Connecticut Public Health Practice-Based Research Network DACS 71133
Product Type: Meeting and Conference Presentation
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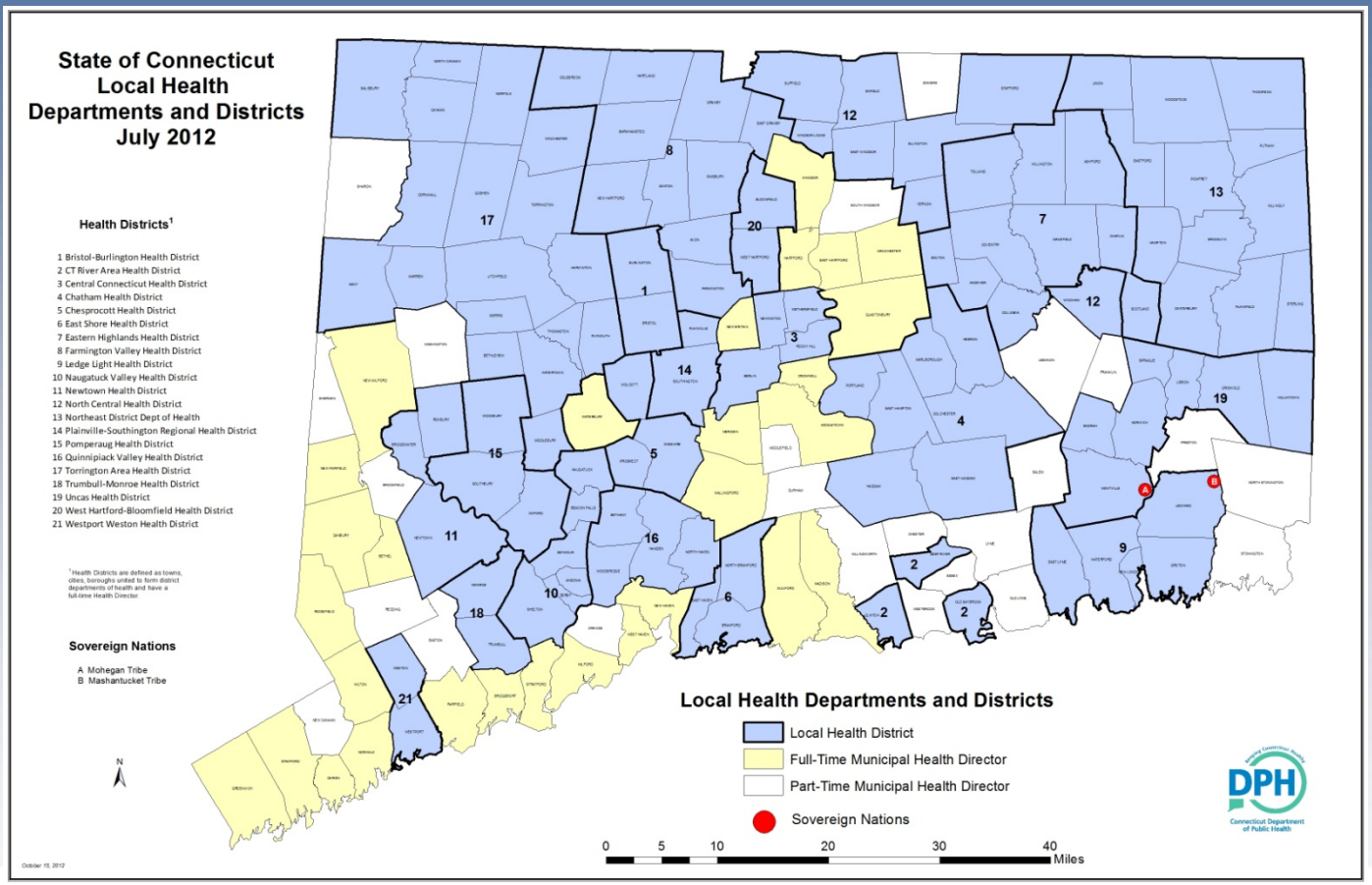
University of Hartford (respectively)
Title of Presentation: Cost effectiveness, efficiency and equity of inspection services throughout Connecticut's local public health system
Meeting: Research-in-progress Presentation at PH PBRN Monthly Virtual Meeting
Date: July 17, 2014
Location: Lexington, KY (virtual)

Project Components

- The project has two components.
  - Component 1 describes and analyzes the scope and cost of four environmental health services provided in Connecticut and the differences in associated costs incurred by local health jurisdictions that may arise from differences in the size and structure of local health departments.
    - These services include: *food protection, public water wells, subsurface sewage disposal and lead poisoning prevention and control*.
  - Component 2 evaluates the impact of size and organizational structure relative to a number of hypotheses about the efficiency, effectiveness and equity of food protection services.

CT Local Health Departments and Districts



Full and Part-Time Health Departments in Connecticut

	#Towns	Population	Percent	Pop. Range
Full-Time	**145**	**3,374,354**	**94%**	
Municipal	29	1,657,005	46%	18,239 -145,638
Districts (21)	116	1,717,349	48%	28,194 -166,117
Part-Time	**24**	**203,491**	**6%**	**1,917- 25,729**
TOTAL	**169**	**3,577,845**		

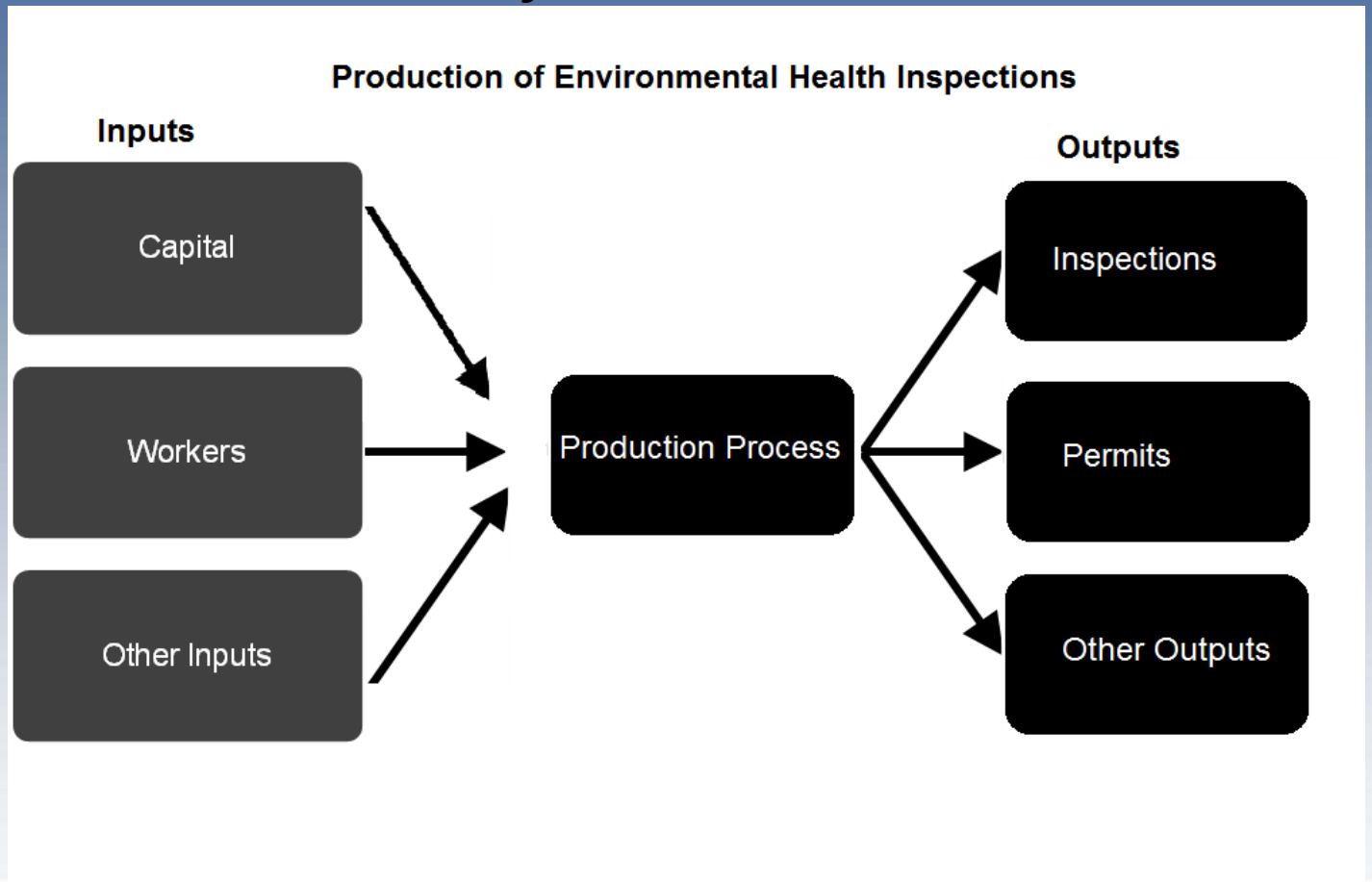
Some Key Questions That Our Cost Functions Can Address

- Are providers “too small” or “too large” ?
- To answer: estimate scale economies

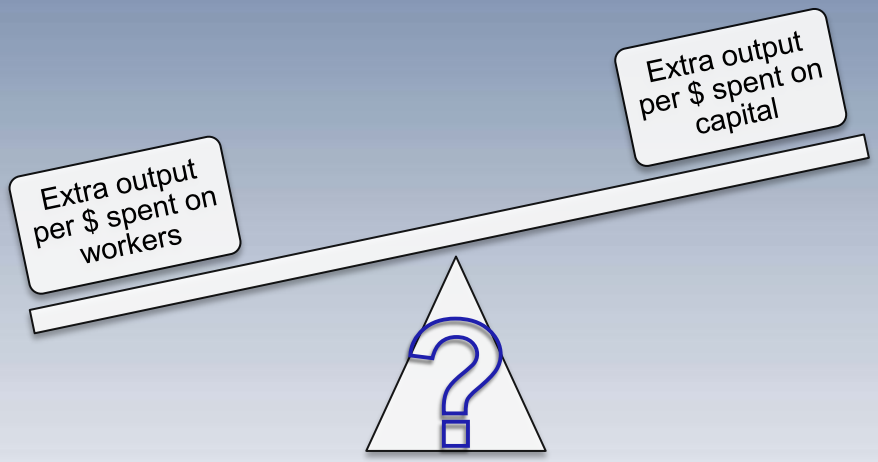
- Is it less costly to “produce” more or less of different types of inspections together?

  (Some jurisdictions don’t do all inspections, or only small amounts of some inspections, due to small district size; others considering merging may do more of some – how does this affect the cost of doing others??)
- To answer: estimate economies of scope

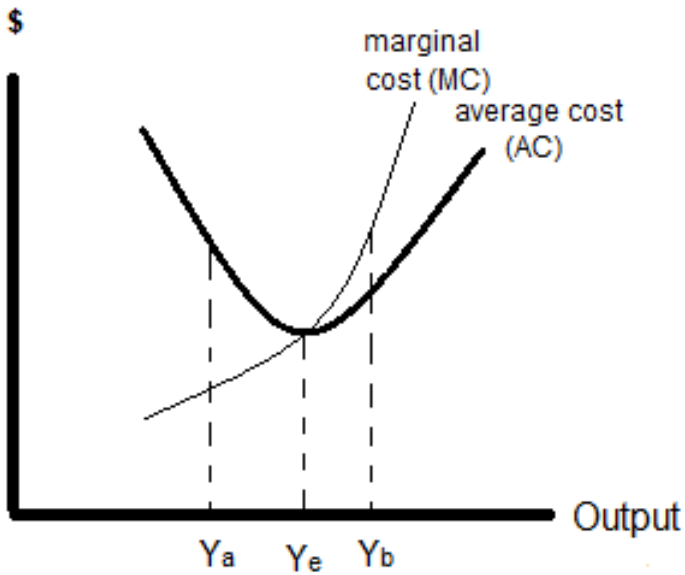
Economic Theory of Production and Costs



Health districts should choose their input mix to balance the benefits of spending more on workers vs. on physical capital

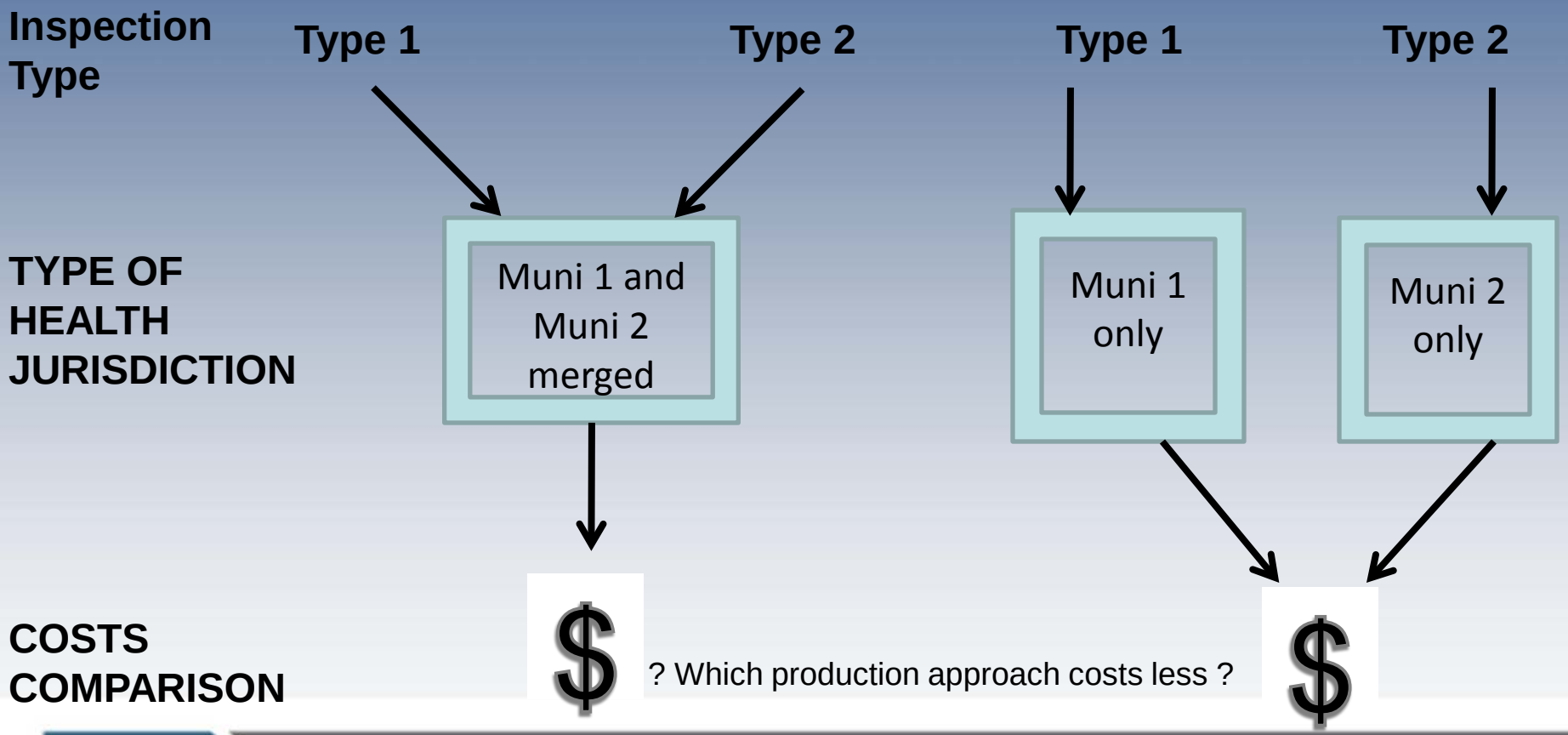


Health Districts Should Strive to be at point Y_e



Average cost (AC) is the cost per unit of output (Y), while marginal cost (MC) is the change in total cost from a small change in output. Figure 3 shows that micro-economic theory implies the provider's AC curve is U-shaped, and the MC curve slopes up. AC is minimized at Ye, so Ye is the "efficient" level of output. If MC<AC (economies of scale), as in the provider output level Ya, then the provider can lower its AC by increasing Y until it reaches Ye.

Economies of Scope and Specialization



Outputs for Cost Functions

- Drinking Water:

  - Output:

  number of private well permits +

  number of public well permits

Outputs for Cost Functions (continued)

- Food Services:
  - Output: Number of inspections

(in different “classes”, including temporary events)

Outputs for Cost Functions (continued)

- Sewage:

  -Outputs: total # of permits =

  Number of new permits +

  Number of repair permits +

  Number tested +

  Number of B100's (makes sure have space for a workable septic system)

Outputs
for Cost Functions (continued)

- Lead
  - Output:

    # of inspections

Cost Function Variables

- Q: Outputs in each category (lead, water, sewer, food)
- P: Price of inputs (average wage for all workers; price index for capital structures)
- X: any nurse staff (yes/no);
  urban or rural (yes/no);
  # of patients w/blood lead levels≥10
- D: (D1=municipal health dept, D2=district, 3=part-time)
- t: time trend
- All dollar values are adjusted for inflation

Estimating Equation

Variation of a Translog Total Cost Function:

$$\log(TC_{it})=\log(TC_{it}(\mathbf{Q}_{it}, \mathbf{P}_{it}, \mathbf{X}_{it}, \mathbf{t}, \mathbf{D}_j)) = \alpha_0 + \alpha_p \log(P_{Lit}) \log(P_{Kit}) + \alpha_L \log(P_{Lit})^2$$

$$+ \Sigma_m \Sigma_n \delta_{mn} \log(Q_{nit}) \log(Q_{mit}) + \Sigma_n \delta_n \log(Q_{nit})^2 + \Sigma_j \delta_j D_j + \Sigma_r \alpha_r X_{rit} + \gamma\, t + u_{it}$$

t = 2005, 2006, …, 2012; i = 1,2,…,75; j = 1 (municipal), 2 (district);
(m,n) = water, septic, food, lead; r = (any nurse; urban/rural; blood level≥10)
Parameters to be estimated by least squares regression: α, δ, γ ; $u_{it} \sim N(0, \sigma^2)$

Elasticity of Scale

- Can easily compute scale economies for each (i, t) observation:

With only one output,

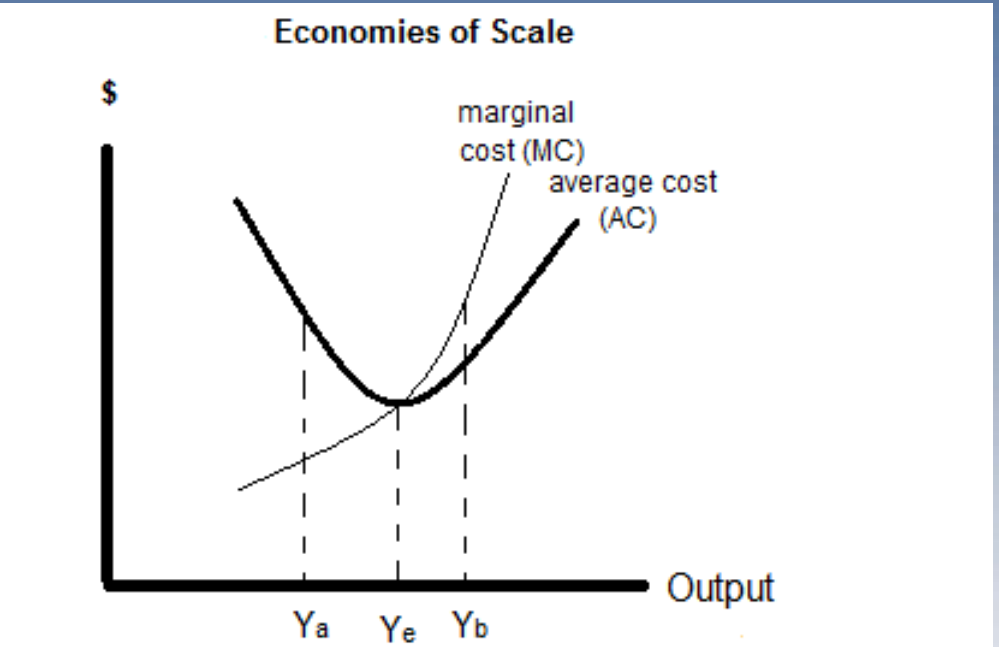
$$\varepsilon = [\partial TC/\partial Q][Q/TC]$$
$$= \partial \log TC / \partial \log Q$$
$$= MC/AC$$

If $\varepsilon > 1$, MC>AC, so AC rising (decreasing returns to scale)

If $0<\varepsilon<1$, MC<AC, so AC falling (increasing returns to scale)

If $\varepsilon=1$, MC=AC (constant returns to scale, or minimum efficient scale)

Health Districts Should Strive to be at point Y_e



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Elasticity of Scale and Scope: Total Cost

Scale Economies with 4 Outputs (Baumol et al, 1982):

$$\varepsilon = \partial TC/\partial Q_1 \bullet (Q_1/TC) + \partial TC/\partial Q_2 \bullet (Q_2/TC)$$

$$+ \partial TC/\partial Q_3 \bullet (Q_3/TC) + \partial TC/\partial Q_4 \bullet (Q_4/TC)$$

Scope Economies with 2 or more Outputs:

$$\partial[\partial \log TC/\partial \log Q_1]/\partial Q_2 \bullet [TC/Q_1] = \partial^2 TC/\partial Q_1 \partial Q_2 \bullet [TC/Q_1]$$
$$= [\partial MC_1/\partial Q_2] \bullet [TC/Q_1] < 0$$

is a sufficient condition:

MC curve for one output drops when more of the other output is produced (weak complementarity, Vita, 1990)

(In reverse, could have economies of specialization if > 0)

Data and Organizational Issues

- Annual Report Data: issues include completion rates, completeness and validity of data, changes in data elements
- Missing values for key variables in some years for some districts reduces sample
- Determining appropriate outputs for lead, water and septic

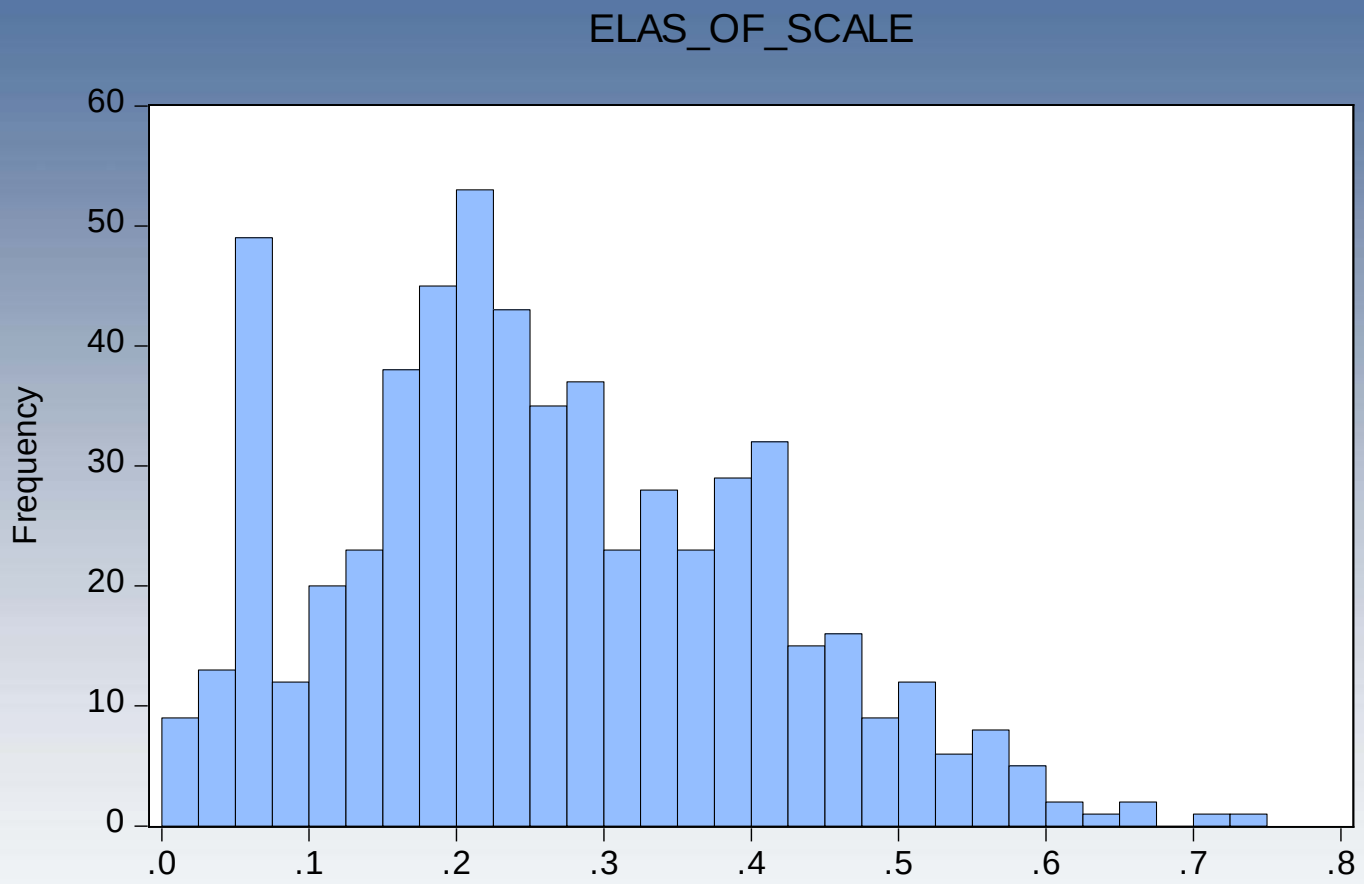
Descriptive Statistics

	TOT_COST_...	WAGE_AVG_...	PK	WATER_PRI...	WATER_PUB...	LEAD_INSPE...	FOOD_INSP...	SEPTIC_TOT...	ANYNURSES...	RURAL_URB...
Mean	1541909.	36438.35	1.222980	40.15667	1.645000	21.93000	434.4133	256.8017	0.451667	0.835000
Median	565452.8	38659.47	1.265176	14.50000	1.000000	1.000000	268.5000	140.0000	0.000000	1.000000
Maximum	31742872	282258.3	1.380691	2450.000	50.00000	1216.000	2175.000	2326.000	2.000000	1.000000
Minimum	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	0.000000	0.000000
Std. Dev.	3618671.	22383.82	0.120494	117.5077	4.213300	103.9473	474.8163	349.0570	0.501414	0.371490
Skewness	5.323260	2.348341	-0.612508	14.96361	10.37520	9.005902	1.416675	2.581481	0.233992	-1.805051
Kurtosis	35.65862	28.67831	2.179612	297.3867	116.9925	93.78727	4.469357	11.12175	1.158712	4.258211
Jarque-Bera	29498.35	15587.81	54.34251	2188979.	335622.0	214168.8	254.6720	2315.475	90.23375	365.3984
Probability	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
Sum	9.25E+08	20004653	733.7878	24094.00	987.0000	13158.00	260648.0	154081.0	271.0000	501.0000
Sum Sq. Dev.	7.84E+15	2.75E+11	8.696796	8271031.	10633.39	6472217.	1.35E+08	72982631	150.5983	82.66500
Observations	600	549	600	600	600	600	600	600	600	600

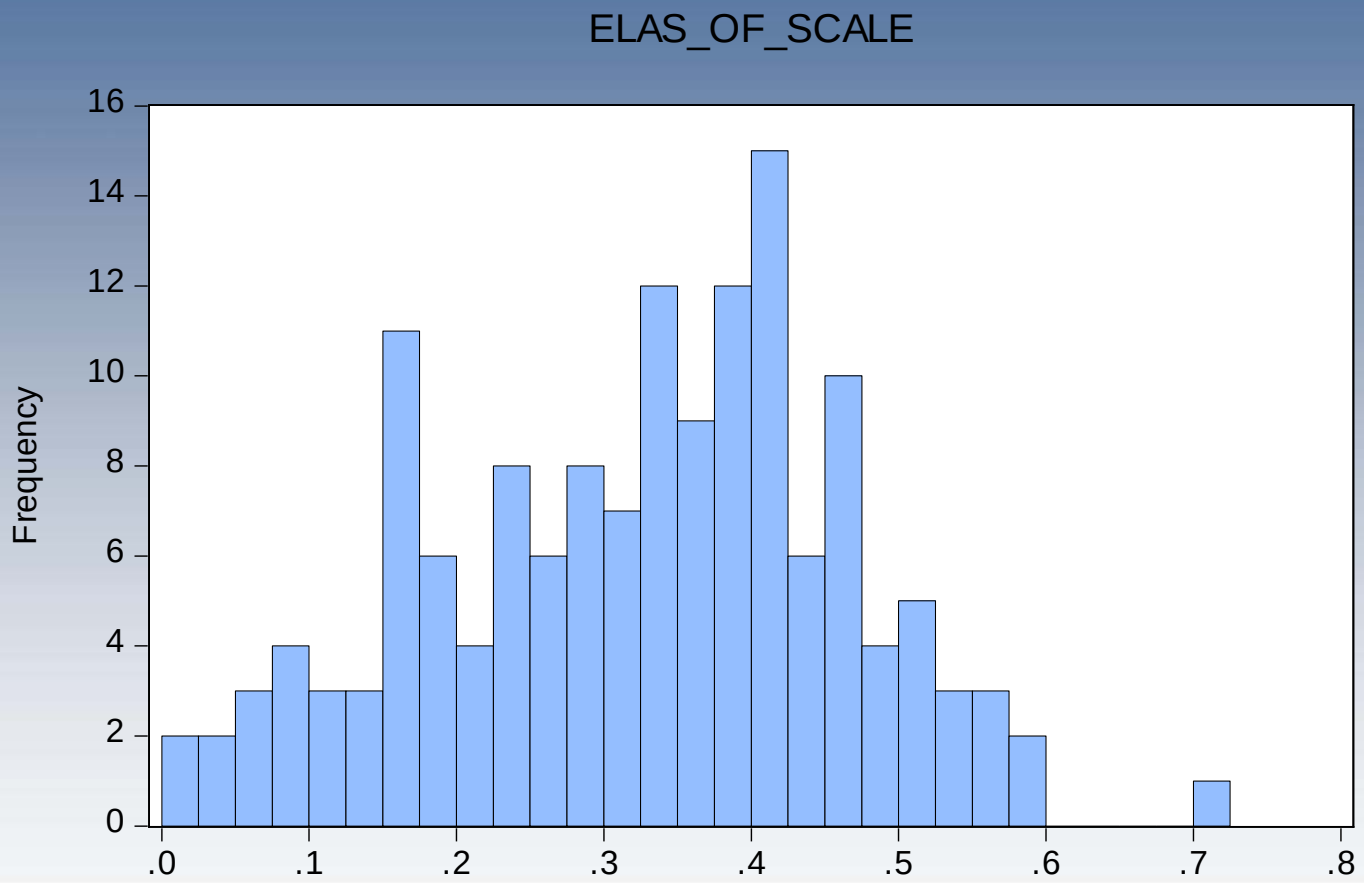
Summary of Cost Function Results

- R-squared = 0.63
- All inspections variables are jointly significant (P-value=0.000)

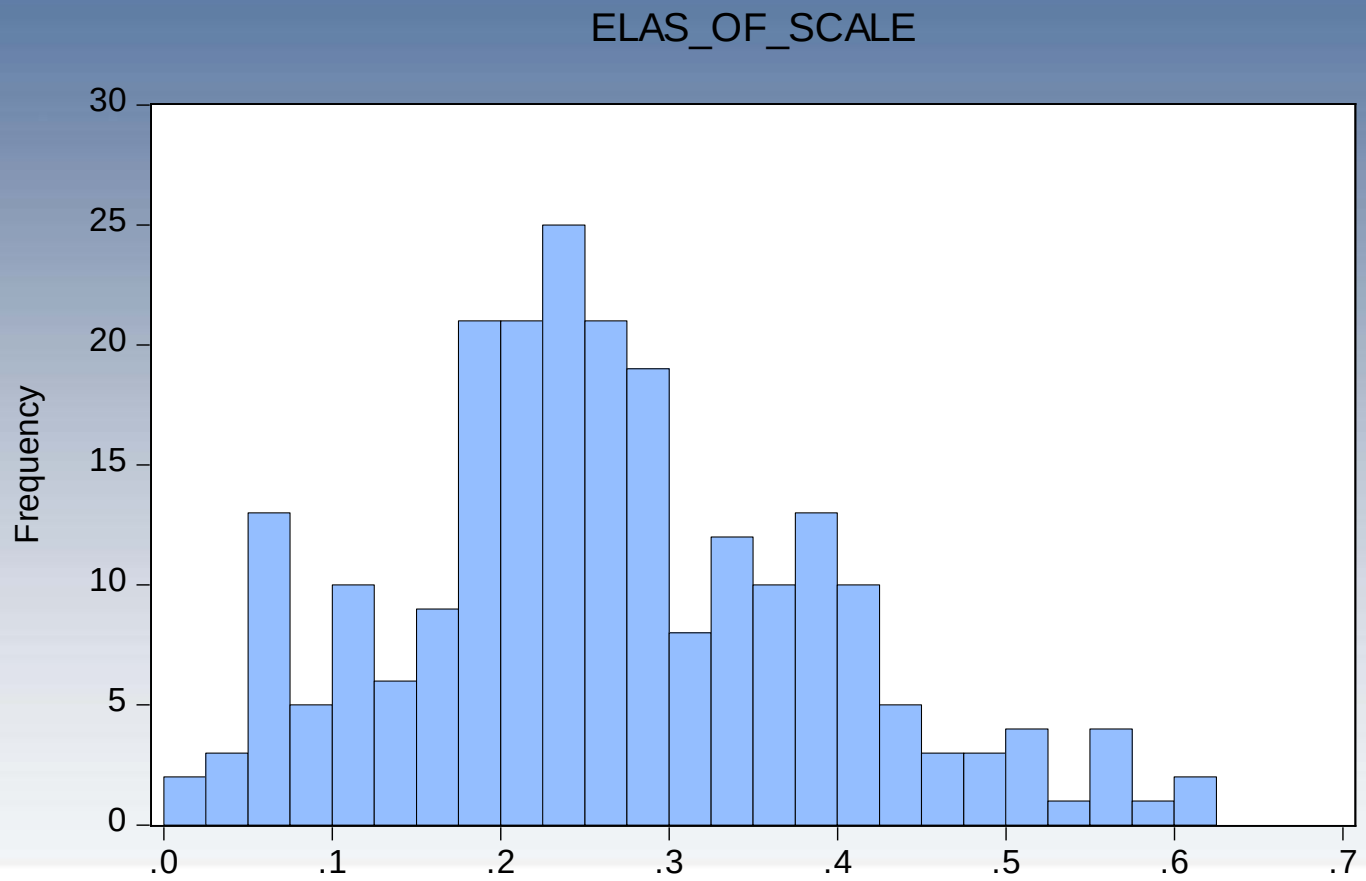
Elasticity of Scale – all jurisdictions, 2005-2012



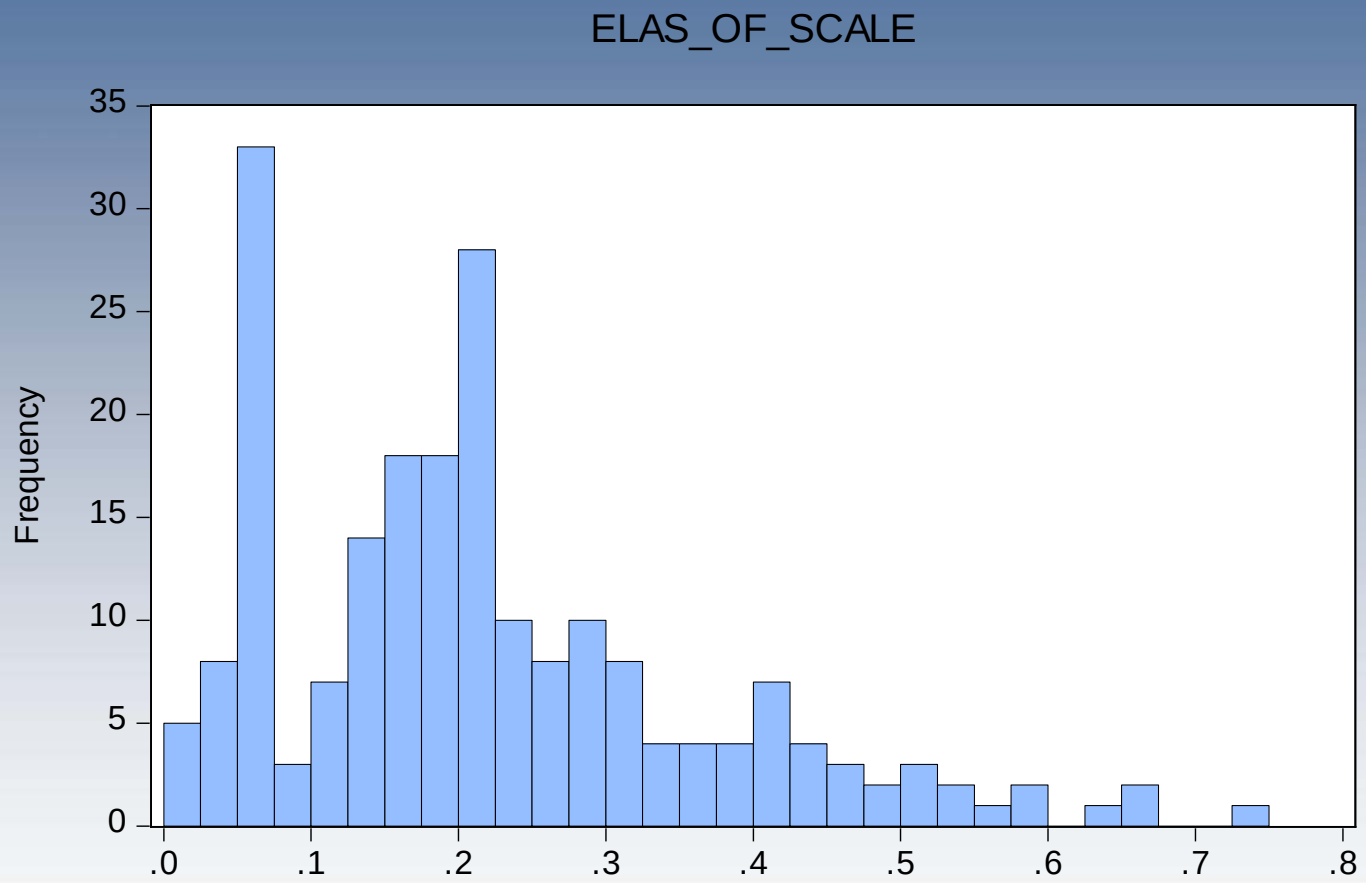
Elasticity of Scale – Districts, 2005-2012



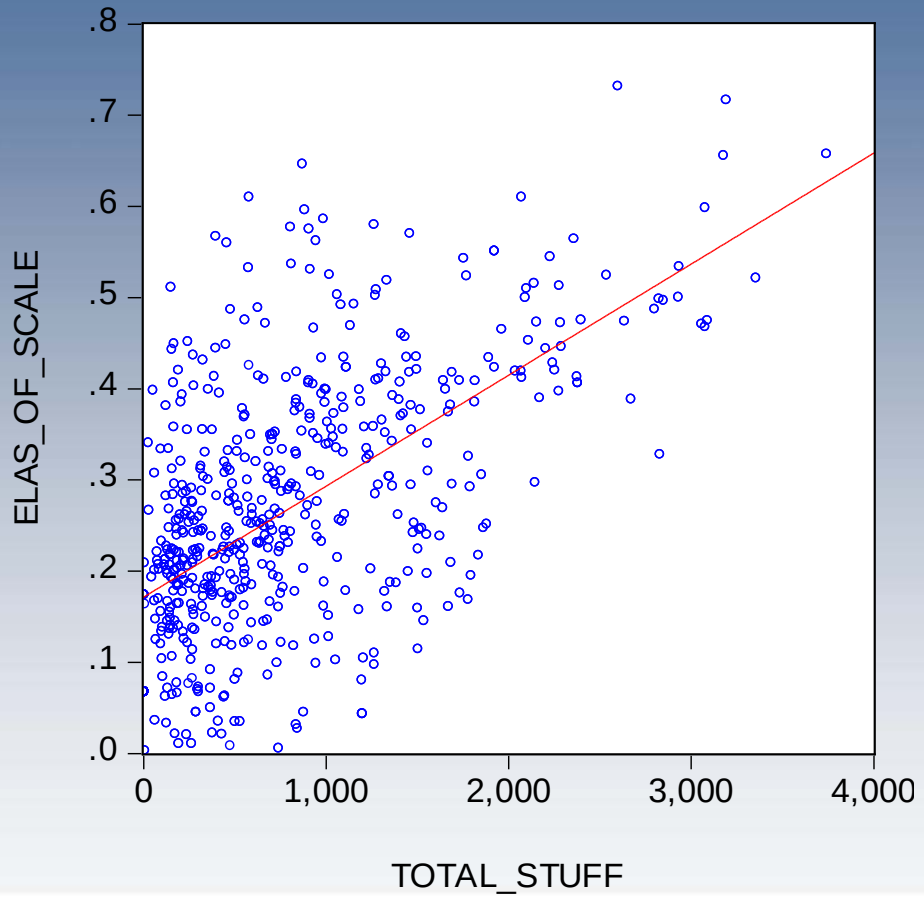
Elasticity of Scale – Municipal Health Departments



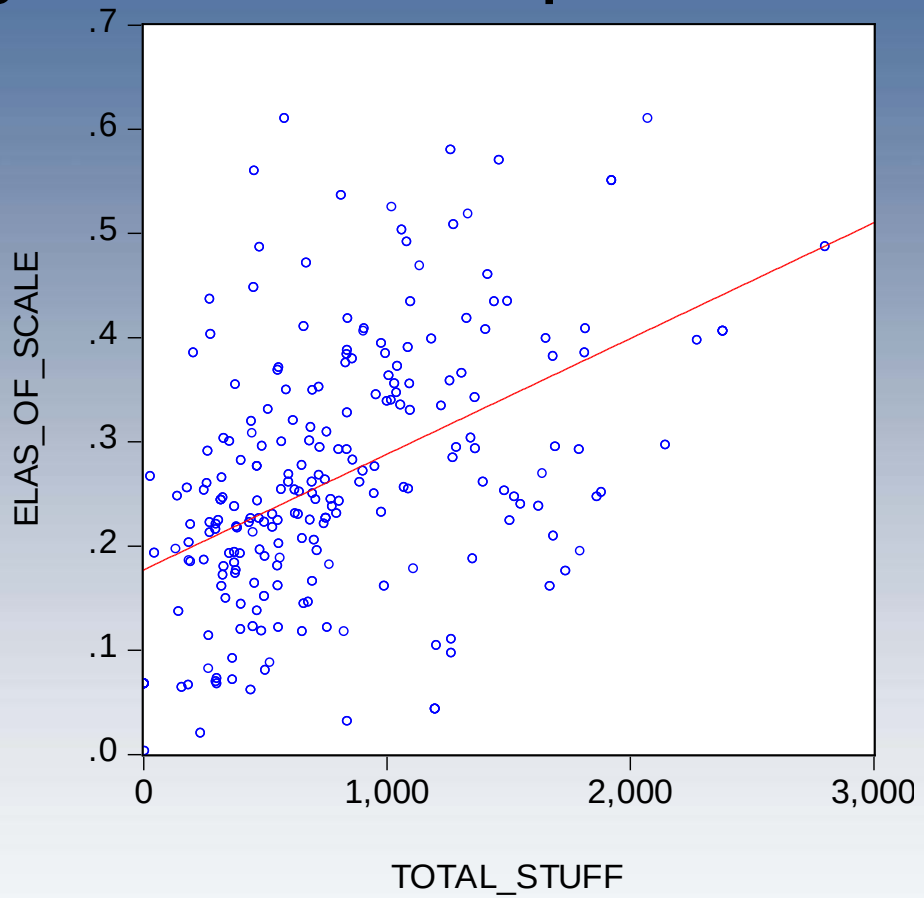
Elasticity of Scale – Part-Timers



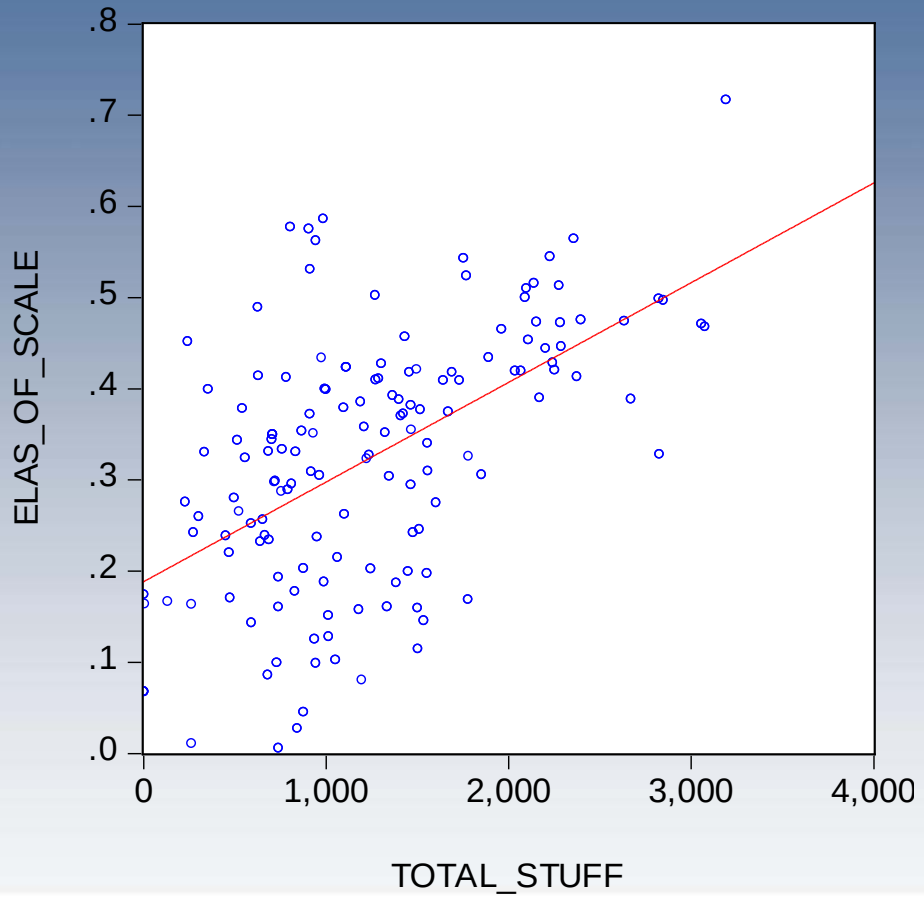
Elasticity vs. Total Output - Overall



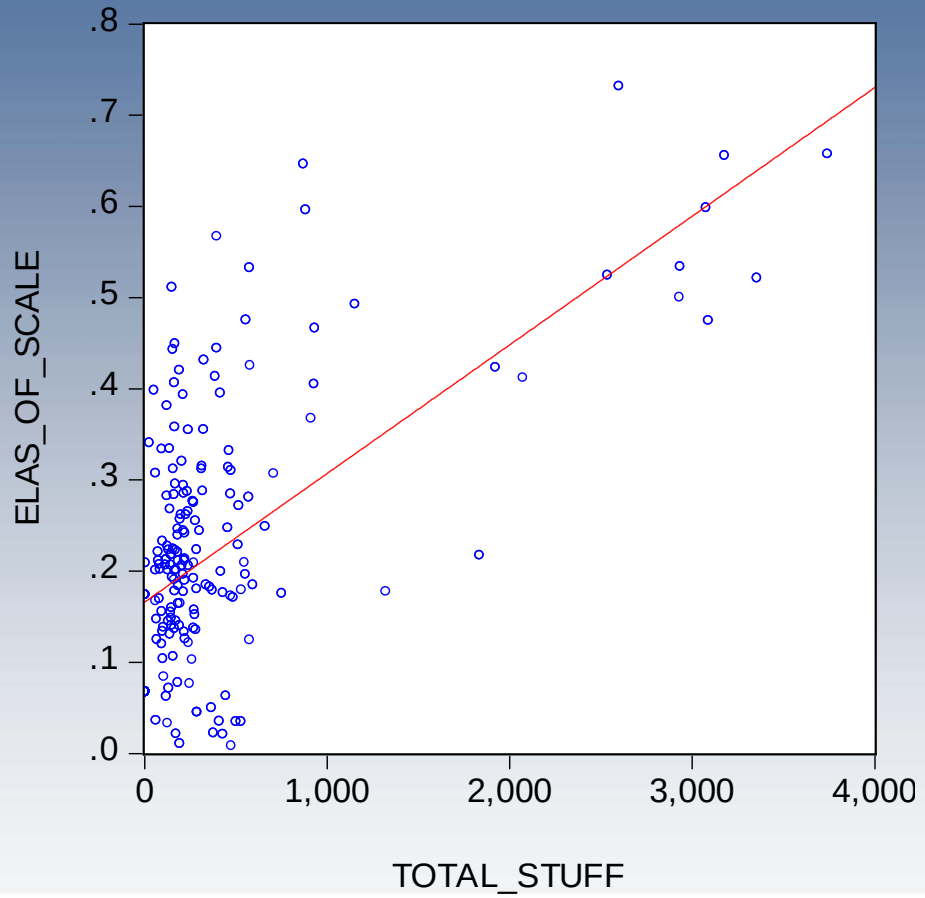
Elasticity vs. Total Output - Municipalities



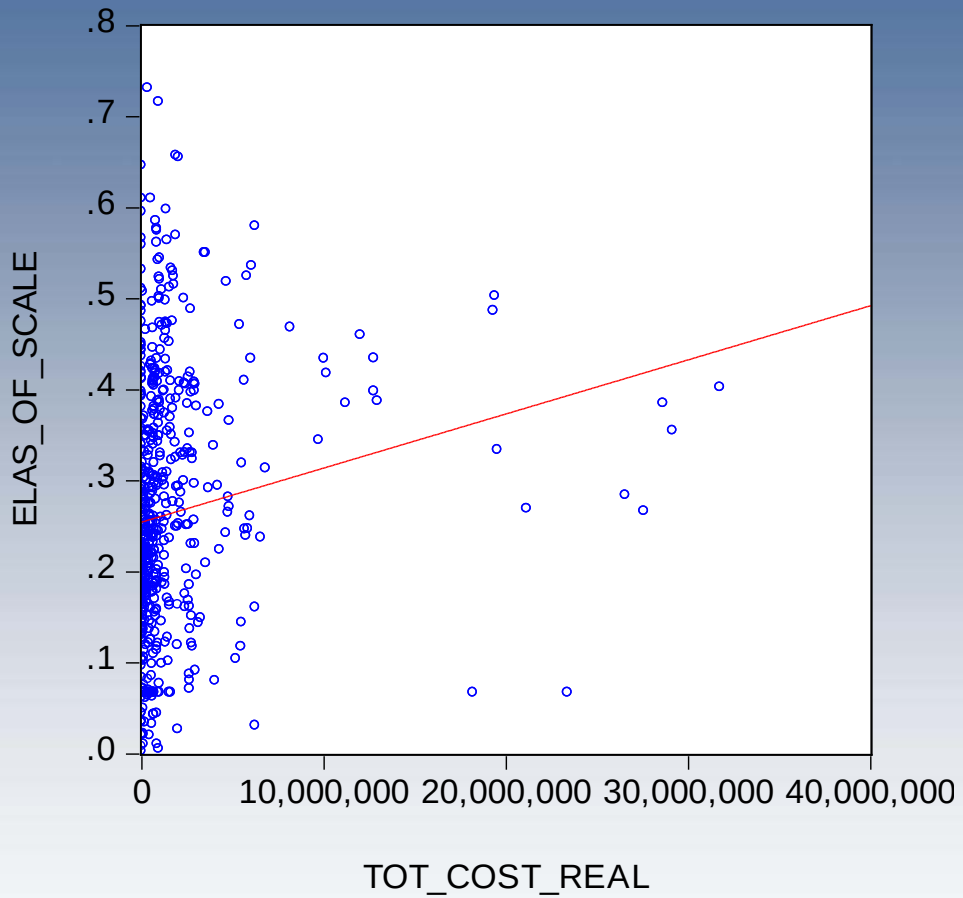
Elasticity vs. Total Output - Districts



Elasticity vs. Total Output – Part-Timers



Elasticity vs. Total Costs – Overall



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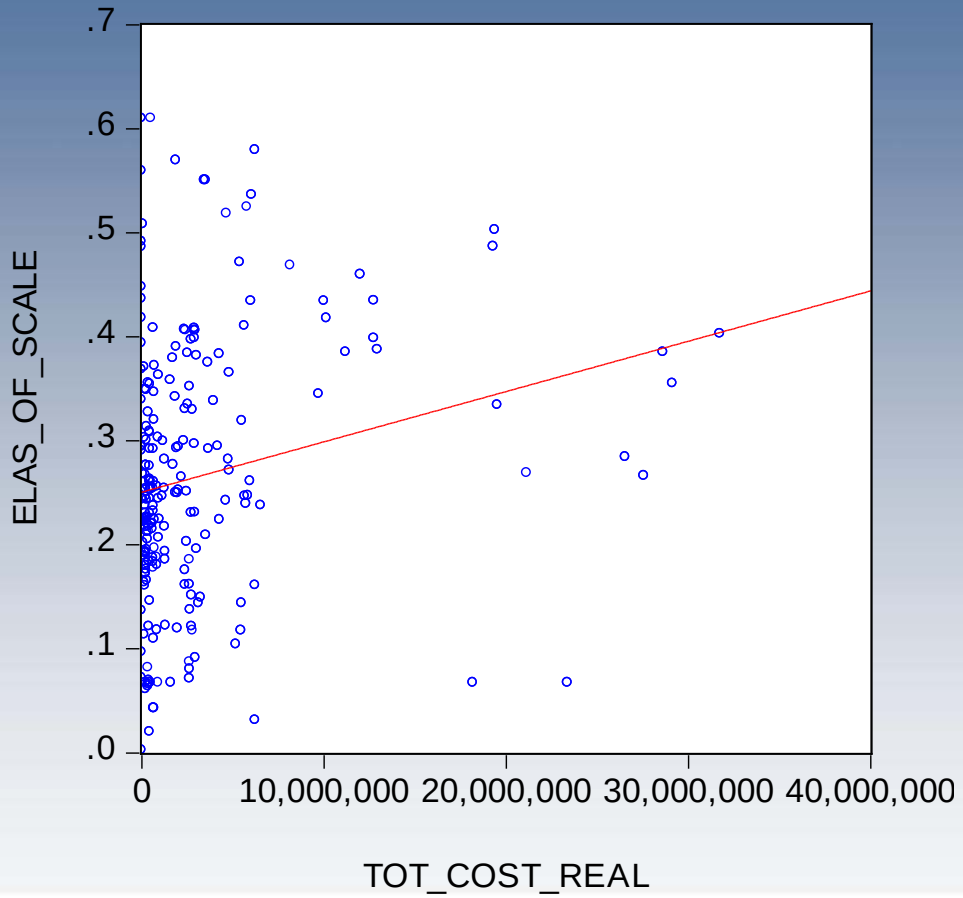
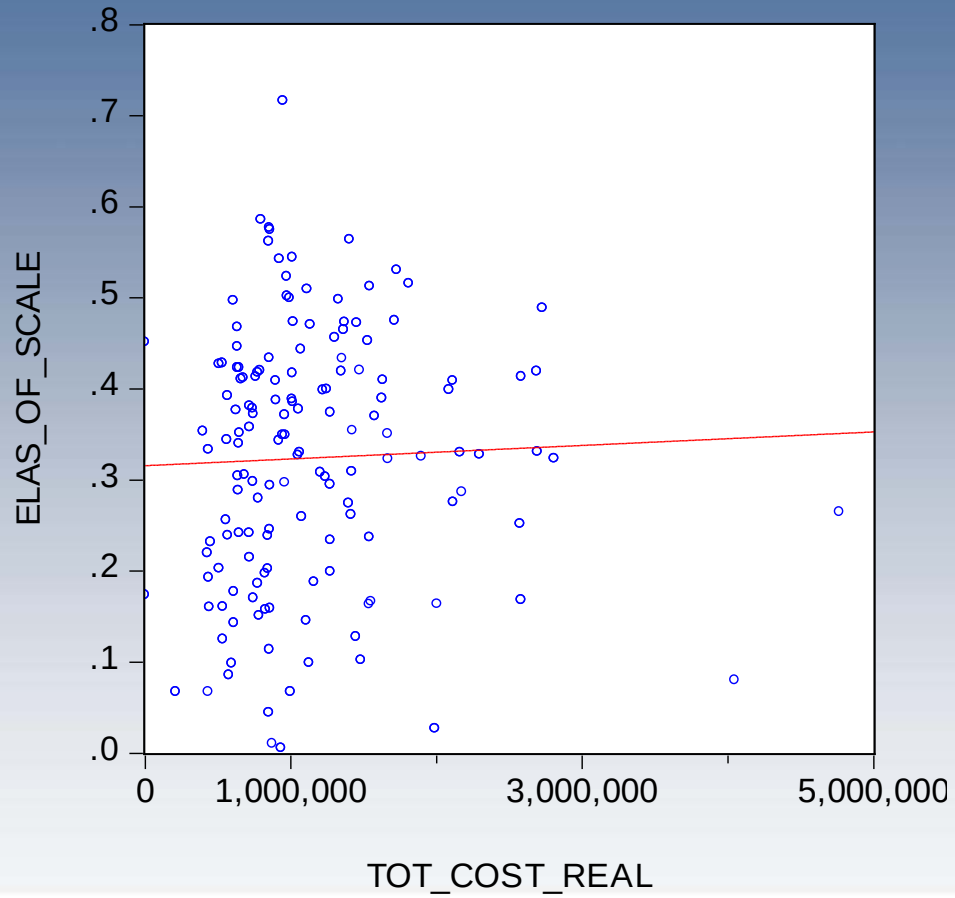
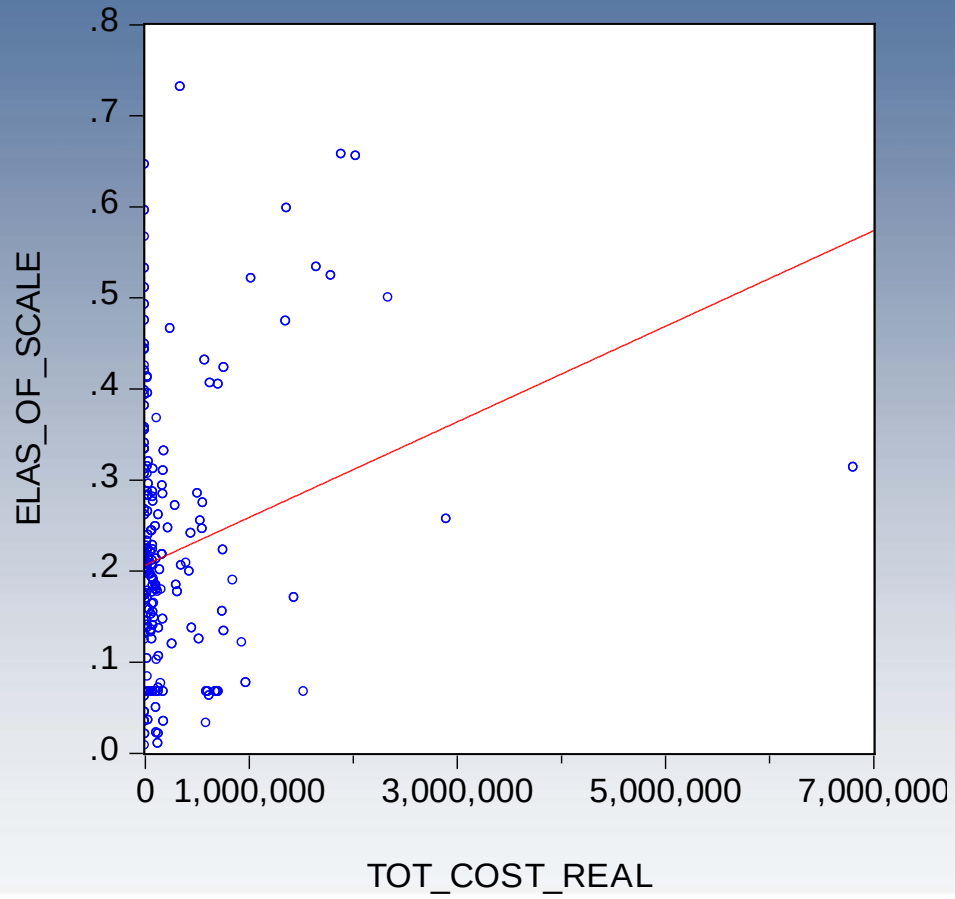


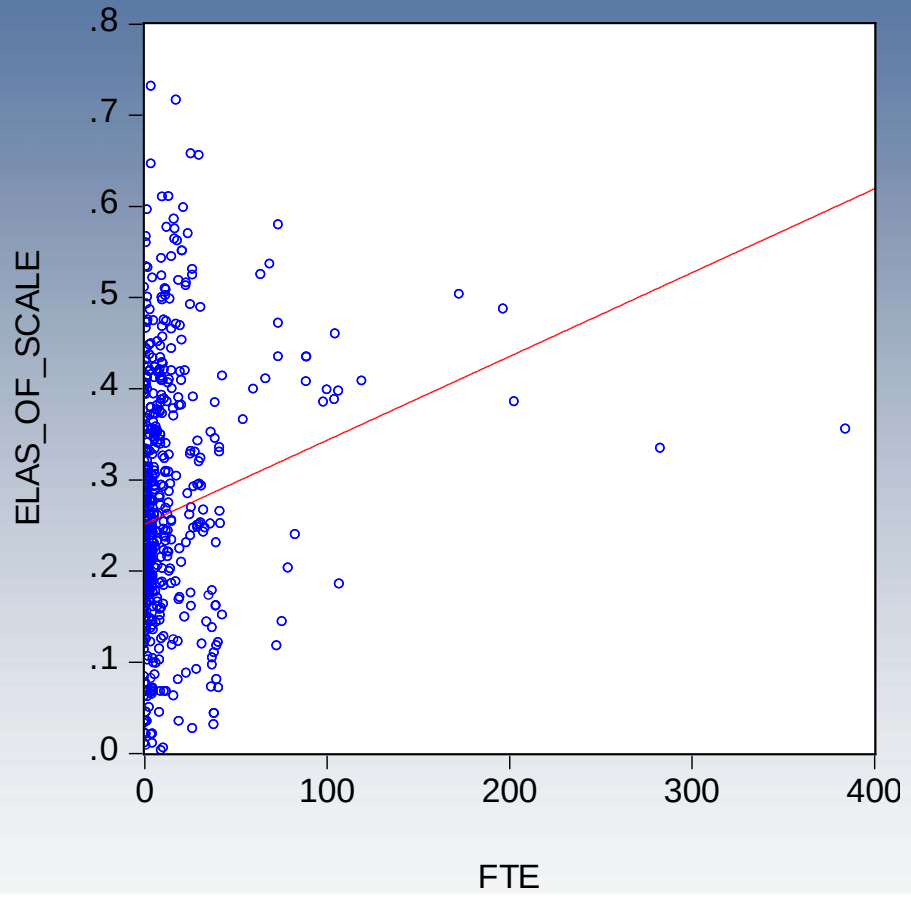
Elasticity vs. Total Costs – Districts



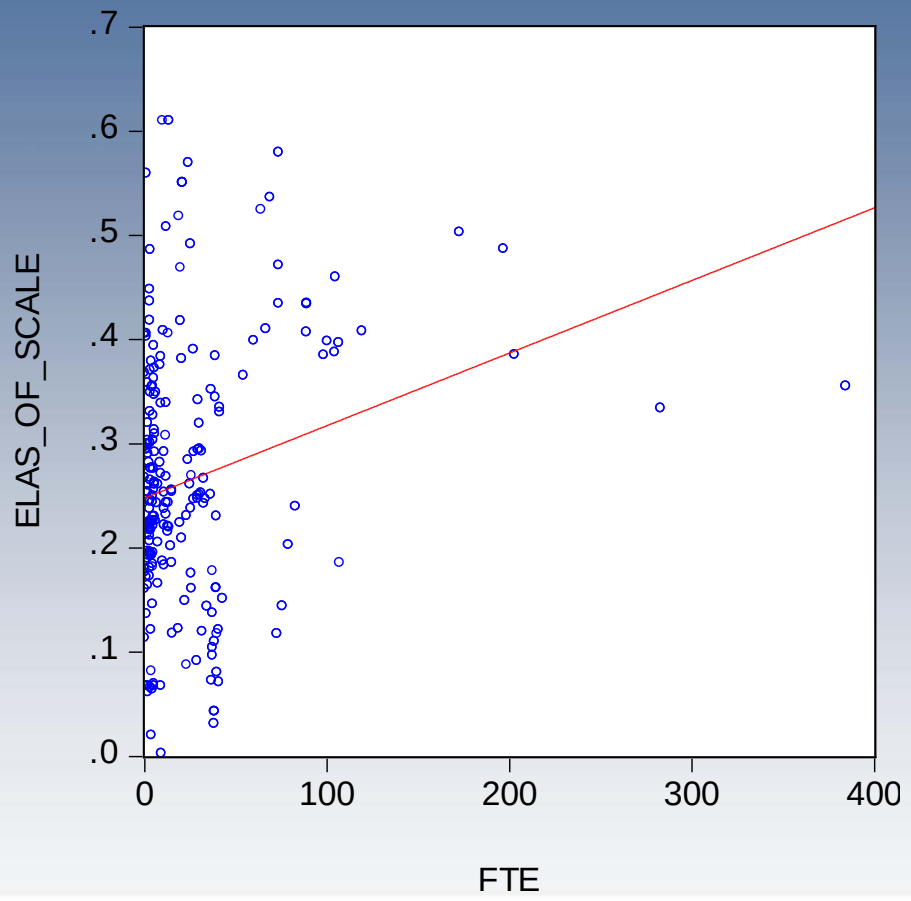
Elasticity vs. Total Costs – Part-Timers



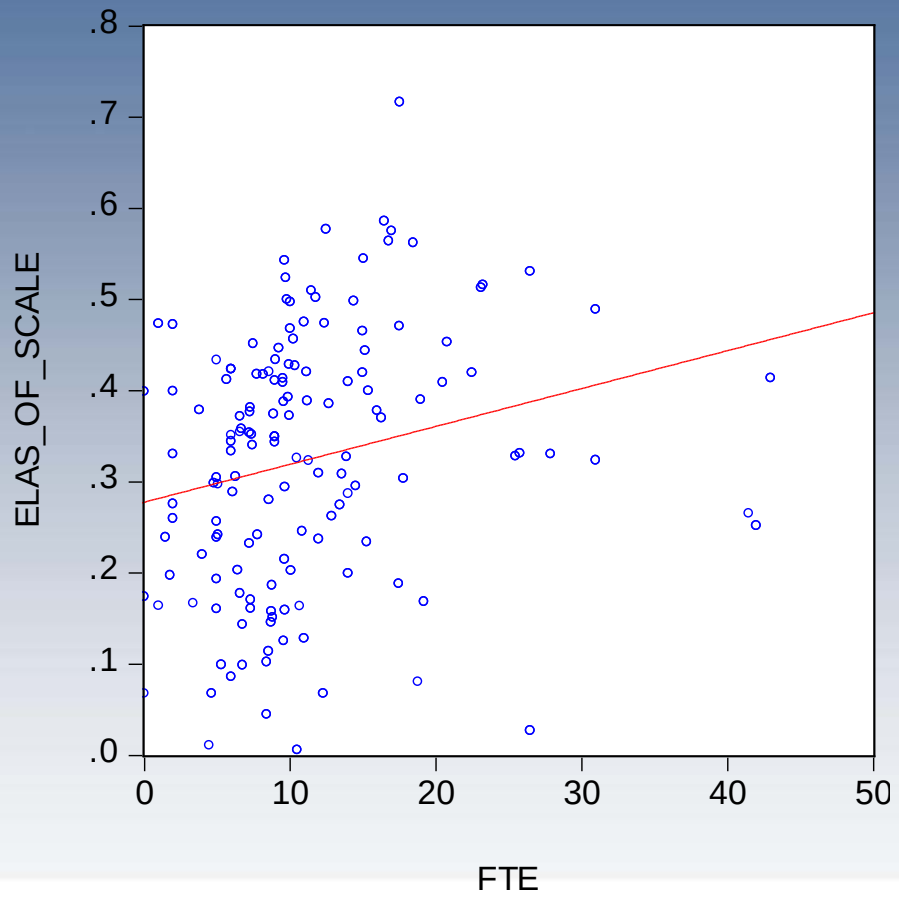
Elasticity vs. FTE – all municipalities



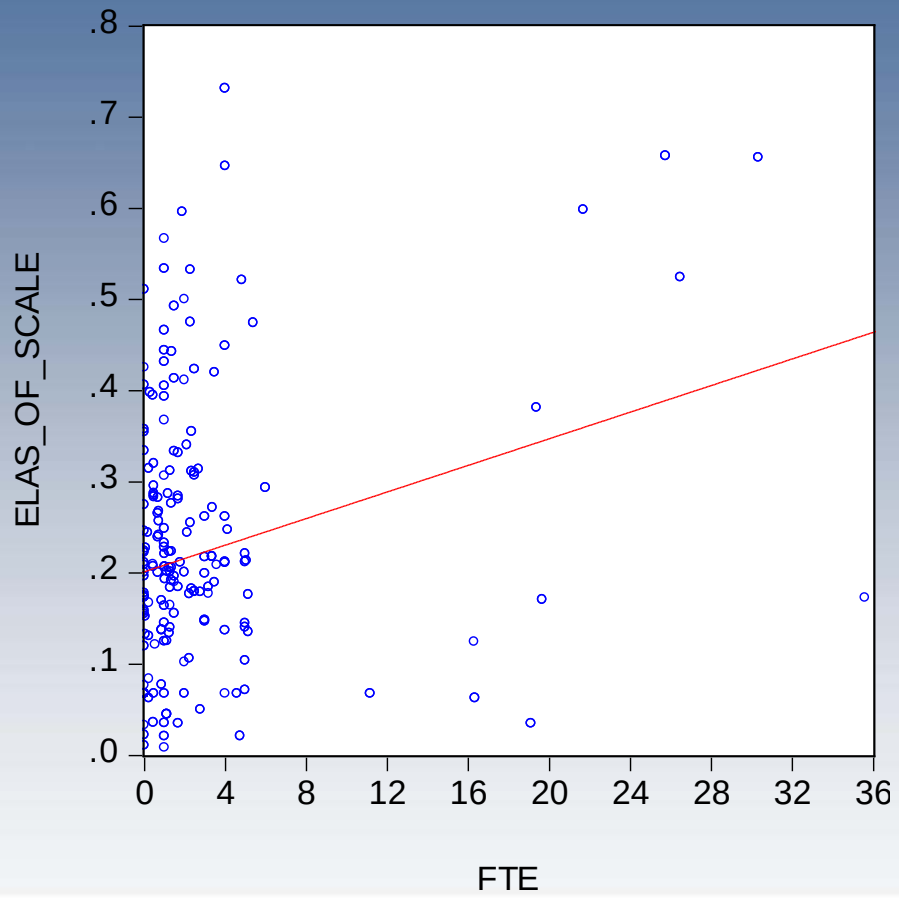
Elasticity vs. FTE – Municipal Health Departments



Elasticity vs. FTE - Districts



Elasticity vs. FTE – Part-Timers



Economies of Scope or Specialization

- By doing more inspections of one type, how does that affect the incremental costs of other types of inspections?
- Can be important to understand when considering merging or sharing services
- If > 0, more of an output increases MC of another output (economies of specialization)
- If < 0, more of an output decreases MC of another output (economies of scope)

Economies of Scope or Specialization

- Water and Septic: <0
- Water and Lead: >0
- Water and Food: >0
- Food and Lead: <0
- Food and Septic: <0
- Lead and Septic: <0

Economies of Scope - Interpretations

- <0 – cost savings for mergers when two jurisdictions focus on different outputs (economies of scope)
- >0 – cost savings for ***not*** merging when two jurisdictions focus on different outputs (economies of specialization)
- e.g., district A does many food inspections, few others; district B does many lead inspections, few others.
- If <0, cost savings from merging or sharing resources
- If >0, cost savings from not merging/sharing

Limitations

- Data !!!
- Economies of scale: depend on small changes in output;
- Economies of scope: assumes hold all other types inspections constant (difficult to compare 3 types of inspections, but pair-wise comparisons more relevant)
- Many municipal health departments and districts offer other services; we only control for environmental health outputs, so output may be understated – perhaps they are further down on AC curve than we have found

Summary of policy implications

- Drawbacks from merging or sharing resources:
  - Elasticity of scale assumes small changes
  - Some jurisdictions may be experiencing economies of specialization for some outputs
- Benefits to merging or sharing resources:
  - Economies of scale to be gained for merging small jurisdictions (such as part-timers)
  - Some jurisdictions may benefit from economies of scope for some outputs

Conclusions and Future Research

- Supplemental survey to annual reports
- Hope to obtain information for calculating unit costs
- Focus groups – for component 2
- Key informant interviews – for component 2