DETERMINANTS OF COMPLIANCE IN THE EMISSIONS COMPENSATION PROGRAM IN SANTIAGO, CHILE

Milagros Palacios
Programa Magíster en Economía de Recursos Naturales y del Medio Ambiente, Universidad de Concepción.

Carlos Chávez
Departamento de Economía, Universidad de Concepción.

(*Environment and Development Economics* Vol. 10 (4), 2005)

♦Objectives:

- To study the enforcement design and compliance results in the Emissions Compensation Program (ECP) Santiago.

- To identify the determinants factors of compliance decision with emissions capacity permits for sources participating in the ECP in the period 1993-1999.

- To quantify the impacts of these factors on the sources' compliance decision.

Program Design and Compliance Results

Basics Aspects of the ECP

- ***Purpose:*** to control and reduce daily emissions of TSP coming from fixed industrial sources of a certain size located in metropolitan Santiago, Chile. ECP started in 1993.

- ***How the ECP works?***

- ECP allocated maximum daily emissions capacity permits called "initial daily emissions" (IDE) to industrial furnaces, heat boilers, and vapor generators whose flow volume was greater than or equal to 1000 m^3/hr.

- Each unit of IDE allows the release of one kilogram of TSP daily, and has no expiration date.

- New sources as well as expansion of the existing ones, must cover their emissions by compensating (offset) with existing sources.

♦*Violations:*

The possible violations considered in the EC Program framework includes:

(i) Existing and new sources exceed the maximum concentration limit of 112 mg/m^3;

(ii) The daily declared emissions (DDE) of existing sources exceed the IDE; and

(iii) New sources do not obtain the necessary permits to cover their emissions as established by Air Quality Office-SESMA

- In this study, we only considered violations (ii) and (iii).

Enforcement Design in the ECP

♦***Monitoring and Self-reporting***

- The existing and new sources participating in the ECP report annually their DDE to Air Quality-SESMA .

- Independent laboratories measure emissions and provide the supporting information for reports.

- Monitoring activity from regulator includes: review on emissions reports, on-site inspections, check calibration of equipment.

♦***Sanctions***

- A source detected in violation face an administrative procedure called “sanitary summary”.

- Monetary sanctions (USD $ 5 to USD $ 90,000)

- Prohibition of operation.

EMISSIONS CAPACITY PERMITS VIOLATIONS IN THE ECP OF SANTIAGO:1993 –1999

		1993	1995	1996	1997	1998	1999
SOURCES	**TOTAL**	**680**	**690**	**631**	**576**	**566**	**573**
VIOLACIÓN DERECHOS CAPACIDAD DE EMISION[a]							
PERMISOS (kg/dia)-EDI		4,604.10	4,604.10	4,604.10	4,087.50	4,087.50	4,087.50
EMISIONES AGREGADAS (kg/dia)-EDD		7,442.50	6,500.20	5,195.10	3,535.00	1,953.60	1,636.60
VIOLACIÓN AGREGADA (Kg/día)		2,838.50	1,896.16	591	0	0	0
VIOLACIÓN MÁXIMA (Kg/día)		93.8	83.5	68	65	28.3	25.6
VIOLACIÓN MÍNIMA (Kg/día)		0.03	0.03	0.03	0.03	0.05	0.05
TAMAÑO PROMEDIO VIOLACIÓN		8.1	7.7	6.5	4.8	3.5	3.2
N° DE FUENTES NO CUMPLIMIENTO		**344**	**294**	**224**	**144**	**46**	**36**
% FUENTES EN NO CUMPLIMIENTO		**50.6**	**42.6**	**35.5**	**25**	**8.1**	**6.3**
USUARIOS DE GAS NATURAL		**0**	**0**	**0**	**1**	**144**	**179**

Fuente: Elaboración propia a partir de información proporcionada por el SESMA (2002)

[a] La emisión declarada diaria (EDD) de las fuentes existentes consideradas en el programa supere los derechos de capacidad máxima de emisión (EDI) asignados.

Econometric Model

Marginal Abatement Cost (MAC)

$$MAC_i = MAC\ (e_i,\ te_i,\ ea_i,\ a_i,\ c_i,\ q_i,\ z_i)$$

Expected Marginal Sanction (EMS)

$$EMS_i = EMS\ (e_i,\ u_i,\ z_i,\ k_i,\ s_i)$$

Estimated Equation – Probit Model:

$COMPL_i = COMPL($FURNACE, GENVAPOR, NEW, FOOD_BEV, TEXTIL, CHEM, SERVICE, EQ_ABAT, FUEL1, FUEL2, FUEL3, NAT_GAS, POP_DEN, IDE, PROD_CAP, FAC_SIZE$)$

Where:

COMPL = 1, if EDD ≤ EDI
CUMPL = 0, otherwise

Results.

TABLE 4. PARAMETER ESTIMATES OF THE COMPLIANCE DECISION, 1993-1999.

Variable	Coefficient	Standard Deviation
Constant	-0.13635	0.17307
FURNACE	-0.40308 *	0.09728
GENVAPOR	-0.39043 *	0.08533
NEW	0.29100 *	0.12614
EQ_ABAT	-0.09069	0.09714
FUEL1	0.26562 **	0.14179
FUEL2	0.46712 *	0.16159
FUEL3	0.67791 *	0.12508
NAT_GAS	1.97622 *	0.20954
FOOD_BEV	0.24740 *	0.08930
TEXTIL	0.41053 *	0.09472
CHEM	0.20644 **	0.11196
SERVIC	0.00216	0.10456
IDE	0.00469 *	0.00169
FAC_SIZE	-0.05050 *	0.01521
POP_DEN	-0.00002 *	0.00001
AVE_INC	0.0002 *	0.0001
Maximum likelihood function, unrestricted	-1,566.04	
Maximum likelihood function, restricted	-1,713.30	
Maximum likelihood statistic	294.52	
Pseudo-R^2	0.09	
Chi-squared (χ^2)	28.85	
No. observations	2,550	

*Significant at 5%, two-tailed test

**Significant at 10%, two-tailed test

Source: Elaborated by the authors based on econometric results (2002)

TABLE 5. PARAMETER ESTIMATES OF THE COMPLIANCE DECISION: PERIODS 1993-1997 AND 1998-1999

Variable	1993-1997 Coefficient		1993-1997 Standard Deviation	1998-1999 Coefficient		1998-1999 Standard Deviation
Constant	-0.12052363		0.1955739	0.7226222	*	0.3723540
FURNACE	-0.57915339	*	0.1118795	0.1504546	*	0.2328228
GENVAPOR	-0.60020454	*	0.0991176	0.3330565	*	0.1959621
NEW	0.31933577	*	0.1405344	0.5951116		0.4652496
EQ_ABAT	-0.01923157		0.1048433	-0.2733424		0.3032782
FUEL1	0.21966891		0.1540420	-0.2810594		0.3381618
FUEL2	0.25874847		0.1772724			0.2361856
FUEL3	0.51815876	*	0.1373219	0.2632664		
NAT_GAS				0.9677100	*	0.3537551
FOOD_BEV	0.26113360	*	0.1010027	0.7675435	*	0.2469013
TEXTIL	0.43430841	*	0.1068278	0.9825998	*	0.2773685
CHEM	0.30458683	*	0.1260770	0.4222940		0.2907377
SERVIC	-0.03408943		0.1212500	0.1259633		0.2474381
IDE	0.00545929	*	0.0021120	0.1847517		0.0226897
FAC_SIZE	-0.02605027		0.0163058	-0.1324417	*	0.0541898
POP_DEN	-0.00001267	**	0.0000083	-0.2875459		0.0004206
AVE_INC	0.00013829	**	0.0000848	0.1163025		0.0000062
Maximum likelihood function, unrestricted	-1,236.21			-205.13		
Maximum likelihood function, restricted	-1,292.71			-240.79		
Maximum likelihood statistic	113.00			71.32		
Pseudo-R^2	0.04			0.15		
Chi –squared	27.49			27.49		
No. observations	1,865			685		

* Significance at 5%, two-tailed test

** Significance al 10%, two-tailed test

Source: Elaborated by the authors based on econometric results (2002)

[a] For the period 1993-1997, we did not consider the variable NAT_GAS, because this variable did not display variation in the sources during these years (no source used natural gas until late 1997). For similar reasons, we did not consider the variable FUEL2 for the period of 1998-1999.

TABLE 6. MARGINAL EFFECTS OF CHANGES IN INDEPENDENT VARIABLES ON THE COMPLIANCE PROBABILITY [a]

	1993-1997	1998-1999	Entire Period 1993-1999
FURNACE	-0.2310	0.2157	-0.1529
GENVAPOR	-0.2394	0.4775	-0.1481
NEW	0.1274	----------	0.1104
EQ_ABAT	----------	----------	----------
FUEL1	----------	----------	0.1008
FUEL2	----------	----------	0.1772
FUEL3	0.2067	----------	0.2572
NAT_GAS	----------	0.1387	0.7497
FOOD_BEV	0.1042	0.1100	0.9386
TEXTIL	0.1733	0.1409	0.1557
CHEM	0.1215	----------	0.7832
SERVIC	----------	----------	----------
IDE	0.0022	----------	0.1781
FAC_SIZE	----------	-0.1899	-0.1916
POP_DEN	0.0000	----------	-0.6627
AVE_INC	0.0001	----------	0.6405

Source: Elaborated by the authors based on econometric results (2002)
[a] Considers only variables significant at 10%.

TABLE 7. PROBABILITIES OF BEING IN COMPLIANCE WITH EMISSIONS CAPACITY PERMITS, 1993-1997 AND 1998-1999

	ANALYSIS OF COMPLIANCE PROBABILITY VARYING:						
Variable Modified	Type of Source			Industrial Sector			Source Age
	Industrial Furnace Fuel with sulfur between 0.3% and 1%	Heater Furnace Fuel with sulfur between 0.3% and 1%	Vapor Generator Fuel with sulfur between 0.3% and 1%	Industrial Furnace Fuel with sulfur between 0.3% and 1%	Industrial Furnace Fuel with sulfur between 0.3% and 1%	Industrial Furnace Fuel with sulfur between 0.3% and 1%	Industrial Furnace Fuel with sulfur between 0.3% and 1%
Industrial Sector	Food and Beverage	Food and Beverage	Food and Beverage	Textile	Chemical	Others	Food and Beverage
Source Age	After March 1992	After March 1992	After March 1992	After March 1992	After March 1992	After March 1992	Before March 1992
Probability Period 1993-1997	**0.71**	**0.71**	**0.87**	**0.77**	**0.73**	**0.62**	**0.60**
Probability Period 1998-1999	**0.91**	**0.93**	**0.88**	**0.94**	**0.71**	**0.71**	**0.91**

Source: Elaborated by the authors based on econometric results (2002)