Cost and Efficiency Analysis of En-route Traffic Control

C. Edward Huang
Adib Kanafani

University of California, Berkeley

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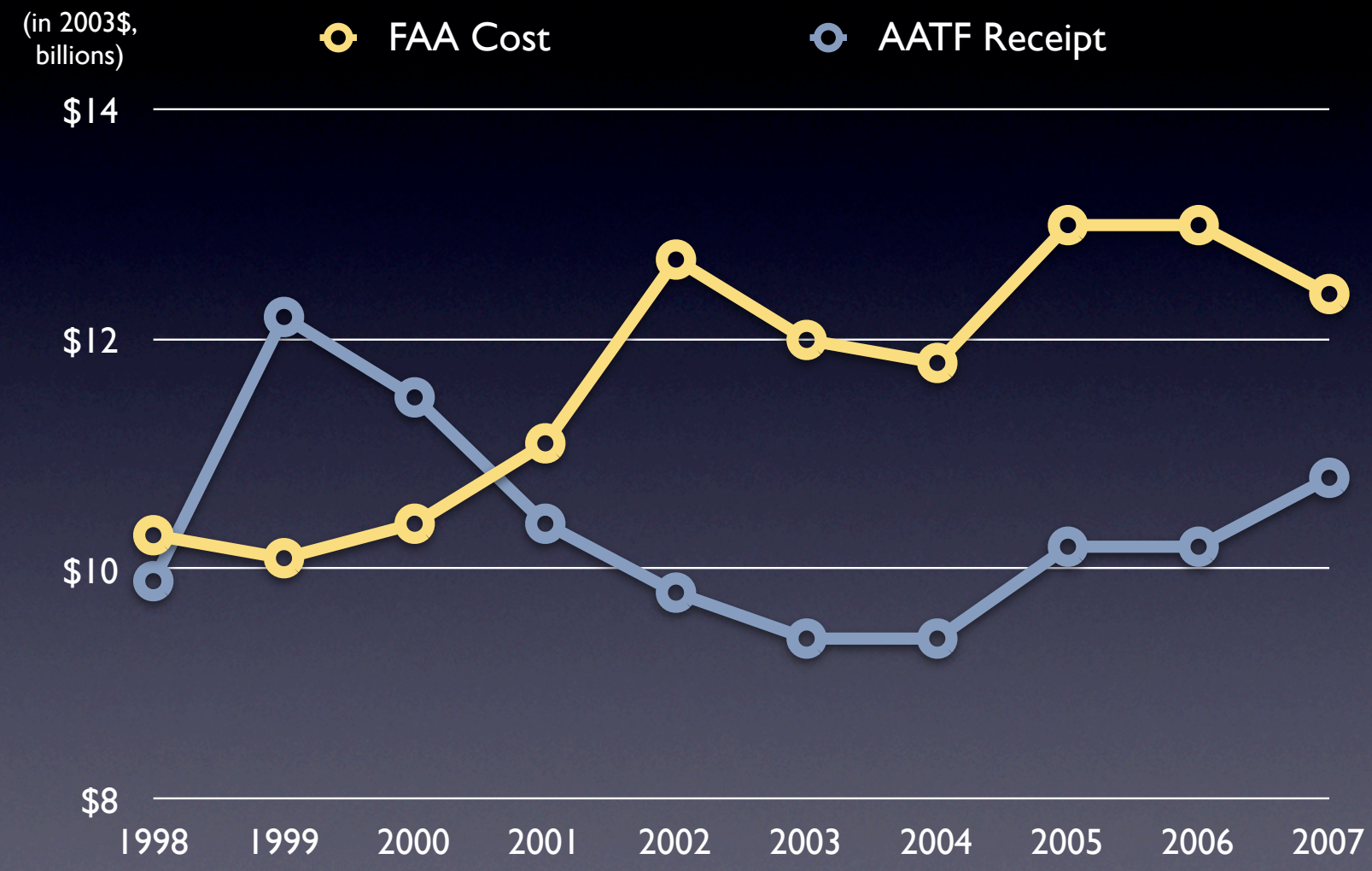
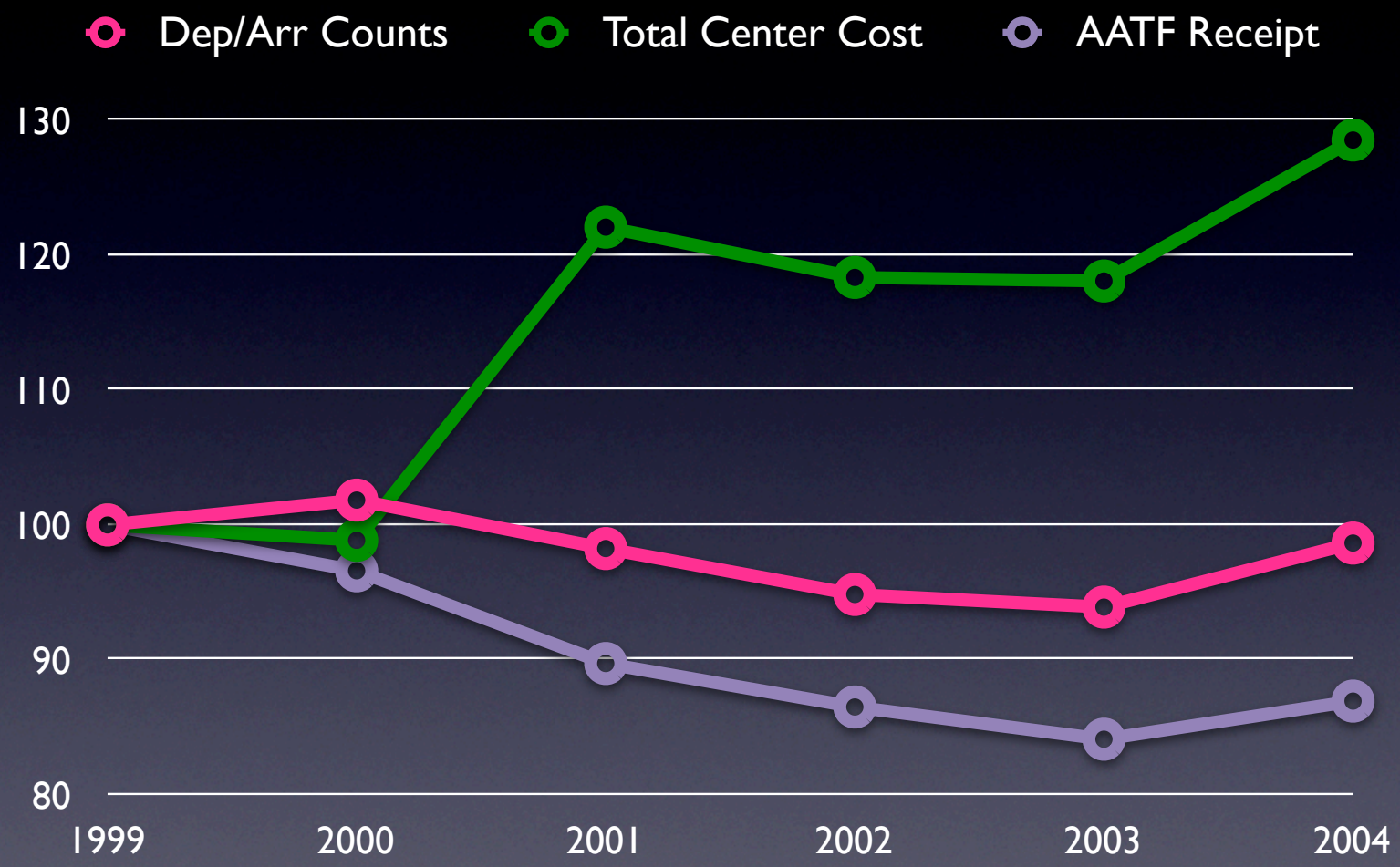
Draining AATF



Cost Up, Revenue Down



20 US En-route Centers

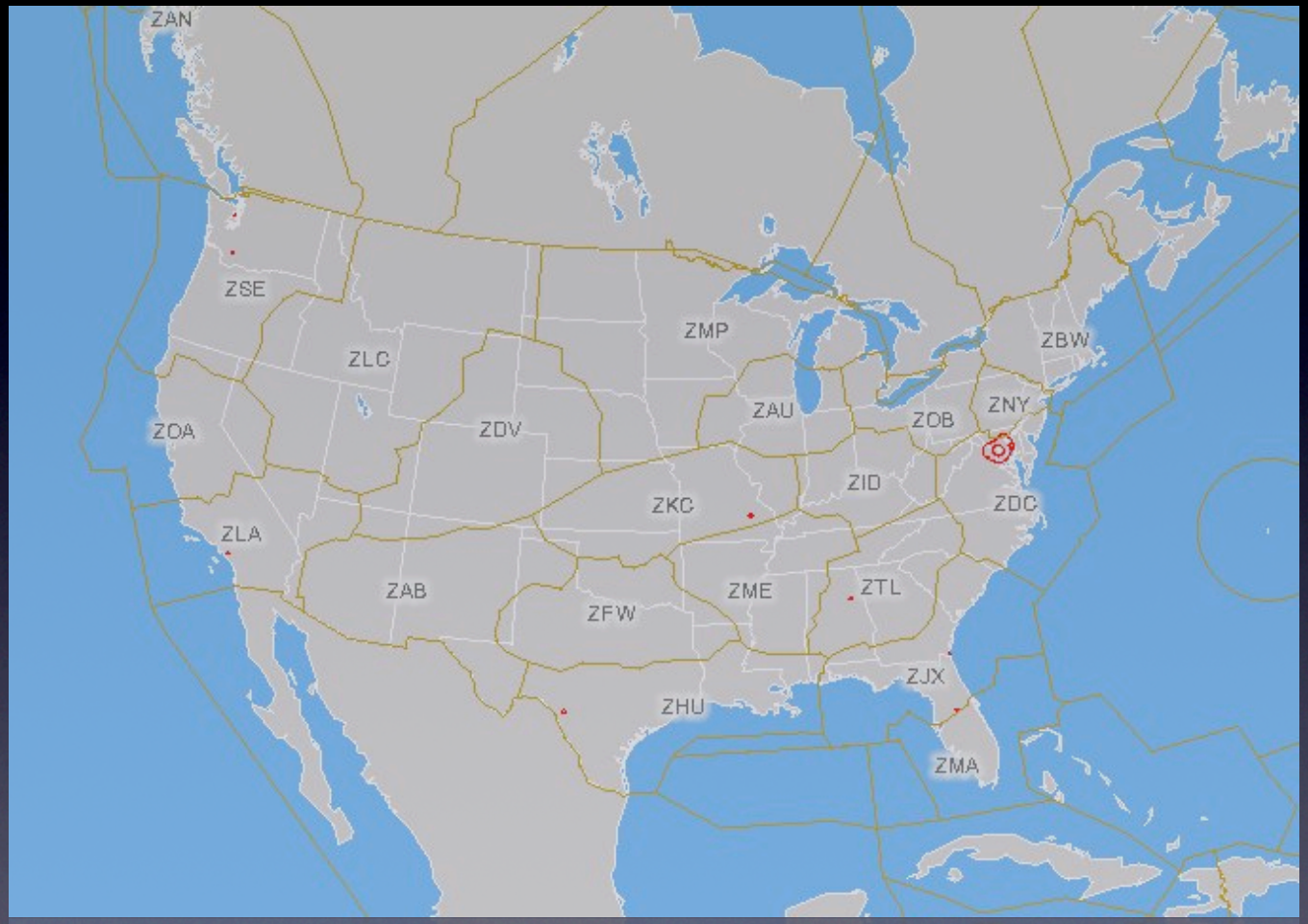
Motivation

- Cost is one important aspect of ATC financing
- Very few cost studies (FAA 1995, FAA 2005)
- Limitations of previous studies:
  - no multi-year comparison
  - linear assumption between output and cost
  - no efficiency evaluation of ATC
- Strategies to promote efficiency

Outline of Presentation

- Data
- Cost Analysis
- Stochastic Frontier Analysis
- Conclusions

20 Mainland Centers



- All operated by FAA
- Account for 25% of FAA cost in 2004

picture source: wikipedia

Data

Cost

- FAA Cost Accounting System
- Cost allocated to centers in 30+ accounts
- Only direct costs (labor, capital) are used

Product

- ATADS (Air Traffic Activity Data System)
- Departure/arrival and overflight counts

Price

- Average controller salary
- Average capital price (capital exp./stock)

1999~2004, 6 yr x 20 centers=120 obs

Descriptive Statistics

Variable	Mean	Min	Max	Std Dev	(Between)	(Within)
TC	18.14	17.61	18.57	0.21	0.19	0.09
Q_{da}	14.23	13.53	14.66	0.27	0.27	0.05
Q_o	13.06	11.41	14.17	0.74	0.75	0.07
w_l	11.83	11.68	11.93	0.09	0.00	0.09
w_k	3.95	3.77	4.09	0.11	0.00	0.11
Size	3.70	2.10	4.61	0.58	0.58	0.00
Sectors	3.83	3.30	4.16	0.22	0.22	0.00

- Everything logged
- Total Cost=Labor+Capital
- Qda=2*departures, Qo=overflights

- Most variation of outputs is between centers

Cost Functions

- Easier to deal with multiple products
- Cobb-Douglas setting is used
- Pooled vs. Panel

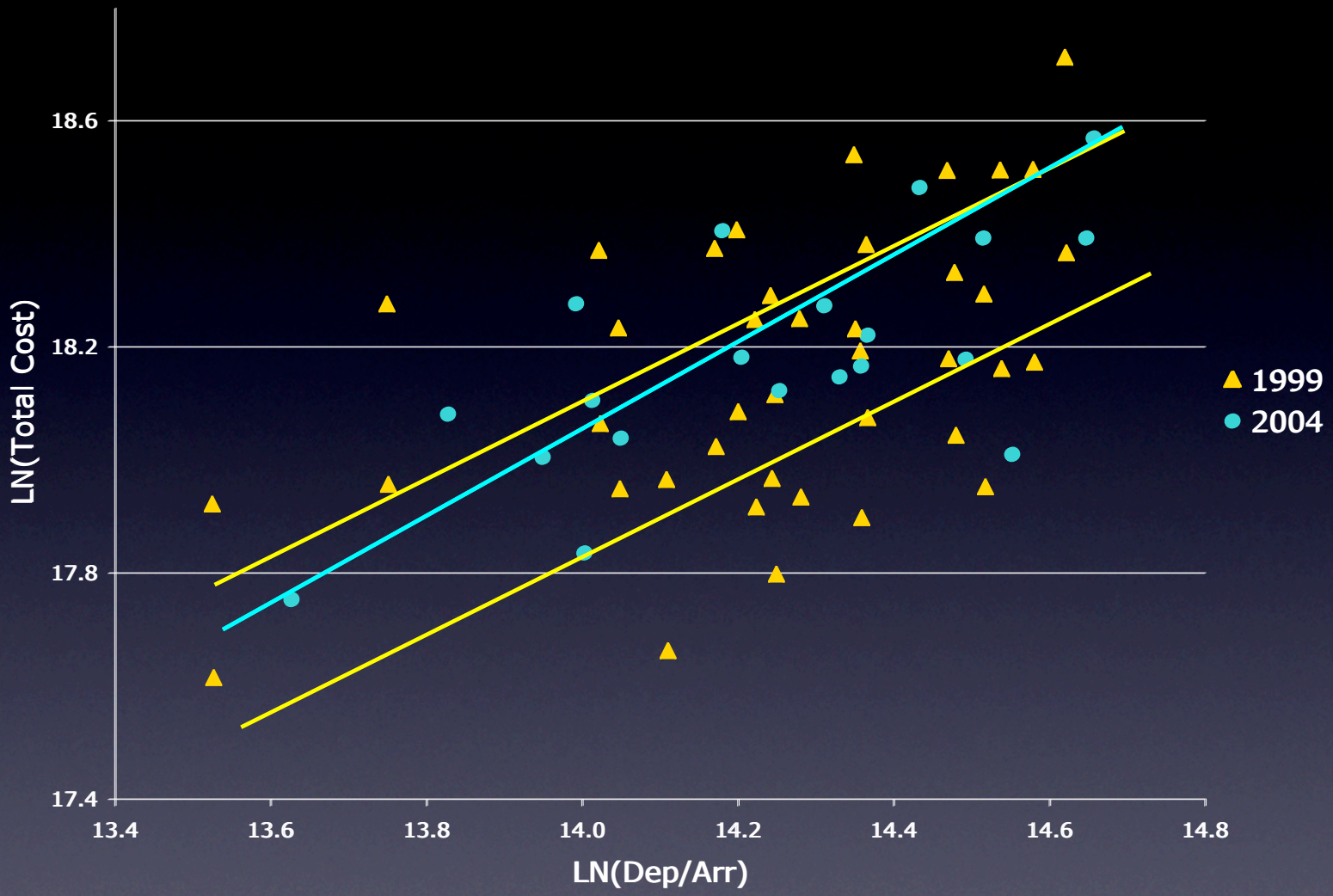
- Y=Labor+investment
- X=dep/arr, overflights (Q),
  salary, capital price (w)

Pooled

- Center ID's are ignored

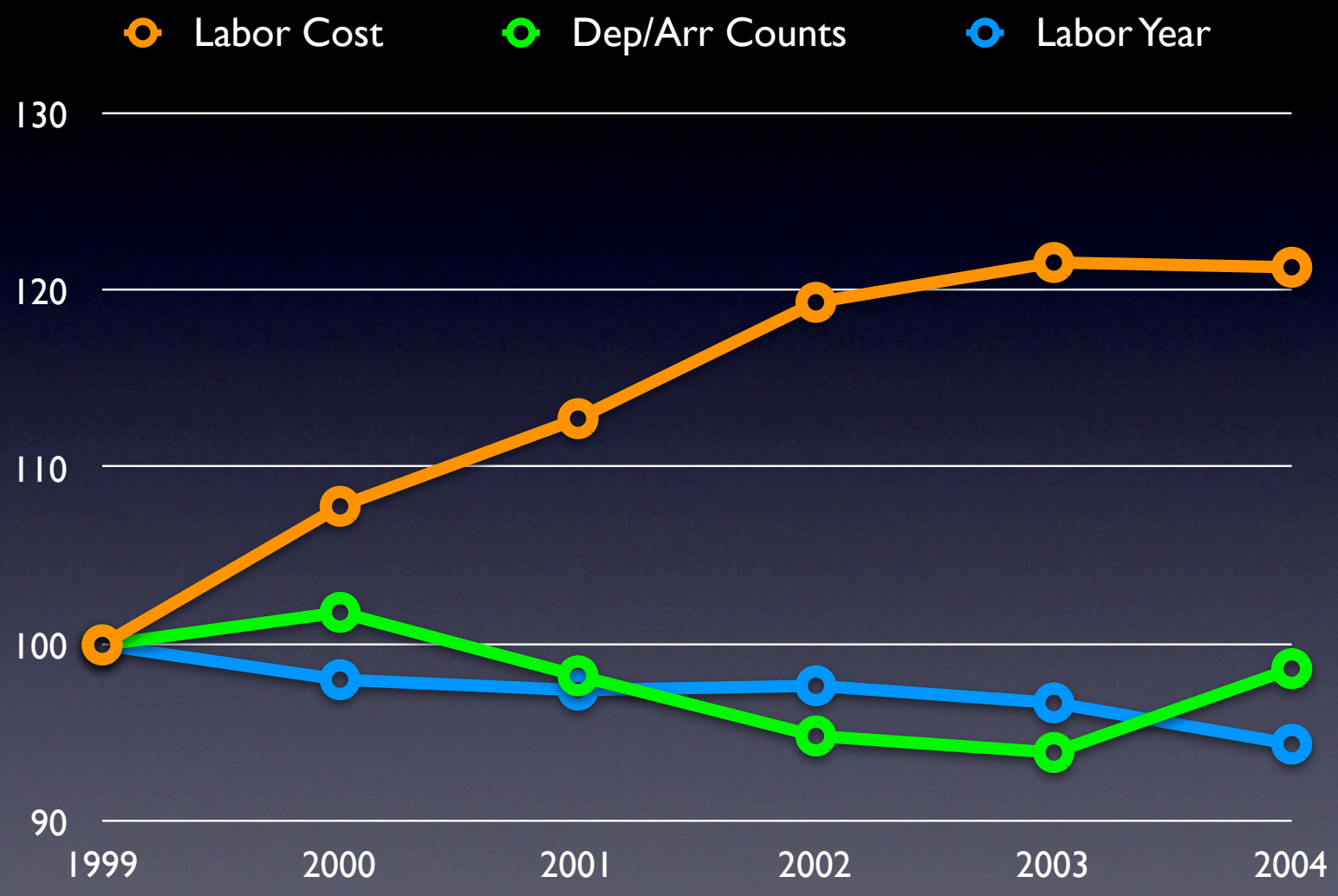
Y=total cost	coeff.	std. err.	t
dep/arr	0.51	0.035	14.7
overflight	0.13	0.013	10.2
salary	1.28	0.551	2.3
capital price	-0.37	0.412	-0.9
constant	-4.52	4.940	-0.9
R-squared	0.76		
F	89.99		

- Dep/arr flights are more costly (about 4X overflight)
- Economy of density exists
- Can be viewed as long-run cost function



- Cost relation is similar between 99 and 04

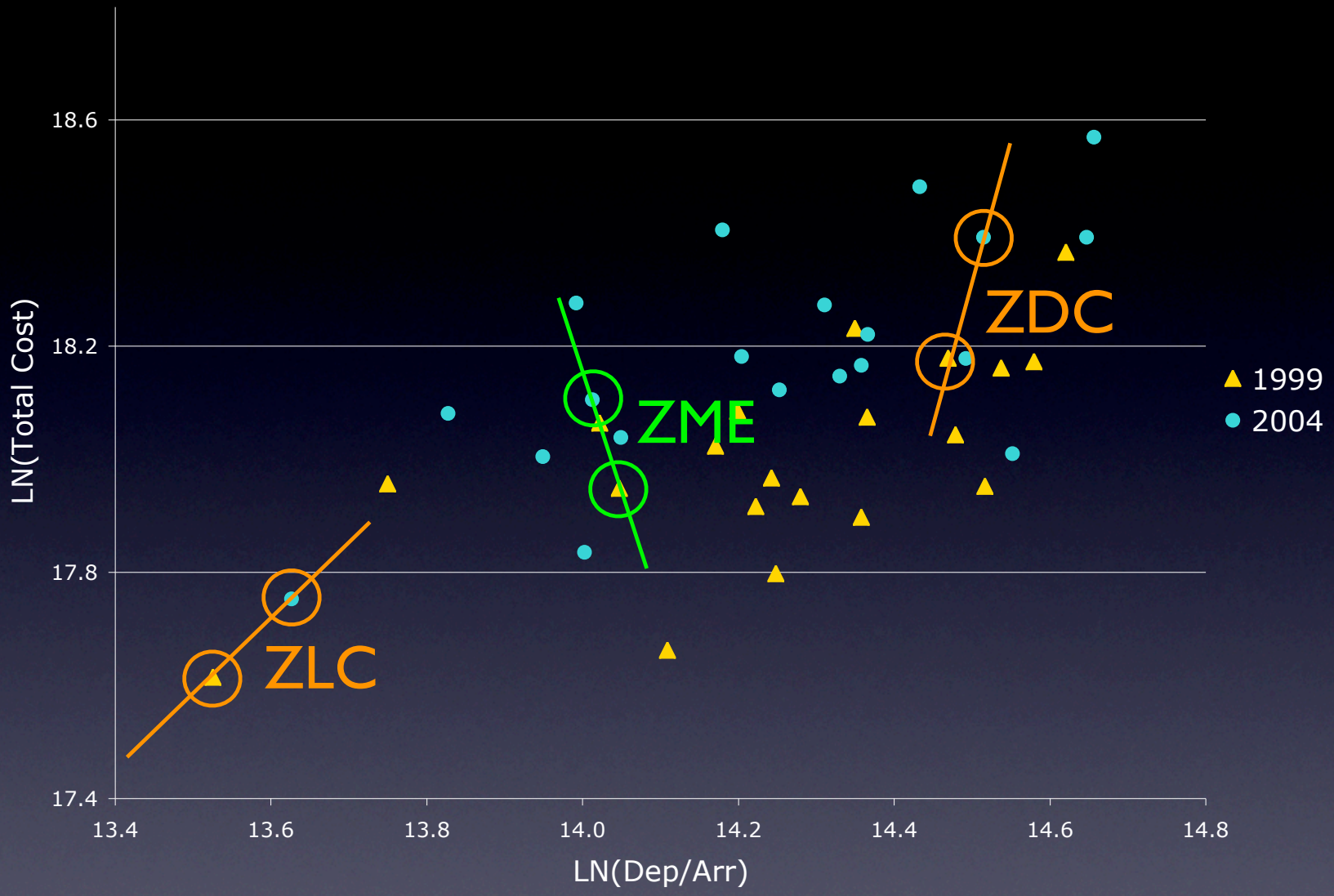
Labor force is inline with traffic



Panel (Fixed-effect)

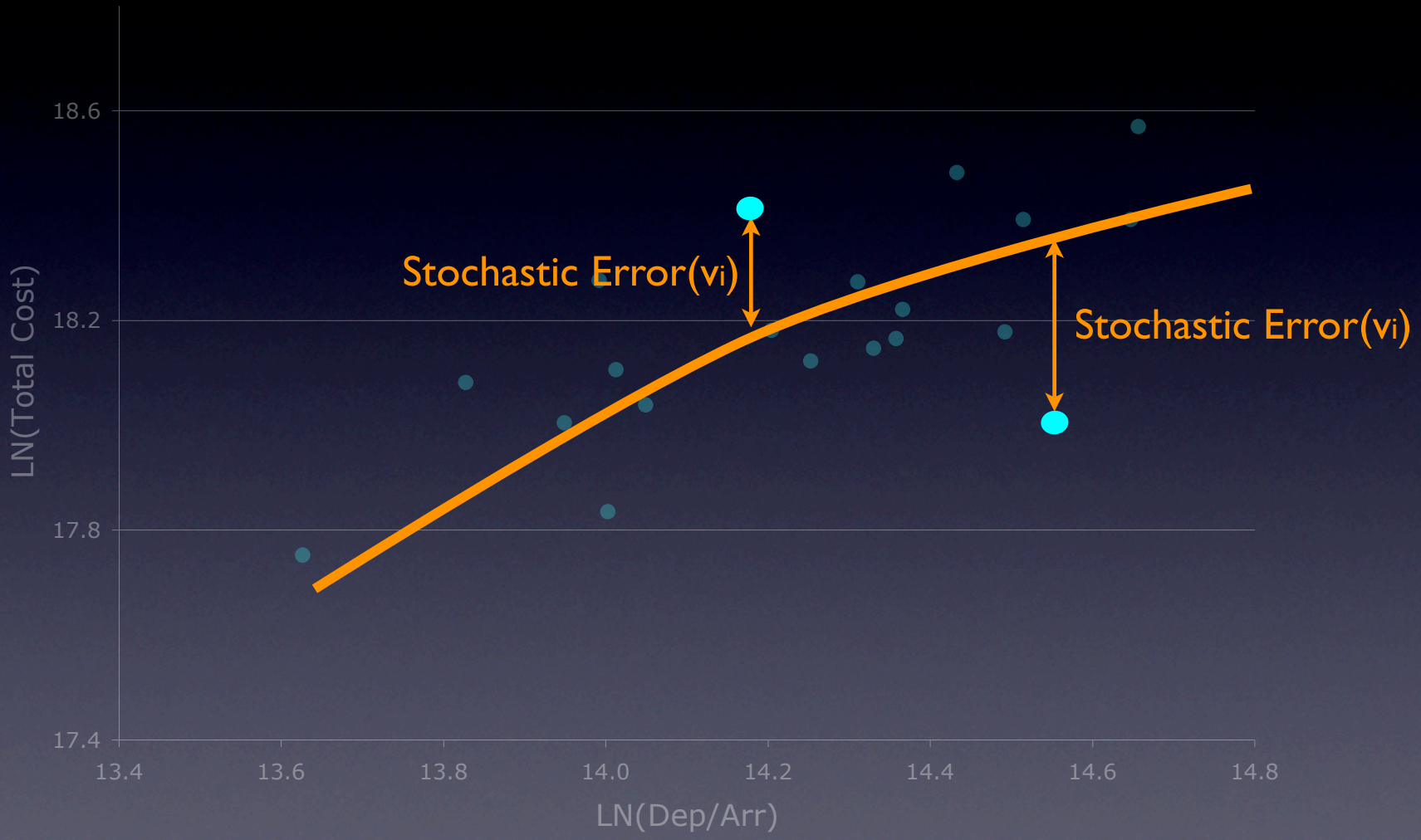
Y=total cost	coeff.	std. err.	t
dep/arr	0.09	0.118	0.8
overflight	0.88	0.109	0.8
salary	1.21	0.329	3.7
capital price	-0.37	0.253	-1.5
constant	-2.61	3.230	-0.8
R-squared	0.49		
F	33.60		

- Total cost is not sensitive to traffic level
- May be due to inflexibility in inputs and lack of control on outputs
- Short-run cost: salary is determinant

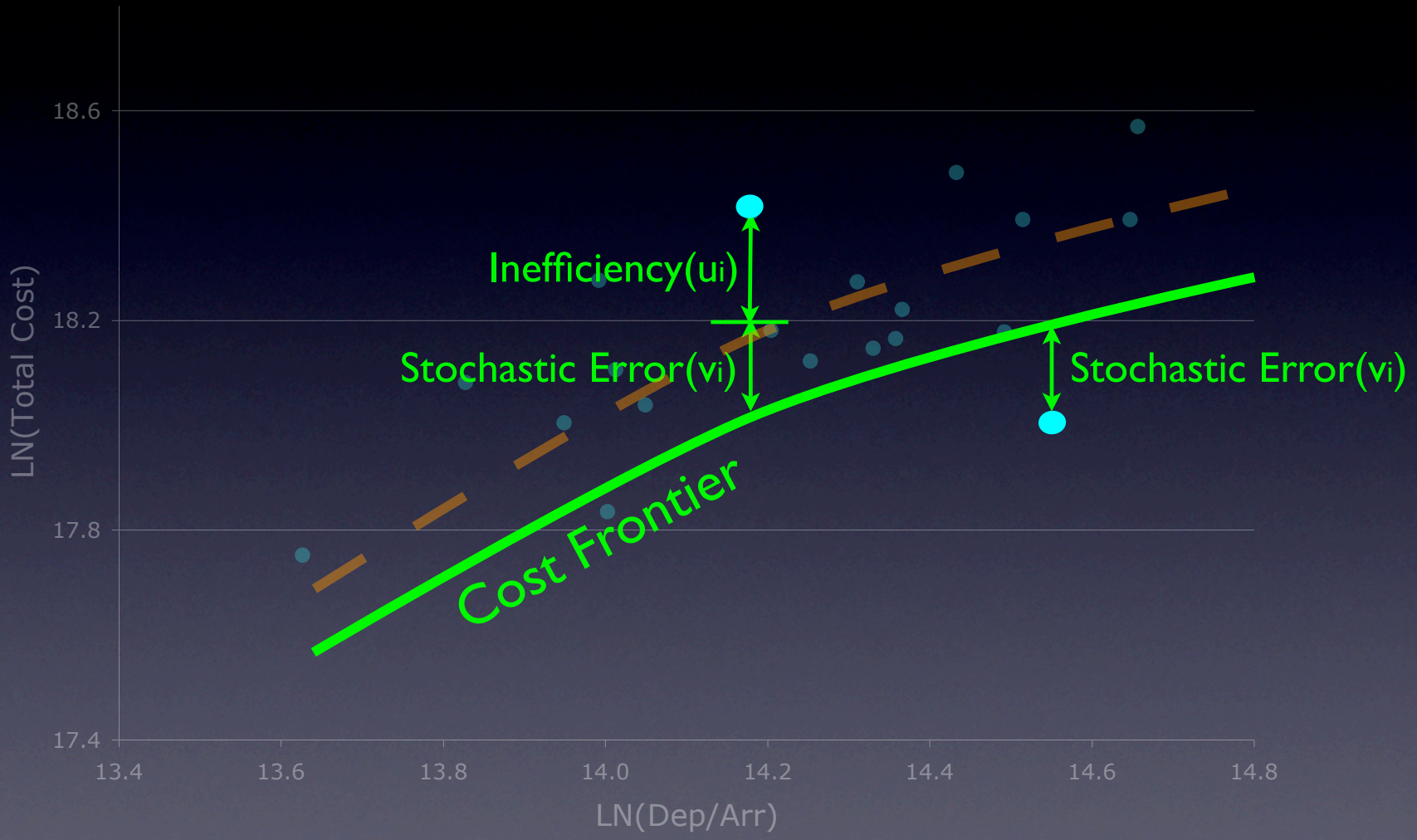


- Different trends within centers make output coefficients insignificant

All Efficient Assumption



Stochastic Frontier Analysis



Stochastic Frontier Analysis

- An additional technical inefficiency term u

$$lnC_i' = \beta_0 + \sum_{k=1}^{m} \beta_k^y lnY_{ki} + \sum_{j=1}^{n} \beta_j^w lnw_{ji} + v_i + u_i$$

- Distribution of u can be half-N, truncated-N, gamma, etc
- Inefficiency Score (log-linear):

$$IE_i = \frac{C_i'}{C_i} = exp(u_i)$$

Inefficiency Scores

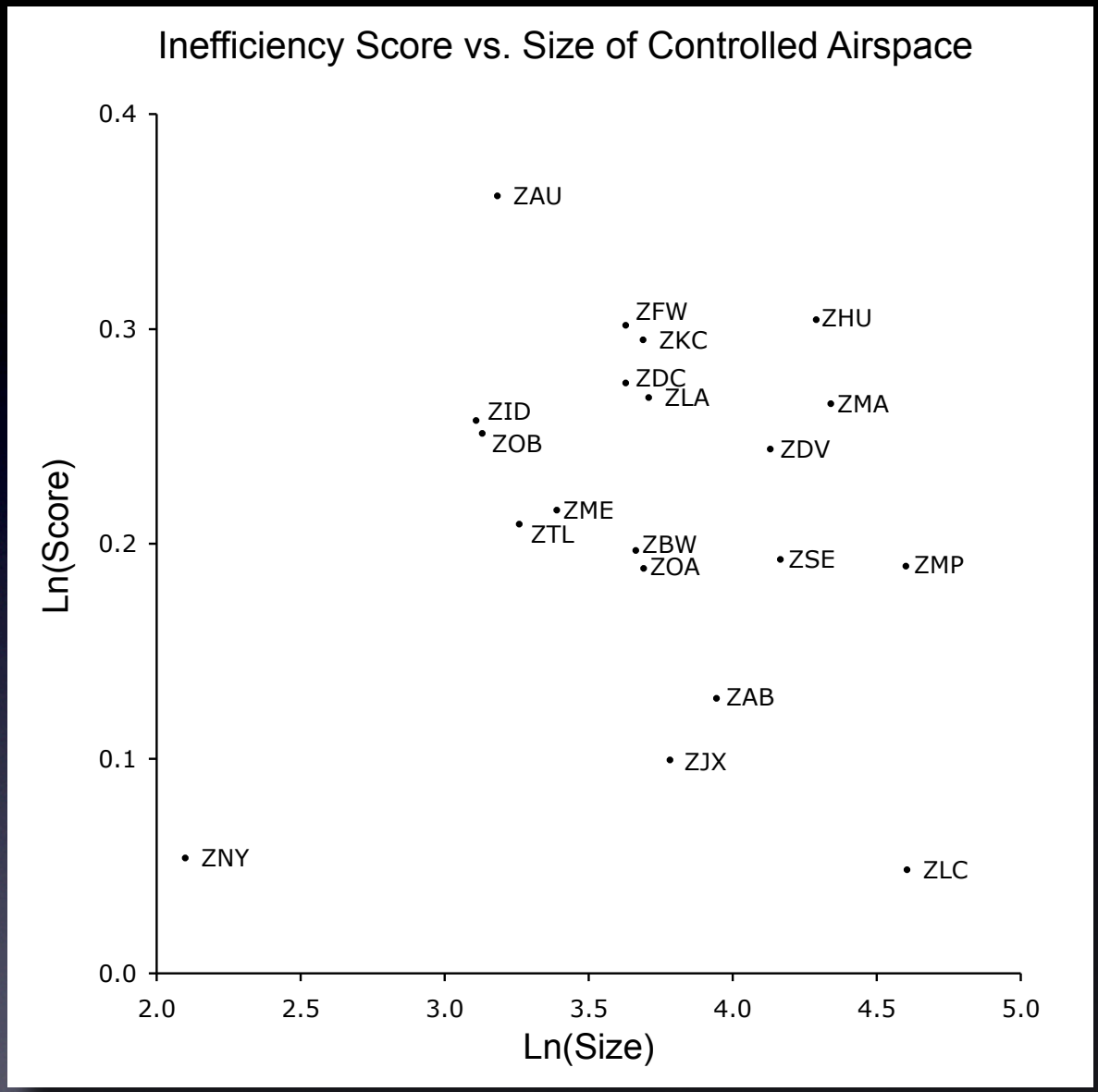
Center	Efficiency	Center	Efficiency
ZLC	1.049	ZDV	1.276
ZNY	1.055	ZOB	1.286
ZJX	1.105	ZID	1.293
ZAB	1.137	ZMA	1.304
ZOA	1.208	ZLA	1.308
ZMP	1.209	ZDC	1.316
ZSE	1.213	ZKC	1.343
ZBW	1.218	ZFW	1.352
ZTL	1.232	ZHU	1.356
ZME	1.241	ZAU	1.436

- random-effect time-invariant model
- half-normal distribution of inefficiency

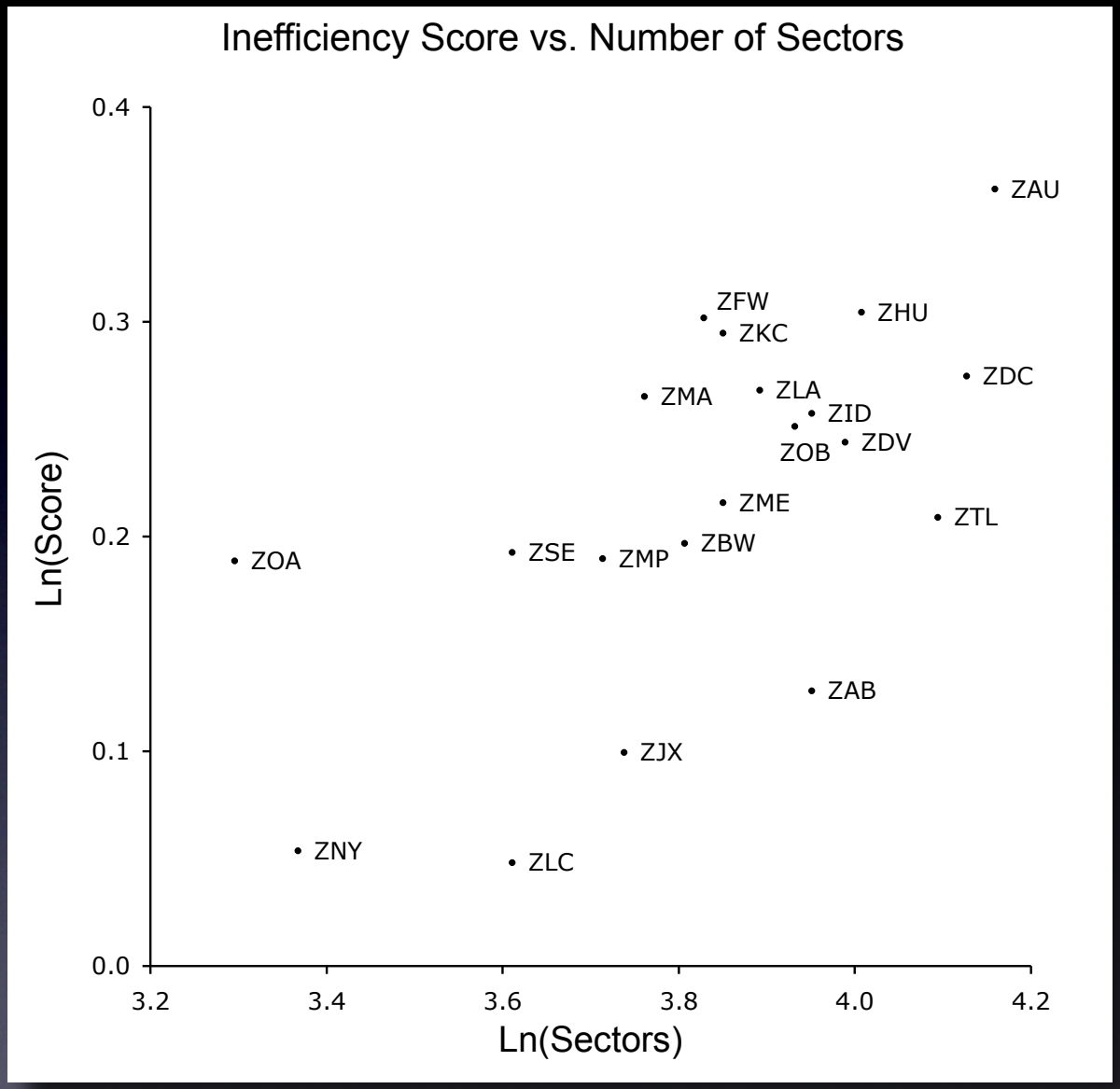
ID	Center	ID	Center	ID	Center	ID	Center	ID	Center	ID	Center	ID	Center
ZAB	Albuquerque	ZDC	Washington	ZHU	Houston	ZKC	Kansas City	ZMA	Miami	ZNY	New York	ZSE	Seattle
ZAU	Chicago	ZDV	Denver	ZID	Indianapolis	ZLA	Los Angeles	ZME	Memphis	ZOA	Oakland	ZTL	Atlanta
ZBW	Boston	ZFW	Dallas Fort Worth	ZJX	Jacksonville	ZLC	Salt Lake City	ZMP	Minneapolis	ZOB	Cleveland		

Explaining inefficiency

Y=score	coeff.	std. err.	t
size	-0.00025	0.00077	-0.3
sectors	0.0065	0.0020	3.3
constant	0.95	0.11	8.9
R-squared	0.41		
F	6.00		



- Size is not related to inefficiency



- More sectors is related to inefficiency

Conclusion

- Departure/arrival flights are costlier than overflights
- Economy of density exists in en-route ATC
- In the short run, the cost structure is more related to price than output.
- To plan for the long run, technology upgrade may be necessary to remain cost-efficient

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