Load-based licensing: Getting the rates right

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Overview

- Background: Load-based licensing in NSW
- Related literature
- Theoretical model
- Data and Method
- Results
- Conclusions
- Recommendations

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Load-based licensing - Background

- Similar to Pigouvian Pollution Fees
- Introduced in 1999 by Protection of the Environment Operations (General) Regulation 1998 covering all sorts of water and air pollutants
- Regulation includes differentiation by pollutant (11 air pollutants and 17 water pollutants), location (3 different zones), pollution levels (threshold values) based on sector (94 sectors)
- **Gradually increase of pollutant fee unit value from 2000 to 2003 from $0, $24, $29, $35**
- Focus Nitrous OxNOX: Recently increase in pollutant weighting from 6 to 9 (no data available)

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Related Literature

- Pigouvian Tax
  - Empirical survey on air pollution taxation by Cansier, D. and R. Krumm in 1997
  - Effectiveness of French Air Pollution Taxation: Millock, K. E. and C. Nauges. In 2003
- NOx emissions
  - Swedish NOX tax: Högelund-Isaksson, L. in 2005
  - NOX RECLAIM Emissions trading system:
    Foster, V. and R.W. Hahn in 1995
    Fromm, O. and B. Hansjürgens in 1996

Aim of this paper

- Assess the effectiveness of the marginal fee rates implemented in NSW load-based licensing scheme
  - Was the tax effective in reducing NOx emissions so far?
  - Which factors have been significant in reducing the emissions?
    - Increases in fee rate
    - Location
    - Industry based threshold
  - Which factors have been leading to reductions over time in 2000 – 2003?
  - What was the effect of the annual increase over time?
- Derive policy recommendations
  - How can the policy instrument be improved?

Theoretical Model (I)

- Profit maximization with pollution tax

$$\max_{y,e} \Pi = py - c(y,e) - te$$

p= exogenous price, y=output, c=cost function, x=input, e=emissions, t=marginal tax rate

- Payable pollution fee (PF) in NSW corresponds to "te"

$$PF = \begin{cases} etP_w S_w / 10000 \quad if \quad e < FRT \\ (2e - FRT)tP_w S_w / 10000 \quad if \quad e > FRT \end{cases}$$

e=emissions, t= fee rate, P_w=pollutant weighting, S_w=Spatial weighting, FRT_i=fee rate threshold for industry i

With FRT= FRT_i*y

Theoretical Model (II)

- Based on e≤FRT
  Relative emissions per unit of output (E=e/y) will depend on

$$E = \psi(p,\ c,\ t,\ P_w,\ S_w).$$

p= exogenous price, c=cost function, t=marginal tax rate, P_w=pollutant weighting, S_w=Spatial weighting

- Elasticity of emissions with respect to the fee rate

$$\frac{\Delta E}{\Delta t} \frac{t}{E}$$

Data (I)

- after filtering out installations with less than 3 year records: 65 installations remain in sample
- Total number of data points 246
- Location: 40 in zone with S_w=7, 15 with S_w= 2 and 2 with S_w=1
- Sector coverage: 16 industries
- Size: 1/3 installation with emissions ≥ 200,000 kg NOx/a;
  2/3 installations with emissions < 200,000 kg NOx/a
- Fee rate threshold: 9 installations were in 26 observations above the threshold

Data were optained by the Department of Environment and Heritage and Conservation NSW

Data (II)

- Critical zone weighting
  - Zone 7= urban Sydney (Ashfield, Auburn, Bankstown, Baulkham Hills, Blacktown, Blue Mountains, Botany, Burwood, Camden, Campbelltown, Canterbury, Concord, Drummoyne, Fairfield, Hawkesbury, Holroyd, Hornsby, Hunters Hill, Hurstville, Kiama, Kogarah, Ku-ring-gai, Lane Cove, Leichhardt, Liverpool, Manly, Marrickville, Mosman, North Sydney, Parramatta, Penrith, Pittwater, Randwick, Rockdale, Ryde, Shellharbour, South Sydney, Strathfield, Sutherland Shire, Sydney, Warringah, Waverley, Willoughby, Wollongong, Woollahra.)
  - Zone 2 = urban other NSW: Cessnock, Gosford, Lake Macquarie, Maitland, Muswellbrook, Newcastle, Port Stephens, Singleton, Wollondilly, Wyong.
  - Zone 1 = for all other areas in NSW

Data (III)

Aggregate emissions of NOx over sample and average load-based fee paid

	Year (Load fee)			
	2000 ($0)	2001 ($24)	2002 ($29)	2003 ($35)
Emissions				
tons of NO_x	159,980	178,901	172,522	151,353
index (2000 =100)	100	111.82	107.83	94.60
Output				
million units	16,400	23,496	21,466	21,165
index (2000 =100)	100	143.27	130.89	129.06
Emissions / Output (t NO_x/million units of output)	9.75	7.61	8.04	7.15
Total NOx load-based fee paid across all installations in a year ($mill)	0	59.2	63.9	70.1
Average load-based fee paid across all installations in a year ($/t NOx)	0	33.07	37.06	46.31

Methods

- Three econometric models estimated using ML.
  - 1. model to assess the direction of relationship: simple pooled estimator, ignoring panel data structure
  - 2. model to assess the influence of different variables: natural logarithm including all variables and heteroscedastic covariance structure (presence of group wise heteroscedasticity)
  - 3. model to estimate the change in NOx emissions over time: first difference of NOX emissions per unit of output including all variables and heteroscedastic covariance structure (test for autocorrelation conducted but no autocorrelation was found).

Results

- 1. model: poor data fit, weak negative relationship (-0.0011) for coefficient on the fee rate, but insignificant.
- 2. model: Better data fit. All variables apart from fee rate significant (such as FRT and zoning (spatial index)).
- 3. model: poor data fit; only electricity industry has increased emissions over time (significant positive correlation)

Conclusions

- Some reduction in NOx emissions took place during 2000-2003
- No clear relationship to introduction of load-based licensing scheme
- Increasing fees did not show significant influence on NOx emissions (both level and change of emissions)
- Other elements like location, threshold had explanatory significance in the level of output but not the change of emissions over time
- Overall: level of fee was not set “correctly” to reduce emissions, higher fees necessary (e.g. Sweden has 200 times higher rates)

Recommendations

- Increase fees substantially and think about recycling of fees to increase support
  - increase in pollutant weighting from 6 to 9 was first step in right direction
- Introduce continuous-time monitoring equipment since this reveals cheap reduction options due to process optimisation
- Explore option of emissions trading similar to RECLAIM model in California

Table 2. Results from estimation of an econometric model of a natural logarithm of NOx emissions per unit of output from installations in NSW (2000-2003)

Explanatory variables	Levels of class variables	Estimate	Standard Error	DF	t Value	Pr > |t|
Intercept		1.4289	0.8137	224	1.76	0.0805
Rate		-0.00374	0.00472	224	-0.79	0.4285
FRT	0	-1.0159	0.2431	224	-4.18	<.0001
FRT	1	0	.	.	.	.
CZ	1	0.9346	0.3027	224	3.09	0.0023
CZ	2	0.9138	0.2835	224	3.22	0.0015
CZ	7	0	.	.	.	.
IndID	10	-0.4273	0.8229	224	-0.52	0.6041
IndID	12	0.6818	0.7894	224	0.86	0.3886
IndID	13	-2.264	0.7794	224	-2.9	0.004
IndID	14	-1.1822	0.8987	224	-1.32	0.1897
IndID	17	-4.0589	0.8246	224	-4.92	<.0001
IndID	21	-0.7106	0.8129	224	-0.87	0.3829
IndID	27	-3.371	0.9216	224	-3.66	0.0003
IndID	34	6.2847	0.8104	224	7.75	<.0001
IndID	55	0.2843	0.833	224	0.34	0.7332
IndID	56	-2.934	0.8294	224	-3.54	0.0005
IndID	57	-3.361	0.9418	224	-3.57	0.0004
IndID	58	-1.3968	0.9191	224	-1.52	0.13
IndID	60	-2.5527	0.8925	224	-2.86	0.0046
IndID	66	-3.5772	0.9047	224	-3.95	0.0001
IndID	67	-0.3079	0.8466	224	-0.36	0.7165
IndID	68	-2.1878	0.7776	224	-2.81	0.0053
IndID	74	0	.	.	.	.

Covariance parameter estimates

Residual size 0	1.7147
Residual size 1	0.3670

L.R. test for heteroscedasticity 15.47 at 1 d.f.