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Technical Annex

From Kyoto to Copenhagen: Meeting the Climate Change Challenge

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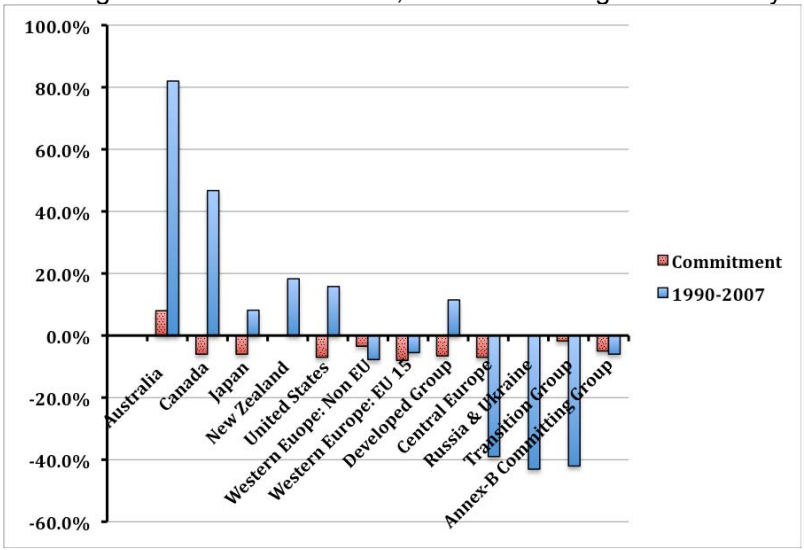
This document is the technical annex to the full paper "From Kyoto to Copenhagen: Meeting the Climate Change Challenge" which is available separately.

A1. Comparative Data

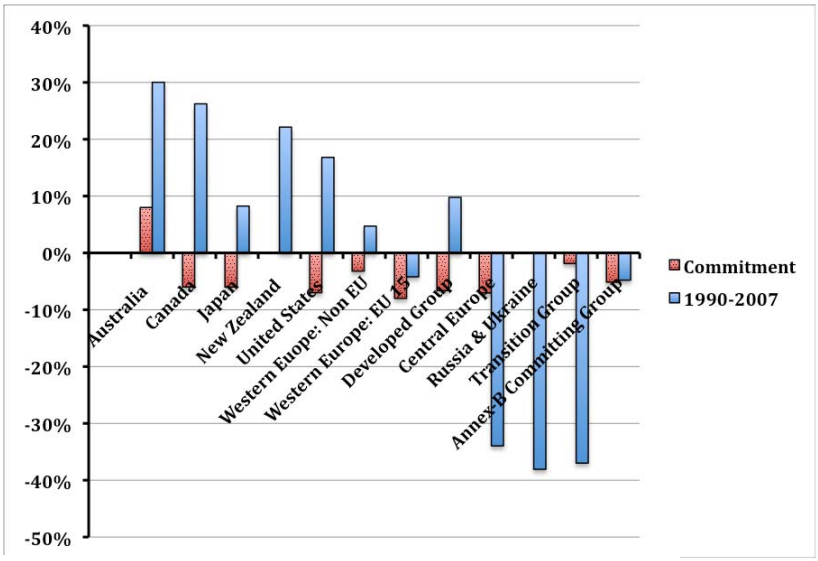
This part of the Technical Annex provides cross-country data comparisons on a variety of key variables in support of the analysis in the paper. The underlying data on GHG emissions is from the UNFCCC (United Nations Framework Convention on Climate Change) website while the data on CO_2 emissions and fossil-fuel use is from the emissions from the United States Energy Information Agency (EIA) online database. The data on GDP and population is from the World Bank's World Development Indicators (WDI) database. Figures 1 and 2 show the reduction commitments of the Annex-B countries and their actual performance toward meeting those targets over the period from the 1990 base year through 2007. Figure 1 includes the impact of changes in land use while Figure 2 does not. Figure 3 shows increases in fossil-fuel use across the Annex-B countries from the inception of the Kyoto Protocol in 1998 through 2007, while Figure 4 shows similar data from some key Developing Countries and provides world comparisons. Figure 5 shows the amounts and shares of CO_2 emissions for Developed Countries as group, Transition Countries and Developing Countries. Figures 6 and 7 show per-capita CO_2 emissions for Annex-B Countries on the one hand and Developing Countries on the other, while Figures 8 and 9 show per-capita GDPs. Figures 10 and 11 show overall CO_2 emissions for Annex-B and Developing Countries respectively. Figures 12 and 13 show the CO_2 emissions intensities or ratios of CO_2 emissions to real GDP.

Figure 1. Greenhouse Gas Emissions of Annex-B Countries: Broad Results
Percentage Commitments and Performance to 2007 Relative to 1990 Base Year Including the Effects of Land-Use, Land Use Change and Forestry on GHG Emissions



Source: UNFCCC (United Nations Framework Convention on Climate Change) "GHG data from UNFCCC."

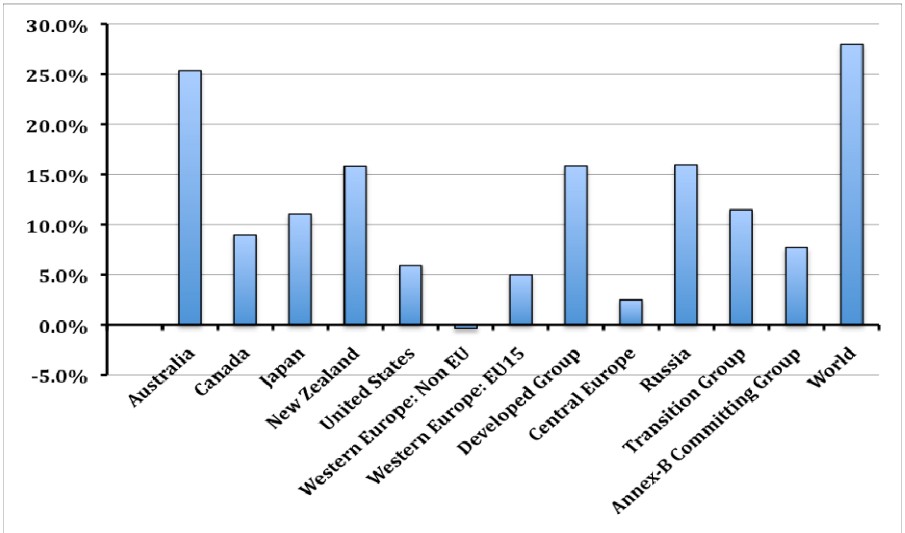
Figure 2. Greenhouse Gas Emissions of Annex-B Countries: Narrow Results
Percentage Commitments and Performance to 2007 Relative to 1990 Base Year Excluding the Effects of Land-Use, Land Use Change and Forestry on GHG Emissions



Source: UNFCCC (United Nations Framework Convention on Climate Change) "GHG data from UNFCCC."

Figure 3. Fossil-Fuel Consumption of Transition and Developed Countries

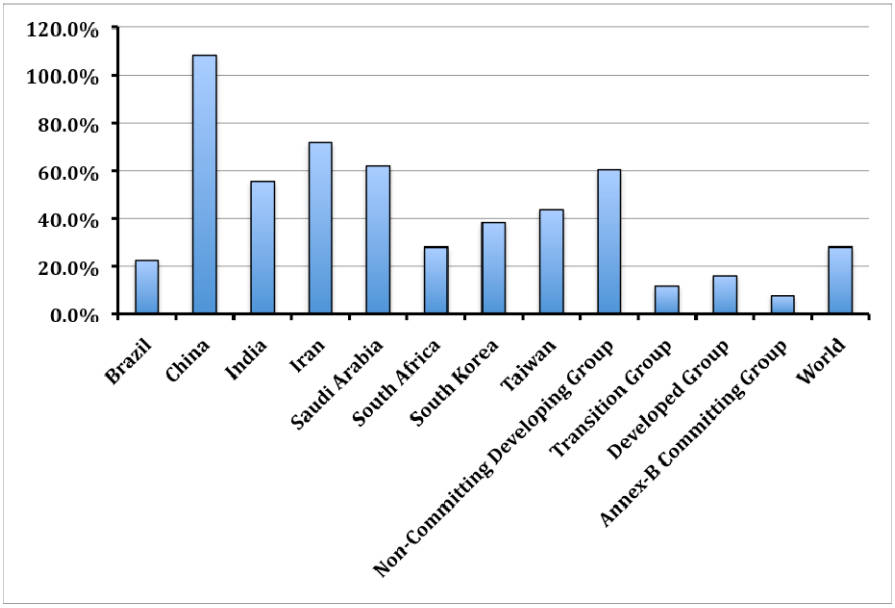
Percentage Increase, 1998-2007



Source: United States, Energy Information Administration (EIA) database.

Figure 4. Fossil-Fuel Consumption Developing Countries

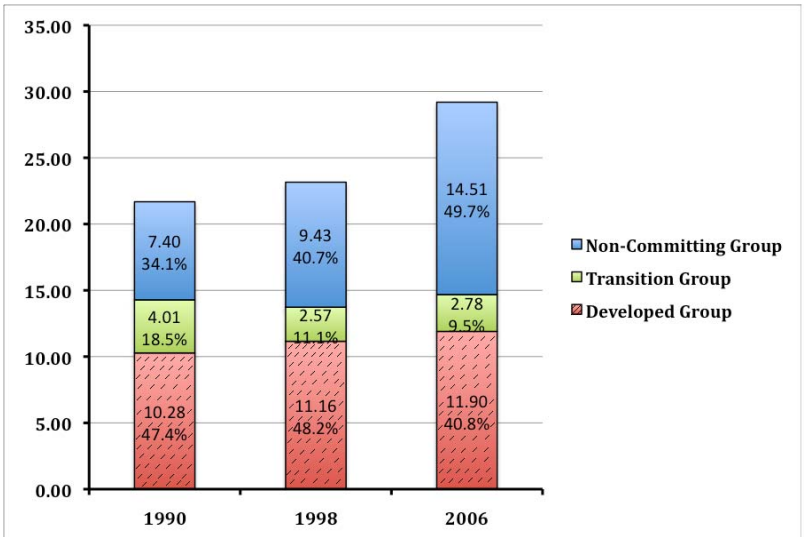
Percentage Increase, 1998-2007



Source: United States, Energy Information Administration (EIA) database.

Figure 5. World Carbon Dioxide Emissions

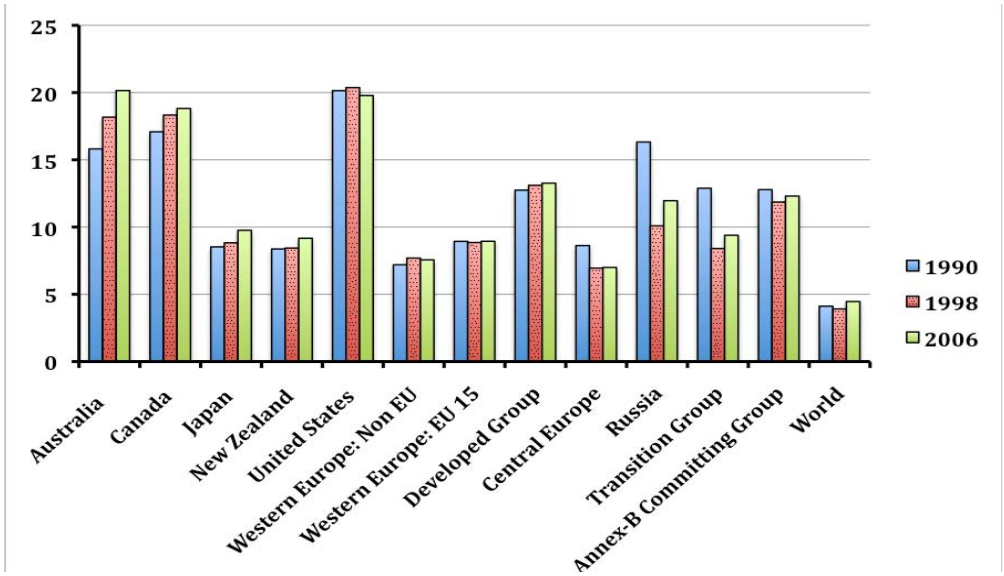
Billions of Metric Tons



Source: United, States Energy Information Administration (EIA) database

Figure 6. Per-Capita CO_2 Emissions of Developed and Transition Countries

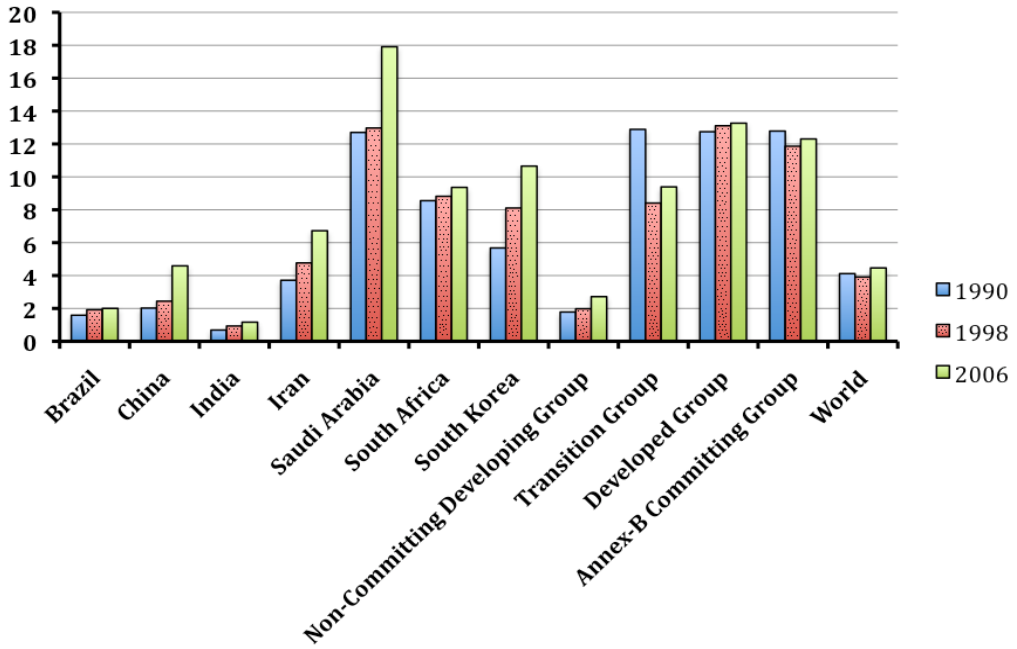
Metric Tons of Carbon Dioxide per Capita



Source: Calculations based on data from United States, Energy Information Administration (EIA) database and the World Bank, World Development Indicators (WDI) database.

Figure 7. Per-Capita CO_2 Emissions of Developing Countries

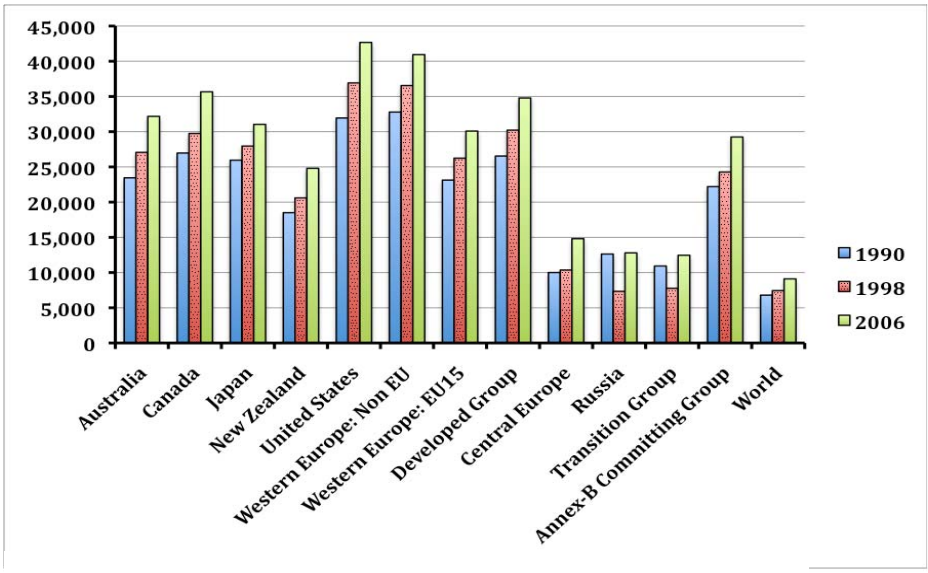
Metric Tons of Carbon Dioxide per Capita



Source: Calculations based on data from United States, Energy Information Administration (EIA) database and the World Bank, World Development Indicators (WDI) database.

Figure 8. Per-Capita Income of Transition and Developed Countries

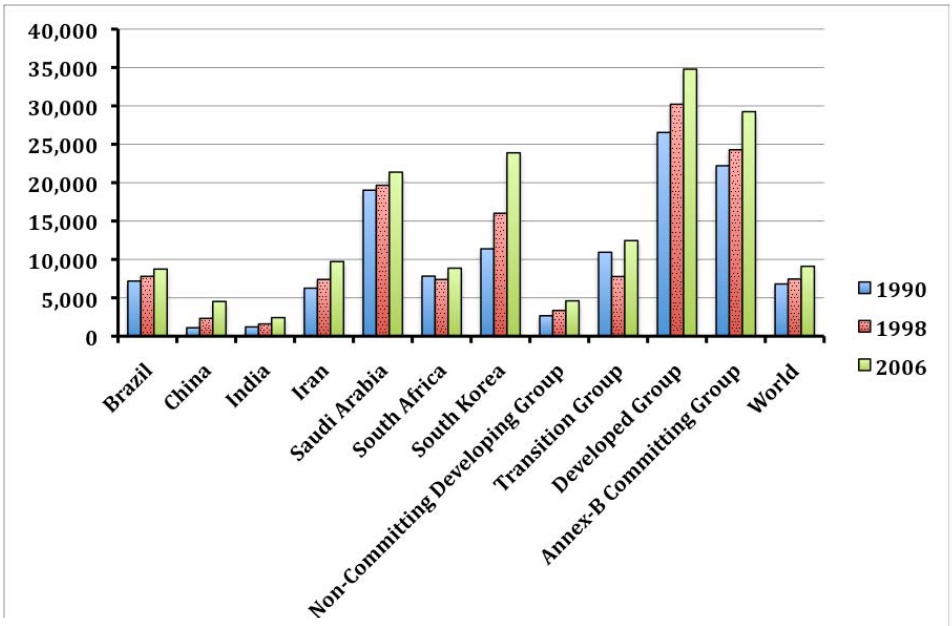
Purchasing Power Parity GDP Conversions; 2005 International Dollars



Source: World Bank, World Development Indicators (WDI) database.

Figure 9. Per-Capita Income of Developing Countries

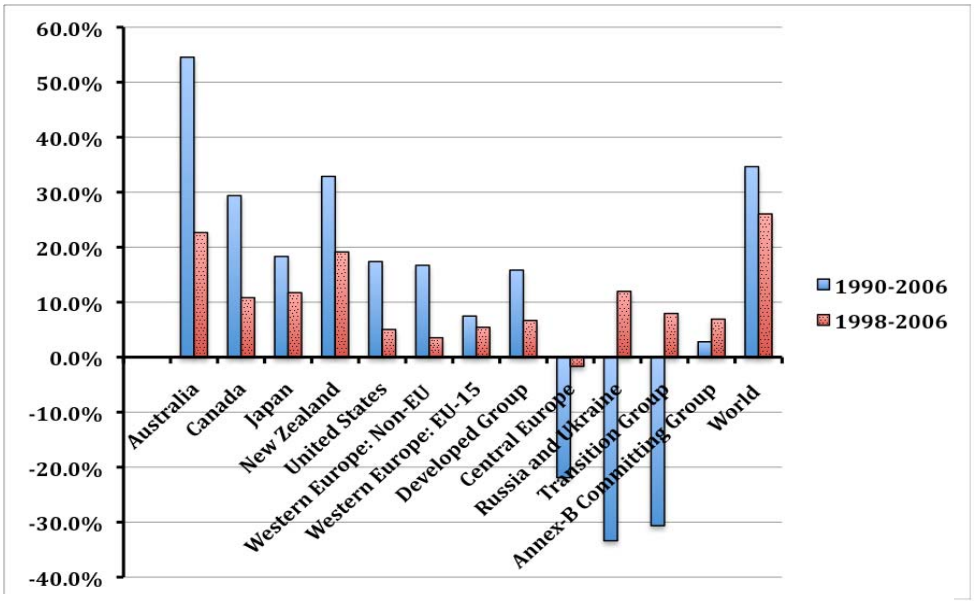
Purchasing Power Parity GDP Conversions; 2005 International Dollars



Source: World Bank; World Development Indicators (WDI) database.

Figure 10. CO_2 Emissions by Transition and Developed Countries

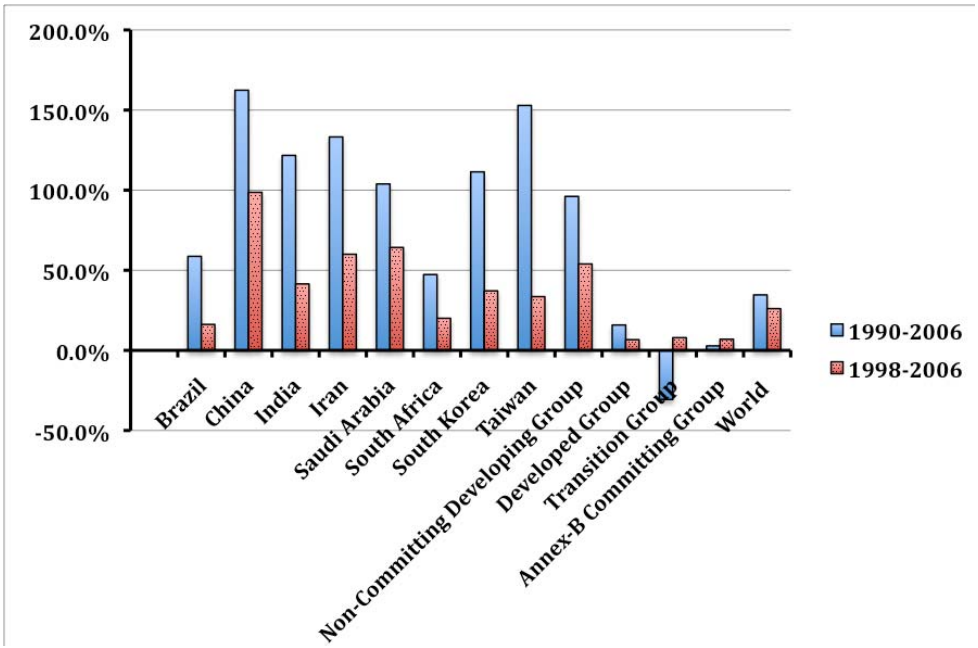
Percentage Increases; 1990-2006 and 1998-2006



Source: United States, Energy Information Administration (EIA) database.

Figure 11. CO_2 Emissions by Developing Countries

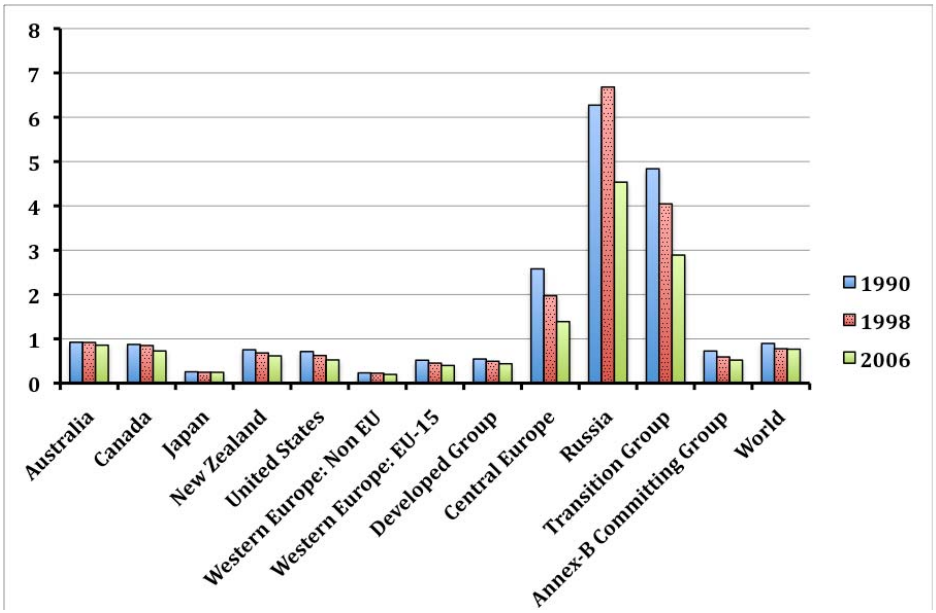
Percentage Increases; 1990-2006 and 1998-2006



Source: United States, Energy Information Administration (EIA) database.

Figure 12. CO_2 Intensity of Transition and Developed Countries

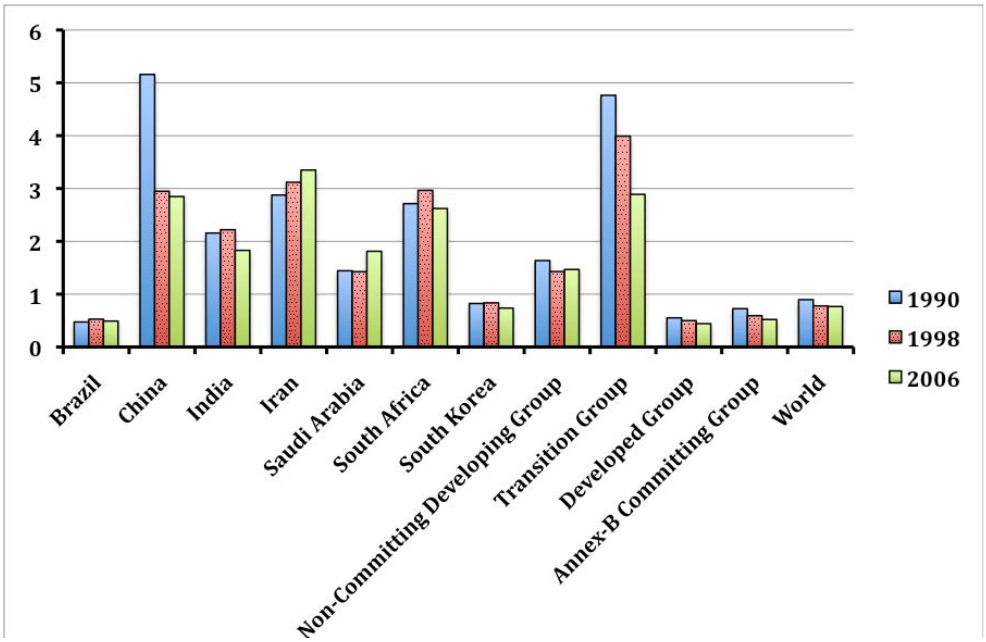
Kilograms of Carbon Dioxide per Constant (2000) US Dollar of GDP



Source: Calculations based on data from United States, Energy Information Administration (EIA) database and the World Bank, World Development Indicators (WDI) database.

Figure 13. CO_2 Intensity of Developing Countries

Kilograms of Carbon Dioxide per Constant (2000) US Dollar of GDP



Source: Calculations based on data from United States, Energy Information Administration (EIA) database and the World Bank, World Development Indicators (WDI) database.

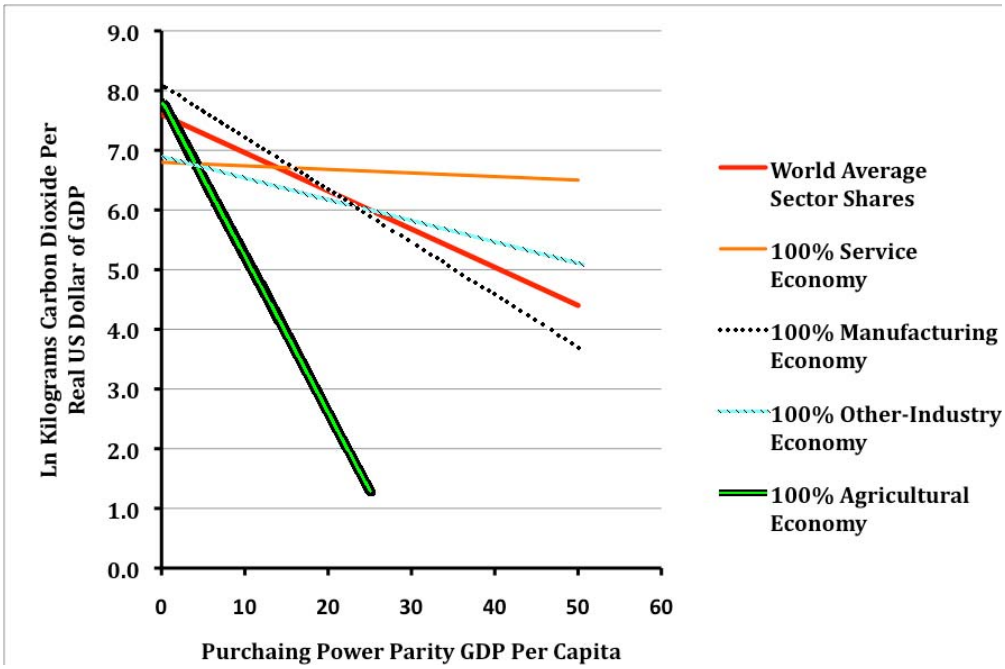
A2. Empirical Findings

This part of the Technical Annex examines whether developing countries are dirtier than developed countries in terms of CO_2 emissions while controlling for important factors such as the size of the country, the types of fossil fuels used, the extent of non-GHG emitting electricity generation (e.g., nuclear power) and the sector composition of the economy. The underlying data on CO_2 emissions, fossil-fuel use and electricity generation is from the United States Energy Information Agency (EIA) online database. Meanwhile, the data on population, population density, per-capita GDP, GDP, and sector shares in GDP is from the World Bank's World Development Indicators (WDI) database.

The regression results reported in Table 1 were obtained for a fixed-effects regression on an unbalanced panel consisting of 122 countries, 26 years from 1980 to 2005, and 2376 observations. Agriculture, services and other industry are treated explicitly, while manufacturing is the residual sector. Likewise natural gas and coal

are treated explicitly with petroleum as the residual fossil fuel. The results show that an increase in development, measured by real per-capita income, is associated with a statistically significant decline in the natural logarithm of CO_2 emission intensity, measured CO_2 emissions by per dollar of real GDP. The red line in Figure 14 shows the decline in the emissions intensity with rising per-capita income for a hypothetical country having the world average sector shares. Taking account of the logarithm scale, for each thousand-dollar increase in GDP, the CO_2 emissions intensity declines by approximately 6.4%. Figure 14 also shows that the emissions intensity would tend to drop rapidly for a 100% agricultural economy or a 100% manufacturing economy, but it would tend to drop more modestly for a 100% other-industry economy or a 100% service economy.

Figure 14. CO_2 Emissions Intensities versus Per-Capita Income



Source: Based on the regression results in Table 1; courtesy of David Still.

Table 1. Regression Results

	ln (CO_2/GDP)
GDP Per Capita	-7.96E-05 ***
Agriculture/GDP	-2.48E-03
(Agriculture/GDP) *(GDP Per Capita)	-1.79E-06 **
Services/GDP	-1.25E-02 ***
(Services/GDP) *(GDP Per Capita)	7.75E-07 ***
Other Industry/GDP	-1.11E-02 ***
(Other Industry/GDP) *(GDP Per Capita)	4.61E-07 ***
(Natural Gas/Fossil Fuel)*(GDP Per Capita)	-1.80E-05 **
(Coal/Fossil Fuel)*(GDP Per Capita)	2.00E-06
% Clean Electricity	-4.56E-03 ***
(% Clean Electricity)*(GDP Per Capita)	-4.17E-08
Land Per Capita	-1.04 ***
Constant	8.21 ***
Observations	2376
Countries	122
Panel Type	Unbalanced
Random versus Fixed Effects	Fixed
R-squared within	0.1426
R-squared between	0.2599
R-squared overall	0.2009

Source: Regression results courtesy of David Still.

* significant at 10%, ** significant at 5%, *** significant at 1%.