The Effect of Adopting the NextGen Air Transportation System on Air Travel Performance: Evidence from High-frequency Air Traffic Data

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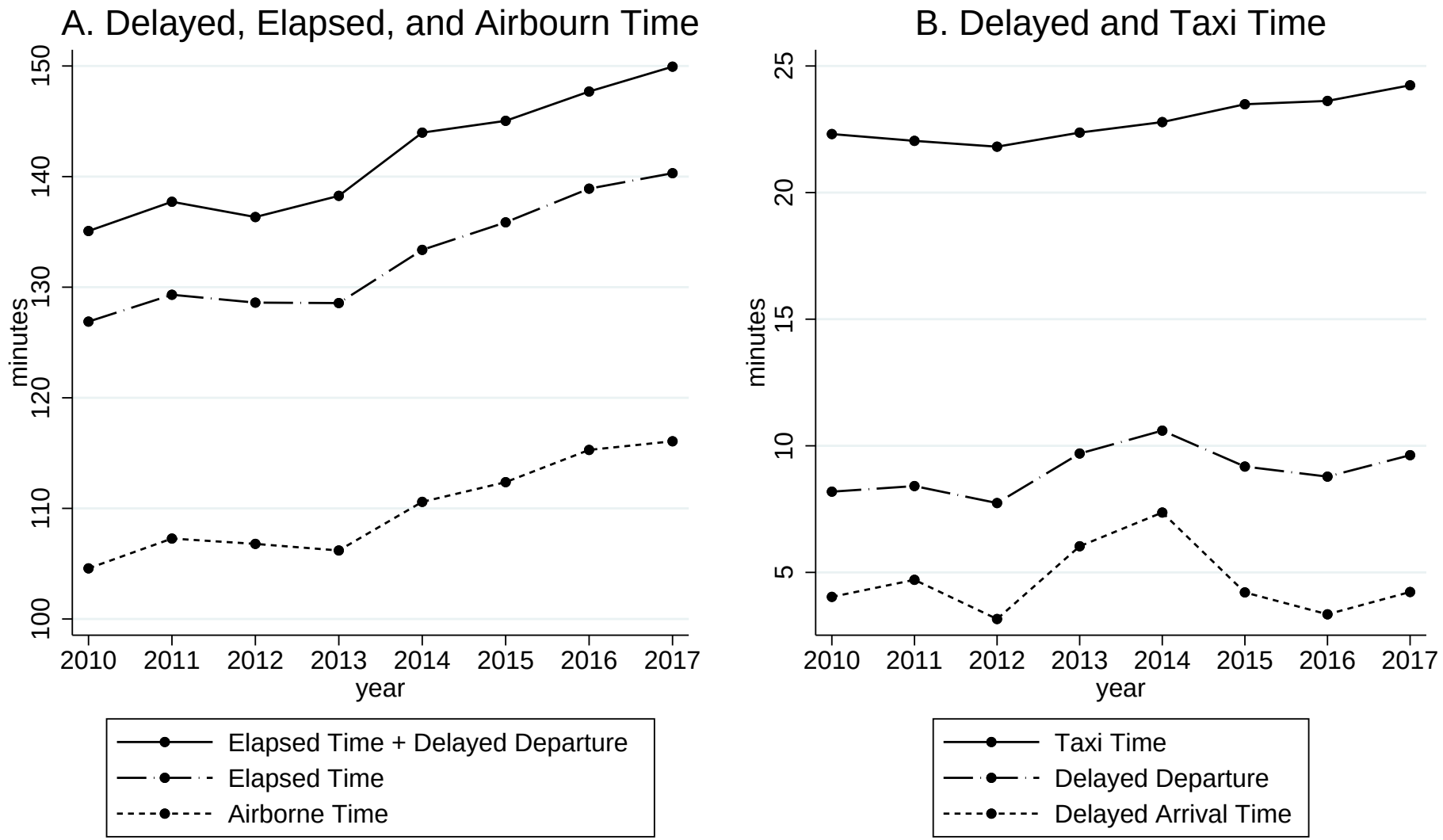
NBER Energy Use in Transpration, Friday May 3, 2019

Congestion in Air Transporation

Jets line up for takeoff, March 27, 2006 at O'Hare International Airport in Chicago, Illinois. (Photo by Tim Boyle/Getty Images)

- Inefficient infrascture wastes time: *Busy airports, such as JFK and Newark in metro New York City tend to be congested 10 to 20 percent of the time. At Newark, for example, planes average taxi times of 52 minutes during congested periods versus 14 minutes during less busy times. Pushback times for planes can exacerbate the situation. – Forbes*
- These inefficiencies also affect fuel consumptions, emissions, and noises

Air Travel Time Has Been Increasing



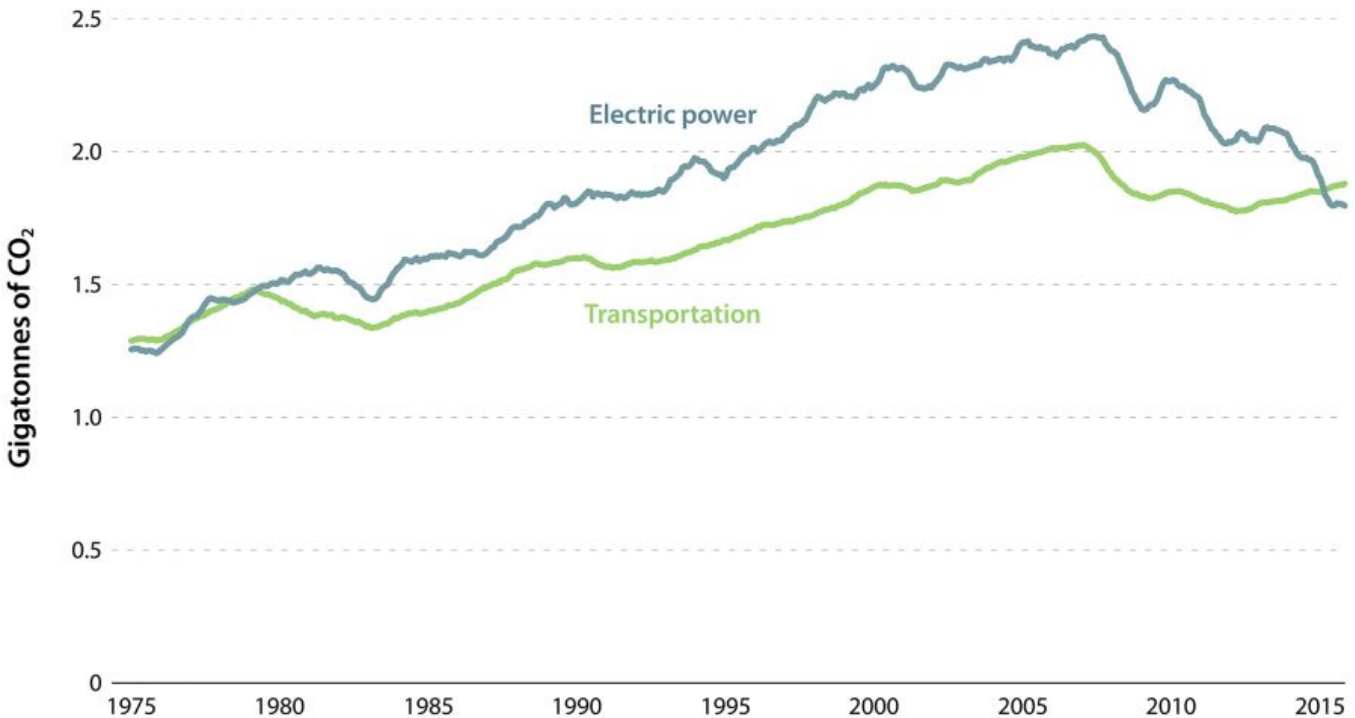
Sources: DOT On-Time Performance

Emissions from Transporation Caught Up with the Power Sector

FIGURE 9.

U.S. CO_2 Emissions by Sector, 1975–2016

CO_2 emissions from transportation began to increase again in 2013.



Source: EIA 2016g.

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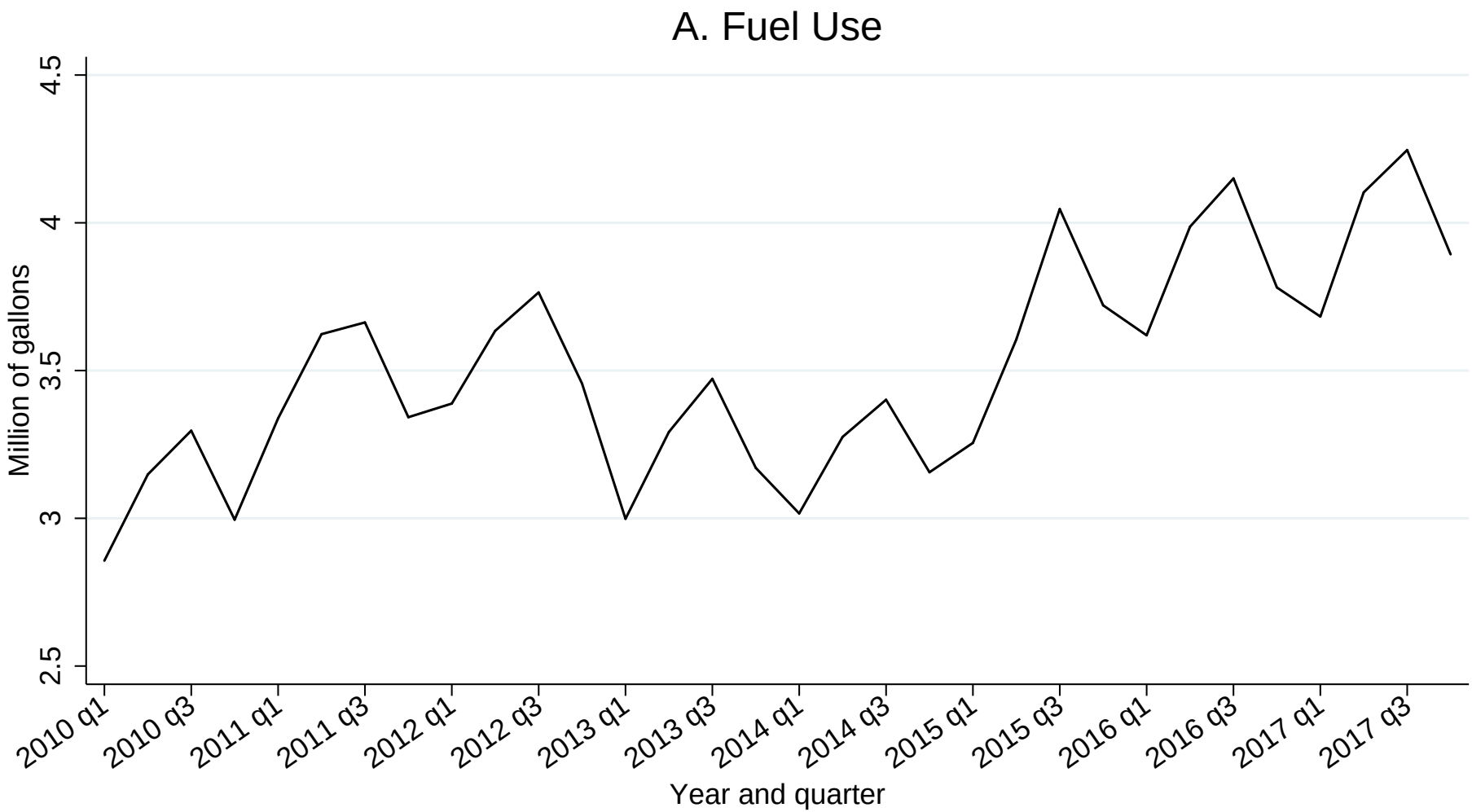
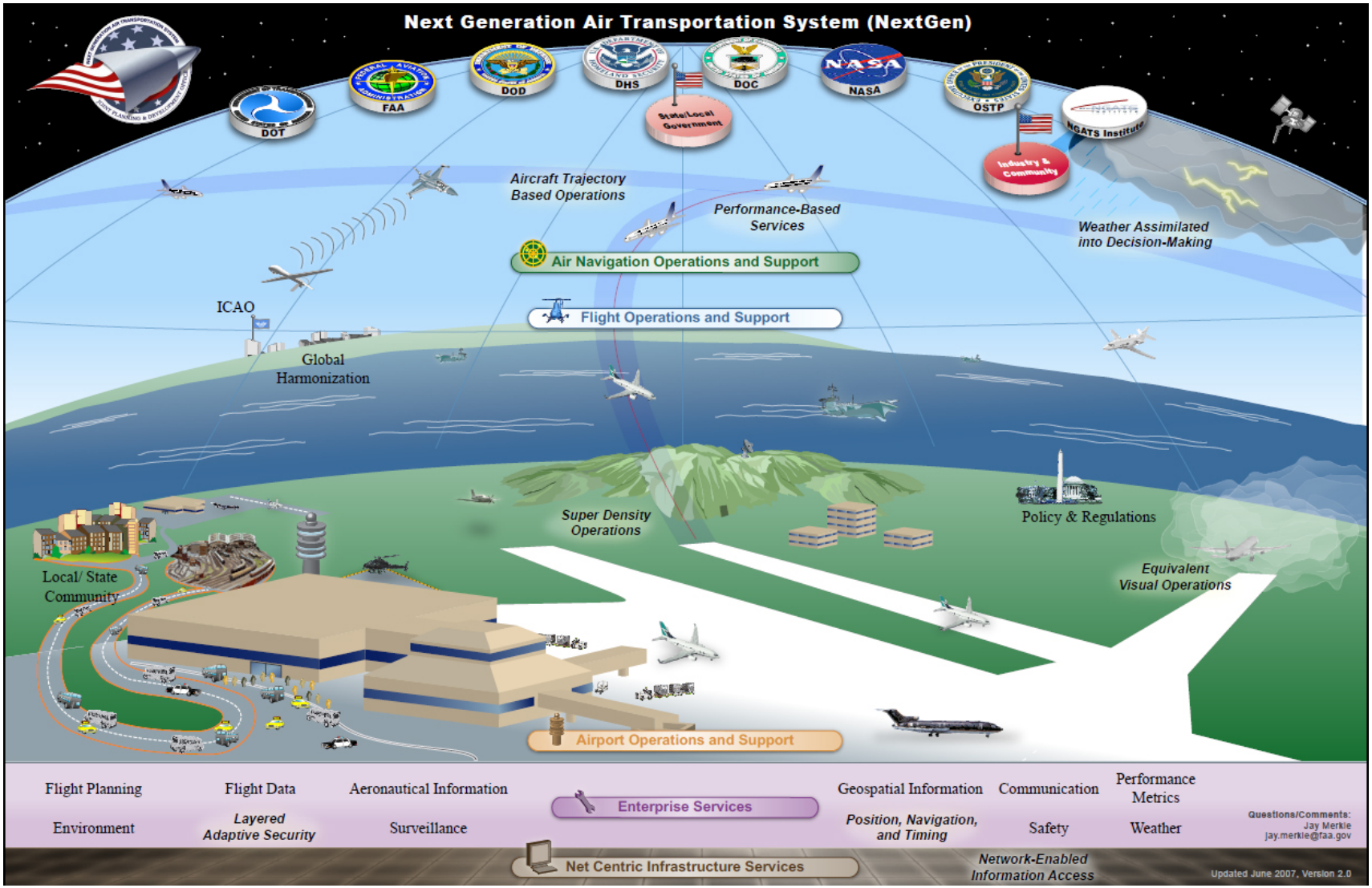
Increasing Jet Fuel Consumption



Sources: DOT Schedule Form-F41 Schedule P-52

NextGen


Next Generation Air Transportation System (NextGen)
DOT
FAA
DOD
DHS
DOC
NASA
OSTP
State/Local Government
Industry & Community
NGATS Institute
Aircraft Trajectory Based Operations
Performance-Based Services
Weather Assimilated into Decision-Making
Air Navigation Operations and Support
Flight Operations and Support
ICAO
Global Harmonization
Super Density Operations
Policy & Regulations
Local/ State Community
Equivalent Visual Operations
Airport Operations and Support
Flight Planning
Flight Data
Aeronautical Information
Enterprise Services
Geospatial Information
Communication
Performance Metrics
Environment
Layered Adaptive Security
Surveillance
Position, Navigation, and Timing
Safety
Weather
Questions/Comments: Jay Merkle jay.merkle@faa.gov
Net Centric Infrastructure Services
Network-Enabled Information Access
Updated June 2007, Version 2.0

Motivation

The US government has planned to implement new airspace infrastructure called the Next Generation Air Transporation System (NextGen) since 2004. The first project was completed in 2014.

The appeal: Investing in NextGen may pay for itself:

- Private benefits from **time-savings** (passenger and airlines) and **fuel-savings** (indirectly associated with time-savings) via reducing delay, taxi-in and taxi-out time.
- Social benefits include reducions to emission and noise.

The usual solution to the air transportation inefficiency:

- Pigouvian tax such as peak-time pricing adjusted by market power and network effect (Daniel, 1995, 2001; Brueckener, 2002; Mayer and Sinai, 2003; Morrison and Winston, 2007).
- There can be additional welfare gains from improving infrastructure.

Main Question and Approach

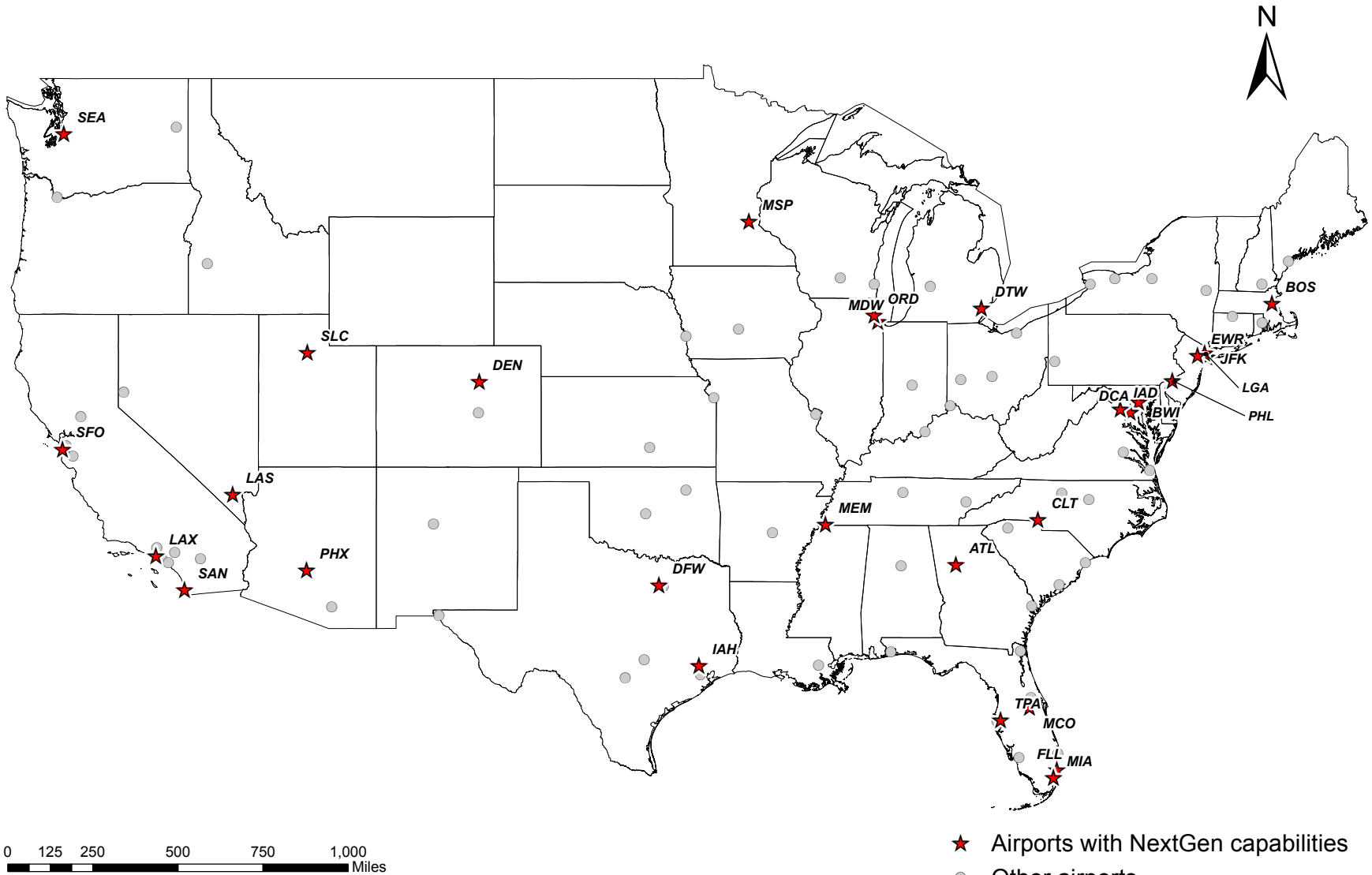
How has adopting NextGen affected **flight travel time**?

- Infer **private benefits** of adopting NextGen for airlines (savings in crew costs and fuel costs via improving flight travel time) and passengers (time-savings)
- Study heterogeneous effects of NextGen

Approach

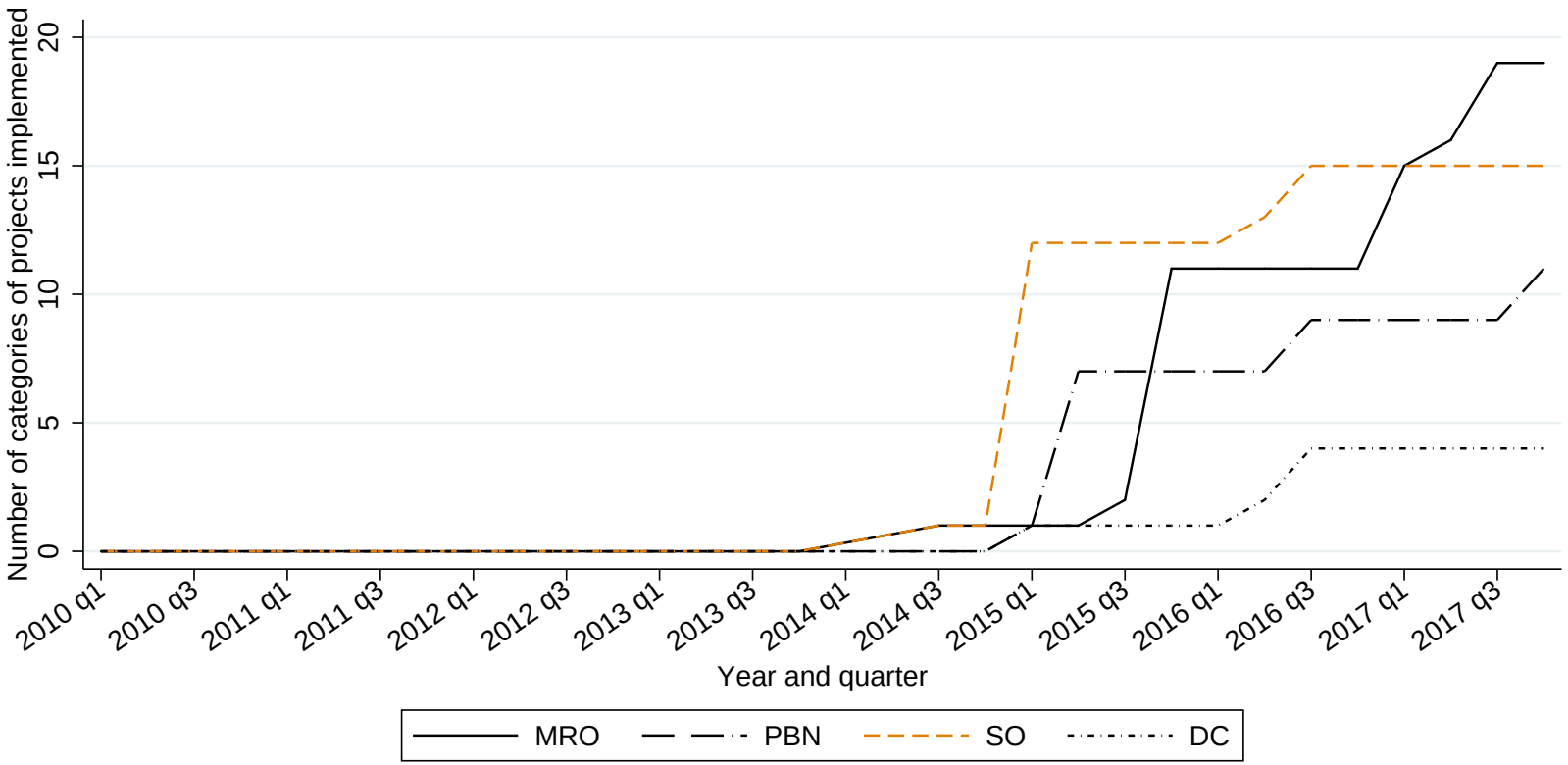
- NextGen has been implemented since 2014
- Use Diff-in-Diff strategy and high-frequency DOT On-Time Performance flight-level data from 2010 to 2017

NextGen 30 Priority Airports

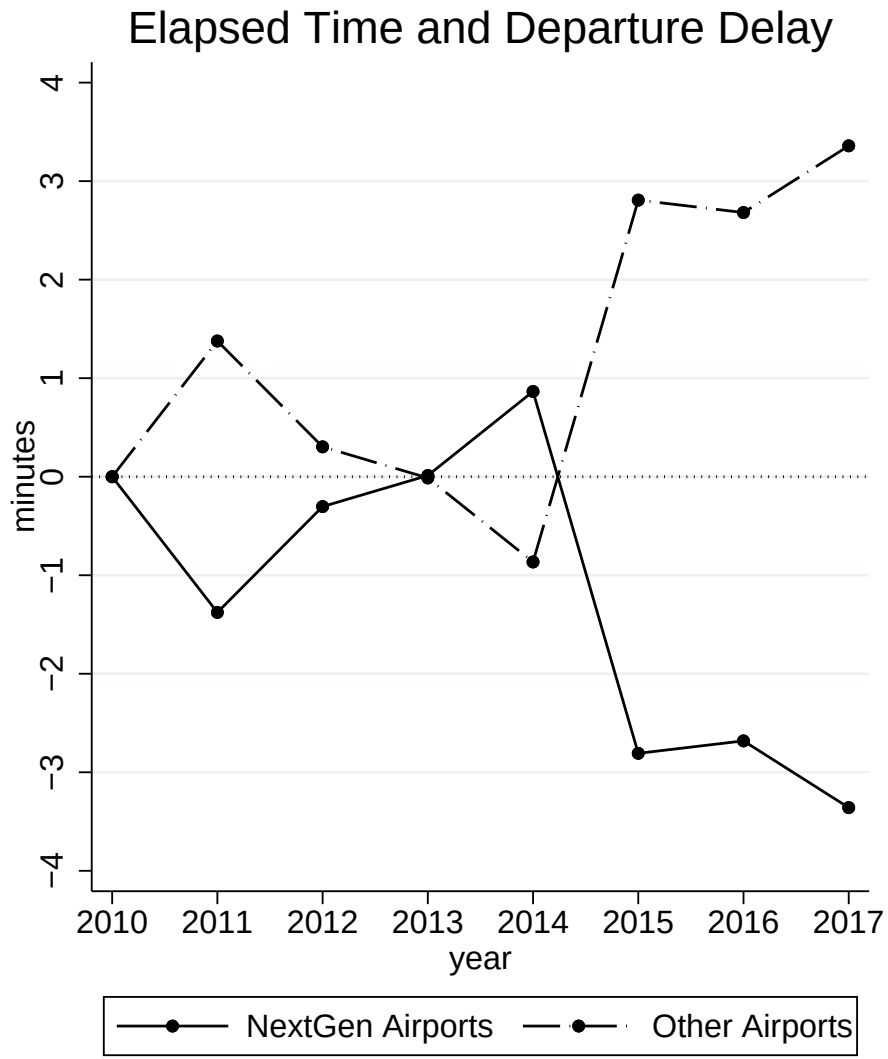


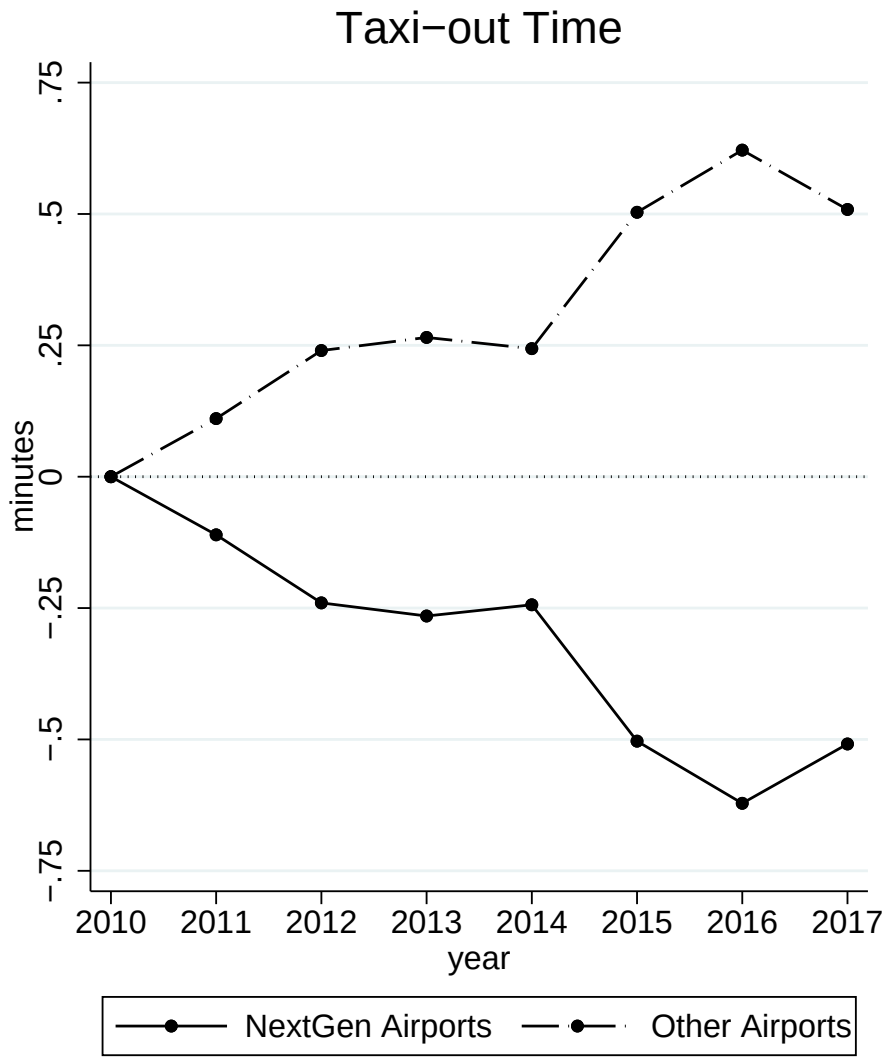
Four Categories of NextGen Projects

- Multiple-runway operations (MRO), Performance-based navigation (PBN), Surface operation and data sharing (SO), and Data communication (DC)
- We collect the *quarterly* completion history of all projects within these four categories at treated airports



Suggestive Evidence of Diff-in-Diff





Data

Daily flight-level data from DOT On-Time Performance, 2010–2017

- Scheduled and actual departure and arrival, duration of elapsed time, airborne time, taxi-in, and taxi-out
- Tail number (this allows us to track specific aircraft), previous operations and delays, and other flight-level information

Other data

- Hourly weather data at the monitor near each airport from NOAA
- Daily terminal air travel tower information such as overflights from FAA
- Aircraft make and model from DOT Form-B43 (linked using tail number)
- Market level data from DOT DB1B
- Airline monthly fuel consumption and costs from DOT Form-F41 Schedule-P52
- Simulated mapping from taxi-in and taxi-out time to fuel consumption, emissions, and noises from the FAA's Aviation Environmental Design Tool (AEDT)

A Diff-in-Diff Design

For flight i traveling from airport o to d operated by airline j on date t and time m

$$travel_{ijodtm} = \beta_1 NextGen_{ot} + \beta_2 NextGen_{dt} + \alpha_{od} + \alpha_j + \alpha_o \times y + \alpha_d \times y + \phi_{tm} + u_{ijodtm}$$

- *travel*: eight dep. vars: minutes of (1) elapsed time plus departure delay, (2) elapsed time, (3) airborne time, (4) taxi-time, (5) taxi-out time, (6) taxi-in time, (7) departure delay, and (8) arrival delay
- $NextGen_{kt}$: $k = o, d$ the number of categories of projects (MRO, PBN, SO, and/or DC) completed at origin/destination airport k at a given quarter
- α_{od}: route fixed effects
- α_j: airline fixed effects
- $\alpha_k \times y$: $k = o, d$, origin/destination airport fixed effects interacted with a linear year trend
- ϕ_{tm}: separate fixed effects of year-by-month, day-of-month, day-of-week, and hour-of-day

Identifying Assumptions

$$travel_{ijodtm} = \beta_1 NextGen_{ot} + \beta_2 NextGen_{dt} + \alpha_{od} + \alpha_j + \alpha_o \times y + \alpha_d \times y + \phi_{tm} + u_{ijodtm}$$

- The treated airports are not randomly assigned
- Assume conditional on controls, treatment in *a given quarter* is as good as random
- The following factors work in favor for the identification:
- Uncertainty and variation of the duration of the previous stages: such as "study stage" and "implementation stage"
- Uncertainty and variation of the time it takes for airline companies to respond to NextGen by rescheduling flights to the Computer Reservation System (CRS) (Forbes, 2008)

Also, we drop the "implementation period" as in Burlig et al. (2019). In practice, we drop 2Q before the treatment and 2013. We also drop observation with missing aircraft information (tailnum cannot be found form B43)

How does NextGen affect flight travel time? A Diff-in-Diff Design

Flight A1: JetBlue Flight 1446 CLT–BOS, Non-stop, Embraer E-190 Departed at 6pm, April 19, 2015	Flight B1: Another flight LAX–BOS, Non-stop, Embraer E-190 Departed at 6pm, April 19, 2015
Flight A0: Departed at 6pm, April 19, 2012	Flight B0: Departed at 6pm, April 19, 2012

- BOS and CLT finished implementing its first project in 2015 Q1
- LAX did not complete any of the four types of NextGen projects until 2016 Q1

Effect of NextGen on Air Travel Time

Table 2: **The effect of NextGen on air travel time**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dep var.: air travel time (minutes)	elapsed time + departure delay	elapsed time	airborne time	taxi time	taxi-out time	taxi-in time	departure delay	arrival delay
Panel A. Effect of Total Number of Categories of Projects (MRO, PBN, SO, and DC) Implemented								
NextGen Origin	-1.267***	-0.195**	-0.030	-0.165***	-0.141***	-0.024	-1.072***	-1.598***
	(0.154)	(0.078)	(0.058)	(0.044)	(0.037)	(0.024)	(0.124)	(0.156)
NextGen Dest.	-1.166***	-0.119	0.046	-0.165***	-0.171***	0.006	-1.047***	-1.000***
	(0.149)	(0.078)	(0.061)	(0.048)	(0.038)	(0.028)	(0.114)	(0.151)
Number of obs.	25,037,569	25,037,569	25,037,569	25,037,569	25,037,569	25,037,569	25,037,569	25,037,569
R-squared	0.80	0.97	0.99	0.22	0.21	0.22	0.04	0.04

Effect of NextGen from 2014 to 2017 on Air Travel Time

- Consider a scenario where airports in 2017 had not been treated, i.e., as if the airports were in the same condition as the beginning of 2014
- Compare the actual travel performance in 2017 vs. the counterfactual level

Table 3: **The effect of NextGen from 2014 to 2017 on air travel time**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Unit (minutes)	elapsed time + departure delay	elapsed time	airborne time	taxi time	taxi-out time	taxi-in time	departure delay	arrival delay
Actual	149.04	139.30	115.78	23.51	16.32	7.18	9.6	4.13
Change	2.54	0.33	-0.02	0.35	0.33	0.02	2.22	2.72
Change (percent)	1.71%	0.24%	-0.01%	1.47%	2.00%	0.26%	23.17%	65.94%
Counterfactual	151.42	139.62	115.77	23.85 3	16.65	7.20	11.80	6.85
Number of obs.							4,736,642	

Notes: The first row reports the actual travel time in 2017. This table reports the counterfactual travel time and delay if the treated airports in 2017 had been untreated, i.e., as if the airports were in the beginning of 2014. We use baseline in Table 2. In Appendix Table A.6 we use estimates in Table 2 Panel B and estimates in Table 8.

Evaluate Private Benefit

Following the FAA (2016) "Economic Values for FAA Investment and Regulatory Decision, A Guide"

- Crew cost: $1,039.58 per hour per flight
- Fuel and oil: $2,443.23 per hour per flight
- Maintenance: $793.39 per hour per flight
- Passenger time (business and casual combined): $48.71 per hour per person
- The number of passengers from DOT DB1B dataset

NextGen from 2014 to 2017: Private Benefit per Flight

Table 4: **The benefit of reducing delay of NextGen in 2017**

Panel A. Itemized Benefit Per Flight

	(1) elapsed time + departure delay	(2) elapsed time	(3) airborne time	(4) taxi time	(5) taxi-out time	(6) taxi-in time	(7) departure delay	(8) arrival delay
Panel A.1 Variable Airline Cost Per Flight (2017 USD)								
Crew cost	44.15	5.70	-0.29	5.99	5.66	0.33	38.45	47.15
Fuel and oil	–	–	-0.29	14.08	13.31	0.77	–	–
Maintenance	–	–	–	4.57	4.32	0.25	–	–
Panel A.2 Passenger Cost Per Flight (2017 USD)								
Time saving	128.10	16.53	-0.842	17.37	16.42	0.95	111.50	136.80
Num. of obs.							4,736,642	

- FAA parameters that we use: Fuel and oil: \$2,443.23 per hour per flight
- We could use gallon of fuel and oil per hour per flight recommended by FAA (2016), and evaluate at 2017 jet fuel price from EIA

NextGen from 2014 to 2017: Private Benefit

Panel B. Benefit of NextGen via Reducing Delay and Air Travel Time in 2017

	Cost saving per flight (2017 USD)	Cost saving in 2017 (million 2017 USD)	(percentage)
Crew cost	70.72	258.58	21.4 %
Fuel and oil	41.20	150.64	12.5 %
Maintenance	13.71	50.13	4.15 %
Passenger	205.14	750.04	62.02 %
Total private benefits	330.77	1209.40	

Next (details at the end of the talk):

- Refine private benefits: fuel and oil consumption
- Add social benefit: emissions (SO2, NOx, CO2, etc.) and noise
- Use FAA AEDT, DOT B52, and DOT Form-F41 Schedule-52 data

Heterogeneous Effects

- Effect by weather condition
- Effect by prior delay
- Effect by hub status

Effect by Weather

Table 5: **Conditional Effect of NextGen on Air Travel Time by Weather Condition**

Dep var.: air travel time (minutes)	(1) elapsed time + departure delay	(2) elapsed time	(3) airborne time	(4) taxi time	(5) taxi-out time	(6) taxi-in time	(7) departure delay	(8) arrival delay
				A. Baseline				
NextGen Origin	-1.267***	-0.195**	-0.030	-0.165***	-0.141***	-0.024	-1.072***	-1.598***
	(0.154)	(0.078)	(0.058)	(0.044)	(0.037)	(0.024)	(0.124)	(0.156)
NextGen Dest.	-1.166***	-0.119	0.046	-0.165***	-0.171***	0.006	-1.047***	-1.000***
	(0.149)	(0.078)	(0.061)	(0.048)	(0.038)	(0.028)	(0.114)	(0.151)
Number of obs.	25,037,569	25,037,569	25,037,569	25,037,569	25,037,569	25,037,569	25,037,569	25,037,569
R-squared	0.80	0.97	0.99	0.22	0.21	0.22	0.04	0.04
				B.1 Sky Ceiling $<$ 1,500 Feet (Origin)				
NextGen Origin	-1.779***	-0.363***	-0.141*	-0.223***	-0.182***	-0.041	-1.416***	-2.010***
	(0.274)	(0.115)	(0.085)	(0.070)	(0.063)	(0.031)	(0.235)	(0.269)
NextGen Dest.	-0.898***	-0.094	-0.045	-0.049	-0.113*	0.065*	-0.804***	-0.679**
	(0.285)	(0.128)	(0.098)	(0.077)	(0.066)	(0.038)	(0.239)	(0.276)
Number of obs.	2,255,847	2,255,847	2,255,847	2,255,847	2,255,847	2,255,847	2,255,847	2,255,847
R-squared	0.75	0.97	0.99	0.21	0.20	0.22	0.06	0.07
				B.2 Sky Ceiling $<$ 1,500 Feet (Destination)				
NextGen Origin	-0.758**	0.037	0.090	-0.053	-0.050	-0.003	-0.795***	-1.053***
	(0.305)	(0.122)	(0.088)	(0.076)	(0.067)	(0.037)	(0.250)	(0.296)
NextGen Dest.	-1.206***	0.155	0.163*	-0.008	-0.073	0.065*	-1.361***	-0.987***
	(0.291)	(0.120)	(0.090)	(0.071)	(0.058)	(0.038)	(0.246)	(0.279)
Number of obs.	2,121,711	2,121,711	2,121,711	2,121,711	2,121,711	2,121,711	2,121,711	2,121,711
R-squared	0.73	0.96	0.98	0.21	0.18	0.23	0.08	0.09

Effect by Prior Delay

Table 6: **Conditional Effect of NextGen on Air Travel Time by Prior Delay**

Dep var.: air travel time (minutes)	(1) elapsed time + departure delay	(2) elapsed time	(3) airborne time	(4) taxi time	(5) taxi-out time	(6) taxi-in time	(7) departure delay	(8) arrival delay
A. Baseline								
NextGen Origin	-1.267***	-0.195**	-0.030	-0.165***	-0.141***	-0.024	-1.072***	-1.598***
	(0.154)	(0.078)	(0.058)	(0.044)	(0.037)	(0.024)	(0.124)	(0.156)
NextGen Dest.	-1.166***	-0.119	0.046	-0.165***	-0.171***	0.006	-1.047***	-1.000***
	(0.149)	(0.078)	(0.061)	(0.048)	(0.038)	(0.028)	(0.114)	(0.151)
Number of obs.	25,037,569	25,037,569	25,037,569	25,037,569	25,037,569	25,037,569	25,037,569	25,037,569
R-squared	0.80	0.97	0.99	0.22	0.21	0.22	0.04	0.04
B.1 Prior Delay > 15 minutes								
NextGen Origin	-2.563***	-0.452***	-0.173***	-0.279***	-0.274***	-0.005	-2.111***	-2.726***
	(0.298)	(0.093)	(0.067)	(0.061)	(0.052)	(0.029)	(0.279)	(0.293)
NextGen Dest.	-1.789***	-0.289***	-0.076	-0.213***	-0.175***	-0.037	-1.500***	-1.640***
	(0.286)	(0.100)	(0.076)	(0.067)	(0.053)	(0.036)	(0.269)	(0.280)
Number of obs.	3,045,782	3,045,782	3,045,782	3,045,782	3,045,782	3,045,782	3,045,782	3,045,782
R-squared	0.62	0.96	0.98	0.21	0.21	0.21	0.07	0.07
B.2 Prior Delay > 30 minutes								
NextGen Origin	-3.012***	-0.630***	-0.236***	-0.394***	-0.388***	-0.006	-2.382***	-3.084***
	(0.371)	(0.105)	(0.075)	(0.071)	(0.060)	(0.033)	(0.352)	(0.362)
NextGen Dest.	-2.013***	-0.379***	-0.081	-0.299***	-0.221***	-0.077*	-1.633***	-1.783***
	(0.363)	(0.114)	(0.085)	(0.077)	(0.061)	(0.042)	(0.342)	(0.355)
Number of obs.	1,770,528	1,770,528	1,770,528	1,770,528	1,770,528	1,770,528	1,770,528	1,770,528
R-squared	0.58	0.96	0.98	0.20	0.21	0.20	0.08	0.08

Effect by Prior Delay

Table 6: **Conditional Effect of NextGen on Air Travel Time by Prior Delay**

Dep var.: air travel time (minutes)	(1) elapsed time + departure delay	(2) elapsed time	(3) airborne time	(4) taxi time	(5) taxi-out time	(6) taxi-in time	(7) departure delay	(8) arrival delay
B.3 Prior Delay > 60 minutes								
NextGen Origin	-3.340***	-0.757***	-0.278***	-0.479***	-0.464***	-0.015	-2.583***	-3.322***
	(0.436)	(0.117)	(0.081)	(0.078)	(0.066)	(0.037)	(0.414)	(0.427)
NextGen Dest.	-2.241***	-0.359***	-0.056	-0.302***	-0.206***	-0.096**	-1.882***	-1.964***
	(0.434)	(0.126)	(0.091)	(0.087)	(0.067)	(0.047)	(0.412)	(0.428)
Number of obs.	1,188,996	1,188,996	1,188,996	1,188,996	1,188,996	1,188,996	1,188,996	1,188,996
R-squared	0.55	0.95	0.98	0.19	0.20	0.20	0.10	0.10
B.4 Prior Delay > 90 minutes								
NextGen Origin	-4.456***	-0.717***	-0.306***	-0.411***	-0.414***	0.003	-3.739***	-4.342***
	(0.644)	(0.142)	(0.096)	(0.099)	(0.085)	(0.046)	(0.631)	(0.640)
NextGen Dest.	-2.323***	-0.263	-0.038	-0.226*	-0.186**	-0.040	-2.060***	-2.038***
	(0.690)	(0.161)	(0.110)	(0.116)	(0.088)	(0.065)	(0.673)	(0.683)
Number of obs.	480,384	480,384	480,384	480,384	480,384	480,384	480,384	480,384
R-squared	0.52	0.95	0.98	0.19	0.20	0.20	0.16	0.16
B.5 Prior Delay > 120 minutes								
NextGen Origin	-4.505***	-0.523***	-0.198*	-0.325***	-0.319***	-0.007	-3.981***	-4.471***
	(0.871)	(0.161)	(0.109)	(0.111)	(0.099)	(0.053)	(0.856)	(0.870)
NextGen Dest.	-2.781***	-0.181	-0.027	-0.154	-0.107	-0.047	-2.600***	-2.508***
	(0.942)	(0.183)	(0.127)	(0.130)	(0.102)	(0.074)	(0.929)	(0.936)
Number of obs.	285,103	285,103	285,103	285,103	285,103	285,103	285,103	285,103
R-squared	0.51	0.95	0.98	0.19	0.20	0.20	0.21	0.20

Effect by Hub Status at Origin Airport

Table 7: **Conditional Effect of NextGen on Air Travel Time by Hub Airlines**

Dep var.: air travel time (minutes)	(1) elapsed time + departure delay	(2) elapsed time	(3) airborne time	(4) taxi time	(5) taxi-out time	(6) taxi-in time	(7) departure delay	(8) arrival delay
A. Baseline								
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	(0.154)	(0.078)	(0.058)	(0.044)	(0.037)	(0.024)	(0.124)	(0.156)
NextGen Dest.	-1.166***	-0.119	0.046	-0.165***	-0.171***	0.006	-1.047***	-1.000***
	(0.149)	(0.078)	(0.061)	(0.048)	(0.038)	(0.028)	(0.114)	(0.151)
Number of obs.	25,037,569	25,037,569	25,037,569	25,037,569	25,037,569	25,037,569	25,037,569	25,037,569
R-squared	0.80	0.97	0.99	0.22	0.21	0.22	0.04	0.04
B.1 Hub Airport and Hub Airline (Origin)								
NextGen Origin	-1.332***	-0.368**	-0.065	-0.304***	-0.199***	-0.104**	-0.964***	-2.094***
	(0.315)	(0.147)	(0.110)	(0.083)	(0.073)	(0.047)	(0.243)	(0.311)
NextGen Dest.	-0.812**	0.030	0.028	0.001	-0.026	0.028	-0.842***	-0.641*
	(0.339)	(0.190)	(0.150)	(0.111)	(0.083)	(0.069)	(0.245)	(0.328)
Number of obs.	6,539,157	6,539,157	6,539,157	6,539,157	6,539,157	6,539,157	6,539,157	6,539,157
R-squared	0.87	0.97	0.99	0.21	0.17	0.23	0.04	0.04
B.2 Hub Airport and Non-hub Airline (Origin)								
NextGen Origin	-2.292***	-0.049	0.271***	-0.320***	-0.348***	0.029	-2.243***	-2.651***
	(0.220)	(0.109)	(0.084)	(0.072)	(0.058)	(0.039)	(0.176)	(0.223)
NextGen Dest.	-0.823**	-0.342**	-0.077	-0.265***	-0.362***	0.098*	-0.481*	-0.704**
	(0.335)	(0.161)	(0.125)	(0.101)	(0.076)	(0.057)	(0.264)	(0.344)
Number of obs.	6,998,051	6,998,051	6,998,051	6,998,051	6,998,051	6,998,051	6,998,051	6,998,051
R-squared	0.78	0.97	0.99	0.18	0.16	0.24	0.04	0.04

Effect by Hub Status at Destination Airport

Table 7: **Conditional Effect of NextGen on Air Travel Time by Hub Airlines**

Dep var.: air travel time (minutes)	(1) elapsed time + departure delay	(2) elapsed time	(3) airborne time	(4) taxi time	(5) taxi-out time	(6) taxi-in time	(7) departure delay	(8) arrival delay
A. Baseline								
NextGen Origin	-1.267***	-0.195**	-0.030	-0.165***	-0.141***	-0.024	-1.072***	-1.598***
	(0.154)	(0.078)	(0.058)	(0.044)	(0.037)	(0.024)	(0.124)	(0.156)
NextGen Dest.	-1.166***	-0.119	0.046	-0.165***	-0.171***	0.006	-1.047***	-1.000***
	(0.149)	(0.078)	(0.061)	(0.048)	(0.038)	(0.028)	(0.114)	(0.151)
Number of obs.	25,037,569	25,037,569	25,037,569	25,037,569	25,037,569	25,037,569	25,037,569	25,037,569
R-squared	0.80	0.97	0.99	0.22	0.21	0.22	0.04	0.04
B.3 Hub Airport and Hub Airline (Destination)								
NextGen Origin	-0.405	-0.210	-0.111	-0.099	-0.117	0.018	-0.195	-0.807**
	(0.343)	(0.177)	(0.137)	(0.103)	(0.086)	(0.061)	(0.274)	(0.337)
NextGen Dest.	-2.493***	-0.626***	-0.438***	-0.188*	-0.236***	0.048	-1.867***	-2.347***
	(0.277)	(0.139)	(0.103)	(0.100)	(0.070)	(0.063)	(0.209)	(0.274)
Number of obs.	6,522,845	6,522,845	6,522,845	6,522,845	6,522,845	6,522,845	6,522,845	6,522,845
R-squared	0.82	0.97	0.99	0.20	0.18	0.15	0.03	0.03
B.4 Hub Airport and Non-hub Airline (Destination)								
NextGen Origin	-1.023***	-0.248	-0.070	-0.178*	-0.205***	0.027	-0.774***	-1.312***
	(0.362)	(0.160)	(0.118)	(0.099)	(0.079)	(0.054)	(0.287)	(0.369)
NextGen Dest.	-2.362***	-0.262**	-0.092	-0.170**	-0.158***	-0.012	-2.100***	-1.851***
	(0.228)	(0.113)	(0.086)	(0.073)	(0.056)	(0.042)	(0.181)	(0.231)
Number of obs.	6,986,915	6,986,915	6,986,915	6,986,915	6,986,915	6,986,915	6,986,915	6,986,915
R-squared	0.78	0.97	0.99	0.19	0.20	0.16	0.04	0.04

Alternative Specifications

- Richer fixed effects:
  - Route # Airline # Day-of-week # Hour-of-day (667,400 cells, 36 obs per cell)
  - Route # Airline # Aircraft model (38,700 cells, 226 obs per cell)
- Additional interaction with linear trend
  - Airline # linear trend
  - Hub status # linear trend
- Alternative measure of treatment
  - Number of projects completed
  - If each category of NextGen has a project completed
  - Number of projects completed for each category
- Alternative sample
  - Do not drop 2013 (5 million obs.)
  - Add flights not matched in form B-43 (8 million obs.)

Next Steps and Approach

- Add CI for our counterfactuals
- Refine private benefits: fuel and oil consumption
- Add social benefit: emissions (SO2, NOx, CO2, etc.) and noise
- Need flight-level actual fuel consumption data. FAA started to collect the data since the Modernization and Reform Act of 2012. Not publicly available yet

Approach: Simulate predicted and counterfactual **fuel consumption, pollution emissions, greenhouse gas (GHG) emissions, and noise** using the Aviation Environmental Design Tool (AEDT) simulator

- An engineering formula/model built upon EuroControl's Base of Aircraft Data (BADA) and Aviation Emission Model (AEM)
- Simulated mapping from **taxi-in and taxi-out time** to the above outcomes at the level of **airport and aircraft**
- Link to our main data using tail number and aircraft model (DOT Form-B43)
  - Current testing: 90% of models in Form-B43 can be found in AEDT
- Calibrate to airline monthly fuel consumption in DOT Form-F41 Schedule-P52

AEDT Simulated Data

Emissions | Speciated Organic Gases

Choose Columns

Event ID	Equipment Type	Departure Airport	Arrival Airport	Mode	Fuel (g)	Distance (km)	Duration	CO (g)	HC (g)	TOG (g)	VOC (g)	NMHC (g)	NOx (g)
100000	H500D	ATL		Above 10000	0.00	0.00	00:00:00.00	0.00	0.00	0.00	0.00	0.00	0.0
100001	H500D	ATL		Above 10000	0.00	0.00	00:00:00.00	0.00	0.00	0.00	0.00	0.00	0.0
100000	H500D	ATL		Climb Below 1000	5182.80	30.52	00:10:24.22	5714.51	89.32	87.51	74.56	77.93	17.3
100001	H500D	ATL		Climb Below 1000	5182.80	30.52	00:10:24.22	5714.51	89.32	87.51	74.56	77.93	17.3
100000	H500D	ATL		Climb Below 10000	5182.80	30.52	00:10:24.22	5714.51	89.32	87.51	74.56	77.93	17.3
100001	H500D	ATL		Climb Below 10000	5182.80	30.52	00:10:24.22	5714.51	89.32	87.51	74.56	77.93	17.3
100000	H500D	ATL		Climb Below Mixing Height	5182.80	30.52	00:10:24.22	5714.51	89.32	87.51	74.56	77.93	17.3
100001	H500D	ATL		Climb Below Mixing Height	5182.80	30.52	00:10:24.22	5714.51	89.32	87.51	74.56	77.93	17.3
100000	H500D	ATL		Climb Ground	504.00	0.00	00:01:00.00	548.77	8.63	8.45	7.20	7.53	1.7
100001	H500D	ATL		Climb Ground	504.00	0.00	00:01:00.00	548.77	8.63	8.45	7.20	7.53	1.7
100000	H500D	ATL		Climb Taxi	0.00	0.00	00:00:00.00	0.00	0.00	0.00	0.00	0.00	0.0
100001	H500D	ATL		Climb Taxi	0.00	0.00	00:00:00.00	0.00	0.00	0.00	0.00	0.00	0.0
100000	H500D	ATL		Descend Below 1000	0.00	0.00	00:00:00.00	0.00	0.00	0.00	0.00	0.00	0.0
100001	H500D	ATL		Descend Below 1000	0.00	0.00	00:00:00.00	0.00	0.00	0.00	0.00	0.00	0.0
100000	H500D	ATL		Descend Below 10000	0.00	0.00	00:00:00.00	0.00	0.00	0.00	0.00	0.00	0.0
100001	H500D	ATL		Descend Below 10000	0.00	0.00	00:00:00.00	0.00	0.00	0.00	0.00	0.00	0.0
100000	H500D	ATL		Descend Below Mixing Height	0.00	0.00	00:00:00.00	0.00	0.00	0.00	0.00	0.00	0.0
100001	H500D	ATL		Descend Below Mixing Height	0.00	0.00	00:00:00.00	0.00	0.00	0.00	0.00	0.00	0.0
100000	H500D	ATL		Descend Ground	0.00	0.00	00:00:00.00	0.00	0.00	0.00	0.00	0.00	0.0
100001	H500D	ATL		Descend Ground	0.00	0.00	00:00:00.00	0.00	0.00	0.00	0.00	0.00	0.0
100000	H500D	ATL		Descend Taxi	0.00	0.00	00:00:00.00	0.00	0.00	0.00	0.00	0.00	0.0
100001	H500D	ATL		Descend Taxi	0.00	0.00	00:00:00.00	0.00	0.00	0.00	0.00	0.00	0.0

24 of 24 item(s) shown. 4 item(s) selected.

A follow-up project: "Network Propagation and Air Traffic Policies" with Jessica Chu and Tom Lam

- Goal: Document network propagation on delays and infer the effectiveness of second-best policies
- Congestion externalities and market inefficiences arise as hub airlines do not internalize congestion imposed on non-hub airlines at a hub airport (Mayer and Sinai, 2003, Morrison and Winston, 2007)
- The external cost could be propagated through a network under what we usually regard as internalized cost. E.g., (i) flights connection within a window of time, (ii) sharing the runway/ATC operation resources within a window of time, (iii) sharing aircraft (i.e., operation N and N+1), and (iv) sharing gates
- Heterogeneity (and high skewness) of social cost of congestion depending on (i) where the minutes of delay are located in the distribution, and (ii) the relative importance of a flight in propagating delays. The heterogeneity may inform us how well second-best policies can approximate the first-best
- Approach: (i) estimate the centrality of the propagation network (done in sample data) and (ii) construct the social cost of delay by adjusting costs of delay using centrality measures

Thank you!

Summary Statistics

Table 1: **Summary statistics of air travel time 2010–2017**

Variable	Mean	SD.	Min.	Max.
Panel A. Air Travel Performance and FAA Treatment				
Actual elapsed route time + departure delay (minutes)	142.7	82.5	-20	2,594
Actual elapsed route time (minutes)	133.7	73.2	20	784
Actual airborne time (minutes)	110.9	71.1	6	723
Actual taxi time (minutes)	22.8	10.5	2	481
Actual taxi-out time (minutes)	15.7	9.0	0	278
Actual taxi-in time (minutes)	7.1	5.2	2	414
Departure delay (minutes)	9.0	36.2	-45	2,402
Arrival delay (minutes)	4.7	38.6	-115	2,444
1 = Travel from or to an NextGen airport	0.92	0.27	0	1
Categories of NextGen projects completed	0.34	0.70	0	3

Panel Information

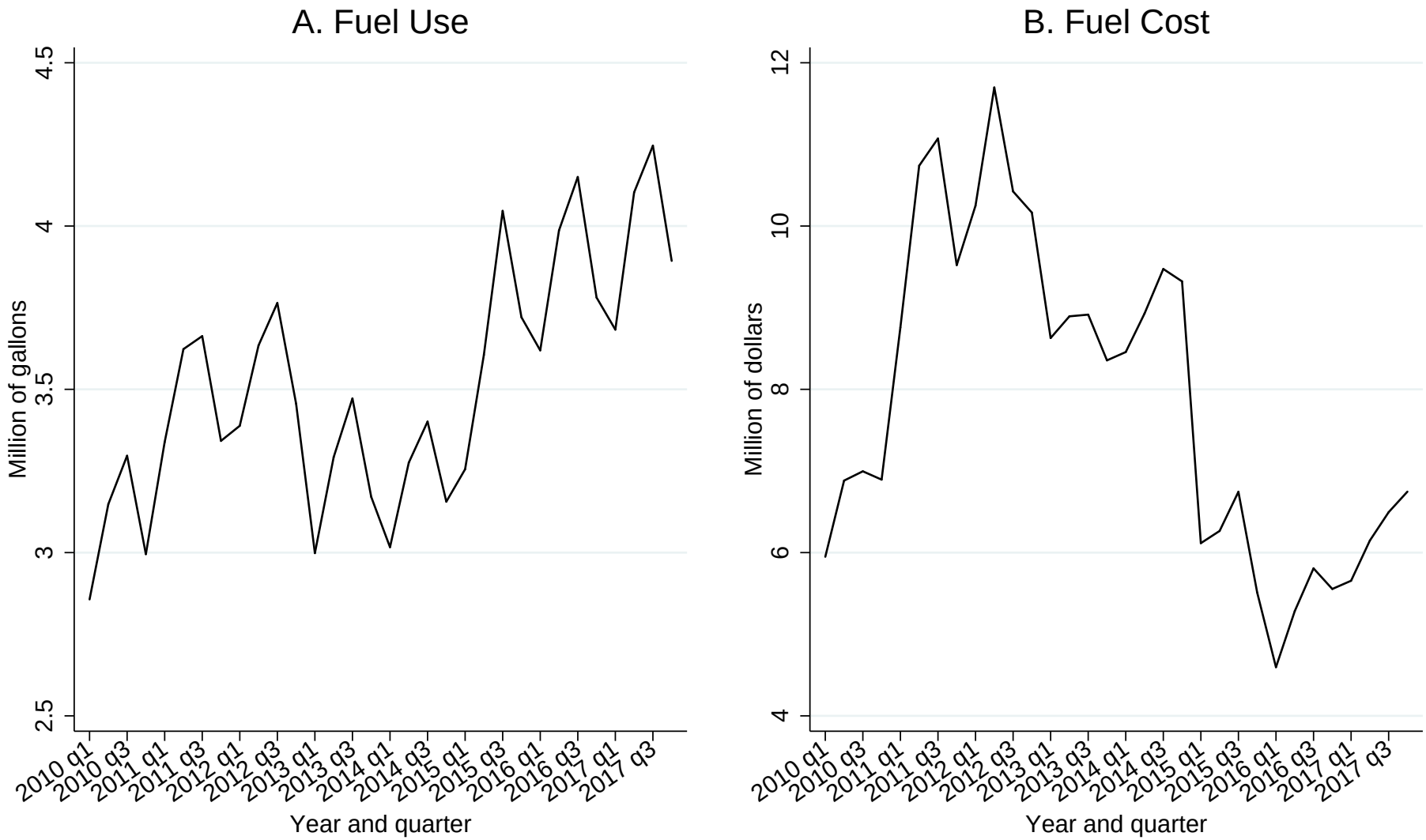
Panel B. Panel Information	
Number of airports	275
Number of airports with FAA projects	39
Number of airlines	19
Number of routes	5,819
Number of routes by airline	14,194
Number of routes by airline by hour-of-day by day-of-week	667,389
Number of routes by airline by aircraft model	38,681
Number of aircraft models	44
Number of aircraft model trims	262
Number of aircraft	6,957
Number of observations	25,037,569

List of Airports (selected)

Table A.1: **List of NextGen Airports**

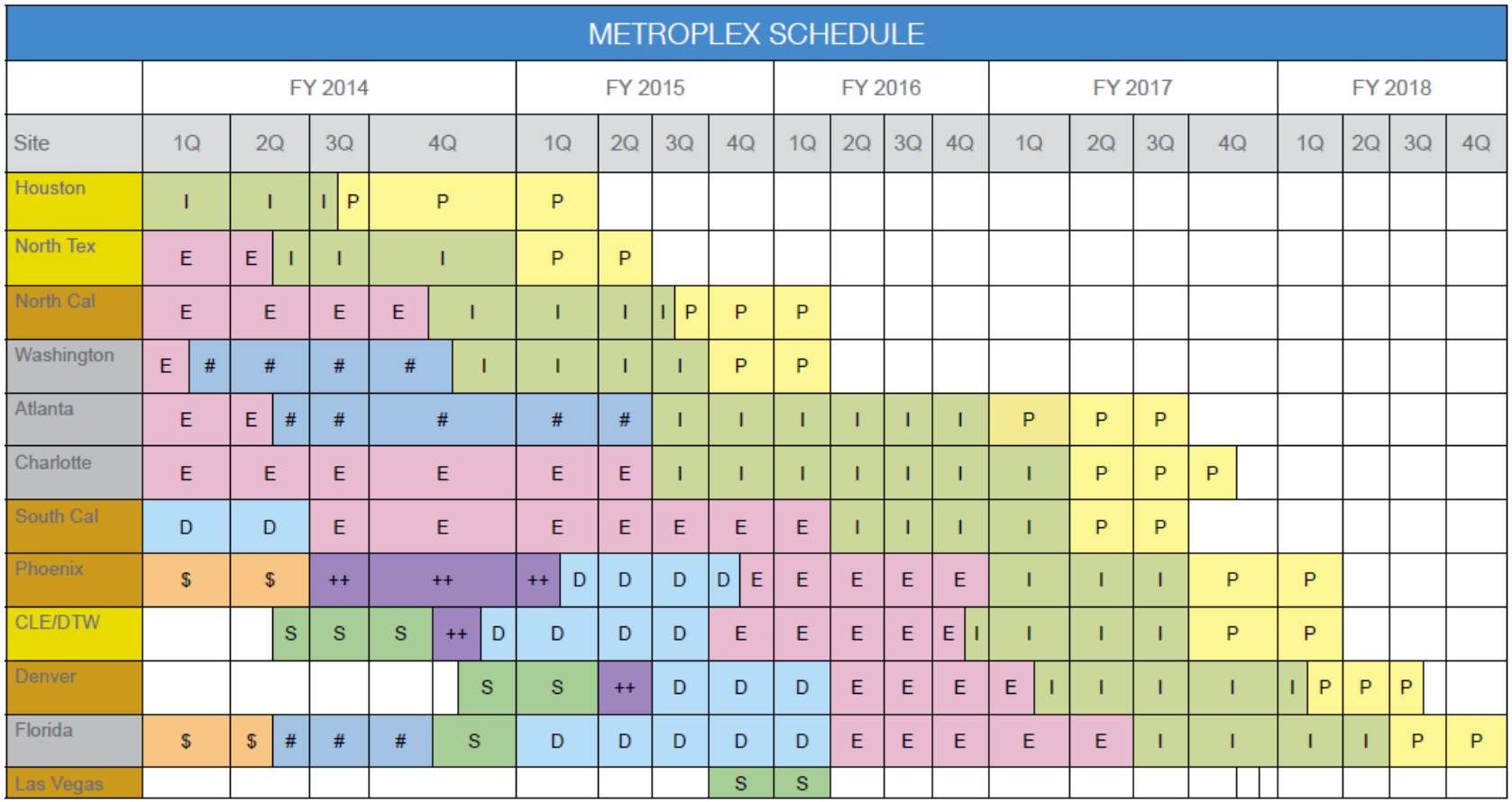
Airport Code	City	State	Hub airport	First year of NextGen	Percentage of flights departing from the airport
ANC	Anchorage	AK	1	2016	0.29
ATL	Atlanta	GA	1	2014	6.53
AUS	Austin	TX	0	2017	0.77
BOS	Boston	MA	0	2015	1.89
CLE	Cleveland	OH	0	2015	0.72
CLT	Charlotte	NC	1	2015	2.09
CVG	Cincinnati	OH	1	2014	0.42
DAL	Dallas	TX	1	2015	0.92
DEN	Denver	CO	1	2015	3.86
DFW	Dallas/Fort Worth	TX	1	2016	4.13
DTW	Detroit	MI	1	2015	2.00
EWR	Newark	NJ	1	2015	1.90
HOU	Houston	TX	0	2014	0.93
IAD	Washington	DC	1	2017	0.98
IAH	Houston	TX	1	2014	2.77
IND	Indianapolis	IN	0	2016	0.50
JFK	New York	NY	1	2015	1.64
LAS	Las Vegas	NV	1	2016	2.47
LAX	Los Angeles	CA	1	2016	3.64
LGA	New York	NY	0	2015	1.64

Total Fuel Use and Fuel Cost, 2010–2017



Sources: DOT Schedule Form-F41 Schedule P-52

Variation and Uncertainty of Implementation Period



Milestone Leads Organizational Symbol	Functional Description
AJV-1	Airspace Services
AJV-121	Airspace Optimization Group
AJV-E	Mission Support, Eastern Service Center
AJV-C	Mission Support, Central Service Center
AJV-W	Mission Support, Western Service Center
AJV-114	Environmental Analysis
AJW-3	Aviation Systems Standards – Flight Checks

S	Study
D	Design
E	Evaluation
I	Implementation
P	Post Implementation
$	Budget Impact
#	ERAM Resource Impact
++	Facility Resource Issue

Summary Statistics of Conditions Associated with Air Travel Performance

Table A.2: **Summary statistics of other conditions associated with air travel performance 2010–2017**

Variable	Mean	SD.	Min.	Max.
Panel A. Conditions associated with air travel delay				
Number of operations per aircraft	5.0	2.1	1	17
1 = Prior flight is delayed	0.36	0.48	0	1
Prior delay (minutes)	15.5	37.5	0	2,028
Flights traveled from or to a hub airport	0.84	0.37	0	1
Origin visibility (km)	14.9	3.1	0	160,000
Origin sky ceiling (km)	12.7	9.7	0	22,000
Destination visibility (km)	15.0	3.1	0	160,000
Destination sky ceiling (km)	12.6	9.6	0	22,000
Number of observations				25,037,569

Alternative Measure of Treatment Variable

Table 8: **Alternative Measure for the Treatment Variables**

Dep var.: air travel time (minutes)	(1) elapsed time + departure delay	(2) elapsed time	(3) airborne time	(4) taxi time	(5) taxi-out time	(6) taxi-in time	(7) departure delay	(8) arrival delay
				A. Baseline				
NextGen Origin	-1.267***	-0.195**	-0.030	-0.165***	-0.141***	-0.024	-1.072***	-1.598***
	(0.154)	(0.078)	(0.058)	(0.044)	(0.037)	(0.024)	(0.124)	(0.156)
NextGen Dest.	-1.166***	-0.119	0.046	-0.165***	-0.171***	0.006	-1.047***	-1.000***
	(0.149)	(0.078)	(0.061)	(0.048)	(0.038)	(0.028)	(0.114)	(0.151)
Number of obs.	25,037,569	25,037,569	25,037,569	25,037,569	25,037,569	25,037,569	25,037,569	25,037,569
R-squared	0.80	0.97	0.99	0.22	0.21	0.22	0.04	0.04
				B. Number of Projects Completed				
NextGen Origin	-0.946***	-0.171***	-0.127***	-0.044	-0.024	-0.020	-0.775***	-1.077***
	(0.118)	(0.060)	(0.048)	(0.033)	(0.027)	(0.019)	(0.098)	(0.122)
NextGen Dest.	-0.421***	0.145**	0.182***	-0.037	-0.112***	0.076***	-0.566***	-0.539***
	(0.111)	(0.063)	(0.045)	(0.038)	(0.028)	(0.021)	(0.084)	(0.121)
Number of obs.	25,037,569	25,037,569	25,037,569	25,037,569	25,037,569	25,037,569	25,037,569	25,037,569
R-squared	0.80	0.97	0.99	0.22	0.21	0.22	0.04	0.04
				C.1 Only Include NextGen at Origin				
NextGen Origin	-1.159***	-0.184**	-0.035	-0.150***	-0.125***	-0.025	-0.975***	-1.505***
	(0.155)	(0.077)	(0.058)	(0.044)	(0.037)	(0.024)	(0.126)	(0.158)
Number of obs.	25,037,569	25,037,569	25,037,569	25,037,569	25,037,569	25,037,569	25,037,569	25,037,569
R-squared	0.80	0.97	0.99	0.22	0.21	0.22	0.04	0.04
				C.2 Only Include NextGen at Destination				
NextGen Dest.	-1.049***	-0.101	0.049	-0.150***	-0.158***	0.008	-0.948***	-0.852***
	(0.150)	(0.078)	(0.061)	(0.048)	(0.037)	(0.028)	(0.116)	(0.154)
Number of obs.	25,037,569	25,037,569	25,037,569	25,037,569	25,037,569	25,037,569	25,037,569	25,037,569
R-squared	0.80	0.97	0.99	0.22	0.21	0.22	0.04	0.04

Effect of Specific Category of NextGen Project

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dep var.: air travel time (minutes)	elapsed time + departure delay	elapsed time	airborne time	taxi time	taxi-out time	taxi-in time	departure delay	arrival delay
Panel B. Effect of Specific Category of Projects								
NextGen Origin MRO = 1	0.047	0.256**	0.184*	0.071	0.128**	-0.057	-0.208	0.064
	(0.208)	(0.122)	(0.098)	(0.076)	(0.065)	(0.038)	(0.153)	(0.206)
NextGen Origin PBN = 1	-2.119***	-1.409***	-0.784***	-0.625***	-0.683***	0.058	-0.710**	-1.843***
	(0.438)	(0.209)	(0.188)	(0.130)	(0.123)	(0.074)	(0.343)	(0.452)
NextGen Origin SO = 1	-3.460***	-0.781***	-0.453***	-0.328***	-0.371***	0.042	-2.679***	-4.645***
	(0.402)	(0.201)	(0.164)	(0.108)	(0.092)	(0.053)	(0.331)	(0.443)
NextGen Origin DC = 1	-1.555***	0.043	0.370***	-0.327***	-0.266***	-0.061	-1.598***	-2.063***
	(0.313)	(0.143)	(0.114)	(0.085)	(0.067)	(0.051)	(0.248)	(0.301)
NextGen Dest. MRO = 1	0.337	0.470***	0.112	0.358***	-0.047	0.405***	-0.133	-0.091
	(0.236)	(0.132)	(0.106)	(0.076)	(0.057)	(0.044)	(0.167)	(0.231)
NextGen Dest. PBN = 1	-1.336**	-0.235	0.129	-0.364**	-0.062	-0.302***	-1.101***	-1.035**
	(0.570)	(0.273)	(0.199)	(0.149)	(0.116)	(0.081)	(0.390)	(0.508)
NextGen Dest. SO = 1	-3.758***	-0.905***	-0.114	-0.791***	-0.394***	-0.397***	-2.853***	-2.516***
	(0.450)	(0.221)	(0.174)	(0.121)	(0.096)	(0.065)	(0.331)	(0.457)
NextGen Dest. DC = 1	-1.933***	-0.775***	-0.063	-0.711***	-0.313***	-0.399***	-1.158***	-1.563***
	(0.282)	(0.146)	(0.109)	(0.097)	(0.072)	(0.058)	(0.219)	(0.276)
Number of obs.	25,037,569	25,037,569	25,037,569	25,037,569	25,037,569	25,037,569	25,037,569	25,037,569
R-squared	0.80	0.97	0.99	0.22	0.21	0.22	0.04	0.04

Effect of Specific Category of NextGen Project (cont)

D. Effect of the Number of Projects for Each NextGen Category

NextGen Origin Num. of MRO	-0.046	0.274***	0.119	0.155***	0.178***	-0.022	-0.320**	-0.115
	(0.155)	(0.084)	(0.073)	(0.051)	(0.045)	(0.027)	(0.126)	(0.169)
NextGen Origin Num. of PBN	-1.920***	-1.348***	-0.771***	-0.577***	-0.643***	0.066	-0.572*	-1.633***
	(0.442)	(0.213)	(0.187)	(0.131)	(0.121)	(0.073)	(0.344)	(0.453)
NextGen Origin Num. of SO	-2.851***	-1.200***	-0.924***	-0.276***	-0.289***	0.013	-1.651***	-3.114***
	(0.370)	(0.212)	(0.169)	(0.101)	(0.078)	(0.061)	(0.291)	(0.379)
NextGen Origin Num. of DC	-1.628***	-0.046	0.318***	-0.363***	-0.311***	-0.052	-1.583***	-2.136***
	(0.309)	(0.143)	(0.116)	(0.086)	(0.069)	(0.049)	(0.249)	(0.300)
NextGen Dest. Num. of MRO	0.678***	0.621***	0.333***	0.288***	-0.124***	0.412***	0.056	-0.324*
	(0.186)	(0.100)	(0.074)	(0.059)	(0.044)	(0.031)	(0.132)	(0.187)
NextGen Dest. Num. of PBN	-1.115**	-0.154	0.142	-0.296**	-0.032	-0.264***	-0.961**	-0.824
	(0.567)	(0.267)	(0.196)	(0.148)	(0.117)	(0.077)	(0.390)	(0.521)
NextGen Dest. Num. of SO	-2.451***	-0.598***	-0.103	-0.495***	0.000	-0.495***	-1.853***	-0.464
	(0.382)	(0.187)	(0.157)	(0.102)	(0.079)	(0.054)	(0.301)	(0.396)
NextGen Dest. Num. of DC	-2.133***	-0.911***	-0.130	-0.781***	-0.284***	-0.497***	-1.222***	-1.511***
	(0.283)	(0.147)	(0.112)	(0.097)	(0.072)	(0.057)	(0.220)	(0.277)
Number of obs.	25,037,569	25,037,569	25,037,569	25,037,569	25,037,569	25,037,569	25,037,569	25,037,569
R-squared	0.80	0.97	0.99	0.22	0.21	0.22	0.04	0.04

Richer Fixed Effects

Table 9: **Richer Fixed Effects and Alternative Identifying Assumptions**

Dep var.: air travel time (minutes)	(1) elapsed time + departure delay	(2) elapsed time	(3) airborne time	(4) taxi time	(5) taxi-out time	(6) taxi-in time	(7) departure delay	(8) arrival delay
				A. Baseline				
NextGen Origin	-1.267***	-0.195**	-0.030	-0.165***	-0.141***	-0.024	-1.072***	-1.598***
	(0.154)	(0.078)	(0.058)	(0.044)	(0.037)	(0.024)	(0.124)	(0.156)
NextGen Dest.	-1.166***	-0.119	0.046	-0.165***	-0.171***	0.006	-1.047***	-1.000***
	(0.149)	(0.078)	(0.061)	(0.048)	(0.038)	(0.028)	(0.114)	(0.151)
Number of obs.	25,037,569	25,037,569	25,037,569	25,037,569	25,037,569	25,037,569	25,037,569	25,037,569
R-squared	0.80	0.97	0.99	0.22	0.21	0.22	0.04	0.04
				B.1 Richer Fixed Effects: Route by Carrier by Day-of-week by Hour-of-day				
NextGen Origin	-1.223***	-0.232***	-0.055	-0.177***	-0.138***	-0.039	-0.992***	-1.585***
	(0.163)	(0.080)	(0.061)	(0.046)	(0.039)	(0.024)	(0.132)	(0.164)
NextGen Dest.	-1.183***	-0.108	0.036	-0.145***	-0.145***	0.001	-1.075***	-1.012***
	(0.156)	(0.082)	(0.065)	(0.051)	(0.038)	(0.031)	(0.119)	(0.159)
Number of obs.	24,997,532	24,997,532	24,997,532	24,997,532	24,997,532	24,997,532	24,997,532	24,997,532
R-squared	0.81	0.97	0.99	0.30	0.28	0.30	0.08	0.08
				B.2 Richer Fixed Effects: Route by Carrier by Aircraft Model Trim				
NextGen Origin	-1.258***	-0.135*	0.011	-0.147***	-0.141***	-0.006	-1.123***	-1.547***
	(0.160)	(0.080)	(0.059)	(0.045)	(0.037)	(0.024)	(0.132)	(0.162)
NextGen Dest.	-1.237***	-0.103	0.040	-0.143***	-0.174***	0.031	-1.134***	-1.035***
	(0.156)	(0.082)	(0.063)	(0.050)	(0.038)	(0.029)	(0.122)	(0.157)
Number of obs.	25,034,463	25,034,463	25,034,463	25,034,463	25,034,463	25,034,463	25,034,463	25,034,463
r2	0.80	0.97	0.99	0.24	0.23	0.24	0.04	0.04

Richer Fixed Effects

Table 9: **Richer Fixed Effects and Alternative Identifying Assumptions**

Dep var.: air travel time (minutes)	(1) elapsed time + departure delay	(2) elapsed time	(3) airborne time	(4) taxi time	(5) taxi-out time	(6) taxi-in time	(7) departure delay	(8) arrival delay
				A. Baseline				
NextGen Origin	-1.267***	-0.195**	-0.030	-0.165***	-0.141***	-0.024	-1.072***	-1.598***
	(0.154)	(0.078)	(0.058)	(0.044)	(0.037)	(0.024)	(0.124)	(0.156)
NextGen Dest.	-1.166***	-0.119	0.046	-0.165***	-0.171***	0.006	-1.047***	-1.000***
	(0.149)	(0.078)	(0.061)	(0.048)	(0.038)	(0.028)	(0.114)	(0.151)
Number of obs.	25,037,569	25,037,569	25,037,569	25,037,569	25,037,569	25,037,569	25,037,569	25,037,569
R-squared	0.80	0.97	0.99	0.22	0.21	0.22	0.04	0.04
				C.1 Further Relax Parallel Trend Assumption: Add Airline Fixed Effects by Linear Trend				
NextGen Origin	-1.138***	-0.166**	-0.019	-0.147***	-0.144***	-0.003	-0.972***	-1.498***
	(0.154)	(0.076)	(0.057)	(0.043)	(0.037)	(0.024)	(0.122)	(0.154)
NextGen Dest.	-1.037***	-0.089	0.058	-0.147***	-0.174***	0.027	-0.947***	-0.900***
	(0.148)	(0.077)	(0.059)	(0.048)	(0.038)	(0.028)	(0.113)	(0.149)
Number of obs.	25,037,569	25,037,569	25,037,569	25,037,569	25,037,569	25,037,569	25,037,569	25,037,569
R-squared	0.80	0.97	0.99	0.22	0.21	0.22	0.04	0.04
				C.2 Further Relax Parallel Trend Assumption: Add Airline Hub Status by Linear Trend				
NextGen Origin	-1.287***	-0.186**	-0.028	-0.158***	-0.133***	-0.025	-1.101***	-1.625***
	(0.153)	(0.078)	(0.058)	(0.044)	(0.038)	(0.024)	(0.123)	(0.155)
NextGen Dest.	-1.200***	-0.117	0.046	-0.162***	-0.174***	0.012	-1.084***	-1.034***
	(0.149)	(0.078)	(0.061)	(0.047)	(0.037)	(0.028)	(0.114)	(0.150)
Number of obs.	25,037,569	25,037,569	25,037,569	25,037,569	25,037,569	25,037,569	25,037,569	25,037,569
R-squared	0.80	0.97	0.99	0.22	0.21	0.22	0.04	0.04

Alternative Sample: Add Flights not Matched in B-43 Form

Table A.5: **Effect of NextGen: Alternative Sample**

Dep var.: air travel time (minutes)	(1) elapsed time + departure delay	(2) elapsed time	(3) airborne time	(4) taxi time	(5) taxi-out time	(6) taxi-in time	(7) departure delay	(8) arrival delay
				A. Baseline				
NextGen Origin	-1.267***	-0.195**	-0.030	-0.165***	-0.141***	-0.024	-1.072***	-1.598***
	(0.154)	(0.078)	(0.058)	(0.044)	(0.037)	(0.024)	(0.124)	(0.156)
NextGen Dest.	-1.166***	-0.119	0.046	-0.165***	-0.171***	0.006	-1.047***	-1.000***
	(0.149)	(0.078)	(0.061)	(0.048)	(0.038)	(0.028)	(0.114)	(0.151)
Number of obs.	25,037,569	25,037,569	25,037,569	25,037,569	25,037,569	25,037,569	25,037,569	25,037,569
R-squared	0.80	0.97	0.99	0.22	0.21	0.22	0.04	0.04
				B. Alternative Sample with Aircraft Not Matched in B43				
NextGen Origin	-0.987***	-0.060	0.048	-0.108***	-0.089***	-0.019	-0.927***	-1.327***
	(0.133)	(0.067)	(0.050)	(0.039)	(0.033)	(0.021)	(0.105)	(0.135)
NextGen Dest.	-1.055***	-0.164**	-0.013	-0.151***	-0.134***	-0.017	-0.891***	-0.859***
	(0.128)	(0.068)	(0.054)	(0.042)	(0.033)	(0.026)	(0.098)	(0.131)
Number of obs.	33,447,478	33,447,478	33,447,478	33,447,478	33,447,478	33,447,478	33,447,478	33,447,478
R-squared	0.79	0.97	0.99	0.24	0.22	0.22	0.04	0.04

Alternative Counterfactual

Table A.6: **The effect of NextGen from 2014 to 2017 on air travel time using alternative estimates**

	(1) elapsed time + departure delay	(2) elapsed time	(3) airborne time	(4) taxi time	(5) taxi-out time	(6) taxi-in time	(7) departure delay	(8) arrival delay
Actual (minutes)	149.04	139.30	115.78	23.51	16.32	7.18	9.6	4.13
Panel A. Baseline (Repeat Table 3)								
Change (minutes)	2.54	0.33	-0.02	035	0.33	0.02	2.22	2.72
Change (percent)	1.71%	0.24%	-0.01%	1.47%	2.00%	0.26%	23.17%	65.94%
Panel B. Use Estimates from Table 2 Panel B								
Change (minutes)	2.71	0.43	-0.04	0.39	0.36	0.03	2.30	2.84
Change (percent)	1.82%	0.31%	-0.04%	1.64%	2.18%	0.41%	23.89%	68.90 %
Number of obs.							4,736,642	

Notes: The first row reports the actual travel time in 2017. This table reports the counterfactual travel time and delay if the treated airports in 2017 had been untreated, i.e., as if the airports were in the beginning of 2014. We use baseline in Table 2. In Appendix Table we use estimates in Table 2 Panel B and estimates in Table 8.