Pattern of Distribution of Global CO2 Emission by Countries

Dinda, Soumyananda

S. R. Fatepuria College, Beldanga, Murshidabad, W.B., India,
Economic Research Unit, Indian Statistical Institute, Kolkata –108,
India

2005

Pattern of Distribution of Global CO$_2$ Emission by Countries

Soumyananda Dinda*

S. R. Fatepuria College, Beldanga, Murshidabad, W.B., India.
Economic Research Unit, Indian Statistical Institute, Kolkata –108, India.
2007

Abstract

This study examines carefully the distribution aspects in details, particularly the pattern of distribution of global CO_2 emission. The paper investigates the share of CO_2 emission for bottom 10 and top 10 percentiles, quartiles and their movements during 1960-1990.

*Address for Correspondence: c/o, Dipankor Coondoo, Economic Research Unit, Indian Statistical Institute, 203, B.T. Road, Kolkata-108, India. Fax: +91-033 –2577 8893, Email: sdinda2000@yahoo.co.in, sdinda@gmail.com, s_dinda@hotmail.com

1. Introduction

A cleaner global environment and the phenomenon of global warming would call for a check on the growth rate of CO_2 emission at the global level. As the global growth rate of CO_2 emission is an aggregate of the corresponding country-specific rates, it follows that any policy formulation for the control of global CO_2 emission must pay attention to the country-specific emission rates and their changes over time. Thus, any meaningful policy discussion for control of global CO_2 emission require a careful examination of the cross-country distribution patterns of global income and corresponding CO_2 emission and their changes over time. To investigate the distribution aspects in details, this paper examines the share of CO_2 emission (following Kakwani (1980)) for bottom 10 and top 10 percentiles, quartiles, other sub-groups and their movements during 1960-1990.

This paper is organized as follow: Section 2 describes data, results are discussed in section 3 and lastly paper concludes.

2. Data Description

For this exercise we have used annual per capita real GDP *(PCGDP)* and annual per capita CO$_2$ *(PCCO2)* emission as measure of income and emission variable, respectively. The basic country-level time series data on population (Pop) and *PCGDP* (expressed in 1985 international prices, i.e., PPP dollars) for the period 1950-1992 were taken from the Penn World Table (Mark 5.6) available at the web site http://www.nber.org/pwt5.6. Country-level annual time series data on *PCCO2* (expressed in metric tons) for the period 1950–1996 were obtained from the Tables of National CO$_2$ Emissions[1] prepared by Carbon Dioxide Information Analysis Center (CDIAC), Oak Ridge National Laboratory (ORNL) of the USA. Combining these data, we could compile a panel data set for 88 countries covering the period 1960–1990 (Coondoo and Dinda 2002).

3. Results

The world is perceived to be a boundaryless unitary place known as *global village*. Conceptually, the world is one economy and each national representative behaves like individuals. The economic actions

---

[1]These estimates do not include bunker fuel used in international transport because of the difficulty of apportioning these fuels among the countries benefiting from such transport activities. See CDIAC for details.

of nation-representative individual are measured in terms of *PCGDP* and corresponding externality in terms of *PCCO2*, which is the main culprit for the global warming. As mentioned earlier, nature of the distribution would be observed in different percentile groups and their movements during 1960-90. For rigorous analysis, we also discuss the trade off between gainers and loosers (Ravallion *et al*. (2000)). The discussion of the major findings follows[2].

The quartile shares of CO_2 emission increase over the period 1960-90. Second and third quartiles rise over time while first quartile (Q1) declines from 9.42 per cent to 4.96 per cent (Table 1, Fig.1). The share of emission of bottom 25 and its components (i.e., bottom 10 (P_{0-10}) and upper bottom 15 (P_{10-25}) percentiles) fall marginally during 1960-68, thereafter increase till 1978 (fig.1A). A sudden fall of the bottom 10 and first quartile are observed in 1979, after that increases marginally[3]. The emission share of bottom 10 drastically declines in post oil shock period, particularly after second oil shock in 1979 and the worldwide depression in 1981-82 (World Bank 1983). The emission share of the poorest or bottom 10 (P_{0-10}) is 3.15 per cent in 1960 and reduces to 1.14 per cent in 1979, thereafter it rises to 1.75 per cent in 1990. So, the emission share of the poorest (P_{0-10}) in 1990 is nearly half of that in 1960.

The share of median group (Q2) initially declines and after 1970 it increases over time due to gain in the emission share of lower middle (P_{25-50}) group, which suddenly jumps up in 1979 (Fig.1D) and continues to rise in 1980s. Its emission share is 3.98 per cent in 1960 and marginally increases to 4.20 per cent in 1978 and jumps to 9.67 per cent in 1979. Emission share of upper middle (P_{50-75}) group improves marginally over the period 1960 – 90.

The top 25% of emission share decreases slowly during 1960-90. Initially, it raises from 76.77 per cent in 1960 to 82.64 per cent in 1967 and thereafter it decreases continuously from 82.40 per cent in 1968 to 68.91 per cent in 1990. It should be noted that developed countries produce more than 2/3 of global emission during 1960-90. The developed countries are major contributors for accumulating CO_2 emission in the atmosphere during 1960-1990 and thus, they have major contribution towards global worming. The emission share of bottom rich (P_{75-90}) group declines from 28.07 per cent in 1960 to 26.66 per cent in 1990 while emission share of top 10 percentile group decreases from 48.7 per cent in 1960 to 42.25 per cent in 1990 (Fig.1B). Thus, the richest nations emit nearly half of global emission in 1960 and marginally reduce in 1990.

A comparative study on the decade-wise percentile groups is also important to perceive the pattern of distribution. Using Table 1, we calculate decade-wise (arithmetic) mean of each percentile group and sub-group of emission share. Figure 2 describes the distribution of average percentile shares for three decades (i.e., 1960s, 1970s and 1980s). Average emission shares of bottom 10 (P_{0-10}) and upper bottom 15 (P_{10-15}) improve in 1970s but deteriorates in 1980s. It should be mentioned that poor nations suffer more in 1980s compare to 1960s and 1970s due to reduction of their emission as well as income shares. Average emission share of top 10 (P_{90-100}) declines marginally in successive decades (i.e., 1970s and 1980s). The richest countries enjoy better environmental quality (as emission declines) in next decades (i.e., 1980s). Fig.2 shows the evidence that lower middle (P_{25-50}) and upper middle (P_{50-75}) groups gain in successive decades. Lower middle (P_{25-50}) group gains maximum emission share in 1980s while upper middle (P_{50-75}) group gains marginally.

The oil shocks in 1970s and the worldwide economic depression in early 1980s affects the world economy and consequently distribution pattern of global emission[4] (World Bank 1983). During these turmoil situations, lower middle (P_{25-50}) group improves their emission share significantly while bottom 10 or less developed economies suffers more. The under developed economies loose the economic activities and thereby income due to international shocks (Unruh and Moomaw (1998), Roberts and Grimes (1997), Schmalensee et al. (1998)). The worldwide industrial recession in late 1960s has also adverse effect on the emission share of bottom 10 (Table 1).

The rising or falling tendencies of these percentile shares indicate that rich nations marginally reduce their emission shares while developing countries raise it during 1960-90. In this context it should be mentioned that Lorenz Ratio (LR) technique is used to measure the inequality of income and emission (Kakwani

---

[2]We follow conventional methodology for calculation of income distribution (See, Kakwani (1980)). We have applied it in this study for the distribution of income and CO_2 emission.

[3] The oil crises in 1970s were big shocks to the poor nations, which were highly affected (Unruh and Moomaw (1998)).

[4] Redistribution is more significant in the post oil shock period.

1980). LR of emission initially rises and later decreases in the World, specifically in the post oil shock period. So, emission inequality[5] falls marginally over time (Fig.1F).

4. Conclusion

This paper examines the distribution pattern of CO_2 emission of 88 countries spread over the world for the period 1960-90. Emission share of top 25 decreases from 77 per cent to 70 per cent whereas bottom 25 reduces it from 9.42 per cent to 4.96 per cent during 1960-90. Only bottom 50 raises emission share from 13 per cent to 19 per cent. Emissions share of bottom 10 and top 10 decline whereas lower middle and upper middle groups raise it. So, the burden of global environmental damage (or cost of rebuilding it) should be distributed accordingly. Therefore, policy makers should be careful to formulate any policy for controlling global emission as well as global warming or global climate change.

Acknowledgements

I am grateful to Professor Dipankor Coondoo for valuable suggestions on this draft.

References:

Coondoo, D. and Dinda, S., 2002, Causality between Income and Emission: A Country group-specific Econometric Analysis, *Ecological Economics*, vol.-40 (3), 351 – 367.

Kakwani, N. C., 1980, *Income inequality and poverty: methods of estimation and policy application*, Oxford University Press, Calcutta.

Ravallion, M., Heil, M. and Jalan, J., 2000, Carbon emissions and income inequality, *Oxford Economic Papers,* vol.-52, 651 – 669.

Roberts, J. T. and Grimes, P. K., 1997, Carbon intensity and economic development 1962 – 1991: A brief exploration of the environmental Kuznets curve, *World Development*, vol.-25(2), 191-198.

Schmalensee, R. T., Stoker, M. and Judson, R. A., 1998, World Carbon Dioxide Emissions: 1950 – 2050, *The Review of Economics and Statistics*, vol.-80, 15-27.

Torras, M. and Boyce, J. K., 1998, Income, inequality, and pollution: a reassessment of the environmental Kuznets Curve, *Ecological Economics*, vol.-25,147 – 160.

Unruh, G. C. and Moomaw, W. R., 1998, An alternative analysis of apparent EKC –type transitions, *Ecological Economics*, vol.-25, 221 – 229.

World Bank, 1983, *World Development Report 1983*, Oxford University press.

Table 1: Trend of Percentile Shares of Carbon Emission in the World during 1960 - 1990.

Percentile Shares of Carbon Emission in the World

year	Average Income	Average Emission	P0-10	P10-25	P25-50	P50-75	P75-90	P90-100	Q1	Q2	Q3
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1960	2693.89	0.71	3.15	6.26	3.98	9.83	28.07	48.70	9.42	13.40	23.23
1961	2790.06	0.72	2.96	4.47	2.80	10.68	30.02	49.07	7.43	10.23	20.91
1962	2871.63	0.76	2.30	3.47	2.54	10.86	31.11	49.74	5.76	8.30	19.16
1963	2959.40	0.77	2.10	3.17	2.62	10.83	31.37	49.90	5.27	7.89	18.73
1964	3097.15	0.82	2.02	3.10	2.45	10.61	31.52	50.31	5.11	7.56	18.17
1965	3194.82	0.84	2.06	3.21	2.71	10.68	30.92	50.43	5.27	7.98	18.65
1966	3278.17	0.85	1.20	3.32	3.67	10.45	30.30	51.06	4.52	8.19	18.64
1967	3347.36	0.87	1.55	2.77	2.85	10.19	30.83	51.81	4.32	7.17	17.36
1968	3466.38	0.93	1.47	2.83	3.02	10.27	30.99	51.41	4.30	7.32	17.60
1969	3649.59	0.97	2.04	3.18	2.79	10.06	31.03	50.90	5.22	8.01	18.07
1970	3792.17	1.04	2.40	3.98	3.15	10.06	30.73	49.68	6.38	9.53	19.59
1971	3939.42	1.05	2.63	4.22	3.18	10.56	30.80	48.59	6.86	10.04	20.60
1972	4091.07	1.09	2.74	4.41	3.26	10.44	30.38	48.76	7.15	10.41	20.85
1973	4264.00	1.16	2.64	4.27	3.20	10.47	31.99	47.43	6.91	10.12	20.58
1974	4380.01	1.13	2.73	4.42	3.34	10.88	31.91	46.71	7.15	10.50	21.37
1975	4357.22	1.09	3.19	5.17	3.81	11.29	30.86	45.69	8.35	12.16	23.46
1976	4527.32	1.16	3.19	5.09	3.60	11.41	30.46	46.25	8.29	11.88	23.29

---

[5] Literacy and democratic setup also reduce the inequality (Torras and Boyce (1998)).

1977	4629.15	1.16	3.49	5.64	4.14	11.56	29.74	45.43	9.12	13.27	24.83
1978	4747.39	1.19	3.66	5.97	4.20	11.84	27.90	46.42	9.64	13.84	25.68
1979	4866.84	1.22	1.14	3.08	9.67	11.85	28.50	45.76	4.22	13.88	25.74
1980	4952.19	1.23	1.25	2.88	9.77	11.83	28.07	46.19	4.13	13.90	25.73
1981	4991.56	1.18	1.25	2.78	10.03	12.08	27.96	45.90	4.03	14.06	26.14
1982	4957.94	1.15	1.35	3.16	10.83	12.25	29.12	43.28	4.51	15.34	27.59
1983	4970.11	1.13	1.44	3.35	11.46	12.43	27.01	44.32	4.78	16.23	28.67
1984	5063.22	1.15	1.34	2.65	12.04	13.26	26.24	44.47	3.99	16.03	29.29
1985	5153.58	1.17	1.39	2.71	12.83	13.20	25.95	43.92	4.10	16.92	30.13
1986	5263.58	1.16	1.58	2.74	13.06	13.10	25.57	43.96	4.32	17.37	30.47
1987	5382.49	1.18	1.52	2.86	13.59	13.13	25.29	43.62	4.38	17.97	31.10
1988	5505.51	1.14	1.64	2.94	13.90	13.00	24.80	43.73	4.57	18.47	31.47
1989	5633.70	1.17	1.70	3.06	13.72	13.02	25.25	43.25	4.77	18.49	31.50
1990	5716.86	1.18	1.75	3.22	13.62	12.51	26.66	42.25	4.96	18.58	31.09

Figure 1: Trends of emission shares of different percentile groups during 1960-1990.

A

B

C

D

3
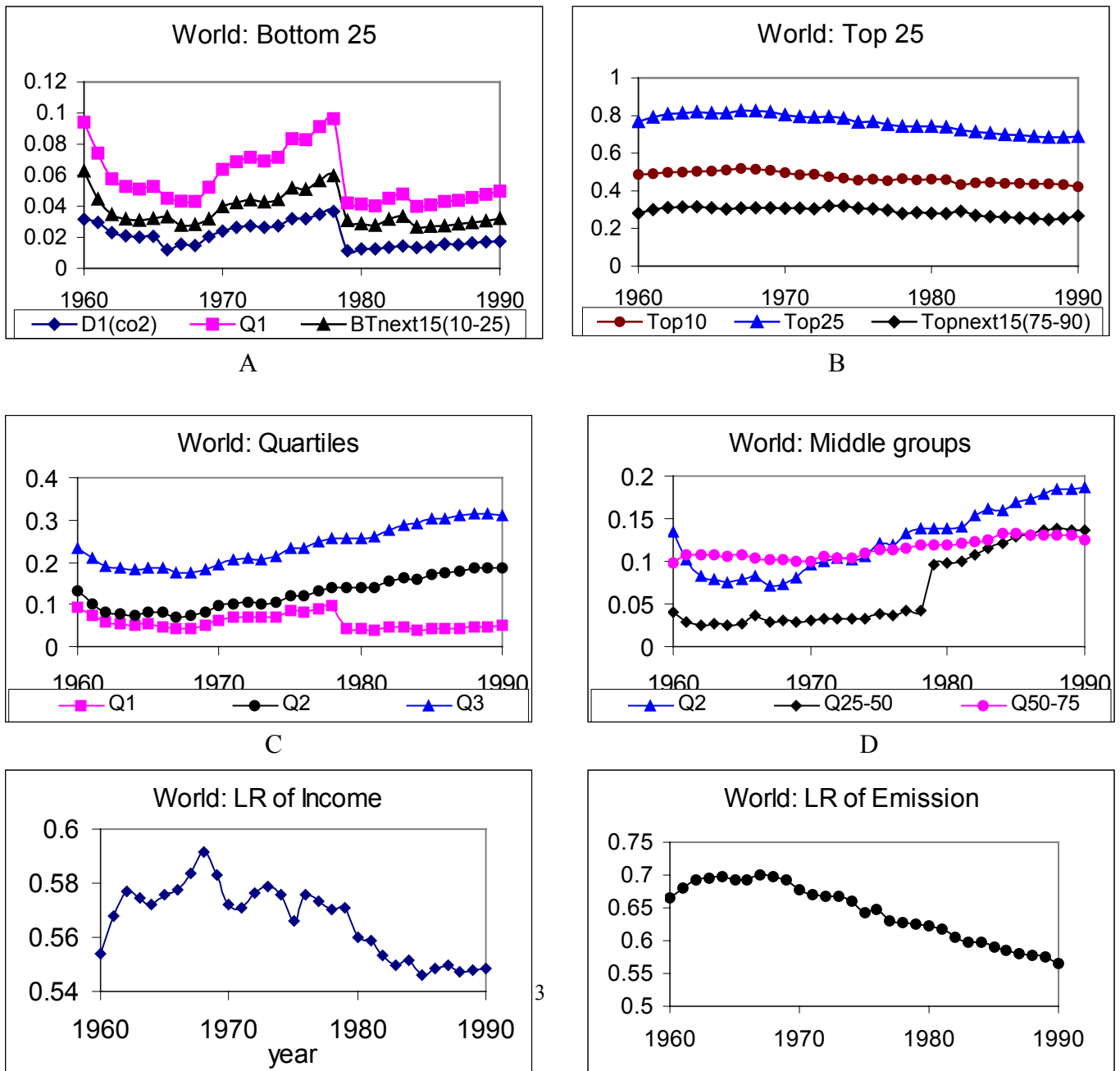
E
F

Figure 2: Decade-wise average emission share of percentile groups.