2009	85.08%	82.60%	1.25%	0.17%	0.0088%
March 2009	80.95%	78.40%	2.10%	0.24%	0.0158%
April 2009	81.93%	79.14%	1.48%	0.28%	0.0151%
May 2009	83.32%	80.49%	0.88%	0.22%	0.0064%
June 2009	78.46%	76.12%	1.49%	0.36%	0.0499%
July 2009	79.49%	77.60%	1.18%	0.29%	0.0283%
August 2009	81.42%	79.68%	0.99%	0.26%	0.0123%
September 2009	88.04%	86.17%	0.57%	0.18%	0.0012%
October 2009	80.42%	77.27%	0.99%	0.20%	0.0023%
November 2009	89.03%	88.59%	0.54%	0.14%	0.0008%
December 2009	74.14%	71.99%	2.78%	0.28%	0.0066%
January 2010	80.46%	78.69%	2.46%	0.27%	0.0040%
February 2010	76.72%	74.64%	5.45%	0.24%	0.0127%
March 2010	80.85%	79.96%	1.50%	0.24%	0.0046%
April 2010	86.10%	85.31%	0.69%	0.18%	0.0008%

The data reported by airlines therefore confirm that:

Tarmac delays strongly correlate to diversions. The correlation coefficient between diversions and 3+ hour tarmac delays in 2009 was 0.83 in 2009. Diversions were less correlated to weather events in general (+0.74) indicating that while tarmac delays and diversions are often part of the same operating strategy by airlines, the presence of severe weather is not as strong a factor in flight diversions.

Tarmac delays are not strongly correlated to flight cancellations. The data suggest that airlines choose between tarmac delays and cancellations. The correlation (0.24) confirms that while weather events influence both cancellations and tarmac delays, tarmac delays and cancellations peak at different times of year based on the type of weather (snow, thunderstorms, wind) and specific airport congestion.

Tarmac delays are seasonal and correlate strongly to months with high thunderstorm and winter weather occurrences. Based on NOAA's 2009 climate summaries, we identified a strongly positive correlation between tarmac delay events and reports of severe winds (+0.83) and hail (+0.81) consistent with winter weather events and summer thunderstorms.

Table 7: Correlating Tarmac Delays with Severe Weather
Source: DOT Bureau of Transportation Statistics and NOAA[38]

	3+ Hour Tarmac Events (BTS)	Severe Weather Events (NOAA)
January 2009	85	114
February 2009	40	1,084
March 2009	85	1,211
April 2009	74	2,660
May 2009	34	3,263
June 2009	268	6,451
July 2009	161	4,053
August 2009	66	2,741
September 2009	6	562
October 2009	11	490
November 2009	4	14
December 2009	34	293
Correlation Coefficient		**0.84**

The table and charts below provides the correlations between on-time, cancellation, diversion, tarmac delay and weather conditions.

38 http://www.spc.noaa.gov/climo/online/monthly/2009_annual_summary.html

Table 8: Correlation Matrix

Boldface correlations are significant at $p < 0.05$

	On-Time Departures	*On-Time Arrivals*	*Cancelled Flights*	*Diverted Flights*	*3 Hour Tarmac Delays*	*Severe Weather*	*Tornados*	*Hail*	*Wind*
On-Time Departures		***0.99***	***-0.76***	***-0.78***	*-0.46*	*-0.29*	*-0.31*	*-0.24*	*-0.32*
On-Time Arrivals	***0.99***		***-0.78***	***-0.76***	*-0.44*	*-0.27*	*-0.33*	*-0.23*	*-0.28*
Cancelled Flights	***-0.76***	***-0.78***		*0.47*	*0.24*	*-0.13*	*0.02*	*-0.12*	*-0.15*
Diverted Flights	***-0.78***	***-0.76***	*0.47*		***0.83***	***0.74***	***0.69***	***0.73***	***0.71***
3 Hour Tarmac Dlys	*-0.46*	*-0.44*	*0.24*	*0.83*		***0.84***	***0.64***	***0.81***	***0.83***
Severe Weather	*-0.29*	*-0.27*	*-0.13*	*0.74*	***0.84***		***0.83***	***0.98***	***0.98***
Tornados	*-0.31*	*-0.33*	*0.02*	*0.69*	***0.64***	***0.83***		***0.90***	***0.70***
Hail	*-0.24*	*-0.23*	*-0.12*	*0.73*	***0.81***	***0.98***	***0.90***		***0.92***
Wind	*-0.32*	*-0.28*	*-0.15*	*0.71*	***0.83***	***0.98***	***0.70***	***0.92***	

Chart 2: Cancelled Flights vs. 3 Hour Tarmac Delays, October 2008-May 2010

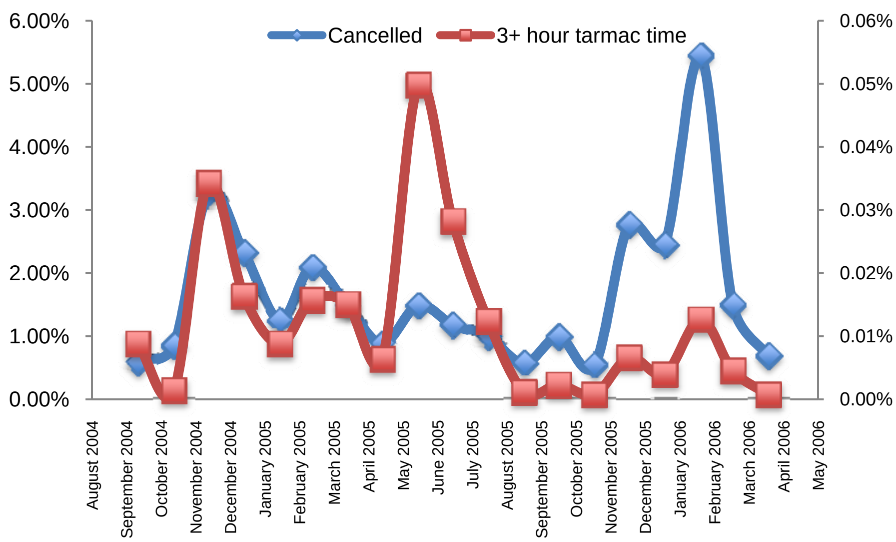
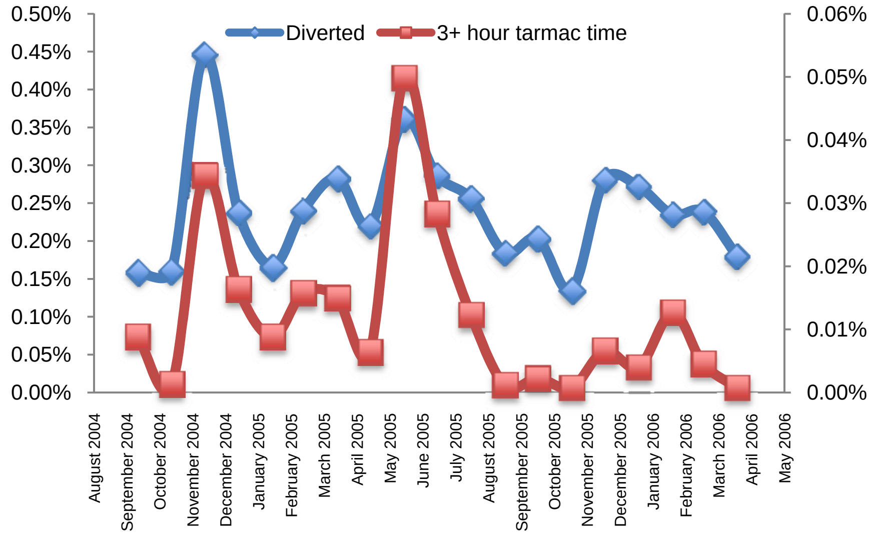


Chart 3: Diverted Flights vs. 3 Hour Tarmac Delays, October 2008-May 2010



Tarmac delays occur in clusters, across airlines at specific airports

The charts above demonstrate that tarmac delays peak during the summer months, and are widely distributed through the rest of the calendar year on average. The data above are based on monthly averages.

From an airline's perspective, the incidence of a single long tarmac delay each week is easier to manage than four concurrent tarmac delays, at one airport on one day. Airlines plan gate utilization based on many factors, including the minimum time to "turn" an aircraft after arrival, the flows of passengers onto connecting flights, market demand for certain departure and arrival times, and the impact of operational disruptions such as weather or airspace congestion.

With an even distribution of tarmac time, finding gate availability for tarmac-delayed flights is simpler. Airlines may have a temporarily empty gate to deplane passengers from, or they may expedite push-back on a departure to open a gap. With a limited number of available hardstands, the flight can hold close to the terminal.[39] When tarmac delays are peaky, occurring in large numbers on single days, the airline must find multiple gate openings while continuing to operate its normal flight schedule.

The following Table demonstrates that tarmac delays are strongly concentrated onto peak days. The top 20 days between May 1, 2008 and April 30, 2010 represent more than 50% of the total taxi-out tarmac delays during a 730 day period. Fourteen of the peak twenty days were in June, July and August.

[39] An example of gate to hardstand ratios is Washington Dulles, which has 143 gates and 14 hardstands (MWAA). Some airports have terminals with significantly higher hardstand ratios (JFK T4 has 16 gates and 17 hardstands).

Table 9: Percent of Flights Cancelled, Diverted and 3+ hour Tarmac Delay
Source: DOT Bureau of Transportation Statistics, based on reported flights for each category

Date	*# of Tarmac Delays*	*Date*	*# of Tarmac Delays*
July 24, 2008	120	March 2, 2009	36
July 14, 2008	65	August 12, 2008	34
July 27, 2009	62	February 12, 2010	33
June 11, 2008	61	August 11, 2008	29
July 28, 2008	59	May 28, 2008	29
August 15, 2008	54	October 16, 2008	28
June 15, 2008	43	January 29, 2009	27
June 10, 2009	42	July 21, 2008	26
December 11, 2008	42	July 1, 2009	24
June 27, 2009	39	June 4, 2009	23

Not only did the tarmac delays in Table 7 occur on the same calendar days, but they focused on specific airports that became overwhelmed with the volume of flights that were stranded.

Of the 120 three-hour taxi-out delays on July 24, 2008, more than 56 occurred at New York airports, 38 at Philadelphia and 19 at Washington-area airports. Of the 65 observed on July 14, 2008, 29 occurred in New York, 21 in Atlanta, 7 in Philadelphia and 5 in Washington. Of the 62 on July 27, 2008, 35 occurred in New York and 26 in Philadelphia. As we discuss below, tarmac delays peak during large-scale airspace failures caused by severe regional weather, not because of specific factors by an individual airline or airport operation.

<u>Tarmac Delays usually occur when severe weather events are prolonged</u>

Tarmac delays occur when weather events, impacting either airports or surrounding airspace, are prolonged. Flights that exhibit tarmac delays are spread across a four-hour window on average, indicating that the underlying factors take several hours to clear a given region.

We reviewed 36 days with high incidence of tarmac delays at specific airports. Each of these days had a minimum of 10 tarmac delays at specific airport, with a total flight count of 692 tarmac taxi-out departures. We collected the times that the first and last flights left the gate before beginning their tarmac delays, across all airlines operating at that airport. We used this as a proxy for the duration of the causal event. We list the days where more than 20 taxi-out tarmac delays occurred in Table 10 below.

Based on the full roster of 692 flights analyzed, the minimum time window for 10 or more tarmac taxi-out delays to occur was 1:20 and the maximum time window was 13 hours. The mean was 4:01 and the weighted mean (accounting for differential levels of tarmac delays) was 4:41. From this, we conclude that taxi-out tarmac delays generally occur when weather events or other disruptions last longer than two hours.

Table 10: First and Last Gate Departures for Tarmac Delays
Source: DOT Bureau of Transportation Statistics, based on reported flights for each category

Date of Incident	*Airport Impacted*	*3+ Hour Taxi-Out Delays*	*First Gate Departure*	*Last Gate Departure*
December 11, 2008	Houston IAH	42	2:50 PM	9:20 PM
July 24, 2008	New York JFK	42	12:25 PM	9:29 PM
July 24, 2008	Philadelphia PHL	38	12:09 PM	8:45 PM
June 11, 2008	New York JFK	33	4:20 PM	8:40 PM
July 15, 2008	New York JFK	32	3:59 PM	9:30 PM
February 12, 2010	Dallas DFW	31	6:25 AM	7:25 PM
October 16, 2008	Houston IAH	28	2:40 PM	4:00 PM
June 27, 2009	New York JFK	25	3:10 PM	6:50 PM
August 15, 2008	New York JFK	23	2:59 PM	5:20 PM
July 28, 2008	New York JFK	22	9:15 AM	1:57 PM
July 14, 2008	Atlanta ATL	21	10:00 AM	11:31 AM
August 22, 2009	New York JFK	20	12:45 PM	4:10 PM
June 10, 2009	New York JFK	20	5:50 AM	8:15 AM
March 2, 2009	Atlanta ATL	20	12:35 PM	8:20 PM

Summer tarmac delays are afternoon phenomena

As demonstrated in previous research regarding passenger re-booking time, the time of day at which an operational disruption occurs impacts the time to re-book passengers. For morning disruptions, passengers can be re-accommodated on afternoon and evening departures, or re-routed by alternate means (train, bus, rental car, etc.) to their destinations.

Table 11: 3+ Hour Taxi-Out Tarmac Delays by Time of Day (Push from Gate)
May 1, 2008 through April 30, 2010
Source: DOT Bureau of Transportation Statistics

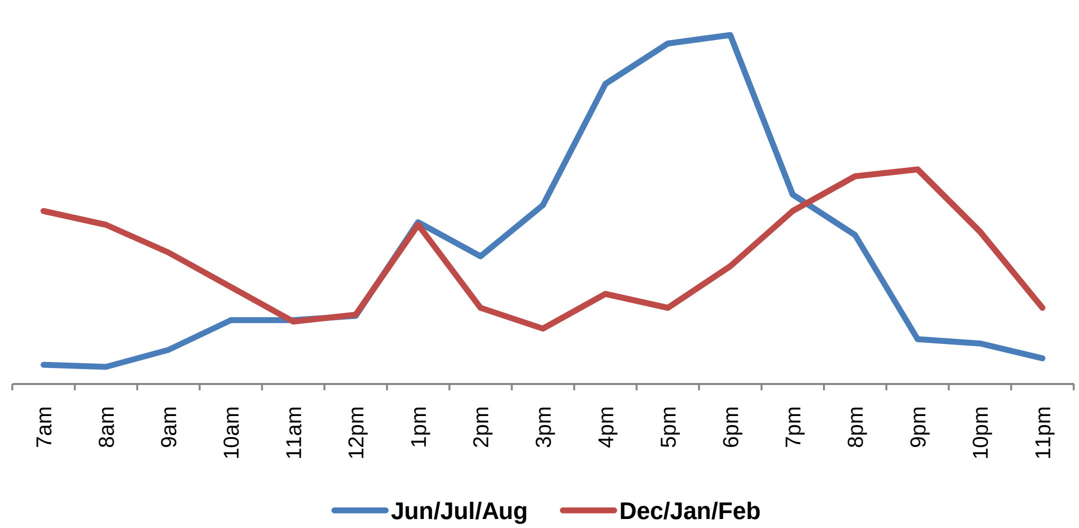
MONTH	***6-9am***	***9-12pm***	***12-3pm***	***3-6pm***	***6-9pm***	***9pm-6am***	***Total***	**% Mo.**
January	34	14	12	9	10	8	**87**	5.4%
February	13	8	19	12	12	21	**85**	5.3%
March	12	4	13	13	25	14	**81**	5.0%
April	2	16	4	8	14	5	**49**	3.0%
May	2	2	10	27	26	0	**67**	4.1%
June	20	9	40	148	122	28	**367**	22.7%
July	3	31	82	138	170	25	**449**	27.8%
August	5	36	45	97	30	1	**214**	13.2%
September	16	7	4	3	2	0	**32**	2.0%
October	0	0	3	35	9	0	**47**	2.9%
November	2	0	0	3	0	1	**6**	0.4%
December	12	18	13	11	45	35	**134**	8.3%
Total	**121**	**145**	**245**	**504**	**465**	**138**	**1,618**	100%
% Time	7.48%	8.96%	15.14%	31.15%	28.74%	8.53%	100%	

More detail in Appendix Five

For evening disruptions, many more passengers will spend the night stranded at the point of cancellation. The higher the network load factor, the longer the passenger re-accommodation time – and the more sensitive the time of day is when computing passenger delays from a disruption.

The distribution of tarmac delay times based on time of day demonstrates the different pattern of lengthy on-board taxi-outs during the winter and summer months. As Chart 4 below shows, during the winter months, tarmac delays related to snowstorms and other winter weather are evenly distributed through the day. Some occur in the morning, others in the evening. During the summer, convective activity in the afternoon is a clear driver of tarmac delay events.

Chart 4: Distribution of 3+ Hour Tarmac Delays by Time of Day
Meteorological Summer (June through August) and Winter (December through February)
Normalized Data. 1,618 Total Flights between May 2008 and April 2010



With limited gate availability and queues for aircraft deicing, airlines have historically boarded and pushed morning flights even if a long on-board delay is anticipated. Airlines position flights to take-off when conditions improve and allow another aircraft to turn at the gate. Long tarmac delays during December, January and February show more even distribution between morning, afternoon and evening hours.

The causal factors for summer tarmac delays are clear: afternoon thunderstorm activity that impacts both airports and the surrounding airspace, blocking departure pathways and reducing the "flow rate" into and out of major markets. According to NOAA, thunderstorms are most likely to happen "in the spring and summer months, and during the afternoon and evening hours."[40] The distribution of tarmac delays demonstrates a similar pattern. On an annual basis, 72% of tarmac delays occur between 1pm and 9pm. During the summer, 82% of tarmac delays occur in this period.

---

[40] National Severe Storms Laboratory, Weather Primer, Thunderstorm Climatology

The data confirm that (1) during the winter months, tarmac delays show a more even distribution through the day, suggesting that airlines may be able to manage exposure to tarmac delays under the new DOT regulations with strategic flight cancellations and advance planning; and (2) that summer tarmac delays are concentrated in the afternoon, are unpredictable, and that the alternative (ad hoc cancellations of flights with little or no notice) is likely to create significant harm to passengers who may wait a day or longer for an alternative flight.

Tarmac Delays are concentrated at specific airports and rare elsewhere

As the sections above have demonstrated, the majority of tarmac delays are summertime events, are concentrated on specific days with severe weather activity, occur in high frequency on these days, and are concentrated in the afternoon. But where do tarmac delays occur?

Diversion-related tarmac delays are well distributed across the United States, as aircraft divert into regional airports when their primary destinations are below approach minimums or closed due to severe weather or other operational disruptions. There is no discernable pattern to the distribution of diversion events. Similarly, taxi-in tarmac delays are now so rare that determining any meaningful patterns or groupings is difficult.

Taxi-out tarmac delays evidence a clear pattern, with the significant majority of occurrences in the corridor between New York (including LaGuardia, JFK and Newark), Philadelphia and the Washington area. There are isolated events in Atlanta (on July 14, 2008 and March 2, 2009), Houston (on December 11, 2008) and Dallas (on February 12, 2010) but few delays show repeatable patterns at any given airport outside New York.

Table 12: Distribution of Taxi-Out Tarmac Delays by City and Airport
May 1, 2008 through April 30, 2010 – NYC (LGA/EWR/JFK) and WAS (BWI/IAD/DCA)
Source: DOT Bureau of Transportation Statistics

Date	*TOTAL*	*ATL*	*BOS*	*CLT*	*DFW*	*IAH*	*NYC*	*PHL*	*WAS*	*OTHER*
7/24/08	**120**	2	2				56	38	19	3
7/14/08	**65**	21			1		29	7	5	2
7/27/09	**62**						35	26	1	0
6/11/08	**61**	1					48	7	3	2
7/28/08	**59**	3	4				38	4	1	9
8/15/08	**54**		1				47	4	2	0
6/15/08	**43**						41		1	1
6/10/09	**42**			1			27	3	9	2
12/11/08	**42**					42				0
6/27/09	**39**		1				37	1		0
3/2/09	**36**	23		11						2
8/12/08	**34**						28		2	4
2/12/10	**33**				33					0
8/11/08	**29**		1		2		21	2		3
5/28/08	**29**	1					24		1	3

This table demonstrates that long taxi-out delays are a symptom of an underlying cause: airspace congestion. A useful metric for measuring airspace congestion is the percentage of flights at a given airport that are reported delayed solely because of Air Traffic Control issues. This excludes events such as mechanical failure, weather, and airport-related security issues. During 2009, airlines reported airspace-related delays to DOT. We compare these reported delays by airport, and provide that airport's share of departures and 2+ hour tarmac delays for comparison, in Table 13.

Table 13: 2009 Taxi-Out Times of 2+ hours, Flights Delayed by Airspace Congestion Only, and Total Minutes of Airspace-Related Delay (as % of Total Departures)
Source: DOT Bureau of Transportation Statistics

Airport	***% of Flight Departures***	***% of 2+ hr Tarmac Delays***	***% of Flights Delayed by Airspace***	***% of Delay Minutes Caused by Airspace***
Atlanta	6.50%	6.51%	12.15%	12.45%
Boston	1.72%	2.41%	2.36%	2.85%
Charlotte	1.82%	2.70%	2.41%	1.93%
Dallas	4.11%	3.26%	3.60%	3.60%
Houston	2.84%	3.19%	3.15%	2.81%
New York Area	5.26%	29.27%	13.24%	19.24%
Philadelphia	1.45%	5.67%	2.59%	3.09%
Washington	3.84%	5.95%	2.86%	2.70%
"Big 8" Total	27.54%	58.96%	42.37%	48.67%
Other Airports	72.46%	41.04%	57.63%	51.33%
Total System	100.00%	100.00%	100.00%	100.00%

As Table 14 below shows, there is high correlation between tarmac delays and airspace congestion.[41] The key eight regions above represent 27.54% of flight departures. They represent 59% of tarmac delays, 42% of airspace-related delayed flights and 49% of the minutes spent waiting for airspace to open.

Table 14: Departure, Tarmac Delay and Airspace Congestion Correlation Matrix
Calendar Year 2009

Correlation	***% of Flight Departures***	***% of 2+ hr Tarmac Delays***	***% of Flights Delayed by Airspace***	***% of Delay Minutes Caused by Airspace***
% of Flight Departures	1.00	0.93	0.99	0.97
% of 2+ Hour Tarmac Delays	0.93	1.00	0.97	0.99
% of Flights Delayed by Airspace	0.99	0.97	1.00	1.00
% of Delay Minutes Caused by Airspace	0.97	0.99	1.00	1.00

Newark Liberty is a strong case in point. The airport sits at the crossroads of arrival and departure corridors for JFK, LaGuardia and Philadelphia. Newark represents 2% of system departures, 8% of 2+ hour tarmac delays, and fully 10% of the airspace delay minutes reported nationwide.

[41] We provide these tables in preparation for a predictive model.

As Newark demonstrates, the degree to which regional clusters of airports share arrival and departure paths through highly congested airspace drives the incidence of tarmac delays. As the next section illustrates, when arrival and departure corridors are lost or narrowed due to severe weather, aircraft at the major cities have nowhere to go.

<u>Tarmac Delays are driven by severe weather that blocks airspace in and out of congested airspace in a limited number of markets</u>

To confirm the correlation between tarmac delays, severe weather and airspace blockage, we researched weather conditions on the peak tarmac delay days during our focus period. We compiled severe weather advisories and NOAA weather summaries for high wind, severe thunderstorms and tornado activity.

Since each of the 10 peak events (with the exception of the December 11, 2008 event in Houston, Texas, caused by a lengthy and unpredicted snowfall event) occurred during the summer season and predominantly impacted the New York to Washington corridor, it is important to understand why flight operations in this region are interlinked, particularly during weather events.

Taxi-out tarmac delays are, at their core, a problem of gate availability, airspace capacity and flow rates. Flow is defined as the capacity of airspace to absorb new departures and remain in balance with arrivals. As a MITRE Center for Advanced Aviation System Development study demonstrated in 2001, the uniqueness of the New York area is the interdependency shared not only by the three major airports in the city (JFK, LaGuardia and Newark) but of Philadelphia and certain arrival and departure paths for the Washington area as well.[42]

The MITRE study demonstrated that the New York cluster (consisting of a triangle bounded by New York, Harrisburg and Washington) was the busiest airspace sector in the country. Chicago was the second-busiest sector with 53% of the arrivals and departures of the New York cluster, followed by Los Angeles with 48%. The three airspace sectors are of similar size.

With high density of peak airports in the cluster, the arrival and departure sectors (called "transition sectors") are narrow compared to other regions. Arrivals at New York, Philadelphia and Washington are concentrated into three compass sectors, unlike mid-continent hubs such as Chicago O'Hare and Dallas Fort-Worth, which use a four-point compass "corner post" strategy for transitioning aircraft to and from the airport.

In a corner post pattern, departures and arrivals are clustered into four channels in and out, oriented towards compass points. Airspace is relatively uncongested since traffic can be spaced out. While New York has four corner posts, the traffic flows only

[42] Beaton, E., DeArmon, J., Wanke, C., and Miller, S. *New York Airspace Effects on Operations.* MITRE Corporation (2001). The authors also published a similar paper in the *Handbook of Airline Operations* (Butler & Keller, 2000) as Chapter 34, *Complex, Congested Airspace and Impacts on Airline Operations.*

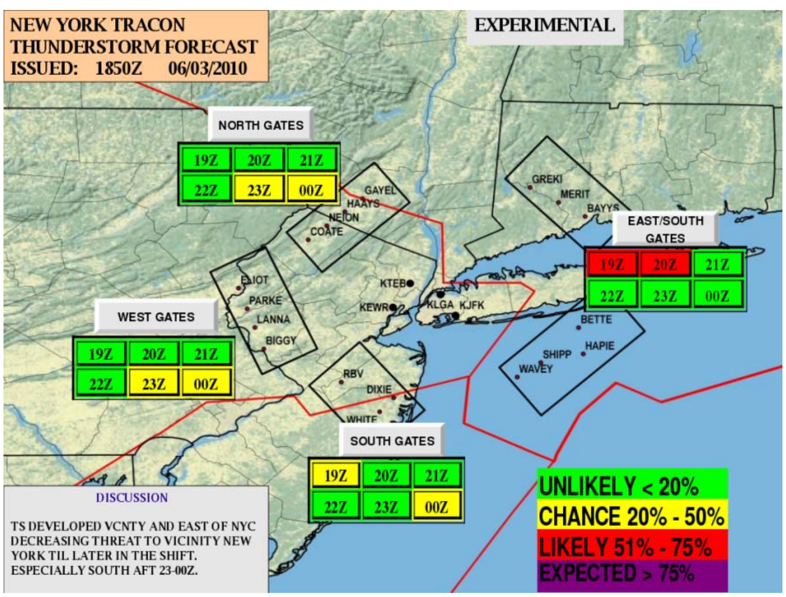
utilize three compass headings, with only the rare deep Caribbean and African flights utilizing the southeast quadrant, and most flights using eight fixes to the southwest.[43]

Traffic flows in and out of the New York cluster therefore focus arrivals and departures onto three compass points, which combined with duplicate flight operations at other busy airports reduces lateral variation among flight paths.

Departures and arrivals are laterally concentrated in the New York cluster, compared to other markets where traffic is more laterally spaced. Traffic arriving into Boston, Providence, Baltimore and Washington can cross arrival patterns into the New York airports. As a result, aircraft flying into and departing from New York area airports must follow narrow flight paths with little variability permitted for weather disruptions. Ground delay programs into and out of the New York area (that limit flow of traffic into blocked or congested airspace) can be caused by relatively minor weather events.

Given this layout of airspace, we researched weather conditions on days with peak tarmac delays. We found a strong correlation between regional, highly disruptive weather events and long, clustered tarmac delays across airports in the New York, Philadelphia and Washington areas.

Chart 5: Four corner-post layout of New York airspace
Source: NOAA (http://www.erh.noaa.gov/zny)



This weather graphic from NOAA demonstrates the four primary corner posts for the New York area airports, along with predicted thunderstorm exposure for each. Note that the corridors overlay flights into Philadelphia and Boston, and in some cases the Washington-area airports.

43 See Beaton (2001), Figure 1, Entries and Exits. The authors attribute this light traffic over the 135 degree compass point to Atlantic offshore identification and warning zones which limit traffic flows over these points. Chapter 34 of the *Handbook* provides comparative data for other New York airports as well.

July 27, 2009. A total of 62 flights experienced an average tarmac delay of 216 minutes per flight, distributed across JFK, LGA, EWR, and PHL. The tarmac delays were clustered between 3pm and 8pm. Weather research for this period demonstrated a severe thunderstorm line that impacted the region during this time period, with hail and high wind activity reported from New York through New Jersey.

July 24, 2008. A total of 42 aircraft experienced tarmac delays averaging 237 minutes at JFK, and another 38 aircraft experienced tarmac delays averaging 244 minutes at PHL. The tarmac delays were spread between 1pm and 9pm. Weather research indicated severe thunderstorm activity in central Pennsylvania with peak intensity between 5pm and 8pm that blocked departure corridors to the west.

June 11, 2008. A total of 33 flights at JFK experienced an average tarmac delay of 238 minutes, with concentration between 4pm and 8pm. Weather research confirmed that a large-scale frontal system with severe thunderstorms, hail and tornado activity first impacted central Pennsylvania (cutting off departure and arrival corridors) before impacting the New York region later in the afternoon.

The unique interdependence of the New York regional airports, along with Philadelphia, Washington and Boston, which share similar arrival and departure corridors, drives the incidence of tarmac delays in the region. Severe weather events are highly correlated to tarmac delays, as they block the key exit routes needed to clear traffic for take-off.

<u>Tarmac Delays are predominantly less than four hours – and very rarely the nine-hour debacles publicized by consumer groups</u>

Research into the correlation between lengthy tarmac delays and severe weather provides an explanation for another key data observation: the number of historical tarmac delays decreases significantly after four hours. Table 10 below illustrates the distribution of taxi-out flight delays per 100,000 annual departures for the period from 2000 through 2009. On average, 15 out of 100,000 departures is delayed more than three hours on the tarmac. Only 3 of 100,000 has a delay between 4 and 5 hours, and just 1 has a delay longer than 5 hours.

While very isolated cases do exist where passengers are trapped on aircraft for more than four hours, they are extremely rare in a transportation system with more than 10,000,000 annual departures. Most tarmac delays are between two and four hours in length.

A strong explanation for the incidence of delays in this time period is the duration of convective weather activity across airports and airspace. As the MITRE 2001 study demonstrated, the zone of airspace most sensitive to arrival and departure flows is a 100-mile radius of the airport facility. According to NOAA, average thunderstorms move at a forward velocity between 30 and 70 miles per hour.[44] A thunderstorm line is therefore

[44] http://www.nws.noaa.gov/om/brochures/tornado.shtml

likely to impact a given airport for between two and four hours in total, with a total stoppage of traffic for between 30 minutes and 90 minutes as the line transits the immediate airspace of the airport and interrupt departures and arrivals.

Table 15: Taxi-Out Delays by Time Category, per 100,000 departures annually
Source: DOT Bureau of Transportation Statistics

Per 100,000 Flights	***0-14***	***15-29***	***30-59***	***1-2hr***	***2-3hr***	***3-4hr***	***4-5hr***	***5+hr***
2000	55,372	37,288	6,416	788	105	23	6	1
2001	57,948	35,958	5,424	590	66	11	2	0
2002	58,468	35,872	5,037	535	70	14	3	2
2003	58,862	35,070	5,337	641	70	14	4	2
2004	56,526	36,316	6,254	791	94	16	3	1
2005	57,231	36,195	5,730	745	84	13	2	0
2006	56,814	35,857	6,328	892	90	16	3	1
2007	54,055	37,716	7,064	1,040	103	19	3	1
2008	55,182	36,826	6,927	961	86	14	3	1
2009	56,731	35,674	6,726	795	65	8	1	0
Average	**56,719**	**36,277**	**6,124**	**778**	**83**	**15**	**3**	**1**

<u>Most Tarmac Delays result in a completed flight</u>

An important factor in calculating the passenger costs and benefits related to tarmac delays is the proportion of lengthy tarmac delays that ultimately cancel. This ratio also provides a baseline for estimating the incremental cancellations from returns to gate under the new Tarmac Delay rules.

A core assumption with any extended tarmac delay is that the flight has a strong chance of completing, delivering passengers to their final destinations. The data from past years confirm this assumption: of 1,257 flights with a 3+ hour tarmac delay between October 2008 and April 2010, 1,147 (91%) of those flights completed with passengers at their final destinations. The remaining 110 (9%) flights cancelled, either on taxi-out or at the diversion airport where passengers were re-booked onto different flights to continue to their destination.

While most passengers have a strong preference to avoid lengthy tarmac delays, the alternative to an extended tarmac delay – a flight cancellation – can disrupt travel plans for days. At summer load factors of 85%, our research indicates that re-accommodation for passengers adds (on average) between 14 and 22 hours of travel time depending on network design, the time of day that the cancellation occurs, and the severity of the weather or airport event that causes the cancellation.

While the average across all passengers on a cancelled flight is between 14 and 22 hours, we estimate that up to 10% of passengers may not be re-accommodated at all within two full days after the event.[45]

Table 16: Completions vs. Cancellations for 3+ hour tarmac taxi-out delays
% Cxld. = (Cancelled) / (Cancelled + Completed)

	Comp.	*Cxld.*	*% Cxld*		*Comp.*	*Cxld.*	*% Cxld.*
Apr-10	4	0	0.0%	**Jul-09**	143	21	12.8%
Mar-10	16	9	36.0%	**Jun-09**	238	40	14.4%
Feb-10	56	5	8.2%	**May-09**	28	7	20.0%
Jan-10	19	2	9.5%	**Apr-09**	69	12	14.8%
Dec-09	30	5	14.3%	**Mar-09**	82	6	6.8%
Nov-09	4	0	0.0%	**Feb-09**	38	5	11.6%
Oct-09	12	0	0.0%	**Jan-09**	80	7	8.0%
Sep-09	6	0	0.0%	**Dec-08**	147	40	21.4%
Aug-09	63	7	10.0%	**Nov-08**	7	0	0.0%
				Oct-08	47	2	4.1%

Airport and gate constraints force a choice between cancellations and tarmac delays

Consumer groups claim that airline scheduling is the root cause of extended tarmac delays. While this statement is factually correct at the extreme (no flights scheduled would mean zero tarmac delays) systems analysis demonstrates that reasonable reductions in airline scheduling will not significantly reduce exposure to extended taxi-out tarmac delays.

If airlines reduce flight schedules by 50% while keeping all current airport and ground handling infrastructure in place, tarmac delays would be significantly reduced. Of course, airline costs would rise dramatically, available seats would be eliminated and the public welfare impact would be significant.

Understanding the link between airline schedules and tarmac delays is essential to considering what factors airlines can control. Reasonable enforcement strategies are based on measuring these controllable factors, and prosecuting cases where airlines willfully disregard passenger welfare when they could have chosen a different outcome. Unreasonable enforcement strategies enact penalties on airlines for situations where causal factors were uncontrollable, or where airlines were acting in the best interests of its passengers in responding to irregular operations.

Gate availability is a critical driver of tarmac delays; if an airline has available gate space, it can hold flights on the gate during severe weather events and wait until conditions improve before pushing back. Similarly, open gates allow inbound flights and diversions to disembark passengers without delay.

---

45 See Marks and Jenkins (2010). Average passenger delay at 85% load factor is 1,396 minutes for a JFK-modeled network with 90% of passengers re-accommodated within 36 hours of the cancellation event.

Gate availability explains why carriers operating at the same airport (and therefore subject to the same airspace constraints) can have significantly different rates of tarmac delays. If two carriers have similar schedules at the same airport, their overall delay time will be similar. But if one has more available gates than the other, a larger portion of delay time can be spent on-gate than on-tarmac.[46]

There are three models for gate operation in the United States: common use, where air carriers share individual gates at a terminal facility commonly operated by the airport authority or private organization; preferred use, where carriers have sole right to use gates owned by the airport; and private use gates where airlines have ownership and sole use of a specific gate. There are many reasons why airlines favor preferred- and exclusive-use facilities, including:

- Each airline has customized departure control software and other software tools for managing passenger boarding, loading and operational reporting;

- Ground equipment for that airline's specific fleet, including baggage loading devices, tugs, tow bars, baggage carts and other handling vehicles can be stored at the gate, instead of moved;

- Airlines have sufficient arrivals and departures at peak airports to make exclusive use cost-effective; and

- Preferred and exclusive-use gates keep out new entrants and are a competitive advantage.

Common-use gates are generally favored by airlines with few flights at a given airport. This includes smaller domestic airlines and international carriers who might serve a given city with one or two daily flights. Preferred- and exclusive-use gates are favored by major and regional airlines with multiple daily flights per gate, and exclusive-use gates are very common at major hub operations where they serve as a competitive deterrent.

Major airports in the United States offer gates on both a common-use and exclusive-use basis. At both New York JFK and Chicago O'Hare, domestic gates are exclusive-use in terminals owned and operated by each airline. International gates are available on a common-use basis, but these are limited in number. At other domestic airports such as Washington Reagan, the airport authority leases gates on a preferential basis, but there is not a minimum usage requirement for a set number of operations a day.[47]

The result of these leasing strategies by airports is a reduction in flexibility when one carrier's demand for gates exceeds the number of preferred- or exclusive-use gates

[46] For a more detailed discussion of gate availability, tarmac delays and cancellations, see the Inspector General report of September 27, 2007, *Actions Needed to Minimize Long On-Board Flight Delays*, Findings p6. The IG presents an analysis of JetBlue's inability on February 14, 2007 to accommodate tarmac-delayed flights on gates. The IG compares JetBlue's operational performance to American and Delta for that event.

[47] Metropolitan Washington Airports Authority, DCA Competition Plan p5

for that airline. During the afternoon and evening hours at major east-coast and central-US hubs, international flights park at common use gates. There is almost no “extra” gate capacity at these airports to absorb the increase in demand during extended tarmac delays.

For a specific example of how gate availability impacts tarmac delays, we analyzed JetBlue’s domestic flight schedule at New York JFK. JetBlue operates a network of 37 domestic markets from JFK with between 126 and 130 daily frequencies. The airline operates a mix of Airbus A320 and Embraer 190 aircraft from its exclusive 26 gate Terminal 5 at JFK. Constructed in 2009, this facility features wide taxiways and easy entry and exit from the airport taxiways.

The JetBlue domestic arrival and departure schedule for a Sunday in July 2010 is shown in Table 17. The flight schedule is based on between 5 and 8 aircraft remaining overnight at the terminal, depending on maintenance requirements.[48] Because JetBlue solely operates narrowbody aircraft, we assume that all gates are interchangeable. Full interchangeability will drive a conservative estimate of gate utilization, since widebody aircraft that require larger stands and/or multiple parking positions will further reduce gate capacity and flexibility for the carrier. We assume that JetBlue has sufficient ramp space around Terminal 5 to park three aircraft away from the gate during maintenance, extended turns, and spare availability, and that departures of international flights can occur from Terminal 4 if needed due to congestion at Terminal 5.

Table 17: Representative JetBlue July 2010 Schedule, JFK Gate Arrivals and Departures, Domestic

Includes departures and arrivals for Continental United States and San Juan

TIME	*ARR*	*DEP*	***TIME***	*ARR*	*DEP*
Overnight	1	0	**2pm-3pm**	6	9
5am-6am	8	0	**3pm-4pm**	6	5
6am-7am	7	5	**4pm-5pm**	5	9
7am-8am	9	8	**5pm-6pm**	6	5
8am-9am	8	12	**6pm-7pm**	4	10
9am-10am	7	11	**7pm-8pm**	6	7
10am-11am	3	4	**8pm-9pm**	10	9
11am-12pm	9	6	**9pm-10pm**	9	9
12pm-1pm	9	4	**10pm-11pm**	5	5
1pm-2pm	4	8	**11pm-12am**	4	1

We assume that all flights arrive and depart within the hour in which they are scheduled, and that the minimum turn-time (to unload, clean, cater, fuel and board an aircraft) at JFK is one hour. To test this assumption, we reviewed JetBlue’s actual flight arrivals and departures for JFK on April 15, 2010, as reported to DOT. For 86 identifiable aircraft turns (excluding aircraft that remained overnight, or that had turn

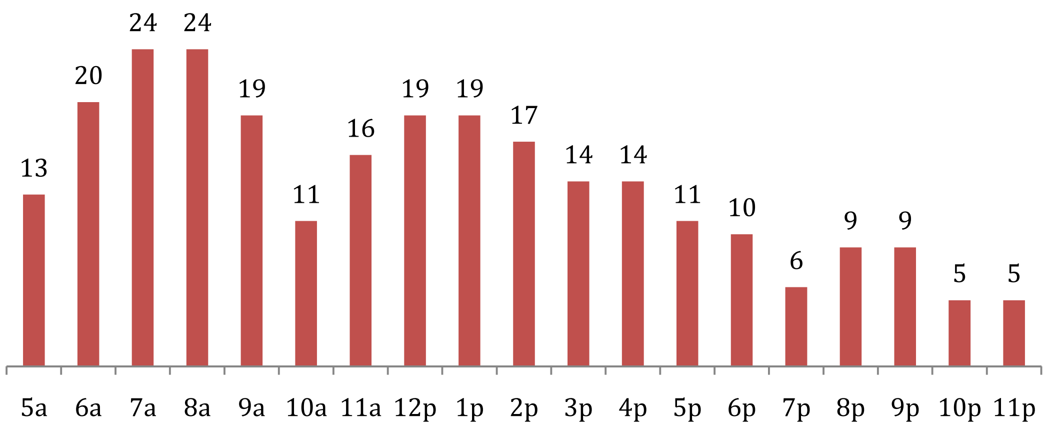
[48] Based on analysis of DOT Part 234 on-time reporting, April 15, 2010 schedule.

times longer than 8 hours (possibly indicating maintenance activity or other abnormal factors specific to that day), the mean turn time scheduled was 1:06 and the median turn time scheduled was 51 minutes.[49] We therefore conclude that a one-hour turn assumption is reasonable for JetBlue's JFK schedule.

While JetBlue may turn aircraft in longer than 1 hour (late night arrivals may not depart until the next morning), in our model no arriving flight is eligible to vacate a gate for one hour after arrival.

From this schedule, we developed a model to estimate peak gate usage during each hour of the day. With 26 gates available, if no operational disruptions occur that would cause gate delays in excess of one hour, JetBlue's flights do not require full utilization of every gate. While JetBlue may choose to fully utilize every gate – by having turn times longer than one hour, by departing international flights from the terminal, or by conducting maintenance activities at the gate instead of at a hardstand – the domestic operation will efficiently utilize a peak of 24 gates during the morning hours, with much lower gate utilization during the afternoon and evening hours. At least two gates can be made available at all times to accommodate delayed flights and ensure arriving flights can deplane quickly.

Chart 6: Standard Day Peak Gate Demand, Model Based on B6 JFK
Source: Marks and Jenkins, Model based on JetBlue Filed Schedule
26 Gates Available



What happens if airspace congestion or other weather factors impact JetBlue's New York operation? As discussed above, the severe weather and airspace congestion events that drive tarmac delays are primarily summertime afternoon phenomena. To assess the impact of disruptions of different lengths, we modeled an operational disruption that prevented all departures starting at 4pm. We reason that an operational disruption that prevents departures provides a choice for the operating airline: reduce the flight schedule through cancellations, thus freeing gates for arriving flights and later

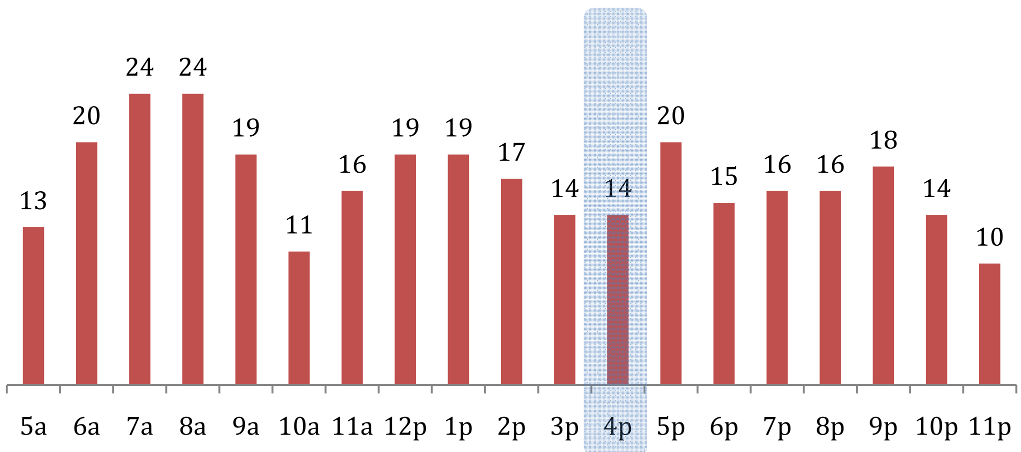
[49] For a complete list of identifiable aircraft turns for JetBlue at JFK on April 15, 2010, see Appendix 8.

departures, or board and push aircraft onto the tarmac, where passengers may experience a lengthy taxi-out.

We start by modeling the impact of a one-hour event. This is representative of an isolated thunderstorm event over the field. The disruption is assumed to start at 4pm and end at 5pm.

We observe that during a one-hour disruption, there is sufficient available gate capacity to absorb flights on the gate. The 9 departures during the 4pm hour are held on gate, and by 5pm the total gates utilized have increased from 11 to 20. From that point, normal arrival and departure activity resumes, but the backlog of flights extends through the evening hours. However, we would not expect to observe any significant tarmac delays in this scenario.

Chart 7: Gate Demand, 1 Hour Disruption at 4pm, Model Based on B6 JFK
Source: Marks and Jenkins, Models based on Filed Schedule
Blue Box indicates Operational Disruption



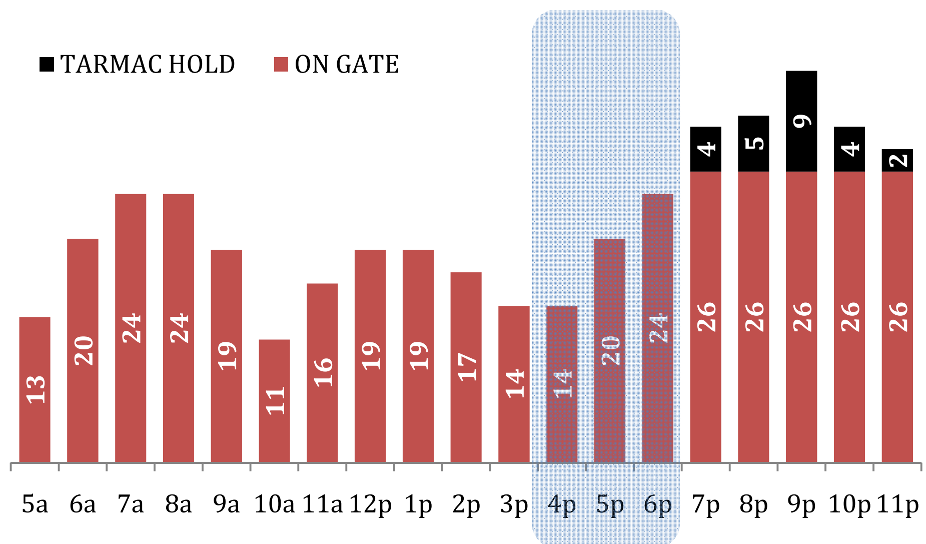
What happens with a three-hour disruption? Now the number of flights held on gate builds quickly as departing flights are held on the gate to comply with tarmac delay rules. As the event passes at 7pm, at least 4 aircraft are holding on the tarmac awaiting a gate. In the 8pm hour, the number of aircraft queued for gates increases to 9. In this scenario, extended tarmac delays are likely. Tarmac delays result from the airline choosing to push the aircraft without the high probability that the aircraft will depart within a reasonable period of time.

In the past, JetBlue would have responded to this operational disruption with a combination of cancellations and tarmac delays. A likely scenario would include cancellation of short-haul flights with high frequency and lower load factors, particularly in markets where other transportation options exist. The 5:15pm Washington, 5:24pm Boston, 4pm Chicago O'Hare, 5:30pm Orlando and 6:10pm Fort Lauderdale flights could be targets for cancellation, since additional frequencies that evening and alternative means (e.g. bus and train) for transportation exit. Longer-haul, lower-frequency operations to Austin, Denver, Phoenix, San Diego, San Jose, Portland and Seattle would likely push from the gate and hold on the tarmac to await departure – rebooking passengers on those flights could take 24-48 hours depending on system loads.

We conclude from this model and Chart 7 that for a generic three-hour operating disruption, the new tarmac delay rule is likely to generate approximately 24 cancellations that otherwise would have become extended tarmac delays. Of 126 daily departures, this represents 19% of flights scheduled for that day.

From this example, we also observe why returning to the gate is impractical, if not impossible. There are simply no gates available, and to free a gate means the likely cancellation of another flight.

Chart 8: Gate Demand, 3 Hour Disruption at 4pm, Model Based on B6 JFK
Source: Marks and Jenkins, Models based on Filed Schedule
Blue Box indicates Operational Disruption

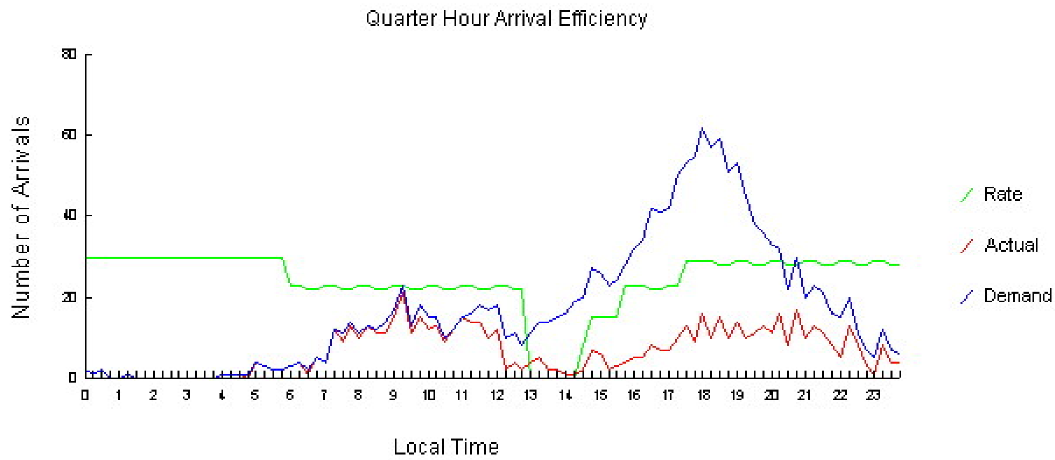


Each airport and airline operation will have a different "trigger" point where operational disruptions cause extended tarmac delays and/or cancellations. The same patterns shown above with a schedule based on JetBlue's JFK operation can be seen in actual FAA data regarding operations and departures at a whole-airport scale.

The following chart is from the FAA Aviation System Performance Metrics (ASPM) data set for Dallas Fort-Worth Airport on May 14, 2010. On this date, a three hour weather event similar to the disruption modeled above occurred between 12pm and 3pm. The airport was completely closed between 1pm and 3pm, causing hundreds of flight cancellations across airlines. American Airlines alone cancelled more than 300 flights; we analyze this case study in Section Four.

The FAA ASPM chart demonstrates that after an operational disruption, there is a "bulge" of inbound aircraft. The bulge exceeds both runway and airport terminal capacity, resulting in significant cancellations. This pattern exists across airports and is a function of the length and severity of the operational disruption.

Chart 9: Dallas Fort Worth Airport, Capacity (Rate, Actual and Demand)
Source: FAA ASPM



Modeling the incidence of such events requires comprehensive integration of airline schedules, operating histories, passenger re-booking and protection strategies, and airspace capacity. JetBlue's operation at JFK provides an informative but not conclusive example to illustrate how longer operational disruptions force airlines to free gates through cancellations and tarmac holds.

<u>Flight scheduling cannot reasonably reduce exposure to tarmac delays</u>

The airport examples above illustrate another key point about tarmac delays: moderate schedule changes to reduce capacity will not eliminate exposure. Airlines plan schedules based on gate availability factors, allowing for moderate disruptions. For an airline with reasonable surplus gate capacity, a one-hour closure of the airport can be absorbed without material cancellations. Flights will be delayed, either at gate or on the tarmac, but aggregate delays will be less than 3 hours.

The severe weather events that cause the clusters of tarmac delays observed are rare. During the summer of 2009, tarmac delays at JFK were clustered onto just four days with abnormal weather both in the immediate New York area and in Pennsylvania airspace that blocked departure corridors from the airport. When setting summer schedules months in advance, airlines cannot know which days will be impacted by these conditions. The random nature of severe weather makes the prediction of thunderstorm activity on a specific day an inexact science.

Based on our analysis of JetBlue's JFK schedule, we estimate that to absorb a three-hour delay without multiple cancellations or tarmac delays, on JetBlue's current flight schedule a total of 35 gates would be required. Given that on a normal weather day the airline uses 24 gates at peak, and between 10-20 gates during most of the day, this represents an excessive capital investment that would translate to higher fares for passengers.

We are also not optimistic that the availability of extra common use gates at airports will have a material impact year-round on tarmac delays. As we have demonstrated, tarmac delay events impact multiple airlines at an airport. During winter disruptions, airlines may demonstrate differential strategies in cancelling flights into an impacted airport. The availability of common use "reliever" gates would likely cause more carriers to gamble on sending flights into impacted airports, with the expectation that aircraft can be parked at common-use gates if that carrier's primary gates are full. Similarly, during summer severe weather, all airlines at an airport are impacted. A high number of common use gates would be required in order to satisfy demand from all airlines. It would be difficult, if not impossible, to finance construction and operation of common facilities that would be used between five and ten days per year.

Conclusions

In the sections above, we have illustrated the seasonal nature of tarmac delays and demonstrated that flight schedule reductions at key airports will not eliminate exposure to tarmac delays. With fixed gate constraints, airlines face a clear choice during irregular operations: cancel flights, or push from the gate before weather or airspace clears and risk a tarmac delay.

In the past year, consumer groups have expressed a strong preference for cancellations over extended tarmac delays. We have demonstrated that taxi-out tarmac delays are caused by different factors than diversion and taxi-in delays, that diversion delays cause the extended consumer suffering that generates media attention, and that taxi-in delays are extremely rare after 2007 policy changes by airlines.

Should consumer groups take the position that cancellations are preferable to taxi-out tarmac delays? As we have shown, during the winter months, airlines have better forward visibility of winter storms that impact certain airports. Flight cancellations can be planned hours, if not days, in advance, and customers can be notified. Winter load factors are lower than summer load factors – in 2009, the January systemwide load factor was 72.82%, while the peak summer load factor in July was 87.09%. Except for winter flights to warm leisure destinations, there are generally ample available seats to re-accommodate passengers on cancelled flights during the winter when the weather clears. Based on our analysis, we agree that pre-cancelling flights during the winter is preferable from a passenger perspective to extended tarmac delays. The airlines agree too as flight cancellation rates peak in December and January.

Winter tarmac delays are caused by other factors – extended lines for aircraft de-icing, dangerous freezing rain and unpredicted storms. Compared to summer months, these events are rare, but we expect that airlines will respond to new tarmac delay rules by increasing cancellation rates in advance of snowstorms, particularly at airports where gates are constrained.

Our concern focuses on the summer months, when the following conditions compound, increasing passenger misery.

- Severe weather occurs with higher frequency, often predicted less than 24 hours in advance when advance cancellations are no longer possible.

- Flight operations peak as airlines add flights to accommodate both business and leisure passengers.

- Passenger load factors peak, meaning that few if any seats are available and stranding passengers on cancelled flights for days.

In prior research, we have established that ad-hoc, short-notice cancellations during the summer months have a significant and damaging effect on consumers. Re-accommodation averages between 13 and 20 hours, and in many cases at least 10% of passengers will not find seats on available flights within two full days after the cancellation occurs.

Systemic analysis of tarmac delays demonstrates the importance of pushing aircraft from the gate, even without a confident departure time, to free capacity for other flights. Re-scheduling, de-peaking and capacity changes will not solve the core exposure to long-term severe weather events that close airports for hours, or congest key airspace. During the winter, flight cancellations are less disruptive for passengers, but during the summer months, they can significantly disrupt travel plans and cause harm.

SECTION FOUR: AIRLINE PROCEDURES AND CASE STUDIES

Because the introduction of revised tarmac regulations took effect on April 29, 2010, there is limited information available through public sources to estimate the impact of new rules on flight cancellations, tarmac delays and passenger welfare. In May 2010, there were lengthy operational disruptions which merit examination, and we present focused case studies in this section to illustrate how the DOT rules change airline operating decisions and impact consumers. Before reviewing actual data, however, it is important to assess the operational decision-making at airlines regarding lengthy tarmac delays and how airlines have managed exposure to potentially punitive fines.

The uncertain enforcement strategy of DOT has driven ultra-conservative behavior by airlines to minimize exposure to fines. The uncertainty about enforcement has been compounded by the Secretary's April 2010 commitment to "strong enforcement" that parallels the maximum-fine enforcement levied against Toyota.

The consumer problem is that excessively conservative behavior by airlines, while virtually guaranteeing that tarmac delays will be close to zero, negatively impact hundreds of thousands of passengers each year who otherwise would have completed their flights. A multi-million dollar fine represents between 200 and 300 times the revenue that an airline would earn from completing a flight operation.

As rational agents, airlines will take action for any flight that has a 1% chance of bumping against the 3 hour limit. For illustration, consider an airline that has 100 flights, each with 100 passengers who paid $175 apiece for that flight. Based on the weather forecast and airport operations, the airline determines that each flight independently has a 99% chance of departing or successfully returning to gate before the three hour limit, and a 1% chance of violating the three-hour limit.

Without intervention, the airline is likely to have one violation and a possible $2.75 million fine. If the airline proactively intervenes and cancels every flight, in a worst-case scenario where 100% of the passengers request refunds in lieu of traveling on later flights, the airline is only out $1.75 million of revenue. 10,000 passengers are inconvenienced, while 100 passengers are spared a tarmac delay.

Prior to the introduction of tarmac delay rules, the pilot-in-command of a given flight had the final authority in most cases to complete or terminate the flight. The pilot could judge whether departure was likely, whether conditions on the aircraft were deteriorating, or whether passenger disembarkation should occur. The pilot coordinated with ramp and ground personnel for the airline when required, and worked with the FAA to re-plan flights around blocked airspace.

Under the new rules, the prospect of punitive fines has transferred decision making from the cockpit to the airline's operations control center. The time required to taxi back to the gate during a severe weather event is uncertain, and as illustrated in the previous section, aircraft may need to wait for a gate to open once they return to the ramp. As a result, airlines have introduced sequential thresholds at which pilots, dispatchers and airline managers make coordinated decisions about aborting a flight.

We analyzed how these changes have been implemented at two large airlines, Delta Air Lines (the largest US carrier) and American Airlines. We selected these carriers because they represent two different approaches with the same objective: minimize any possible exposure to the tarmac delay rules. For each airline, we review the changes in policy and examine a case study from May 2010 to project how the tarmac delay rules are likely to impact operations system-wide over time.

Delta Air Lines

Delta Air Lines ("Delta"), formed by the 2008 merger of Delta and Northwest, employs more than 70,000 worldwide and operates more than 700 aircraft. The airline carries more than 160 million passengers each year on 13,000 daily flights to 369 destinations with 10 connecting hubs (seven domestic and three international). Delta is the largest carrier in the United States and the third-largest carrier in the world.

Delta's network has significant exposure in key eastern markets that are prone to tarmac delays. Hub operations in Atlanta and New York are impacted by severe weather during both the summer and winter seasons. The airline has extensive operations in Washington, Boston, Cincinnati, Detroit, and Minneapolis, and all experience severe weather on a frequent basis. During the rulemaking period Delta took a vocal role in debating the merits of tarmac delay rules.

Taxi-Out Delays. In March 2010, Delta adopted new taxi-out procedures across its domestic network in response to the new tarmac delay regulations. These new procedures took effect on March 15, 2010. The new policy is outlined in Table 18. Once a flight hits the mandatory return threshold, or once a flight crew is instructed to return to gate, the flight crew may not continue the flight even if departure is imminent.

Table 18: Taxi-Out Delay Operating Checkpoints, Delta Air Lines
Source: Delta

Time from Push-Back	*Checkpoint*	*Action Required*
2 hours from push	Food and water	Pilots confirm that food and water has been distributed. Pilots and cabin crew inform passengers of the DOT rule and Delta's compliance strategy.
2 hours from push	Flight return assessment	Delta's operations center conducts a review of the delayed flight and flags the operation for further action.
2:15 from push	Flight return decision	Unless takeoff is certain within 30 minutes, the flight is recalled to the gate.
2:30 from push	**Mandatory return**	The aircraft returns to the gate **even if departure is imminent** except in extraordinary circumstances.

For international operations, Delta implemented a four-hour threshold. The international thresholds are identical to the domestic series, but with one hour added (except for food and water, which remains at 2 hours). For example, on international flights, the Flight Return Assessment is conducted at three hours after push, the Flight Return Decision occurs fifteen minutes later, and the Mandatory Return occurs at three hours and thirty minutes past push-back.

Flight Diversions and Taxi-In Delays. For diversions and taxi-in delays, Delta has adopted more stringent limits than mandated by the Department of Transportation. Delta requires aircraft to be at the gate within 90 minutes of landing, whether or not the aircraft has arrived at its final destination or diverted to an on-line or off-line airport. Delta instructs the flight crew and dispatchers to coordinate action for any flight that is approaching the 90 minute threshold, with coordination across the local airport and ramp tower to ensure the aircraft is deplaned promptly. Senior operations managers are notified at one hour after landing.[50]

At major hubs, Delta tightly coordinates with airport authorities to access common-use or other-airline gates when required. For Atlanta Hartsfield, Delta's largest hub, local station personnel coordinate with Atlanta airport managers once an arrival delay exceeds 75 minutes.

Another major US airline, United, has adopted a set of policies similar to Delta's. United has a mandatory return to gate policy at 2.5 hours after push-back. International flights are limited to a 4.0 hour taxi-out. United also monitors inbound taxi delays with a 60 minute target maximum time to deplane after arrival or diversion. [51]

American Airlines

American Airlines is the second largest US carrier and operates a global network with service to South America, Latin America, Europe, Asia, India and the Caribbean. The airline operates 620 aircraft (plus another 270 regional aircraft under the wholly-owned American Eagle subsidiary) to 250 destinations in 40 countries with more than 3,400 daily flights.

American has taken a more flexible approach to managing extended tarmac delays than Delta, preferring to allow systems operation personnel and pilots to coordinate action on a case-by-case basis. Prior to the new tarmac delay rules taking effect, American had flagged flights for further action after two hours of taxi time.[52]

American has responded to the new regulations by adjusting its operating and on-board procedures as follows:

---

[50] Delta ATL Station Plan of Action, 4/2/07 (ATL IROPS Extended Delay Coordination Plan, October 10, 2009)

[51] United Air Lines Extended Tarmac Delay Policy, April 29, 2010 (united.com)

[52] Delta ATL Station Plan of Action 4/2/07

- First, flight attendants have been instructed to provide verbal notice when passengers are not permitted to deplane at the gate. The DOT Office of Enforcement has provided specific guidance that enforcement will be based on the last time customers are permitted to deplane, not necessarily the time the aircraft departs the gate.

- Second, American has adjusted its internal notification procedures to identify flights with between a one and two hour tarmac delay. These flights are flagged for further action but no immediate decision is made until two hours of taxi time. Automated software tools sort active flights by taxi-in and taxi-out time. Automatic paging systems notify senior managers.

- One justification for American's case-by-case approach is the wide variation in taxi-in times across its system. At Dallas, returning to the gate is facilitated by a network of taxiways that bypass active runways. At LaGuardia and O'Hare, interlinked taxiways and runways may not allow return to gate on an expedited basis.

- Third, at two hours of taxi-out, unless take-off is imminent, a decision is made to return to the gate. If the decision is made to prolong the taxi delay beyond two hours, the decision requires concurrence by senior operating team members.

Like Delta, American has set stringent thresholds to ensure that flights do not approach three hours of tarmac time. Unlike Delta, American has high volume of operations at airports where gate availability is at a premium, forcing American to be aggressive with cancellations and diversions. Historically, this is evident by American's diversion ratio. In 2009, American diverted 1,881 of 551,597 flights (0.34%), and of these 1,881 flights, a total of 1,771 (94%) continued to their final destinations. Delta, which operates a network of comparable scope into similar metropolitan markets, diverted 1,027 of 427,007 flights (0.24%) of which 93% continued to final destinations.[53]

Case Study

Through flight arrivals and departures information, we identified a large-scale disruption at Dallas Fort-Worth airport on May 14, 2010 that impacted hundreds of flights and caused widespread diversions. We interviewed American Airlines operations personnel on June 8, 2010 about the incident and (unless noted) have based our analysis on publicly available schedules and operational data released by DOT.

Rain and thunderstorms were forecast for the morning of May 14, 2010 as part of a frontal boundary passing through Texas. Both the National Weather Service and American Airlines' meteorologists did not expect the storms to be severe. The NWS forecast called for a 40% chance of scattered rain showers. During the morning, the weather patterns suggested that severe thunderstorm activity was possible after 11:00am,

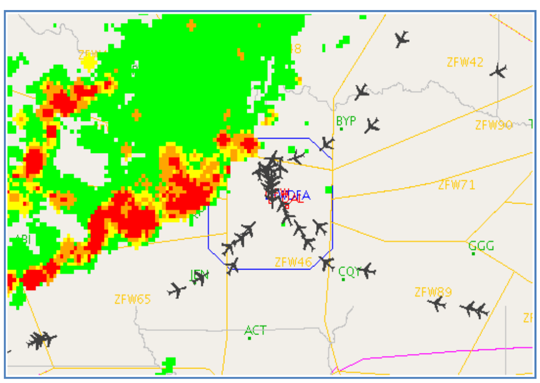
[53] Transtats, Summary Statistics by Airline, 2009

and radar confirmed that a line of severe weather was developing that could impact the DFW airport. By noon local time, the NWS issued a Severe Thunderstorm Warning for the area around DFW forecasting winds in excess of 60 mph and heavy rainfall. While the severe cell was moving southeast at 20 mph, the line was not showing significant movement.[54]

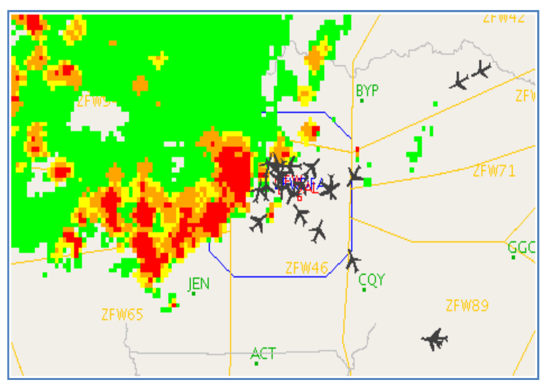
At 11:00am local time, the northwestern cornerpost (UKW) into DFW was blocked. ATC redirected traffic onto the remaining three cornerposts (BYP, JEN and CQY) impacting traffic flows. The reduction in traffic flows caused the first three diversions of the day. At 11:30am, the FAA and AA implemented a ground-delay program for American's operations at DFW, expecting that the approaching thunderstorm line would trap aircraft on the ground for a prolonged period of time. At 12:00pm, the severe weather crossed the field boundary, stopping traffic altogether.

Chart 10: Weather and Flow Patterns, DFW Airport, May 14, 2010
Source: American Airlines Operations Center

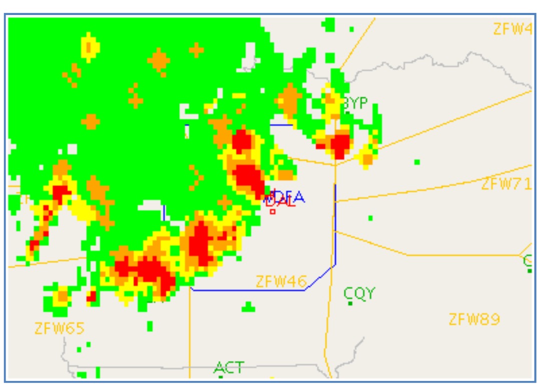
11am Local Time



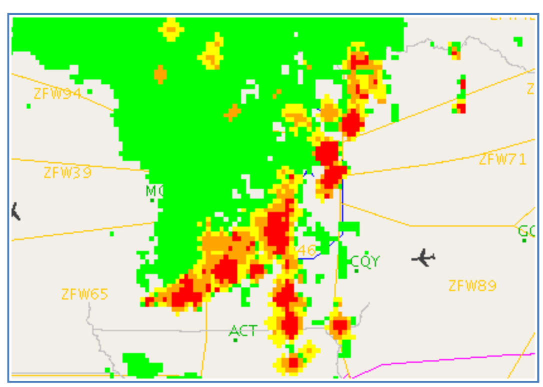
12pm Local Time



1pm Local Time



2pm Local Time



---

54 NWS WUUS54 KFWD 141658 1800Z

The severe weather over the airport continued unabated until 3pm local time. During that time, American diverted 66 flights and cancelled more than 308 flights both at DFW and at spoke cities. Of these 308 flights, American estimates that 150 would have operated but for exposure to the tarmac delay rules. These 150 flights represented inbound and outbound aircraft where taxi-times were uncertain, and where there was a material risk of an extended tarmac delay. As the JetBlue gate model demonstrated in the previous section, with gate constraints, airlines must choose between tarmac delays and flight cancellations. American elected to pursue a combination of diversions and cancellations.

Using operational data reported by American Airlines to DOT, we have identified the flights cancelled at DFW airport on May 14 due to the weather event. Of the 308 flights cancelled, 147 were flights scheduled to arrive at DFW and 161 were departures from DFW to other cities. Just 10 flights were cancelled prior to 12pm. A complete roster of flights cancelled that were scheduled into or out of DFW on May 14, 2010 between 12pm and 9pm is shown in Table 19 below.

Table 19: American Airlines Flights Cancelled, DFW, May 14, 2010, 12pm-9pm
Source: DOT On-Time Performance Data

Hub Arrival & Hub Departure Times	*Arrivals Cancelled at Origin Airport*	*Departures Cancelled at DFW Airport*
12pm-1pm (9 flights)	SAT (1 total)	ATL, BNA, BWI, IAH, ICT, OKC, PDX, SEA (8 total)
1pm-2pm (26 flights)	COS, DEN, IAH, MCI, OMA, ORD, SAT (7 total)	DAY, DCA, DEN, ELP, EWR, LGA, MFE, ORD, ORF, PBI, PHX, PIT, SAT, SFO, SNA, TUL, TUS, XNA (19 total)
2pm-3pm (35 flights)	ABQ, BNA, ELP, LAX, MIA, OKC, PHX, SNA, TUS, XNA (10 total)	ABQ, ATL, AUS, BNA, CMH, DTW, ELP, HSV, IAH, JAX, LAS, LAX, LGA, MEM, MIA, OKC, ORD, RDU, RSW, SAT, SJC, SLC, SNA, STL, TPA (25 total)
3pm-4pm (21 flights)	BWI, IAH, ICT, MIA, ORD, PHX (6 total)	ABQ, AUS, BHM, COS, DEN, ELP, ICT, LAS, LAX, LGA, MCI, OMA, SAT, SDF, SFO (15 total)
4pm-5pm (35 flights)	AUS, BUR, DEN, JAX, LAX, LGA, MEM, MSP, ORD, PSP, SAT, SEA, SFO, SLC, STL, TUL (18 total)	BNA, BWI, CLT, FLL, LGA, MCO, MEM, MIA, MSY, ONT, ORD, PHL, RDU, SEA, SMF, TPA, TUL (17 total)
5pm-6pm (31 flights)	ABQ, ATL, BNA, DCA, ELP, IAH, LGA, MCO, MFE, OKC, OMA, ORD, PHL, RDU, RNO, SAN, SAT, SFO, SMF, SNA, TUS (21 total)	ATL, DEN, IAH, LAX, MSP, OKC, ORD (2), STL, TUS (10 total)
6pm-7pm (34 flights)	ABQ, ATL, AUS, BNA, EWR, IAD, MCI, MCO, MEM, MSY, ONT, ORD, PDX, SAT, STL, TPA (16 total)	BNA, COS, IAD, JAX, LGA, MSY, OMA, ORD, ORF, PBI, PDX, PSP, RSW, SAN, SEA, SLC, SNA, TUL (18 total)
7pm-8pm (21 flights)	BHM, BWI, DAY, ELP, HSV, ICT, OKC, PBI (8 total)	ABQ, AUS, BOS, BUR, DCA, EWR, MCI, ORD, PHX, RDU, RNO, SFO (13 total)
8pm-9pm (37 flights)	ABQ, ATL, BOS, CMH, DCA, DEN, ELP, FLL, IND, JAX, LAS, LGA, MCI, MEM, MFE, MSY, ORF, PIT, RSW, SDF, SJC, SLC, TPA (23 total)	ATL, IAD, IAH, IND, LAS, MEM, MFE, ORD, PDX, PHL, SAN, SDF, SJC, TPA (14 total)

We can draw three core conclusions from Table 19.

First, the cancellation of a flight segment at either a spoke or hub airport due to tarmac delay concerns necessitates a follow-on cancellation when hub arrivals and departures are balanced. Flights that cancelled at DFW during the weather event (instead of holding on the tarmac) caused follow-on cancellations later in the day.[55]

Second, gate availability can be traced as a direct causal factor in arrival cancellations through the mid-afternoon, when weather had cleared but the impact of cancelled outbound flights had yet to be felt. With aircraft still on gate at DFW, there was nowhere to de-plane aircraft at the hub. This pattern supports American's assertion that cancellations could have been prevented with moderate tarmac delays.

Third, events of this magnitude create prolonged disruption for passengers that may extend rebooking time significantly. Of the 161 departures cancelled during the event, 8 were flights to Chicago O'Hare; 7 to San Antonio; 5 to Nashville, Denver and New York LaGuardia; and 4 each to Albuquerque, El Paso, Houston, Las Vegas, Los Angeles, San Francisco and Santa Ana. Three flights were cancelled to each of 16 cities. Based on our modeling, that magnitude of backlogged passengers would have created very long re-booking times in excess of 18 hours.

Based on this analysis, we conclude that a 20% estimate for flight cancellations during a specific day related to a weather event can be supported by quantitative review. We also conclude that tarmac-related cancellations cause follow-on cancellations of return or onward flights at a minimum 1:1 ratio at airports with balanced arrivals and departures.

Estimating the Impact of Tarmac Delay Rules on Systemwide Cancellations

This operational event represented the worst-case scenario for airline operations that strikes relatively infrequently, but causes profound disruptions for passengers when it does. It is helpful to extrapolate how American's response to this weather event can predict the general impact over the long term of tarmac delay rules on cancelled flights.[56]

Based on our analysis of historical tarmac delays, we identified 29 weather events during calendar year 2009 that approximated the severity of the DFW incident on May 14, 2010. These incidents were spread across New York (11 of 29), Philadelphia (5), and other major hub airports nationwide.

---

[55] There is significant operational research demonstrating the impact of follow-on cancellations in airline networks after major system disruptions. See Bierlaire, M. *et al*, *Column Generation Methods for Disrupting Airline Schedules* (2007), and Kohl, N. *et al*, *Airline Disruption Management: Perspectives, Experiences and Outlook* (2004). Both demonstrate that out-and-back cancellations are strategies for airline recovery after a disruptive event.

[56] We note in the next section that cancellation rates are likely to differ in the long-term and the short-term. This analysis focuses on long-term factors where a fine structure is defined and is punitive. In the next section we note the extreme uncertainty that results from an unknown enforcement paradigm and the pre-cancellations that result, causing much more disruption than the long-term estimates will predict.

On May 14, 2010, American attributed the cancellation of 150 of its 748 daily flights to the tarmac delay rule, or 20.1% of aggregate flights for the day. Our gate scheduling models generate similar results for disruptions of the same length. In the JetBlue JFK simulation presented above in Section Three, a three-hour tarmac delay causes 3-hour exposure for 24 of 126 sample flights, or 19%. Based on this modeling, we conclude that American's pro-active cancellation strategy on May 14th impacting 20% of daily operations is representative of overall industry actions during similar situations.

Direct Cancellations

If 20% of flights are likely to be cancelled during three-hour severe weather events due to tarmac delay factors, we can model the number of flights and passengers per year that will be impacted *at airports where the operational disruption occurs*. Our methodology is to:

- Identify the major airports where three-hour weather events are common and weight those airports by frequency of events. This is based on historical analysis of tarmac delays over the period from October 2008 through April 2010.

- Calculate the number of severe events comparable to the May 14, 2010 incident at DFW likely to occur, on average, annually at each airport.

- With an assumption that 20.0% of daily flights will be cancelled due to the tarmac delay rule at impacted airports (supported by the 19.8% result from our models and 20.1% demonstrated by American on May 14, 2010), we calculate the incremental cancellations from the tarmac rule each year.

- Based annual passenger domestic enplanements and annual scheduled (revenue) flights for each airport, we calculate the average passengers per flight and therefore the total passengers impacted each year by these incremental cancellations.

To calculate the direct incremental impact, we use the following variables:

Flights	Annual domestic flights from the selected airport
Weighting	Percentage of annual events (29) that occur at the selected airport on average in a given year
Weather Events	Number of annual events (of 29 total nationwide) that occur at the selected airport
Flights Cancelled	20.0% of daily flight operations per model times the number of of Weather Events
Domestic Pax	Number of annual domestic passenger enplanements
Passengers/Flight	Number of domestic passengers per domestic flight departure
Impacted Passengers	Flights Cancelled * Passengers/Flight

Table 20: Calculating Direct Impact of Three-Hour Tarmac Rule Cancellations
Source: Traffic Data from BTS Transtats

Airport	*Domestic Flights*	*Relative Weighting*	*Wx Events*	*Flights Cxld*	*Domestic Pax.*	*Pax/ Flt*	*Impacted Pax*
New York JFK	130,771	31%	9	645	12,013,938	91.9	59,256
New York LaGuardia	160,935	17%	5	441	10,540,878	65.5	28,885
Newark Liberty	145,124	14%	4	318	11,283,497	77.8	24,725
Philadelphia	191,323	14%	4	419	13,146,192	68.7	28,790
Washington Dulles	121,597	10%	3	200	8,173,190	67.2	13,443
Dallas Fort Worth	281,659	3%	1	154	24,280,857	86.2	13,276
Houston Intercontinental	212,619	3%	1	117	15,446,782	72.7	8,500
Atlanta	437,074	3%	1	239	37,829,938	86.6	20,686
Boston Logan	146,630	3%	1	80	10,813,926	73.7	5,900
			29	**2,613**			**203,461**

On the assumption that all airlines act to minimize exposure to fines, we conclude that the introduction of the tarmac delay rules will have a significant incremental impact on flight cancellations. We estimate that more than 2,600 flights will be cancelled directly at impacted airports *that would not have been cancelled prior to the rule*. We expect that over 203,000 passengers will be displaced for 21 or more hours that would otherwise have traveled to their final destinations with an average 2.7 hours of incremental tarmac time.[57]

Is this a reasonable assumption? In 2009, 50,579 flights experienced taxi times of between 1 and 2 hours, 4,109 flights experienced taxi times between 2 and 3 hours, and 604 experienced taxi-out times greater than 3 hours. For the reasons explained at the beginning of this Section, we expect that airlines will cancel before push-back flights that have a possibility of bumping against the three hour limit. We also expect that the significant majority of the 4,700 annual flights (on average) with taxi times greater than two hours will return to the gate, and a portion of those flights will cancel. Our 2,600 flight estimate for direct cancellations represents a meaningful but not unreasonable portion of these impacted flights.

Indirect Cancellations

As illustrated in the Dallas Fort-Worth case study, the cancellation of a hub flight almost always results in a follow-on cancellation of the return flight from a spoke city. Similarly, cancellations from a spoke city almost always result in the cancellation of a later flight from the hub. There are two reasons for indirect, follow-on cancellations: aircraft availability and ferry avoidance.

Aircraft Availability. Airlines will schedule aircraft for round-trip flights from a hub to a spoke city. A flight will originate from the hub, fly to the spoke city, turn, and return back to the hub. Based on American's May 14, 2010 filings with DOT, 45% of

[57] See Table 21 for full calculations.

their spoke flights were scheduled as out-and-back operations.[58] When the outbound flight cancels, there is no aircraft in position to operate the return flight. As a result, a return flight is cancelled. This results in a 1:1 ratio of indirect to direct cancellations, since the original flight is in position at the hub to operate the next out and back.

Airlines also schedule aircraft to flow through hubs. A flight could start at American's hub in Dallas, fly to Raleigh, turn and then fly to American's Chicago hub. Since American's hubs are balanced, an equal number of aircraft would flow from Chicago to Dallas in a given period. Some flights may be scheduled for additional segments or hub visits within the period, for example, operating DFW-RDU-MIA-DFW. Based on American's schedule, we estimate that 55% of their flights are scheduled to flow among hubs. When the outbound flight from DFW cancels, more than one additional cancellation may be required to re-balance the airline's network.

The net result of both out-and-back and flow scheduling models is that the minimum ratio of indirect to direct cancellations will be 1:1. For at least half of the flights cancelled, the ratio is often greater than 1:1.

Ferry Avoidance. What happens if a tarmac-related cancellation occurs at a spoke city? For example, consider a Delta departure from Dallas to Atlanta that cancels because of tarmac concerns. Delta's network then has an "extra" aircraft at Dallas available to operate a subsequent scheduled flight to Atlanta. In rare cases, the airline will choose to ferry an empty aircraft back to the hub, or operate an "extra section" flight with stranded passengers. In most cases, the airline will simply cancel a flight from Atlanta to Dallas and operate the scheduled return with the displaced plane.

We conclude that a 1:1 ratio of direct to indirect cancellations is a reasonable long-term estimate. While some cancellations may trigger more than one follow-on cancellation, airlines may offset by (rarely) ferrying empty aircraft into position and/or operating an "extra section" off schedule to transport displaced passengers. For the purposes of modeling, these factors offset and drive a standard 1:1 ratio.

<u>Implications of Direct vs. Indirect Cancellations</u>

We estimate above that over 2,600 flights annually in the long term will cancel due specifically and directly to tarmac rules during severe weather events. As described in Section Three, this is caused by gate availability and fine avoidance strategies. Due to aircraft availability and positioning, another 2,600 flights *at a minimum* will also cancel as the airline recovers its network to the published schedule.

The passenger implications are very significant. More than 203,000 passengers will be displaced on direct cancellations, plus another 203,000 on indirect cancellations. For the 406,000 passengers impacted, average re-booking time will be long. In prior research we estimated that passenger re-booking time for a large network at an 83% load

[58] DOT On-Time Performance Data, Detailed Arrival and Departure Statistics, American Airlines, May 14, 2010, DFW Airport, Sorted by Tail Number

factor would be 21.6 hours.[59] This was based on an actual flight schedule based at New York JFK airport, with arrival and departure times tied to business and leisure demand, at a load factor tied to system availability during real-world tarmac delays. The disruption was assumed to start at 2pm (similar to thunderstorm activity demonstrated in Section Three) and last for two hours, with departing flights during that window cancelled.

How does this wait compare with the time a passenger would have spent in transit before the tarmac delay rules took effect? We demonstrated in Section Three that 91% of tarmac-delayed flights complete, so not all passengers would have been on completed flights even before the tarmac delay rules became effective. As illustrated in Table 10, of flights that have tarmac delays greater than 2 hours, 81% depart before three hours, 96% before 4 hours and 99% before 5 hours. The average time spent on an aircraft with longer than two hours of tarmac delay is 2.68 hours.[60]

In Table 21 below, we estimate the total increase in passenger travel time due to direct and indirect cancellations. Using a 1:1 ratio of direct to indirect cancellations, we estimate that over 406,000 passengers annually will be on cancelled flights due to the tarmac delay rules. We then calculate that the incremental travel time for each of these passengers is 17 hours, after adjustment for the time they would have spent in a tarmac delay if the flights had been completed. A total of 6.9 million incremental passenger hours will be spent each year waiting for available seats on new flights. At the provided DOT value of passenger time ($29.53) this translates to $204 million in incremental cost per year, or $2.15 billion of incremental cost over a 20 year period, discounted at 7%.

In the next section, we compare this analysis with the actual results reported by airlines in May 2010. In Section Six, we then compare this estimate with the public welfare study conducted by DOT during the rulemaking process.

---

[59] Marks, J. and Jenkins, D. (2010)

[60] This can also be calculated using the table in the DOT RIA, p40. The table shows that 469,518 passengers on average between 2007-2008 were on flights with tarmac delays greater than two hours, and that the weighted-average delay for these passengers was 2.68 hours.

Table 21: Estimating Passenger Costs from Cancellation-Related Trip Delays
Sources: As Noted

Line	Item	Quantity		Notes
1	Average tarmac delay for passengers (hrs) on flights with > 2 hour tarmac delays	2.7		From DOT RIA p40, weighted average
2	Passengers on directly cancelled flights	203,461		From model
3	Percent of passengers on directly cancelled flights who would have completed their journeys on tarmac-delayed flights before the rule	91%		DOT BTS, 2009 completions
4	Ratio of Direct to Indirect Cancellations	1:1		Assumption per above
5	Passengers on indirectly cancelled flights who would have completed their journeys but for tarmac delays	98.39%		DOT 2009 Flight Completion Rate
6	Incremental travel time for cancelled passengers (hrs)	21.6		Marks and Jenkins (2010)
	<u>Average travel time before tarmac rule impact</u>			
7	Tarmac delay passengers (completed flights)	91%		Line 3
8	Tarmac Time	2.7		Line 1
9	Cancelled passengers	9%		100% minus Line 3
10	Travel time increase (tarmac time + rebooking time)	24.3		Line 1 + Line 6
11	Blended average (hours)	4.6		Weighted average
	<u>Passenger Impact</u>			
12	Passengers on Direct Cancellations	203,461		From model
13	Passengers on Indirect Cancellations	203,461		Line 4
14	Total Passengers [C]	406,922		Lines 12 + 13
15	Re-Accommodation Time after Cancellation	21.6		Line 6
16	Average travel time before rule	-4.6		Line 11
17	Net Change	17.0		Lines 15 - 16
18	Journey time increase, all passengers	6,899,769		Lines 14 * 17
19	Value of Time per Hour	$ 29.53		DOT RIA p42
20	Annual value (each year)	$ (203,750,191)		Lines 18 * 19
21	20 year discounted value @ 7%	$ (2,158,532,429)		Present value of Line 20

SECTION FIVE: MAY 2010 OPERATIONAL REPORTS

On June 8, 2010, DOT released the Air Travel Consumer Report. The Report is based on information filed by the 18 reporting airlines to the DOT Bureau of Transportation Statistics. The complete report is summarized below as Table 22.

Table 22: May 2010 System Operational Performance
Source: DOT BTS Part 234 Reporting & NAS Weather Summary

	May 10	%	May 09	%	Change	%	
Flight Operations	542,747		546,832		(4,085)	-0.7%	(1)
On-Time Arrivals	433,848	79.9%	440,151	80.5%	(6,303)	-1.4%	(2)
Late Arrivals	100,683	18.6%	100,688	18.4%	(5)	0.0%	
Weather-Related	39,436	7.3%	47,329	8.7%	(7,893)	-16.7%	(3)
Non-Weather-Related	61,247	11.3%	53,359	9.8%	7,888	14.8%	
Cancelled Flights	6,716	1.24%	4,792	0.88%	1,924	40%	(4)
Diverted Flights	1,500	0.28%	1,201	0.22%	299	25%	(5)
Taxi Out Times (3+ hrs)	* 1	nm	35	0.01%	(34)	-97%	
Taxi Times (2-3 hrs)	346	0.064%	355	0.065%	(9)	-2.5%	(6)
Prior to Cancellation	49	0.009%	14	0.003%	35	250%	(7)
Gate Return	86	0.016%	22	0.004%	64	291%	(8)
Taxi-Out	171	0.032%	271	0.050%	(100)	-37%	
Taxi-In	10	0.002%	19	0.003%	(9)	-47%	
Diversion Airport	30	0.006%	29	0.005%	1	3.4%	
Taxi Times (1-2 hrs)	3,998	0.74%	4,747	0.87%	(749)	-16%	
Prior to Cancellation	75	0.014%	40	0.007%	35	88%	
Gate Return	335	0.062%	212	0.039%	123	58%	
Taxi-Out	3,143	0.579%	4,209	0.770%	(1,066)	-25%	
Taxi-In	269	0.050%	131	0.024%	138	105%	
Diversion Airport	176	0.032%	155	0.028%	21	14%	

* Delta 2011 ATL-DFW, 182 minute delay due to safety factors (lightning on ramp)

To summarize the table above, during May 2010:

- Total flight operations by reporting carriers were similar year over year, reflecting a 0.7% decrease in total flights (1). The overall percentage of aircraft arriving on-time was similar between the comparable periods (2).

- Weather was significantly better in terms of overall airspace impact. Weather-related delays were 16.7% lower in May 2010 than in May 2009 (3).

- Cancellations rose 40%, to 1.24% of operations from 0.88% in May 2009 (4). Diversions rose 25% from 0.22% to 0.28%. (5).

- Two-hour or greater tarmac delays occurred on 346 flights, or 0.064% of total departures (6). The distribution of tarmac delays across departures, arrivals and diversions was steady year over year. The outcome of the tarmac-delayed taxi-out flights changed substantially.

  - Of the 306 flights that experienced tarmac delays on departure, 49 were cancelled. This reflects a 250% jump year over year (7).

  - 86 returned to the gate, a 291% increase year over year (8).

- Taxi delays between one and two hours declined by 16%, proportional to the improvement in weather conditions. But gate returns and cancellations both jumped significantly, by 58% and 88% respectively.

- Five flights had tarmac delays of 180 minutes or greater. Four of these occurred at diversion airports after a severe weather outbreak in Denver. The fifth was a taxi-out delay of 182 minutes on a flight from Atlanta to Dallas.

Detailed Review of Operating Data

We have reviewed the high-level analysis by DOT along with supporting quantitative information on flight departures and arrivals available from BTS. Except as noted, our data are from public sources. We focus on the following:

1. For flights that departed the gate and experienced 2+ hour tarmac delays (putting them at risk under current procedures for returns to gate and cancellation), how likely were these flights to cancel before the tarmac rules took effect, and now after?

2. Are there substantial differences in results by airline and airport?

3. What are the implications for overall system cancellations due to cancellations after gate push-back?

4. What do the results suggest about direct and indirect cancellations?

Each of these questions is addressed below.

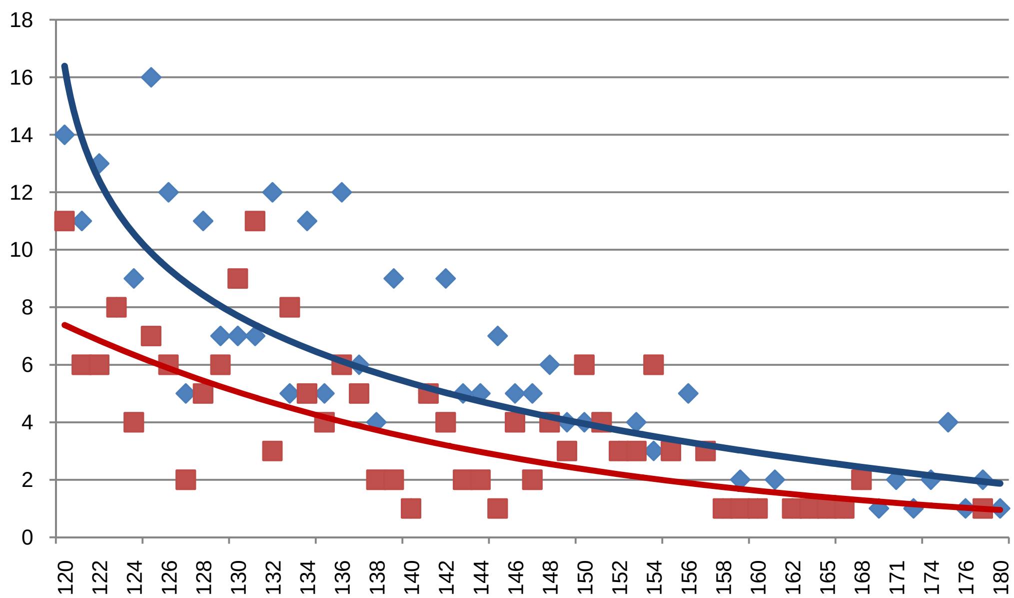
<u>Cancellation Rate for 2+ Hour Tarmac Delays</u>

Table 22 demonstrates that cancellations are now higher across all departures, with significant increases in cancellation rates for those flights with more than one hour of taxi time. For flights with taxi times between 60 and 120 minutes, cancellations jumped 88%. For flights with taxi times between 120 and 180 minutes, cancellations jumped 250%. This confirms that the changes to airline operations described in Section Four have had a significant impact on cancellations, far greater than the incremental change predicted by DOT during the regulatory evaluation phase.

We are particularly interested in the changes related to flights that spend more than 120 minutes on the tarmac, since these flights are flagged by all major airlines for special handling. We expect that many of these flights would depart the airport before and after the rule took effect, since the distribution of taxi times (as shown in Table 15 on p33) slopes downward. Flights that are near the front of the queue for departure at the two-hour mark are unlikely to be recalled by airline operations. Overall, however, we would expect to see a significant increase in cancellations for those flights that exceed two hour taxi times. More flights will be brought back to the gate, and more of those flights will cancel. The overall cancellation impact of these returns to gate is not captured in full by the "Prior to Cancellation" lines in Table 22. To free a gate, an airline may choose to cancel a different departure.

The data confirm that airlines have responded to the Final Rule and fine structures by managing their exposure, recalling aircraft and canceling flights. The number of flights left on the tarmac to depart has dropped by 25% (1-2 hour delays) and 37% (2-3 hour delays). Weather conditions do not explain these increases; the May report shows that weather conditions were substantially better in May 2010 than May 2009, with weather-related delays down 16.7%.

Chart 11: May 2010 vs. May 2009, Taxi Times 2-3 Hours
2010 in Red; 2009 in Blue
Source: DOT Part 234 Data Reports



By plotting taxi times of 2-3 hours for May 2010 vs. May 2009, we can visualize how airlines have reduced their exposure to the Final Rule and punitive fines. In the chart above, the blue dots represent May 2009 flights and the red dots May 2010 flights.

Chart 11 shows that airlines have taken significant steps to reduce exposure to the fine. The lower trend line for 2010 shows that cancellations and returns to gate have reduced the number of flights at all delay levels.

Differences Among Airlines and Airports

We reviewed some differences among airline policies concerning tarmac delays greater than two hours in Section Four. Using May 2010 operating data, we can review the differences in practice. We focused on flights with tarmac delays between two and three hours, since our research indicates that all carriers flag operations in this bracket for special handling.

The following table shows by airline how cancellations and multiple gate departures have changed between May 2010 and May 2009. On a systemwide basis, cancellations of flights with tarmac delays between two and three hours increased from 3.94% (of total 2-3 hour delays) in May 2009 to 14.16% in May 2010. Multiple gate departures increased from 6.2% to 24.86%. Of particular interest are airlines that did not recall or cancel aircraft before the Final Rule took effect. In 2009 these flights all completed with significant tarmac delays. After the Final Rule, a significant portion of these flights cancelled.

Table 23: May 2010 Cancellations and Multiple Gate Departures, By Airline
For Flights with Tarmac Times Between 2 and 3 Hours
Source: DOT BTS Part 234 Reporting

	CANCELLATIONS			**MULTIPLE GATE DEPARTURES**		
AIRLINE	**May 2010**	**May 2009**	**CY 2009**	**May 2010**	**May 2009**	**CY 2009**
AirTran Airways	41.67%	11.11%	4.88%	25%	0%	12.20%
American Airlines	15.38%	2.67%	3.95%	15.38%	1.33%	6.22%
American Eagle	30.77%	17.14%	9.30%	30.77%	8.57%	12.68%
Atlantic Southeast	12.90%	0%	3.37%	22.58%	12.50%	13.48%
Comair	13.64%	8.57%	9.57%	13.64%	5.71%	10.49%
Continental	13.33%	0%	2.41%	33.33%	0%	13.90%
Delta	11.49%	0%	1.75%	26.44%	0%	6.83%
ExpressJet	13.64%	0%	3.10%	45.45%	0%	13.08%
Pinnacle	35.29%	0%	13.42%	5.80%	16.67%	23.49%
United	3.70%	0%	2.17%	22.22%	4.17%	9.49%
US Airways	10.71%	2.22%	6.66%	28.57%	8.89%	8.87%
Southwest	0%	0%	0%	30%	9.09%	4.04%
ALL AIRLINES	**14.16%**	**3.94%**	**4.83%**	**24.86%**	**6.20%**	**10.29%**

Changes in operational policy are observed at Continental, Delta and ExpressJet. A preference to cancel versus risking a tarmac fine can be observed at Atlantic Southeast, American and United as well. At Pinnacle, a significant number of flights simply cancel rather than returning to the gate for a re-departure. By comparing data across airlines, we conclude that the overall patterns shown in the May 2010 report are systemwide, and not caused by the specific actions of a single carrier.

We now review similar data by airport. Using DOT-reported data, we compare cancellations and multiple gate departures for airports reporting greater than 20 tarmac-delayed (60+ minute) flights in both May 2009 and May 2010.

Table 24: May 2010 Cancellations and Multiple Gate Departures, By Airport
For Flights with Tarmac Times Between 2 and 3 Hours
Source: DOT BTS Part 234 Reporting

	CANCELLATIONS			MULTIPLE GATE DEPARTURE		
AIRPORT	**May 2010**	**May 2009**	**CY 2009**	**May 2010**	**May 2009**	**CY 2009**
Dallas Fort Worth	20.00%	8.00%	7.34%	20%	0%	3.95%
Detroit	28.57%	0.00%	18.18%	28.57%	25.00%	12.12%
Washington Reagan	12.50%	5.88%	9.74%	37.50%	17.65%	15.90%
Newark Liberty	20.00%	0%	1.80%	80.00%	0.00%	10.21%
Philadelphia	11.76%	0.00%	3.10%	29.41%	6.67%	6.67%
Washington Dulles	12.00%	8%	8.46%	28.00%	0%	13.93%
Chicago O'Hare	15.63%	5%	7.87%	37.50%	11%	10.16%
New York La Guardia	29.79%	14%	5.03%	25.53%	14%	8.88%
New York Kennedy	8.33%	2%	2.61%	25.00%	1.11%	5.81%
Atlanta	14.52%	0%	5.53%	14.52%	11.11%	14.07%
ALL AIRPORTS	**14.16%**	**3.94%**	**4.83%**	**24.86%**	**6.20%**	**10.29%**

Cancellations are higher across the board, very significantly in some markets. Multiple gate departures are significantly higher in specific cases and overall show an increase. Of particular interest are the New York airports, where the highest portion of aircraft with tarmac delays exceeding two hours return to the gate.

By comparing cancellations across airports, we conclude that the trends observed in May are not specific to a set of airports or regions. They are general trends and caused by regulation, not by weather conditions.

System Implications

What are the implications for system cancellations due to tarmac rule changes and fines, based on the May 2010 results reported in Table 22?

- Comparing the same time period year-over-year, where weather conditions improved and overall flight delays remained steady, cancellations and diversions rose dramatically.

- Flights that would have departed before the three hour limit are impacted by the new rule and fines. Cancellations and passenger inconvenience have risen.

- Diversions have risen significantly after the introduction of taxi-in limits. In Table 8, we demonstrated a strong positive correlation between diversions and severe weather (0.74). In May 2010, the two were negatively correlated. We conclude that airline behavior has changed, preferring to divert aircraft en route than risk a tarmac delay. The 47% decline in taxi-in delays supports this conclusion.

The trends shown are systemwide. They are not specific to certain airlines or regions. They represent an overall shift by the industry to respond to new regulation and the threat of punitive enforcement. As such, diversion and cancellation patterns are unlikely to change without significant action by DOT.

Direct and Indirect Cancellations

In May 2009, there were 35 tarmac delays greater than 3 hours. Of those, 34 occurred on taxi-out and 1 occurred after landing. In May 2010, there were 5, of which 4 occurred after diversions and only 1 on taxi-out. Overall cancellations increased 40% in the same period, by 1,924 flights. Weather was not a significant explanatory factor (but as demonstrated in Table 8, severe weather does not correlate strongly to cancellations) nor were airline-specific or regional factors.

We project that about 2,600 annual flights will be cancelled directly by the tarmac rules and associated fines. We project another 2,600 flights will be indirectly cancelled as networks recover. In Chart 1, we showed that 4.1% of tarmac delays occur in the month of May on average (67 of 1,618 sampled flights).

The observed increase in cancellations (1,924) significantly exceeds even the annual sum of tarmac-delayed flights in 2009. What accounts for the significant difference? It is possible but not probable that differences in airline-controlled factors caused this increase. Given that the level of flight operations remained steady, the statistical increase in cancellations due to crew staffing, mechanical events, and security-related factors should be minimal on a systemwide basis with more than 540,000 departures in the sample pool.

In May 2009, there were 34 taxi-out delays over three hours. The increase in cancellations exceeds 1,900 flights. Since other material factors remained constant year over year, we conclude that the tarmac rules (and particularly the threat of prohibitive and punitive fines) have driven extreme risk-aversion by airlines. That risk aversion is resulting in cancellations, both after departure and before push-back, of flights that would have operated and completed prior to the rule *and not experienced a tarmac delay*. The threat of punitive fines and an uncertain enforcement strategy by DOT are observable and notable in reported data.

While our models suggest that in the long term four cancellations will result from each tarmac-delay prevented, two direct and two indirect, in the short term the indirect cancellation rates are clearly much higher. Up to 10 cancellations for every tarmac delay prevented is a reasonable estimate as airlines struggle to understand the implications of DOT policy and enforcement strategies.

Conclusions

The May 2010 airline operating results are disturbing and predictable. Flight cancellations have risen. At every airline, across the country, new procedures have been implemented to prevent exposure to the punitive fines associated with the Final Rule. In the absence of clarity from DOT on enforcement, hundreds of flights that would have completed without a tarmac delay are now cancelled. Tens of thousands of passengers have already been inconvenienced.

Some parties have argued that 120 days between publication of the Final Rule and the effective date did not leave sufficient time for airlines to adjust their schedules and operating practices, and therefore that cancellation rates will decline over the long run.[61] We agree and estimate that cancellations will trend in the long run to a 4:1 ratio against tarmac delays prevented. We conclude that extreme uncertainty about DOT's fine structure, in light of Secretary LaHood's threat of "strong enforcement," has caused a rational but unwanted set of decisions from airlines. This is understandable, given the magnitude of the proposed fines relative to the revenue earned from a completed flight.

In the next section, we demonstrate that DOT's analysis of the implications of tarmac limits was flawed. Using both historical analysis and the May 2010 results, we show that immediate action is necessary to address the significant public harm caused.

[61] Business Travel Coalition, March 2010

SECTION SIX: PUBLIC WELFARE ANALYSIS

The Department of Transportation is required by Executive Order 12866 to conduct a Regulatory Impact Analysis (RIA) that will "estimate the economic impact, in terms of all public costs and benefits, accruing to passengers, air carriers and other entities" of a regulatory change. The RIA occurs during the rulemaking process and measures the public value change on an incremental basis from the status quo. The Regulatory Impact Analysis should confirm that the change in regulation has public benefit, or that the rulemaking has the least impact of possible approaches if negative. As the RIA states, "a fundamental indicator of a publicly acceptable rule is one in which public benefits exceed public costs."[62]

For measures related to the Enhancing Airline Passenger Protections rules, DOT contracted HDR Decision Economics ("HDR") to prepare a preliminary and final RIA. The HDR analysis measured the impact of proposed tarmac delay and consumer regulation on an incremental basis against the public welfare in place before changes. DOT presented the draft RIA in December 2008. The completed RIA was published on December 20, 2009 and released to the public on December 30, 2009.

About HDR. HDR's website (www.hdrinc.com) discusses "extensive experience" in decision economics across a range of infrastructure projects, including notable airport-related projects to assess economic, environmental and financial impact of runway and terminal projects. HDR lists expertise in airport economics, airport and runway planning, and multimodal projects. In contrast, HDR does not provide examples of projects requiring the assessment, modeling or prediction of airspace management changes, weather, flight scheduling, or airline customer service. HDR does not list projects that would involve modeling airline behavior in delaying or cancelling flights, managing limited gate infrastructure, or rebooking passengers during irregular operations.

Considered Alternatives. The RIA considered the costs and benefits for the overall package of proposed regulatory changes, as well as different scenarios related to the tarmac delay cutoff. The RIA considered the following scenarios:

1. (Base Case) **3 hour tarmac delay** maximum, for taxi-out, taxi-in and diversion scenarios. This scenario matched the language proposed by Congress as part of the FAA Reauthorization and Passenger Bill of Rights Legislation.

2. (High Case**) 4 hour tarmac delay** maximum.

3. (Self-Enforced Case) Airlines that are not already compliant choose their own limit, assumed at **5 hours**.

HDR Estimated Positive NPV from Rule Changes. The RIA predicted that the expected present value of benefits from the baseline scenario was $100.6 million (over 20 years, discounted at 7%) with corresponding benefits of $169.7 million. The estimated

[62] HDR, Final RIA, p4

net present value, measured on an incremental basis from the status quo, was $69.1 million. HDR estimated that a 4 hour tarmac limit produced higher net present value, $73.4 million versus $69.1 million, but the Department chose to implement the more aggressive 3 hour standard.

Methodology. The RIA made the following fundamental assumptions in its cost and benefit analysis.

- That personal time for passengers is worth between $23.80 and $35.60 per hour, with an average value of $29.53 per hour, incorporating both business travel ($32.10 to $48.10) and leisure ($20.00 to $30.00) passengers.[63] The time of family and friends meeting passengers at the destination airport is valued at $10.60 per hour, the DOT-recommended value for travel time (2003).

- That the change in rules would cause no change in overall trip time except in cases of cancellations. Time spent in the airport terminal would be valued at a 'premium' compared to time spent on board the aircraft without the option to disembark.

- The analysis assumes that aircraft that return to the gate only require incremental servicing (food, water and lavatories) and available gates or stairs/buses to allow deplaning. The analysis makes no estimate of baggage unloading for passengers that abandon the flight. In DOT Enforcement guidance provided April 28, 2010, Section 14 states that DOT has discretion to waive penalties if "all passengers agree to forego their right to deplane." It is therefore <u>certain</u> that every return to gate will have passengers who leave the aircraft, and a number of passengers may not re-board. Baggage unloading cost can therefore be significant.

- The RIA assumes no incremental de-icing costs. Modern de-icing and anti-icing fluids (Types III and IV at 75/25 and 100/0 dilutions) have hold-over times between 30 and 80 minutes. A material number of aircraft will be de-iced in the second hour of a tarmac delay and return to gate due to the tarmac delay rule, forcing a second application of fluid.

- The RIA assumes that incremental flights will be cancelled due to gate availability, with "resulting cost to passengers and carriers." The RIA claims that "little data exists [sic] to estimate the incremental impact on flight cancellations of flight delays based on carrier actions/decisions with respect to an outside requirement such as the Final Rule." The RIA cites a study that noted "an additional 5% of flights were cancelled when… closure time was extended by one hour." (The study actually cited 5.9%, not 5.0% as DOT quotes, but in the context of May 2010 results the difference is not relevant.[64]) The RIA therefore

[63] HDR RIA p21, from US Department of Transportation "Revised Departmental Guidance, Valuation of Travel Time in Economic Analysis, 2003".

[64] Rupp, N. *et al*. *Airline Schedule Recovery After Airport Closures: Empirical Evidence After September 11th*. Organizacoes em Contexto (2007).

assumes that between 0% and 5% of flights with on-tarmac departure delays of greater than 3 hours will now be cancelled. The assumption for baseline analysis is 2.8%.

- The RIA assumes no follow-on cancellations or ferry costs to re-position aircraft to conduct subsequent departures.[65]

- The RIA assumes that for passengers on cancelled flights, 95% of passengers will seek re-accommodation on later flights with average delay of 519 to 549 minutes. The remaining 5% are presumed to postpone trips and/or seek refunds.

- No fine is assumed for violations of the Final Rule.

- Costs to carriers are limited to food and water, lavatory servicing, buses and stairs or gates, and fuel for taxi back to the gate.

- Taxi-time assumptions for returning to the gate and then back to the "penalty box" are based on aggregate 2007 data for carriers not already compliant (Hawaiian, Southwest and Northwest were excluded from the data set). The taxi assumptions make no adjustment to (1) align taxi times with airports where such delays statistically occur, (2) account for the congestion on taxi-in and taxi-out resulting from clusters of concurrent tarmac delays, and (3) account for slower taxi speeds during inclement weather, including reduced visibility due to rain or snow. The taxi assumptions assume that a gate would be available immediately for the returning aircraft.

To calculate the public benefit from changes to tarmac delay rules, the RIA considers four categories of costs, three for airlines and one for consumers. These costs are calculated as follows:

Airline passenger costs. These costs are borne by the airline. The RIA assigns costs for food and water (to be served after two hours of taxi-out time), plus a per-passenger disembarkation and enplanement fee as a proxy for airport-related charges. For the baseline scenario, the RIA calculates food and drink at $3.71 per passenger, deplaning fees of $1.37 per passenger, and enplanement fees of $1.37 per passenger. The number of enplaning passengers is lower than the number of deplaning passengers due to cancellations after return to gate, in proportion to the cancellation rate assumed.

Airline flight costs. These costs are borne by the airline and include a fixed fuel cost of $88.24 for each return to gate and $88.24 for each re-departure. Again, the number of re-departures is lower than total returns to gate due to cancellations. In addition the RIA assumes a fixed cost per individual flight cancellation of $14,818.

---

[65] DOT cites a total cost per cancelled flight of $14,818 in 2008 dollars, as calculated by Dr. Shavell of MITRE. Shavell's cost estimate is based on each flight, not cancellation event, so the cost of subsequent (follow-on) cancellations are not factored into his analysis. For example, the cancellation of an out-and-back from a hub would have total cost of $29,636, not $14,818. See Shavell, Z. *The Effects of Schedule Disruptions on the Economics of Airline Operations* (2000).

Passenger-related costs. These costs are borne by the passenger. They include 6 minutes of incremental time spent deplaning, 6 minutes spent boarding, and an assumption of 5.9 hours (534 minutes, equal to the average of 519 and 549 minutes, less 180 minutes of taxi time), all at an average hourly dollar value of $29.53.

The RIA then calculates the public benefits and costs from consumer complaints, reporting, provision of food and water, deceptive practice regulations and website data disclosure.

We do not dispute or adjust the RIA's calculation of costs unrelated to the Tarmac Delay Rule. While we disagree with the following assumptions, we do not have enough data about HDR's methodology from the RIA to estimate incremental harm or benefit. We therefore do not change these three assumptions for the purposes of our analysis.

- Baggage unloading costs and de-icing costs are material. These are carrier costs not assumed by HDR.

- Taxi times should be adjusted for inclement weather, congestion from multiple tarmac delays at impacted airports, and taxi-in times for the specific airports that are chronically impacted by long taxi-out delays.

- The number of flights listed as "not already compliant for contingency plans" – Southwest, Northwest and Hawaiian – are used for all RIA calculations. Evidence clearly demonstrates that Southwest and Northwest were not compliant in their operations; Northwest had 31 tarmac delays in 2008 and Southwest had 16. The imposition of punitive fines will cause behavior changes at these airlines, and those changes should be incorporated into the RIA analysis.

However, we believe the RIA's analysis contains three serious oversights that are a relevant part of public welfare and should be considered by DOT based on real-world data observations. We incorporate these adjustments into our analysis.

Mandatory Returns to Gate

As illustrated in Section Four in our discussion of Delta, United and American, the existence of punitive fines and the threat of "strong enforcement" for any violation has driven highly risk-averse behavior by airlines. Carriers such as Delta and United have implemented a hard "return to gate" at 2.5 hours after taxi-out. Our interviews with airlines that have not set a hard policy is that 2.5 hours is the informal recall point unless departure is imminent within minutes.

HDR provides information on the number of flights with between 2.5 hours and 3.0 hours of taxi-out time *for the carriers not already compliant with contingency plans* (Southwest, Northwest and Hawaiian). HDR states that the average for 2007 and 2008 is 1,284 flights and 86,689 incremental passengers.

With the threat of punitive fines, airline policy now dictates that these flights return to the gate. This drives incremental fuel cost, deplaning and enplanement costs, and incremental cancellations from gate demand.

Cancellation Delay Time

To estimate the incremental time passengers spend waiting for an alternative flight after cancellation, the RIA cites a 2007 study by Wang and Sherry that is based on 2004 and 2005 systemwide data.[66] As our prior research details, the Wang and Sherry study is outdated in three respects that should have been identified and corrected by DOT prior to RIA publication.[67]

First, Wang and Sherry base their research on systemwide data from 2004 and 2005 when systemwide load factors were substantially lower than current on both a seasonal and year-round basis. During 2004, the domestic systemwide load factor was 74.46% with a minimum of 65.28% in January 2004 and a maximum of 82.2% in July. During 2005, the load factor was 77.16% with a minimum of 69.77% in January and 83.94% in July. For 2009, the domestic load factor was 81.05%, with a minimum of 72.82% in January and a maximum of 87.09% in July. As our research demonstrated, increasing load factors have a disproportionate impact on passenger re-accommodation time.

Second, Wang and Sherry's model assumes full transferability among passengers during operational crises. In recent years, airlines have phased out so-called "Part 240" protections that re-book passengers (upon request) on alternative carriers. Today, only one carrier provides re-booking for uncontrollable factors (United) although all carriers will offer a refund for a cancelled flight upon request. This means that passengers on a cancelled flight must choose between a refund or the next available seat on their booking airline. At high summer load factors, this can take days.

Third, Wang and Sherry's model incorporated a fixed upper-bound maximum delay of 15 hours. While this may have been reasonable in 2005 when load factors were lower and when more carriers (including American) offered Part 240 protection, it is not reasonable today.

We introduced a Passenger Displacement Model to calculate re-booking time for on-line passengers during extensive disruptions. Based on our review of historical tarmac delays, we determined that the average start time for tarmac delays is approximately 2pm (on a year-round basis) and the average monthly load factor weighted for the incidence of tarmac delays was 83% in 2009.[68] Our models for a tarmac delay-prone airport such as JFK predicted that under these circumstances – a 2pm incident start

---

66 Wang, D., Sherry, L. and Donohue, G. *Passenger Trip Time Metric for Air Transportation.* The 2nd International Conference on Research in Air Transportation (2006).

67 Marks and Jenkins (2010)

68 Average start time from Marks and Jenkins (2010). Incidence of tarmac delays is based on weighted average of monthly load factors in 2009 (Jan 72.82%, Feb 75.28% etc. as reported by DOT) times the number of monthly tarmac delays each month (87 in January, 43 in February, etc.).

and an 83% load factor – the average delay would be 21.6 hours. 91% of passengers could be re-accommodated within two business days. Interviews with airline operations teams over the past month confirm that actual experience in re-accommodation times approximate the model output.

Our methodology provides an annual estimate of passenger re-accommodation time on a year-round basis by weighting monthly load factors by tarmac delay frequency and by averaging the start time differences for snow and thunderstorm events. We therefore provide an adjustment for longer passenger wait times of 18.6 hours (21.6 minus 180 minutes to express on an incremental basis) versus 5.9 hours (534 average minutes minus 180).

Cancellation Adjustments

Both our gate assignment model and the actual experience of airlines in May 2010 suggest that the actual cancellation rate on a marginal basis from the Tarmac Delay Rule significantly exceeds 2.75%. Instead of a predicted impact of 0.0275:1, cancellations are 4:1 or higher. The impact on consumers is orders of magnitude higher than predicted.

During the rulemaking period, DOT received specific feedback that the tarmac delay rule would increase cancellations. The RIA describes this feedback on p58:

> "It was argued that in order to avoid potential… fines, carriers would be more likely to return to the gate and cancel some flights. The Department acknowledges the concern regarding cancellations and potential increases in delays if a flight must return to the gate and thus loses its place in line to depart, and in response notes that the [Final] Rule expressly includes exceptions to requiring the carriers to allow deplaning in situations in which air traffic control advises the pilot in command that returning to the gate or another disembarkation point elsewhere in order to deplane passengers would significantly disrupt airport operation and in situations when deplaning would present a safety issue. Therefore the RIA retains the assumption of no incremental increase in trip times."

The Department received feedback that the cancellation assumption was too low but chose not to respond to the point. Without explanation, and recognizing the criticality of the cancellation assumption to the overall net benefits from the Final Rule, we conclude the Department was concerned about the optics of a higher cancellation rate if such an assumption caused public harm instead of benefits.

In the meantime, it is clear that the RIA's assumption of 2.8% cancellations is neither rational nor realistic. The RIA cited a 2007 study by Rupp *et al.* that calculated incremental flight cancellations at 5.9% from a one-hour disruption.[69] The RIA states that up to 5% of flights with on-tarmac delays of 3 or more hours will be cancelled, but the RIA uses 2.8% (without explanation) in its final calculations. For the purposes of policy analysis now that the Final Rule is effective, we believe it is critical to incorporate

---

[69] Rupp, N., Holmes, G. and DeSimone, J. *Airline Schedule Recovery After Airport Closures: Empirical Evidence since September 11th*. Organizacoes em Contexto (2007)

the 14.16% rate observed in May 2010 for 2+ hour taxi-outs until such time as real-world airline data demonstrate a higher or lower actual rate. We also examine the implications of the 4:1 trend already observed on a systemwide basis from the rule.

RIA Adjustments

To illustrate the impact of these adjustments on the RIA analysis and conclusions, we start from the baseline benefits, costs and net benefits listed in the RIA. HDR estimated baseline benefits of $169.7 million (20 years at 7% discount rate) and costs of $100.6 million. The net benefit was $69.1 million.

<u>Base Adjustments</u>

We adjust this $69.1 million in Appendix Two based on the existence of punitive fines and the threat of "strong enforcement." These fines cause airlines to introduce mandatory return-to-gate provisions for all flights on taxi-out at 2:30 after push-back.

Mandatory Return to Gate Adjustments. An incremental 1,284 annual flights[70] return to gate. Of these returns, an equal proportion to the base 3+ hour flights cancel (2.8%). The 86,689 passengers on these incremental returns-to-gate must be deplaned and 84,522 re-board.[71] The net change to airline costs, with annual inflation assumed at 2.6%,[72] is ($12.6) million over 20 years at 7%.

Cancellation Re-Booking Time Adjustment. For the 3,176 passengers on cancelled flights in the RIA model, total delay time is increased from 5.9 hours to 18.6 hours to reflect real-world load factors and the elimination of Part 240 transfers. The net change in travel time is therefore 12.7 hours. For the 2,167 passengers who are on the incremental cancellations from mandatory returns to gate, the full delay time (18.6 hrs) is charged. The DOT-standard rate of $29.53 per hour is used and inflation is assumed at 2.6% for the 20 year period. The net change is ($30.75) million over 20 years at 7%.

Cancellation Rate Adjustment. We correct total cancellations due to tarmac delay rules to the observed May 2010 cancellation rate of 14.16%. We do not include any follow-on cancellations or diversion costs in order to mirror DOT's methodology. An incremental 315 flights cancel annually. After crediting back passenger re-embarkation and taxi-out fuel costs, the net change from cancellation adjustments is ($210.3) million over 20 years at 7%. (See Appendix Two)

Based only on these changes, the public welfare change is reduced from a positive $69.1 million to a negative $184.7 million – in other words, the combination of prohibitive fines, a cancellation rate based in actual results and passenger re-accommodation time that reflects current load factors show that the DOT changes as enacted are significantly negative to public welfare.

---

70 RIA p40 2.5-3.0 hour departures

71 RIA p40 2.5-3.0 hour passengers and cancellation assumption 2.75%

72 9 year trailing average inflation rate based on published CPI

Incorporating May 2010 Data

We then calculate the public cost using operating results from May 2010. Based on our case study with American Airlines, our modeling for a JFK-based schedule, and the May 2010 reported data, a ratio of 2:1 direct cancellations to prevented tarmac delays can be observed. We also incorporate a 1:1 ratio of indirect to direct cancellations, to reflect aircraft availability and network re-balancing, for a total 4:1 impact.

At 5,200 annual cancellations, the net public cost is $3.5 billion over 20 years. At 5,924 annual cancellations (using 4x DOT's baseline of 1,481 tarmac delays) the net public cost is $3.9 billion over 20 years. (See Appendix Three)

However, when compared to 5,200 annual cancellations and the associated multi-billion dollar public harm, the May trends show a significantly higher cancellation rate. Based on the annual distribution of tarmac delays, 5,200 per year would imply an average 630 in the month of May. Of the 1,924 incremental cancellations in May, another 1,300 are unexplained. We believe at least a portion of these are due to risk-averse airline behavior, but several additional months of data will be required to conduct a full analysis.

SUMMARY

The Regulatory Impact Analysis contains significant omissions and assumptions that are not reflective of real-world conditions. Of particular concern are operating metrics that understate flights by excluding carriers in technical (but not actual) compliance with contingency requirements; passenger re-accommodation times based on 2004 and 2005 data materially different from 2009 and 2010 conditions; the entire absence of follow-on cancellations; exclusion of a fine structure that creates absolute deterrence from violating the rule; and lack of clarity for key assumptions.

Basic adjustments of the RIA model to account for a punitive fine structure (based on actual airline policy implemented in response to tarmac delay rules), more reasonable passenger delay assumptions and the observed cancellation rate of 14% result in a clear conclusion: the Final Rule has negative public benefits. That does not prevent DOT from implementing the rule (non-quantifiable benefits such as piece of mind and comfort outweigh the public costs) but public cost should be part of policy review particularly when considering expansion of tarmac delay rules to two hours or to international flights.

A core uncertainty remains the ambiguous DOT enforcement strategy. Secretary LaHood's threats of "strong enforcement" and analogy to the maximum fines imposed on Toyota have created extreme risk aversion among airlines. If DOT is reasonable in enforcement with a well-documented, transparent fine structure that correlates the fine to the severity of the incident, public welfare from the Final Rule can be improved. At present, DOT's package of tarmac rule changes is strongly negative to the public, with public cost approaching $4 billion over a 20 year period based on May 2010 trends. The benefits to a few are solidly outweighed by the costs to many. Immediate review by regulators, legislators, airlines and consumer groups is necessary.

SECTION SEVEN: CONCLUSIONS

"Carriers have it within their power to schedule their flights more realistically, to have spare aircraft and crews available to avoid cancellations" Bill Mosely, DOT

"Cancellations could go up, but it's not a bad thing… the cancellations are going to prevent people from being stuck on the tarmac." Kate Hanni, FlyersRights.org

"Rigid and inflexible application of the new tarmac delay rule would have the unintended and undesirable effect of exacerbating passenger inconvenience and disruption by forcing the cancellation of flights that could otherwise be operated" Delta, March 5, 2010

Given the choice of an extended tarmac delay or a timely takeoff, any passenger traveling in Economy Class will surely express a preference for the shortest possible taxi time. It is understandable why passengers trapped on flights that divert into remote, unmanned or oversaturated airports have demanded that government take action. It is also understandable why legislators and regulators believe that returning to the gate should be a timely, simple process. For long delays on landing and at diversion airports, deplaning passengers should be a priority. As data records show, it is already a priority for airlines, as these tarmac delays are extinct for US carriers except in cases of safety, security and unanimous consent by passengers.

Given a choice between a lengthy taxi-out delay and a flight cancelled at the last minute, the choice for consumers is less clear. Spending hours on board waiting for takeoff can be miserable for passengers, and new DOT rules that mandate regular updates, food and water already improve this experience for passengers. But a mandatory return to the terminal taxes already congested gate resources and results in additional flight cancellations. Four months of notice before the effective date – from December 30, 2009 to April 29, 2010 – do not provide sufficient time for airlines to increase gate capacity, acquire more aircraft and hire new crews. Over the long term, we may expect airlines to adjust gate scheduling at airports that are frequently impacted by severe weather. In the short term, cancellations are occurring on a large scale with tremendous public cost.

The DOT rules favor the interests of few (trapped on the tarmac) versus those of many (traveling on flights that cancel). The DOT estimates that new tarmac rules will prevent 113,441 passengers from spending an average of 3.64 hours on the tarmac waiting for departure each year.[73] Our models, corroborated by real-world experience of major airlines, indicate that 406,000 passengers will be on 5,200 flights that cancel solely because of tarmac delay rules. The May 2010 operating data suggest these long-term models are overly conservative given risk-averse airline behavior.

Leaders of consumer groups have repeatedly stated that cancellations are preferable to lengthy delays. While advance cancellations provide passengers with advance notice to stay home, find alternate transportation such as rental cars, buses or trains, or postpone trips, the reality for most of these 406,000 passengers is a day or more

[73] Weighted average of non-compliant airlines estimated by HDR, RIA p40

of time spent waiting for an available seat. Our research has indicated that average waiting time for an available seat during the peak summer season will add at least 18 hours to the journey for passengers. A night at the airport or at a local hotel is likely for passengers stranded away from home. DOT's estimates for passenger re-booking time are based on old studies when airlines had significantly more seats available to transport displaced passengers. Unfortunately, tarmac delays have occurred in clusters, during summer afternoons, when finding alternative seats is the most difficult.

We believe that DOT is unlikely to change its 3-hour standard for tarmac delays without significant outside pressure from consumer groups and legislators. The choice of 3 hours came under significant lobbying and pressure from Congress. For diversions and taxi-in delays, 3 hours may be overly generous. Several major airlines target 60 to 90 minutes (including United and Delta respectively). But taxi-out delays are caused by wholly different factors, and these factors are not within airline control. Spare aircraft and crews are not going to solve the problem; the NexGen air traffic control system overhaul, currently in progress, is likely to have a significant positive effect.

Today, airspace corridors into congested cities from Boston to Washington overlap. When severe weather narrows or closes these corridors for hours on end, air traffic has nowhere to go. As our models demonstrate, when weather events drag into a second or third hour, even a highly conservative gate utilization strategy can become overtaxed. In the past, tarmac delays would have resulted, but 91% of these flights on average would successfully depart and passengers would complete their trips. Now, these flights must return to the gate, and if no gate is available, flights cancel. A choice of 4 hours for taxi-out limits would reduce cancellations; a 4 hour standard was clearly demonstrated by DOT to have greater public net benefit than a 3 hour standard.

With the Final Rule in place, DOT must address its enforcement strategy. We recognize that DOT, and the Secretary in particular, have invested time and political capital in curbing tarmac delays. Based on our research, we are critically focused on the presence of punitive fines and the absence of clarity about how DOT will enforce the rules. We believe this is the core explanatory factor to the abnormal cancellation rates seen in May 2010.

As of July 2010, DOT has sent mixed messages. The Office of Enforcement has stated that tarmac violations will be considered on a case-by-case basis for mitigating factors. The Secretary has vowed "strong enforcement" and drawn parallels to cases where maximum penalties were sought. With hundreds of passengers on a given flight, for airlines the maximum penalty is millions of dollars per flight. We demonstrated that tarmac delays generally impact multiple flights at a given airport at once. For this reason, airlines have introduced risk management protocols that mitigate even the slightest risk of a multi-million dollar fine. The most visible manifestation of this policy is the mandate that any taxi-out delay exceeding 150 minutes must return to gate immediately. Only the most senior officers at each airline have the authority to deviate from these standards.

As DOT confirms in its regulatory analysis, the number of flights that cross the 2.5 hour mark in taxi-out is significantly greater than those that exceed 3 hours. Mandatory gate returns now mean thousands of flights return to already congested gate facilities. Few US airports are set up to re-board passengers remotely. Several airlines explicitly forbid re-boarding if deplaning occurs on the tarmac.[74]

Although DOT may claim that the Office of Enforcement already has flexibility to consider mitigating factors in fine assessment, the Secretary's public position and a recent history of maximum fine enforcements has spooked the industry. The result is that many more flights are cancelled than need to be in order to achieve DOT's public policy objectives. The public costs are strongly negative, up to $4 billion over a 20 year period.

To ensure that rules are effective and that the passenger trade-off is balanced between cancellations and taxi-out delays, we believe it is in both DOT's and the public's interest to:

1. **Immediately publish enforcement guidance** for violations of the Tarmac Delay Rule, with specific interpretation of 14 CFR Part 259.4 that relates to safety, security and other "mitigating factors" as outlined summarily by the Office of Enforcement. Sample scenarios should be presented. Fines must be set to reasonably deter violations without causing disproportionate risk-aversion among airlines and public harm from cancellations. DOT's enforcement statements to date have worsened, not mitigated, public harm.

2. **Avoid any further rulemaking on tarmac delays** until the full consumer impact of the Final Rule can be estimated. This includes the reduction of tarmac delay limits for domestic flights (e.g. to 2 hours), extension of tarmac delay rules to small airports, and the implementation of fixed time limits for international flights. The regulatory impact analysis performed is fundamentally flawed and must be re-assessed.

3. **Re-examine** the standards for tarmac delays.

No passenger would voluntarily choose to be stuck on the tarmac for hours. Under consumer and regulatory pressure, airlines have successfully demonstrated a commitment to minimizing taxi-in and diversion related tarmac delays. Taxi-out delays have different causes and are strongly correlated to severe weather and airspace congestion. DOT's inflexible approach to taxi-out tarmac delays, combined with a disproportionate and punitive fine structure, has driven unnecessary and undesirable changes in airline operating practices. The public reality significantly deviates from DOT's expectations during the rulemaking period. Action is needed to resolve ambiguity, introduce reasonable enforcement strategies and re-assess the public costs and benefits from the rules.

---

[74] Continental Airlines *Long Tarmac Delay Plan* (continental.com)

APPENDIX ONE: 14 CFR PART 259.4
TARMAC DELAY RESTRICTIONS

AS PUBLISHED DECEMBER 30, 2009; EFFECTIVE APRIL 29, 2010

Section	**Language**
259.4(a)	**Adoption of Plan.** Each covered carrier shall adopt a Contingency Plan for Lengthy Tarmac Delays for its scheduled and public charter flights at each large and medium hub U.S. airport at which it operates such air service and shall adhere to its plan's terms.
259.4(b)	**Contents of Plan.** Each Contingency Plan for Lengthy Tarmac Delays shall include, at a minimum, the following: 1) For domestic flights, assurance that the air carrier will not permit an aircraft to remain on the tarmac for more than three hours unless: i. The pilot-in-command determines there is a safety-related or security-related reason (e.g. weather, a directive from an appropriate government agency) why the aircraft cannot leave its position on the tarmac to deplane passengers; or ii. Air traffic control advises the pilot-in-command that returning to the gate or another disembarkation point elsewhere in order to deplane passengers would significantly disrupt airport operations. 2) For international flights that depart from or arrive at a U.S. airport, assurance that the air carrier will not permit an aircraft to remain on the tarmac at a large or medium hub U.S. airport for more than a set number of hours, as determined by the carrier and set out in its contingency plan, before allowing passengers to deplane, unless: i. The pilot-in-command determines there is a safety-related or security-related reason why the aircraft cannot leave its position on the tarmac to deplane passengers; or ii. Air traffic control advises the pilot-in-command that returning to the gate or another disembarkation point elsewhere in order to deplane passengers would significantly disrupt airport operations. 3) For all flights, assurance that the air carrier will provide adequate food and potable water no later than two hours after the aircraft leaves the gate (in the case of departure) or touches down (in the case of an arrival) if the aircraft remains on the tarmac, unless the pilot-in-command determines that safety or security considerations preclude such service; 4) For all flights, assurance of operable lavatory facilities, as well as adequate medical attention if needed, while the aircraft remains on the tarmac; 5) Assurance of sufficient resources to implement the plan; and 6) Assurance that the plan has been coordinated with airport authorities at all medium and large hub airports that the carrier serves, including medium and large hub diversion airports.

259.4(c)	**Amendment of plan.** At any time, an air carrier may amend its Contingency Plan for Lengthy Tarmac Delays to decrease the time for aircraft to remain on the tarmac for domestic flights covered in paragraph (b)(1) of this section, for aircraft to remain on the tarmac for international flights covered in paragraph (b)(2) of this section, and for the trigger point for food and water covered in paragraph (b)(3) of this section. An air carrier may also amend its plan to increase these intervals (up to the limits in this rule), in which case the amended plan shall apply only to those flights that are first offered for sale after the plan's amendment.
259.4(d)	**Retention of records.** Each air carrier that is required to adopt a Contingency Plan for Lengthy Tarmac Delays shall retain for two years the following information about any tarmac delay that lasts at least three hours: 1) The length of the delay; 2) The precise cause of the delay; 3) The actions taken to minimize hardships for passengers, including the provision of food and water, the maintenance and servicing of lavatories, and medical assistance; 4) Whether the flight ultimately took off (in the case of a departure delay or diversion) or returned to the gate; and 5) An explanation for any tarmac delay that exceeded 3 hours (i.e.,why the aircraft did not return to the gate by the 3-hour mark).
259.4(e)	**Unfair and Deceptive Practice.** An air carrier's failure to comply with the assurances required by this rule and as contained in its Contingency Plan for Lengthy Tarmac Delays will be considered an unfair and deceptive practice within the meaning of 49 U.S.C. 41712 that is subject to enforcement action by the Department.

Appendix Two: RIA Base Adjustments (No Indirect Cancellations, 14.16% Cancellation Rate from May 2010)

	Change Quant.	Change Price	Benefits	Costs	Net
7% Discounting					
Airline & passenger cost			**169,700,000**	**(100,600,000)**	**69,100,000**
Mandatory Return to Gate Adjustment - Fine Driven					
Flights that return to gate, 3+ hr delays	1,481				
Incremental, 2.5-3.0 hrs (Punitive fine)	1,284				
Carrier - fuel cost taxi-in	1,284	(88.24)		(1,463,145)	
Carrier - fuel cost taxi-out	1,252	(88.24)		(1,426,680)	
Incremental cancellations (2.75% rate)	35	(14,818.00)		(6,697,528)	
New Total Passenger Depl.	86,689	(1.37)		(1,533,704)	
New Total Passenger Enpl.	84,522	(1.37)		(1,495,365)	
Total - Mandatory Returns to Gate Adjustment			0	(12,616,422)	**(12,616,422)**
Cancellation Re-Booking Time Adjustments - Load Factor and Schedule Driven					
Baseline assumption, HDR	5.9				
85% load factor, model	18.6				
Change in travel time	12.7				
Passengers	3,176				
Impact, baseline passengers (in hours)	40,335	(29.53)		(15,381,708)	
Incremental pax due to MRGA					
Return to gate adjustment	2,167				
Impact, incremental from MRGA	40,306	(29.53)		(15,370,649)	
Total - Cancellation Re-Booking Time Adjustments			0	(30,752,356)	**(30,752,356)**
Cancellation Adjustment - Operations Driven					
Baseline assumption, cancel rate	2.75%				
New assumption, cancel rate	14.16%				
Total Flights Cancelled to Direct Cancellations	100%	(none)			
Total flights, 2.5 hours+, eligible for cancellation	2,765				
Adjusted cancels, incremental	-315				
Airline costs					
Incremental cost - airlines	315	(14,818.00)		(60,277,751)	
Credit - fewer taxi-outs	315	88.24	358,949		
Credit - fewer re-boarding pax	21,267	1.37	376,259		
Passenger costs					
Incremental travel time	395,569	(29.53)		(150,849,130)	
Total - Cancellation Operations Adjustments			735,208	(211,126,880)	**(210,391,672)**
Benefits, Costs and Net Welfare Change			**170,435,208**	**(355,095,659)**	**(184,660,451)**

Appendix Three: Observed 4:1 overall cancellation impact (2 direct, 2 indirect for every tarmac delay prevented)

	Change Quant.	Change Price	Benefits	Costs	Net
7% Discounting					
Airline & passenger cost			**169,700,000**	**(100,600,000)**	**69,100,000**
Mandatory Return to Gate Adjustment - Fine Driven					
Flights that return to gate, 3+ hr delays (RIA p42)	1,481				
Incremental, 2.5-3.0 hrs (Punitive fine)	1,284				
Carrier - fuel cost taxi-in	1,284	(88.24)		(1,463,145)	
Carrier - fuel cost taxi-out	1,252	(88.24)		(1,426,680)	
Incremental cancellations (2.75% rate)	35	(14,818.00)		(6,697,528)	
New Total Passenger Depl.	86,689	(1.37)		(1,533,704)	
New Total Passenger Enpl.	84,522	(1.37)		(1,495,365)	
Total - Mandatory Returns to Gate Adjustment			0	(12,616,422)	**(12,616,422)**
Cancellation Re-Booking Time Adjustments - Load Factor and Schedule Driven					
Baseline assumption, HDR	5.9				
85% load factor, model	18.6				
Change in travel time	12.7				
Passengers	3,176				
Impact, baseline passengers (in hours)	40,335	(29.53)		(15,381,708)	
Incremental pax due to MRGA					
Return to gate adjustment	2,167				
Impact, incremental from MRGA	40,306	(29.53)		(15,370,649)	
Total - Cancellation Re-Booking Time Adjustments			0	(30,752,356)	**(30,752,356)**
Cancellation Adjustment - Operations Driven					
Baseline assumption, cancel rate	0				
Direct cancellations - 2:1 ratio	2,962				
Less already counted (DOT base 41 + 35 above)	(76)				
Total adjusted cancellations including follow-on	(2,886)				
Total Indirect Cancellations	(2,962)				
Direct + Indirect Cancellations (1:1 ratio)	(5,848)				
Airline costs					
Incremental cost - airlines	5,848	(14,818.00)		(1,119,061,226)	
Credit - fewer taxi-outs	5,848	88.24	6,663,920		
Credit - fewer re-boarding pax	394,827	1.37	6,985,280		
Passenger costs					
Incremental travel time	7,343,774	(29.53)		(2,800,526,062)	
Total - Cancellation Operations Adjustments			13,649,199	(3,919,587,288)	**(3,905,938,089)**
Benefits, Costs and Net Welfare Change			**183,349,199**	**(4,063,556,067)**	**(3,880,206,867)**

Appendix Four: Key Tarmac Delay Events with Weather Cause

Date	Airport(s)	# of Flights	Average Delay	Start	Finish	Airport or Airspace?	Event
7/27/2009	NYC/PHL	62	216	1500	2000	Both	Thunderstorms, high wind, hail
12/11/2008	IAH	42	296	1500	2100	Airport	Unforecast snowstorm event
7/24/2008	JFK	42	237	1200	2100	Airspace	Severe t-storms across central Pennsylvania
7/24/2008	PHL	38	244	1200	2000	Airspace	Severe t-storms across central Pennsylvania
6/11/2008	JFK	33	238	1600	2000	Airspace	Frontal line of severe weather, central USA
6/15/2008	JFK	32	253	1600	2100	Both	Severe t-storm line, tornado in region
6/27/2009	JFK	25	234	1500	1900	Airspace	Eastern US thunderstorm activity
8/15/2008	JFK	23	273	1500	1700	Both	Thunderstorms, NE airspace
7/1/2009	NYC	22	216	1300	1600	Airspace	Central Pennsylvania thunderstorms
7/28/2008	JFK	22	252	900	1400	Airspace	Broad t-storms central, southern US
8/22/2009	JFK	20	205	1200	1600	Airport	Wind and storms in NYC area
6/10/2009	JFK	20	209	600	800	Airspace	Broad storms across the Mid-Atlantic
8/15/2008	LGA	19	213	1500	1700	Both	T-Storms, hail NYC to NE airspace
7/30/2009	NYC/PHL/WAS	16	197	1300	1800	Both	Broad thunderstorm line that extended from Boston to Atlanta
7/23/2008	JFK	15	220	1600	2200	Airspace	Thunderstorms across Pennsylvania and the Northeastern United States
7/21/2008	EWR	15	212	1800	2000	Airspace	Broad thunderstorms across the Mid-Atlantic Region

Appendix Five: Detailed Statistics on Tarmac Delay Times (Flights May 2008 through April 2010)

Time based on last gate departure (local)

MONTH	O/N	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	Grand Total	
January		7	14	13	6	6	2	2	5	5	3	4	2	1	5	4	8			87	5.4%
February		1	6	6	4	1	3	8	10	1	5	3	4	1	5	6	4	13	4	85	5.3%
March		2	9	1	1	1	2	5	2	6	9	1	3	10	5	10	8	3	3	81	5.0%
April	1			2	9	5	2		2	2	4	2	2	3	8	3	3	1		49	3.0%
May		1		1		1	1	2	3	5	6	11	10	12	9	5				67	4.1%
June	2	8	6	6	6		3	6	19	15	24	43	81	65	42	15	8	6	12	367	22.7%
July		2	1			14	17	20	41	21	34	51	53	85	38	47	13	12		449	27.8%
August		1	2	2	10	16	10	6	16	23	26	47	24	13	9	8		1		214	13.2%
September		4	6	6	7					4		1	2	2						32	2.0%
October								2		1	15	18	2	5	4					47	2.9%
November		1	1								1		2				1			6	0.4%
December	5	3	5	4	8	6	4		8	5		6	5	14	15	16	16	8	6	134	8.3%
	8	30	50	41	51	50	44	51	106	88	127	187	190	211	140	114	61	44	25	1618	100.0%
	0.5%	1.9%	3.1%	2.5%	3.2%	3.1%	2.7%	3.2%	6.6%	5.4%	7.8%	11.6%	11.7%	13.0%	8.7%	7.0%	3.8%	2.7%	1.5%	100.0%	

Appendix Six: JetBlue Gate Simulation for JFK

BASE CASE - NO DISRUPTION
NORMAL OPERATIONS

TURN	1.0	HOUR
Total	26	GATES AVAIL.
RON	5	GATES NOT HARDSTAND

HOUR	SCH. ARR	SCH. DEP	DEMAND	TURN	READY	ACT DEP	GATES	AVAILABLE
5a	8	0	13	8	5	0	13	13
6a	7	5	20	7	13	-5	15	6
7a	9	8	24	9	15	-8	16	2
8a	8	12	24	8	16	-12	12	2
9a	7	11	19	7	12	-11	8	7
10a	3	4	11	3	8	-4	7	15
11a	9	6	16	9	7	-6	10	10
12p	9	4	19	9	10	-4	15	7
1p	4	8	19	4	15	-8	11	7
2p	6	9	17	6	11	-9	8	9
3p	6	5	14	6	8	-5	9	12
4p	5	9	14	5	9	-9	5	12
5p	6	5	11	6	5	-5	6	15
6p	4	10	10	4	6	-10	0	16
7p	6	7	6	6	0	-7	-1	20
8p	10	9	9	10	-1	-9	0	17
9p	9	9	9	9	0	-9	0	17
10p	5	5	5	5	0	-5	0	21
11p	5	0	5	5	0	0	5	21

3 HOUR GATE HOLD
START AT 4PM

TURN	1.0	HOUR
Total	26	GATES AVAIL.
RON	5	REMAIN OVERNIGHT

HOUR	SCH. ARR	SCH. DEP	DEMAND	TURN	READY	ACT DEP	GATES	TARMAC
5	8	0	13	8	5	0	13	0
6	7	5	20	7	13	-5	15	0
7	9	8	24	9	15	-8	16	0
8	8	12	24	8	16	-12	12	0
9	7	11	19	7	12	-11	8	0
10	3	4	11	3	8	-4	7	0
11	9	6	16	9	7	-6	10	0
12	9	4	19	9	10	-4	15	0
13	4	8	19	4	15	-8	11	0
14	6	9	17	6	11	-9	8	0
15	6	5	14	6	8	-5	9	0
16	5	9	14	5	9		14	0
17	6	5	20	6	14		20	0
18	4	10	24	4	20		24	0
19	6	7	30	6	24	-9	21	4
20	10	9	31	10	21	-5	26	5
21	9	9	35	9	26	-10	25	9
22	5	5	30	5	25	-7	23	4
O/N	5	0	28	5	23	-23	5	2

Appendix Seven: DOT-reported Taxi-Out Times By Year Across Reporting Airlines

Source: BTS Transtats

Year	Total Gate Departures	0-14	15-29	30-59	60-119	120-179	180-239	240-299	300+	Total 180+
2000	5,495,557	3,042,991	2,049,183	352,612	43,315	5,794	1,277	303	82	1,662
2001	5,736,582	3,324,248	2,062,738	311,157	33,869	3,799	638	117	16	771
2002	5,206,216	3,043,966	1,867,559	262,260	27,835	3,643	733	133	87	953
2003	6,387,071	3,759,578	2,239,972	340,865	40,960	4,494	881	224	97	1,202
2004	6,641,783	3,754,327	2,412,054	415,373	52,546	6,215	1,049	177	42	1,268
2005	7,006,866	4,010,084	2,536,140	401,467	52,192	5,894	921	141	27	1,089
2006	7,019,988	3,988,370	2,517,145	444,211	62,617	6,304	1,112	192	37	1,341
2007	7,294,649	3,943,107	2,751,246	515,302	75,833	7,507	1,370	239	45	1,654
2008	6,872,294	3,792,265	2,530,759	476,050	66,074	5,916	951	212	67	1,230
2009	6,360,908	3,608,623	2,269,159	427,834	50,579	4,109	525	69	10	604

Appendix Eight: JetBlue Airways – New York JFK Arrivals and Departures, Subset of Identifiable Turns by Aircraft April 15, 2010, Ranked by Turn Time. Median 55 minute turns, mean 1:05 minute turns.

Turn Time	Aircraft	Routing	Turn Time	Aircraft	Routing	Turn Time	Aircraft	Routing
0:32	N229JB	ROC-JFK/JFK-BUF	0:44	N279JB	JAX-JFK/JFK-BUF	0:57	N624JB	MSY-JFK/JFK-FLL
0:35	N206JB	IAD-JFK/JFK-PWM	0:47	N307JB	RIC-JFK/JFK-ROC	0:57	N534JB	TPA-JFK/JFK-FLL
0:35	N279JB	JAX-JFK/JFK-AUS	0:50	N206JB	RDU-JFK/JFK-IAD	0:57	N627JB	PBI-JFK/JFK-SJU
0:38	N294JB	ROC-JFK/JFK-CLT	0:50	N568JB	BOS-JFK/JFK-FLL	0:58	N635JB	BUF-JFK/JFK-DEN
0:38	N265JB	RIC-JFK/JFK-BOS	0:50	N519JB	BTV-JFK/JFK-MCO	0:58	N249JB	PIT-JFK/JFK-MSY
0:38	N203JB	RDU-JFK/JFK-ORD	0:50	N521JB	SYR-JFK/JFK-SRQ	0:59	N632JB	TPA-JFK/JFK-SJU
0:38	N229JB	BUF-JFK/JFK-RDU	0:50	N580JB	HOU-JFK/JFK-HOU	1:00	N506JB	BTV-JFK/JFK-PHX
0:38	N247JB	BOS-JFK/JFK-PWM	0:50	N589JB	JAX-JFK/JFK-MSY	1:00	N630JB	FLL-JFK/JFK-TPA
0:38	N247JB	PWM-JFK/JFK-BUF	0:50	N627JB	SJU-JFK/JFK-PDX	1:02	N521JB	SRQ-JFK/JFK-MCO
0:38	N279JB	BUF-JFK/JFK-JAX	0:50	N649JB	MCO-JFK/JFK-MCO	1:03	N645JB	LGB-JFK/JFK-FLL
0:38	N304JB	CLT-JFK/JFK-BOS	0:50	N763JB	PBI-JFK/JFK-BOS	1:03	N715JB	BUF-JFK/JFK-SYR
0:38	N316JB	PIT-JFK/JFK-PWM	0:50	N779JB	MCO-JFK/JFK-TPA	1:10	N571JB	PBI-JFK/JFK-BUR
0:39	N249JB	ORD-JFK/JFK-PIT	0:50	N639JB	RSW-JFK/JFK-SRQ	1:11	N505JB	PSE-JFK/JFK-LAS
0:39	N274JB	IAD-JFK/JFK-BUF	0:51	N292JB	AUS-JFK/JFK-AUS	1:11	N648JB	OAK-JFK/JFK-SJC
0:39	N294JB	ORD-JFK/JFK-ROC	0:51	N618JB	TPA-JFK/JFK-FLL	1:12	N635JB	BQN-JFK/JFK-FLL
0:40	N307JB	BOS-JFK/JFK-BTV	0:51	N635JB	FLL-JFK/JFK-BUF	1:12	N766JB	FLL-JFK/JFK-LGB
0:40	N307JB	BTV-JFK/JFK-RIC	0:52	N715JB	SYR-JFK/JFK-PBI	1:13	N621JB	SYR-JFK/JFK-FLL
0:40	N316JB	PWM-JFK/JFK-BTV	0:52	N636JB	BOS-JFK/JFK-PBI	1:16	N652JB	DEN-JFK/JFK-SYR
0:41	N265JB	ROC-JFK/JFK-RIC	0:53	N636JB	MCO-JFK/JFK-BOS	1:25	N504JB	FLL-JFK/JFK-LAS
0:41	N216JB	MSY-JFK/JFK-MCO	0:54	N570JB	MCO-JFK/JFK-PBI	1:36	N621JB	FLL-JFK/JFK-SYR
0:41	N231JB	CLT-JFK/JFK-RDU	0:55	N517JB	TPA-JFK/JFK-LGB	1:56	N729JB	SAN-JFK/JFK-PSE
0:41	N274JB	BUF-JFK/JFK-ORD	0:55	N595JB	MCO-JFK/JFK-RSW	1:59	N556JB	LAX-JFK/JFK-SYR
0:42	N249JB	CLT-JFK/JFK-ORD	0:55	N588JB	MCO-JFK/JFK-SMF	2:02	N283JB	PWM-JFK/JFK-BOS
0:43	N203JB	RDU-JFK/JFK-RDU	0:55	N708JB	SJU-JFK/JFK-TPA	2:06	N580JB	RSW-JFK/JFK-HOU
0:43	N203JB	ORD-JFK/JFK-JAX	0:56	N703JB	HOU-JFK/JFK-FLL	2:21	N652JB	SYR-JFK/JFK-PBI
0:43	N229JB	ROC-JFK/JFK-ROC	0:56	N506JB	PHX-JFK/JFK-MCO	2:30	N606JB	SFO-JFK/JFK-SJU
0:43	N316JB	BUF-JFK/JFK-PIT	0:56	N646JB	RSW-JFK/JFK-OAK	7:17	N591JB	BUR-JFK/JFK-BUF
						8:02	N612JB	SLC-JFK/JFK-SLC

Appendix 9: FAA ASPM Data Set, DFW Airport, May 14, 2010

Time Starting	Departures	Arrivals	Total Operations	Departure Demand	Arrival Demand	Total Demand	Eff AAR	ADR	Cap AAR	ADR+AAR	% Cap Utilized	Departure Effeciency %	Arrival Efficiency %	SAER
6:00 AM	5	2	7	5	2	7	30	20	30	50	14	100	100	100
6:15 AM	4	3	7	4	3	7	23	20	23	43	16.28	100	100	100
6:30 AM	10	4	14	10	4	14	23	20	23	43	32.56	100	100	100
6:45 AM	11	1	12	11	2	13	22	20	22	42	28.57	100	50	92.31
7:00 AM	8	5	13	8	5	13	22	20	22	42	30.95	100	100	100
7:15 AM	15	4	19	15	4	19	23	20	23	43	44.19	100	100	100
7:30 AM	15	12	27	15	12	27	23	20	23	43	62.79	100	100	100
7:45 AM	14	9	23	14	11	25	22	20	22	42	54.76	100	81.82	92
8:00 AM	8	13	21	8	14	22	22	20	22	42	50	100	92.86	95.45
8:15 AM	7	10	17	7	11	18	23	20	23	43	39.53	100	90.91	94.44
8:30 AM	9	13	22	10	13	23	23	20	23	43	51.16	90	100	95.65
8:45 AM	12	11	23	13	12	25	22	20	22	42	54.76	92.31	91.67	92
9:00 AM	16	11	27	16	14	30	22	20	22	42	64.29	100	78.57	90
9:15 AM	11	15	26	12	17	29	23	20	23	43	60.47	91.67	88.24	89.66
9:30 AM	11	21	32	15	23	38	23	20	23	43	74.42	73.33	91.3	84.21
9:45 AM	13	11	24	17	13	30	22	20	22	42	57.14	76.47	84.62	80
10:00 AM	15	15	30	22	18	40	22	20	22	42	71.43	75	83.33	78.75
10:15 AM	11	12	23	16	15	31	23	20	23	43	53.49	68.75	80	74.19
10:30 AM	13	13	26	16	15	31	23	20	23	43	60.47	81.25	86.67	83.87
10:45 AM	13	9	22	19	10	29	22	20	22	42	52.38	68.42	90	75.86
11:00 AM	14	12	26	21	12	33	22	20	22	42	61.9	70	100	80.91
11:15 AM	14	15	29	17	15	32	23	20	23	43	67.44	82.35	100	90.62
11:30 AM	11	14	25	16	16	32	23	20	23	43	58.14	68.75	87.5	78.12
11:45 AM	14	14	28	20	18	38	22	20	22	42	66.67	70	77.78	73.68
12:00 PM	11	10	21	19	17	36	22	20	22	42	50	57.89	58.82	58.33
12:15 PM	8	12	20	20	18	38	23	20	23	43	46.51	40	66.67	52.63
12:30 PM	6	2	8	18	10	28	23	20	23	43	18.6	33.33	20	28.57
12:45 PM	4	4	8	15	11	26	22	20	22	42	19.05	26.67	36.36	30.77
1:00 PM	0	2	2	11	8	19	22	20	22	42	4.76	0	25	10.53
1:15 PM	0	4	4	11	11	22	0	0	0	0	400	100	100	100
1:30 PM	2	5	7	12	14	26	0	0	0	0	700	100	100	100
1:45 PM	7	2	9	11	14	25	0	0	0	0	900	100	100	100
2:00 PM	2	2	4	5	15	20	0	0	0	0	400	100	100	100
2:15 PM	4	1	5	4	16	20	0	0	0	0	500	100	100	100
2:30 PM	0	1	1	2	19	21	0	0	0	0	100	100	100	100
2:45 PM	4	2	6	6	20	26	8	20	8	28	21.43	66.67	25	34.62

Time Starting	Departures	Arrivals	Total Operations	Departure Demand	Arrival Demand	Total Demand	Eff AAR	ADR	Cap AAR	ADR+AAR	% Cap Utilized	Departure Effeciency %	Arrival Efficiency %	SAER
3:00 PM	2	7	9	8	27	35	15	20	15	35	25.71	25	46.67	41.71
3:15 PM	6	6	12	19	26	45	15	20	15	35	34.29	31.58	40	36.44
3:30 PM	12	2	14	35	23	58	15	20	15	35	40	60	13.33	41.49
3:45 PM	12	3	15	32	24	56	15	20	15	35	42.86	60	20	42.86
4:00 PM	13	4	17	27	28	55	23	20	23	43	39.53	65	17.39	40.76
4:15 PM	16	5	21	23	32	55	23	20	23	43	48.84	80	21.74	46.1
4:30 PM	9	5	14	10	34	44	23	20	23	43	32.56	90	21.74	37.25
4:45 PM	8	8	16	8	42	50	22	20	22	42	38.1	100	36.36	46.55
5:00 PM	5	7	12	5	41	46	22	20	22	42	28.57	100	31.82	39.23
5:15 PM	2	7	9	2	42	44	23	20	23	43	20.93	100	30.43	33.6
5:30 PM	3	10	13	3	50	53	23	20	23	43	30.23	100	43.48	46.68
5:45 PM	3	13	16	3	53	56	29	20	29	49	32.65	100	44.83	47.78
6:00 PM	7	9	16	7	55	62	29	20	29	49	32.65	100	31.03	38.82
6:15 PM	4	16	20	4	62	66	29	20	29	49	40.82	100	55.17	57.89
6:30 PM	6	10	16	6	57	63	29	20	29	49	32.65	100	34.48	40.72
6:45 PM	9	15	24	9	59	68	28	20	28	48	50	100	53.57	59.72
7:00 PM	4	10	14	4	51	55	28	20	28	48	29.17	100	35.71	40.39
7:15 PM	5	14	19	5	53	58	29	20	29	49	38.78	100	48.28	52.73
7:30 PM	6	10	16	6	45	51	29	20	29	49	32.65	100	34.48	42.19
7:45 PM	4	11	15	4	38	42	28	20	28	48	31.25	100	39.29	45.07
8:00 PM	10	13	23	11	36	47	28	20	28	48	47.92	90.91	46.43	56.84
8:15 PM	8	11	19	8	33	41	29	20	29	49	38.78	100	37.93	50.04
8:30 PM	5	16	21	6	32	38	29	20	29	49	42.86	83.33	55.17	59.62
8:45 PM	7	8	15	7	22	29	28	20	28	48	31.25	100	36.36	51.72
9:00 PM	10	17	27	10	30	40	28	20	28	48	56.25	100	60.71	70.54
9:15 PM	13	10	23	13	20	33	29	20	29	49	46.94	100	50	69.7
9:30 PM	7	13	20	10	23	33	29	20	29	49	40.82	70	56.52	60.61
9:45 PM	11	11	22	12	21	33	28	20	28	48	45.83	91.67	52.38	66.67
10:00 PM	14	8	22	14	16	30	28	20	28	48	45.83	100	50	73.33
10:15 PM	7	5	12	8	15	23	29	20	29	49	24.49	87.5	33.33	52.17
10:30 PM	12	13	25	12	20	32	29	20	29	49	51.02	100	65	78.12
10:45 PM	6	8	14	6	11	17	28	20	28	48	29.17	100	72.73	82.35
11:00 PM	9	3	12	9	7	16	28	20	28	48	25	100	42.86	75
11:15 PM	5	1	6	6	5	11	29	20	29	49	12.24	83.33	20	54.55
11:30 PM	6	8	14	7	12	19	29	20	29	49	28.57	85.71	66.67	73.68
11:45 PM	5	4	9	6	7	13	28	20	28	48	18.75	83.33	57.14	69.23
12:00 AM	4	4	8	4	6	10	28	20	28	48	16.67	100	66.67	80