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The Closing of a Major Airport: Immediate Effects and Longer-Term Housing Market Effects

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Outline

- Introduction
- Literature Review
- Empirical Approach
- Data
- Results
- Future Ideas/Follow-up Paper
- Conclusion

Introduction

- Hard to reveal causal effects in the setup of existing airports
  - Persistent airport-structure and neighborhood structure
  - Simultaneity of noise and house prices

- Denver provides an interesting case study of the closing of one major airport and redevelopment of the land

- Announcement of new airport/closing of old airport: 1985
- Closing of old airport/opening of new airport: 1995

- How do neighborhoods in the formerly noisy areas change after these events?

Literature Review

- Boes and Nüesch (2011) analyze house prices around a change in flight regulations for the Zurich Airport that resulted in new flight patterns
- Cohen and Coughlin (2009) analyze house prices over time as the noise distribution around Hartsfield-Jackson Atlanta International Airport changed
- Mense and Kholodilin (2014) focus on the impacts of aircraft noise expectations resulting from the construction of the new Berlin-Brandenburg Airport
- Almer, Boes, and Nüesch (2017) analyze the dynamic adjustments in the rental housing market after an unexpected change in flight regulations – most similar to our approach

Literature Review (continued)

- Ahlfeldt and Maennig (2015): Announcement of the closing of Berlin Airport, hedonic diff-in-diff
  - How has noise become capitalized into property values?
  - How price signals from capitalization impacted voting for new airport?

Background: Stapleton Airport in Denver

- Located in Downtown Denver
- Municipal Airport: Opened in 1929 (mail transport facility)
- Commercial Airport: 1945
- Longer jet runway built in 1962
- Growth limited by downtown Denver (noise) and Rocky Mountain Arsenal
- Announcement of new airport/closing of old airport: 1985
- Opening of new airport/closing of old airport: 1995
- New development of old airport includes retail, residential, and walkable open space

Source: Colorado Encyclopedia

Stapleton:
Before vs After (2004) Closure

Left image: Wikipedia; Right image: AirphotoNA.com

Example Stapleton Homes After Closure

The Denver Post, August 18, 2018

Another Stapleton Neighborhood

https://theknow.denverpost.com/neighborhoods/stapleton/

Our Research Questions:

- What are immediate announcement and closing effects?
- How did closing relate to changes in surrounding neighborhoods?
  - Demographics of neighborhoods
  - Characteristics of newly built homes
- Examine pre-existing housing, sold after closure:
  - Size of properties (SF) and prices
  - Average Income in Tract, and prices

Approach

- $Log(y_{itl}) = \beta_0 X_{it} + \beta_1 N_l + \beta_2 E_t + \beta_3 N_l E_t + \varepsilon_{itl}$ (1)

- y_{itl}: sale price of property i at time t at location l
- X_{it}: house i characteristics at time t

- N_l: Noise at a given location l

- E_t: Indicator for after the "event" (announcement; closure)

- β_3: parameter of interest: how more noise impacts property prices after the "event"

Approach (continued)

- $Log(y_{itlc}) = \beta_0 X_{it} + \beta_1 N_l + \beta_2 E_t + \beta_3 N_l E_t + \delta_c + \varepsilon_{itlc}$ (2)

- δ_c: Census tract fixed effects

Approach (continued)

- Estimate (3) before (1985-95) and after (post-1995) closing:

- $X_{itl} = \beta_0 + \beta_{1D} N_l + \delta_{cD} + \gamma_{tD} + \varepsilon_{itl}$ (3)

- δ_{cD}: tract fixed effects for each period (before and after)

- γ_{tD}: year fixed effects for each period (before and after)

Approach (continued)

- Demographics (Z_{ct}): measured at tract-level (HMDA)
- Reduces precision (but not bias- measurement error on left side); so use interactive approach:
- $Z_{ct} = \beta_0 + \beta_1 N_l + \beta_2 E_t + \beta_3 N_l E_t + \delta_c + \gamma_t + \varepsilon_{itlc}$ (4)
- Z_{ct}: average for all home purchase mortgage borrowers in a tract-year
- N_l: noise (prior to closure) for properties sold at location l

Approach (continued)

- What was relationship between attributes of new houses and demographics, with house prices, following closure?

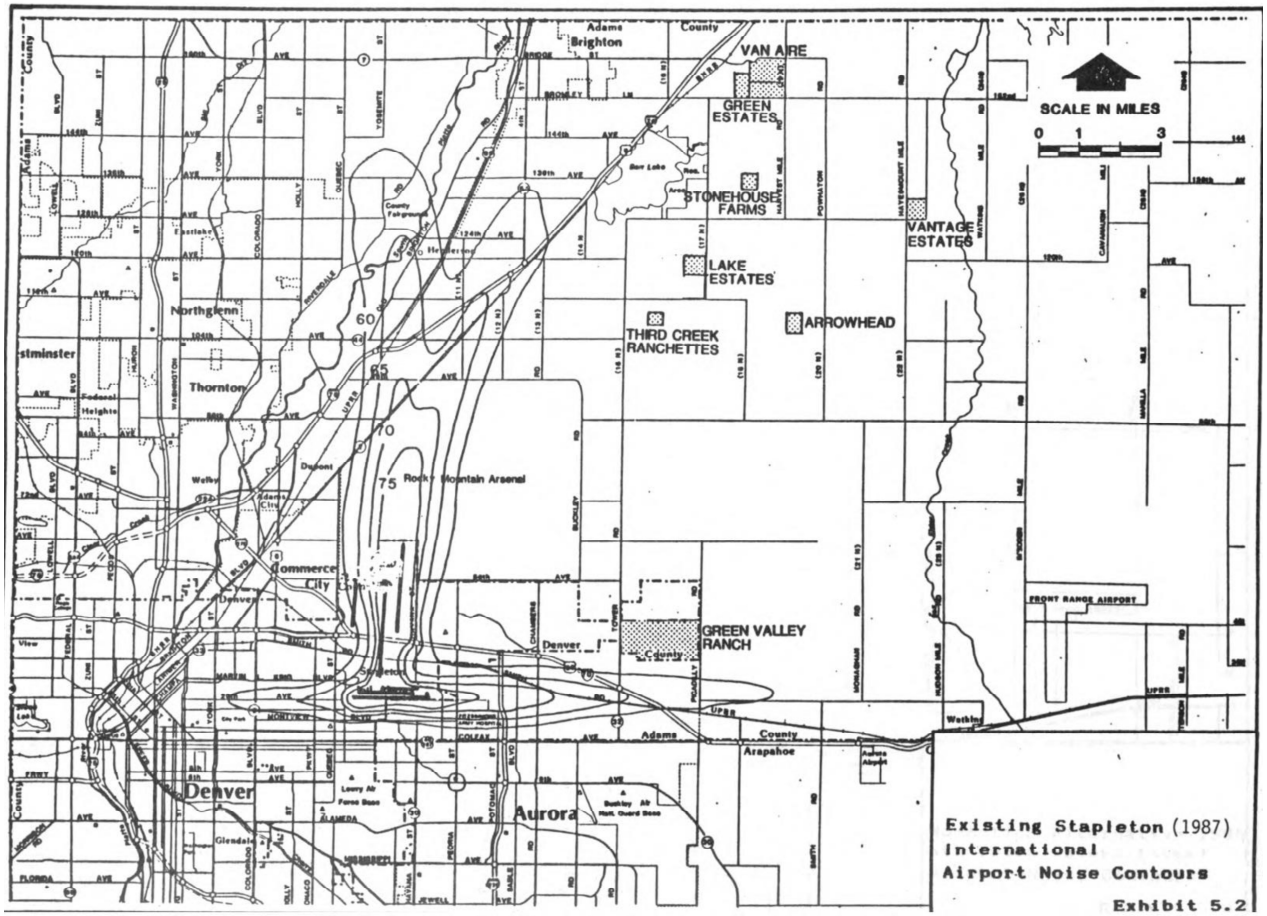
- $Log(y_{itlc}) = \beta_0 X_{it} + \beta_1 N_l + \beta_2 \bar{X}_{ct-3} + \beta_3 \bar{Z}_{ct-3} + \delta_c + \gamma_t + \varepsilon_{itlc}$ (5)

- $\bar{X}_{ct-3}$ is the three-year moving average prior to year t of housing attributes of newly built housing in tract c,
- $\bar{Z}_{ct-3}$ is the three-year moving average prior to year t of borrower demographics for all home purchase mortgages in tract c
- γ_t represents month by year fixed effects.

Data

- 1990 onward: Denver Assessor's Office
- 1984 and 1986: scraped sale price and property address data from Denver land records;
  - Geocoded and matched with Corelogic characteristics data
  - Corelogic data for 1990 onward
- HMDA demographics (income, race): 1990 onward, tract
- Noise: FAA reports for 1987 and 1995;
  - manually geocoded these noise contours
  - Interpolated between contours and extrapolated out to 50 dB to obtain a proxy for a continuum of noise levels

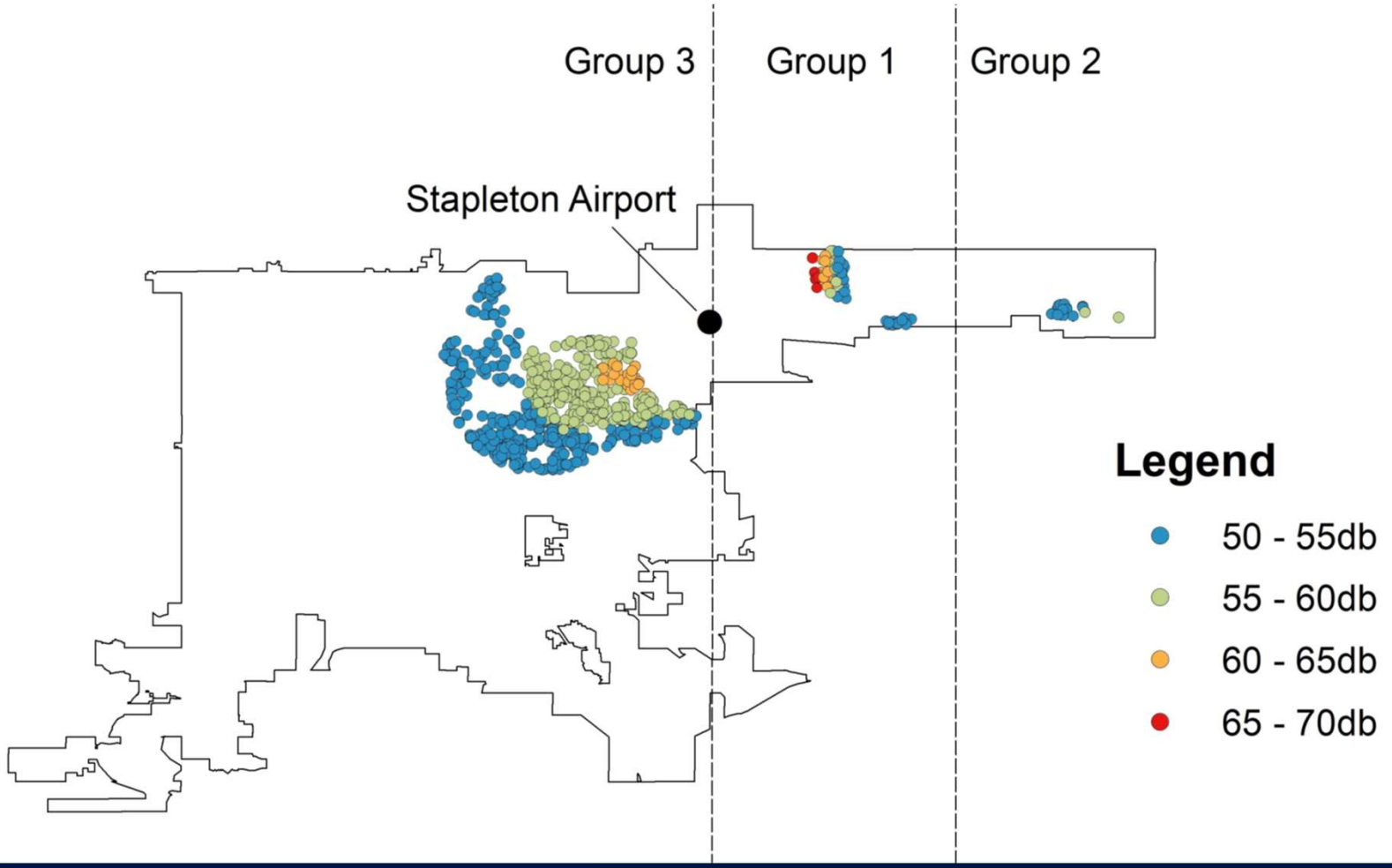
1987 Noise Contour



Source: FAA

1984 and 1986 Sales

Figure 1a – Random Sample of Denver Single Family Residential Property Sales and Noise Exposure, 1984 and 1986



1994 and 1996 Sales

Figure 1b – Denver Single Family Residential Property Sales and Noise Exposure, 1994 and 1996

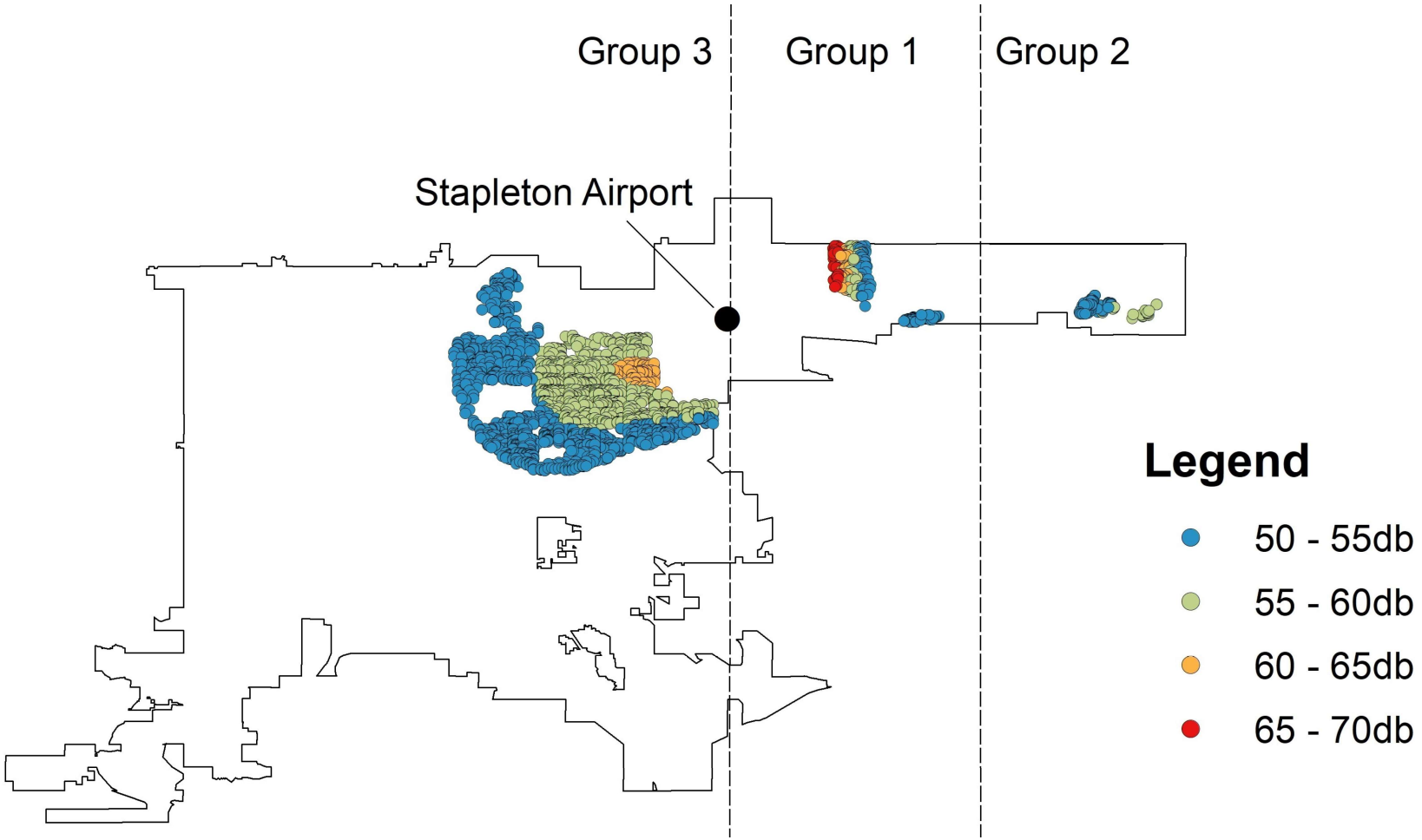


Table A-1: Descriptive Statistics for Difference-in-Differences Regressions

Descriptive Statistics

1985 Announcement	Mean	Std. Dev.	Min	Max	Count
Sales Price	82,910	58,405	6,500	1,400,000	838
Total Bathrooms	1.877	0.841	1	6	838
Age	48.321	22.518	0	103	838
Bedrooms	2.592	0.838	1	8	838
Living SF	1,759	808.4	465	10,391	838
Land SF	6,554	3,487	1,190	45,900	838
Noise	54.700	3.349	50.003	67.620	838
Noise*Year_1985	38.506	25.064	0	67.620	838
Year_1985	0.705	0.456	0	1	838
1995 Closing	Mean	Std. Dev.	Min	Max	Count
Sales Price	106,129	56,471	10,500	525,000	2,812
Total Bathrooms	1.924	0.845	1	8	2,812
Age	57.617	21.016	10	100	2,812
Bedrooms	2.567	0.778	1	8	2,812
Living SF	1,752	724.6	400	6,280	2,812
Land SF	6,211	1,488	1,320	18,200	2,812
Noise	54.832	3.393	50.001	67.651	2,812
Noise*Year_1995	26.623	27.556	0	67.651	2,812
Year_1995	0.485	0.500	0	1	2,812

Table A-2: Descriptive Stats, Average Income and Percent Black Population Regressions

Descriptive Statistics (continued)

	Mean	Std. Dev.	Min	Max	Count
Average Income	79,210	31,067	22,439	176,127	31,715
Log of Average Income	11.202	0.399	10.019	12.079	31,715
Percent Black	14.0	13.4	0	62.0	31,715
Noise	55.001	3.407	50.001	67.703	31,763
Noise*(Year ≥ 1995)	45.817	20.830	0	67.703	31,763

Table A-3: Descriptive Statistics, Housing Quality Regressions

Descriptive Statistics (continued)

Year Built: Pre-1995	Mean	Std. Dev.	Min	Max	Count
Noise	56.570	1.351	50.069	60.545	2,277
Sales Price	173,077	57,652	12,000	800,000	2,277
Land SF	5,384	1,379	3,009	14,581	2,277
Living SF	1,612	525.3	800	3,843	2,277
Bedrooms	2.989	0.603	2	5	2,277
Total Bathrooms	2.666	0.810	1	5	2,277
Year Built	1989	3.716	1985	1995	2,277
Building Age	15.060	7.208	2	32	2,277
Year of Sale	2004	6.227	1995	2017	2,277
Year Built: Post-1995	Mean	Std. Dev.	Min	Max	Count
Noise	59.182	5.876	50.035	75	6,077
Sales Price	305,318	161,107	56,000	1,000,000	6,077
Land SF	4,934	1,769	2,112	16,500	6,077
Living SF	2,202	859.3	796	5,604	6,077
Bedrooms	3.153	0.701	1	7	6,077
Total Bathrooms	3.150	0.683	1	6	6,077
Year Built	2002	3.541	1995	2014	6,077
Building Age	7.800	4.241	2	21	6,077
Year of Sale	2010	4.796	1997	2017	6,077

Table 1: Difference-In-Differences Results – 1985 Announcement and 1995 Closing

Results

Dependent Variable: Log of Sales Price					
	1985 Announcement			1995 Closing	
	Tract Fixed Effects	Group Fixed Effects		Tract Fixed Effects	Group Fixed Effects
Log of Total Bathrooms	0.062*	0.095**		0.028	0.062
	(1.72)	(2.45)		(1.05)	(1.52)
Building Age	-0.000	-0.000		0.004*	0.004*
	(-0.06)	(-0.15)		(1.91)	(1.91)
Log of Bedrooms	0.112	-0.020		0.103**	0.017
	(1.59)	(-0.34)		(2.67)	(0.36)
Log of Living SF	0.334***	0.513***		0.416***	0.692***
	(6.53)	(8.78)		(7.49)	(9.22)
Log of Land SF	0.034	0.057		0.282***	0.292***
	(0.41)	(1.04)		(5.00)	(3.12)
Noise	-0.024**	-0.025**		-0.004	-0.014
	(-2.26)	(-2.62)		(-0.58)	(-1.12)
Noise*Year_1985	0.017*	0.016		-	-
	(1.72)	(1.49)		-	-
Year_1985	-0.873	-0.789		-	-
	(-1.61)	(-1.41)		-	-
Noise*Year_1995	-	-		-0.002	-0.001
	-	-		(-0.46)	(-0.33)
Year_1995	-	-		0.331	0.296
	-	-		(1.67)	(1.16)
Group 1	-	-0.100		-	-0.043
	-	(-1.24)		-	(-0.32)
Group 2	-	0.135*		-	0.350**
	-	(1.75)		-	(2.79)
Constant	9.442***	8.266***		5.285***	4.169***
	(12.53)	(12.64)		(6.87)	(3.32)
R-Squared	0.474	0.372		0.721	0.493
Observations	838	838		2,812	2,812

Results (continued)

Table 2: Regressions of House characteristics

Dependent Variable:		Bedrooms				Total Bathrooms		
Year Built:		1985-95		Post-1995		1985-95		Post-1995
Noise		-0.044***		-0.009		-0.140***		-0.001
		(-99.67)		(-0.59)		(-1,165)		(-0.52)
Constant		5.234***		3.429***		10.17***		3.707***
		(160.11)		(4.68)		(1,435)		(31.38)
R-Squared		0.028		0.024		0.088		0.271
Observations		2,277		6,077		2,277		6,077

Results (continued)

Table 2: Regressions of House Characteristics (continued)

Dependent Variable:	Living SF		Land SF	
Year Built:	1985-95	Post-1995	1985-95	Post-1995
Noise	-120.0***	-19.77	-425.7***	5.922***
	(-1,203)	(-0.92)	(-1,229)	(4.52)
Constant	8,107***	2,921**	26,768***	3,715***
	(1,064)	(2.59)	(1,319)	(27.34)
R-Squared	0.160	0.149	0.161	0.211
Observations	2,277	6,077	2,277	6,077

Table 3: Regressions Results for Properties Sold Between 1990 and 2000

Results (continued)

Dependent Variable:		Log Avg Income		Log Avg Pct Black
Noise		19.98		-0.011
		(0.44)		(-0.30)
Noise*Year_1995		71.88***		-0.065***
		(5.28)		(-5.02)
Constant		32,086***		11.90***
		(10.59)		(7.10)
R-Squared		0.900		0.958
Observations		14,941		14,941

Table 4: Hedonic Model for Post-1995 Transactions

Results (continued)

Dependent Variable: Log of Sales Price			
	Tract Fixed Effects in all regressions		
	Including 3-Year Avg. Living SF of Tract	Including 3-Year Avg. Income of Tract	Including 3-Year Avg. Income and Living SF
Noise	-0.003***	-0.003***	-0.003***
	(-4.29)	(-4.44)	(-4.56)
Log of Bedrooms	0.086***	0.091***	0.091***
	(15.39)	(16.63)	(16.61)
Log of Total Bathrooms	0.075***	0.072***	0.071***
	(14.91)	(14.54)	(14.44)
Log of Land SF	0.133***	0.128***	0.127***
	(19.55)	(19.09)	(19.00)
Log of Living SF	0.388***	0.390***	0.389***
	(68.35)	(69.84)	(69.73)
Log of 3-Year Avg. Living SF of Tract	0.113***	-	0.157***
	(7.22)	-	(10.19)
Log of 3-Year Avg. Income of Tract	-	0.428***	0.437***
	-	(37.18)	(37.89)
Constant	6.482***	2.713***	1.528***
	(49.53)	(19.10)	(8.33)
R-Squared	0.797	0.803	0.804
Observations	41,867	41,867	41,867

Note: regressions here include properties built prior to 1992, so that changes in unobservables of new housing built after closure cannot influence estimated price levels

Conclusion and Future Ideas/Work

- Diff-in-diff framework: Short-run impacts
  - residents react immediately to announcement
  - No effect after actual closure (10 years after announcement)

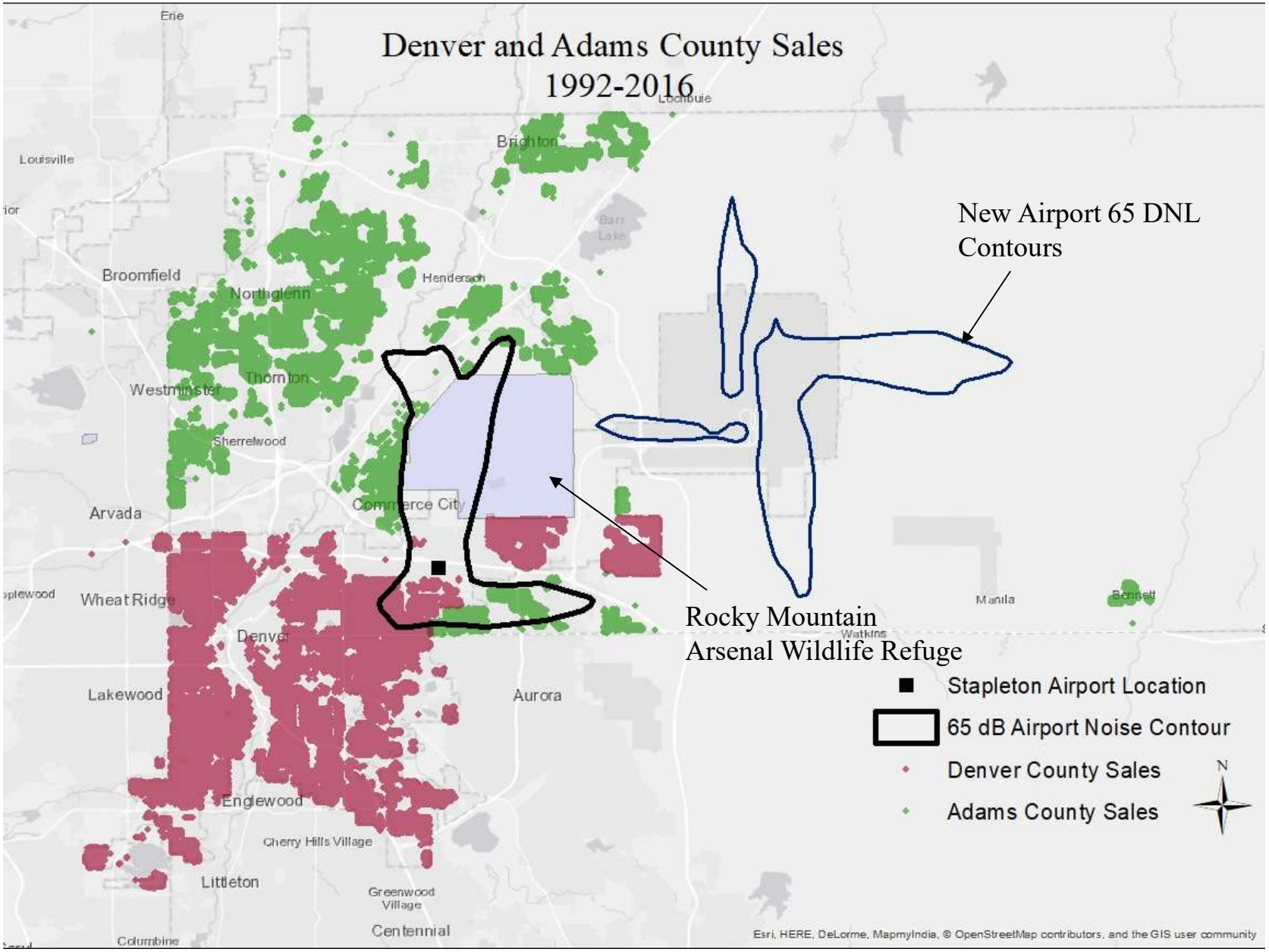
- Longer-run:
  - Changes in newly-built housing:
  - Bigger and “nicer” houses built and sold after closure in formerly noisy areas
  - Changes in new home buyers:
  - average income rose after closure
  - Likelihood that homebuyer was black population fell in formerly noisy areas

Conclusion (continued)

- Examine Dynamics at neighborhood level:
  - House prices higher in neighborhoods near airport with "larger" housing
  - House prices higher in neighborhoods near airport with higher incomes of homebuyers
- Focus on houses built several years before the closure so that unobservables of new housing after closure cannot influence price levels

Future Work/Ideas

- Dynamics of new airport announcement and opening
- Challenge: Data availability pre-1990 for Adams and Weld Counties


Denver and Adams County Sales
1992-2016
New Airport 65 DNL Contours
Rocky Mountain Arsenal Wildlife Refuge
Stapleton Airport Location
65 dB Airport Noise Contour
Denver County Sales
Adams County Sales
N
Erie
Louisville
Lafayette
Brighton
Barr Lake
Broomfield
Northglenn
Henderson
Thornton
Westminster
Sherrelwood
Commerce City
Arvada
Wheat Ridge
Denver
Manila
Bennett
Watkins
Lakewood
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Thank You!

- Comments/Questions?
- Email me:
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