

Appendix A to

Tradable Permits and Unrealized Gains from Trade

(Not for publication)

Results: 1 Bad Output with Constant Returns to Scale (CRS)

Table 2

Command-and-Control

Year	Electricity production in base-case (billion kWh)	SO ₂ emissions in base-case (1000 tons)	Electricity production with Command-and- Control (billion kWh)	Percent increase in electricity with no inefficiency
1995	480.2	3,303.5	508.1	5.80
1996	510.4	3,624.5	537.9	5.39
1997	526.5	3,731.4	558.2	6.03
1998	524.6	3,553.2	555.7	5.94
1999	528.3	3,371.5	556.3	5.31
2000	550.5	3,231.9	581.7	5.67
2001	522.2	2,924.0	550.2	5.35
2002	530.9	2,793.4	557.9	5.09
2003	535.4	2,914.3	570.6	6.58
2004	540.1	2,804.3	572.6	6.01
2005	556.7	2,856.9	590.1	6.01
Mean				5.75

Table 3

Tradable Permits (spatial trading)

Year	Electricity production in base-case (billion kWh)	SO ₂ emissions in base-case (1000 tons)	Electricity production with Tradable Permits (billion kWh)	SO ₂ emissions with Tradable Permits (1000 tons)	Percent increase in electricity with no inefficiency
1995	480.2	3,303.5	525.0	3,303.5	9.32
1996	510.4	3,624.5	553.8	3,624.5	8.50
1997	526.5	3,731.4	575.3	3,309.7	9.27
1998	524.6	3,553.2	570.7	2,279.0	8.79
1999	528.3	3,371.5	574.1	3,371.5	8.67
2000	550.5	3,231.9	598.9	3,231.9	8.78

2001	522.2	2,924.0	567.2	2,924.0	8.62
2002	530.9	2,793.4	574.5	2,793.4	8.20
2003	535.4	2,914.3	593.3	2,914.3	10.81
2004	540.1	2,804.3	589.1	2,804.3	9.08
2005	556.7	2,856.9	605.5	2,856.9	8.78
Mean					8.98

Table 4

Tradable Permits (spatial and temporal trading)

Year	Electricity production in base-case (billion kWh)	SO ₂ emissions in base-case (1000 tons)	Electricity production with Tradable Permits (billion kWh)	SO ₂ emissions with Tradable Permits (1000 tons)	Percent increase in electricity with no inefficiency
1995	480.2	3,303.5	524.2	3,033.0	9.16
1996	510.4	3,624.5	555.8	3,887.6	8.91
1997	526.5	3,731.4	575.2	3,137.8	9.26
1998	524.6	3,553.2	570.7	2,279.0	8.79
1999	528.3	3,371.5	574.0	3,258.0	8.66
2000	550.5	3,231.9	599.4	3,329.6	8.87
2001	522.2	2,924.0	571.1	3,343.7	9.37
2002	530.9	2,793.4	577.5	3,020.5	8.77
2003	535.4	2,914.3	595.8	3,073.5	11.29
2004	540.1	2,804.3	593.5	3,145.0	9.88
2005	556.7	2,856.9	615.4	3,601.4	10.55
Mean					9.42

Results: 1 Bad Output with Non-Increasing Returns to Scale (NIRS)

Table 2

Command-and-Control

Year	Electricity production in base-case (billion kWh)	SO ₂ emissions in base-case (1000 tons)	Electricity production with Command-and-Control (billion kWh)	Percent increase in electricity with no inefficiency
1995	480.2	3,303.5	505.7	5.30
1996	510.4	3,624.5	534.3	4.68

1997	526.5	3,731.4	555.0	5.43
1998	524.6	3,553.2	550.0	4.85
1999	528.3	3,371.5	551.5	4.39
2000	550.5	3,231.9	579.5	5.26
2001	522.2	2,924.0	549.2	5.18
2002	530.9	2,793.4	554.8	4.50
2003	535.4	2,914.3	564.2	5.37
2004	540.1	2,804.3	569.8	5.50
2005	556.7	2,856.9	583.3	4.78
Mean				5.02

Table 3

Tradable Permits (spatial trading) – NIRS

Year	Electricity production in base-case (billion kWh)	SO ₂ emissions in base-case (1000 tons)	Electricity production with Tradable Permits (billion kWh)	SO ₂ emissions with Tradable Permits (1000 tons)	Percent increase in electricity with no inefficiency
1995	480.2	3,303.5	519.6	3,303.5	8.20
1996	510.4	3,624.5	549.1	3,624.5	7.59
1997	526.5	3,731.4	570.3	3,362.6	8.32
1998	524.6	3,553.2	565.3	2,749.7	7.76
1999	528.3	3,371.5	570.6	3,371.5	8.02
2000	550.5	3,231.9	594.1	3,231.9	7.91
2001	522.2	2,924.0	561.8	2,924.0	7.59
2002	530.9	2,793.4	569.7	2,793.4	7.31
2003	535.4	2,914.3	584.6	2,914.3	9.18
2004	540.1	2,804.3	585.0	2,804.3	8.31
2005	556.7	2,856.9	597.3	2,856.9	7.30
Mean					7.95

Table 4

Tradable Permits (spatial and temporal trading)

Year	Electricity production in base-case (billion kWh)	SO ₂ emissions in base-case (1000 tons)	Electricity production with Tradable Permits (billion kWh)	SO ₂ emissions with Tradable Permits (1000 tons)	Percent increase in electricity with no inefficiency
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1995	480.2	3,303.5	518.0	2,881.8	7.87
1996	510.4	3,624.5	551.2	3,885.7	7.99
1997	526.5	3,731.4	569.3	3,083.2	8.14
1998	524.6	3,553.2	565.3	2,749.7	7.76
1999	528.3	3,371.5	570.6	3,285.7	8.01
2000	550.5	3,231.9	593.6	3,131.7	7.82
2001	522.2	2,924.0	563.8	3,100.6	7.97
2002	530.9	2,793.4	573.8	3,107.5	8.08
2003	535.4	2,914.3	587.5	3,248.6	9.73
2004	540.1	2,804.3	587.2	3,223.1	8.72
2005	556.7	2,856.9	602.5	3,411.4	8.23
Mean					8.22

Results: 3 Bad Outputs with Non-Increasing Returns to Scale (NIRS)

Table 2

Command-and-Control

Year	Electricity production in base-case (billion kWh)	SO ₂ emissions in base-case (1000 tons)	Electricity production with Command-and-Control (billion kWh)	Percent increase in electricity with no inefficiency
1995	480.2	3,303.5	492.2	2.48
1996	510.4	3,624.5	523.0	2.47
1997	526.5	3,731.4	538.2	2.22
1998	524.6	3,553.2	537.1	2.39
1999	528.3	3,371.5	540.8	2.37
2000	550.5	3,231.9	558.9	1.52
2001	522.2	2,924.0	532.1	1.90
2002	530.9	2,793.4	541.2	1.94
2003	535.4	2,914.3	546.6	2.08
2004	540.1	2,804.3	550.9	2.01
2005	556.7	2,856.9	569.1	2.23
Mean				2.14

Table 3

Tradable Permits (spatial trading) – NIRS

Year	Electricity production in base-case (billion kWh)	SO ₂ emissions in base-case (1000 tons)	Electricity production with Tradable Permits (billion kWh)	SO ₂ emissions with Tradable Permits (1000 tons)	Percent increase in electricity with no inefficiency
1995	480.2	3,303.5	499.4	3,303.5	3.98
1996	510.4	3,624.5	531.2	3,599.1	4.08
1997	526.5	3,731.4	547.2	3,596.5	3.94
1998	524.6	3,553.2	545.3	3,184.4	3.96
1999	528.3	3,371.5	547.4	3,137.8	3.62
2000	550.5	3,231.9	566.1	2,845.8	2.82
2001	522.2	2,924.0	538.9	2,805.2	3.19
2002	530.9	2,793.4	553.8	2,793.4	4.31
2003	535.4	2,914.3	555.7	2,914.3	3.79
2004	540.1	2,804.3	556.6	2,804.3	3.05
2005	556.7	2,856.9	576.4	2,856.9	3.54
Mean					3.65

Table 4

Tradable Permits (spatial and temporal trading)

Year	Electricity production in base-case (billion kWh)	SO ₂ emissions in base-case (1000 tons)	Electricity production with Tradable Permits (billion kWh)	SO ₂ emissions with Tradable Permits (1000 tons)	Percent increase in electricity with no inefficiency
1995	480.2	3,303.5	499.4	3,325.3	3.98
1996	510.4	3,624.5	531.2	3,599.1	4.08
1997	526.5	3,731.4	547.2	3,596.5	3.94
1998	524.6	3,553.2	545.3	3,184.4	3.96
1999	528.3	3,371.5	547.4	3,137.8	3.62
2000	550.5	3,231.9	566.1	2,845.8	2.82
2001	522.2	2,924.0	538.9	2,805.2	3.19
2002	530.9	2,793.4	554.2	2,892.8	4.39
2003	535.4	2,914.3	556.1	3,099.7	3.87
2004	540.1	2,804.3	556.7	2,876.3	3.08
2005	556.7	2,856.9	576.6	3,069.4	3.58
Mean					3.67

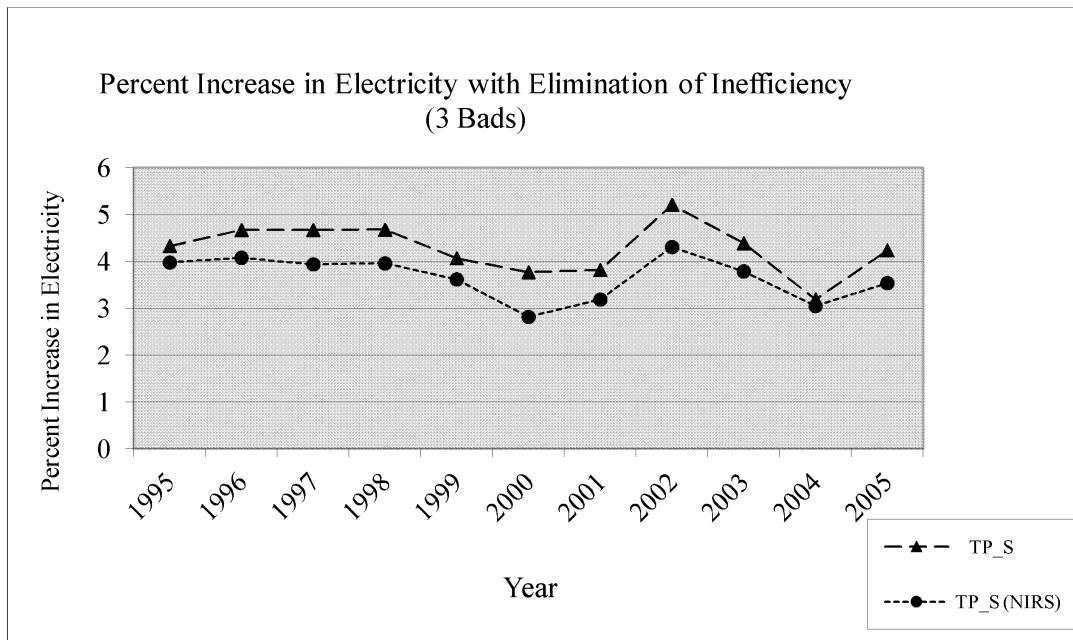


Figure 2

NOTE:

TP_S represents technical inefficiency with constant return to scale (CRS)

TP_S (NIRS) represents technical inefficiency with non-increasing returns to scale (NIRS).