Understanding Historical Emission Trends

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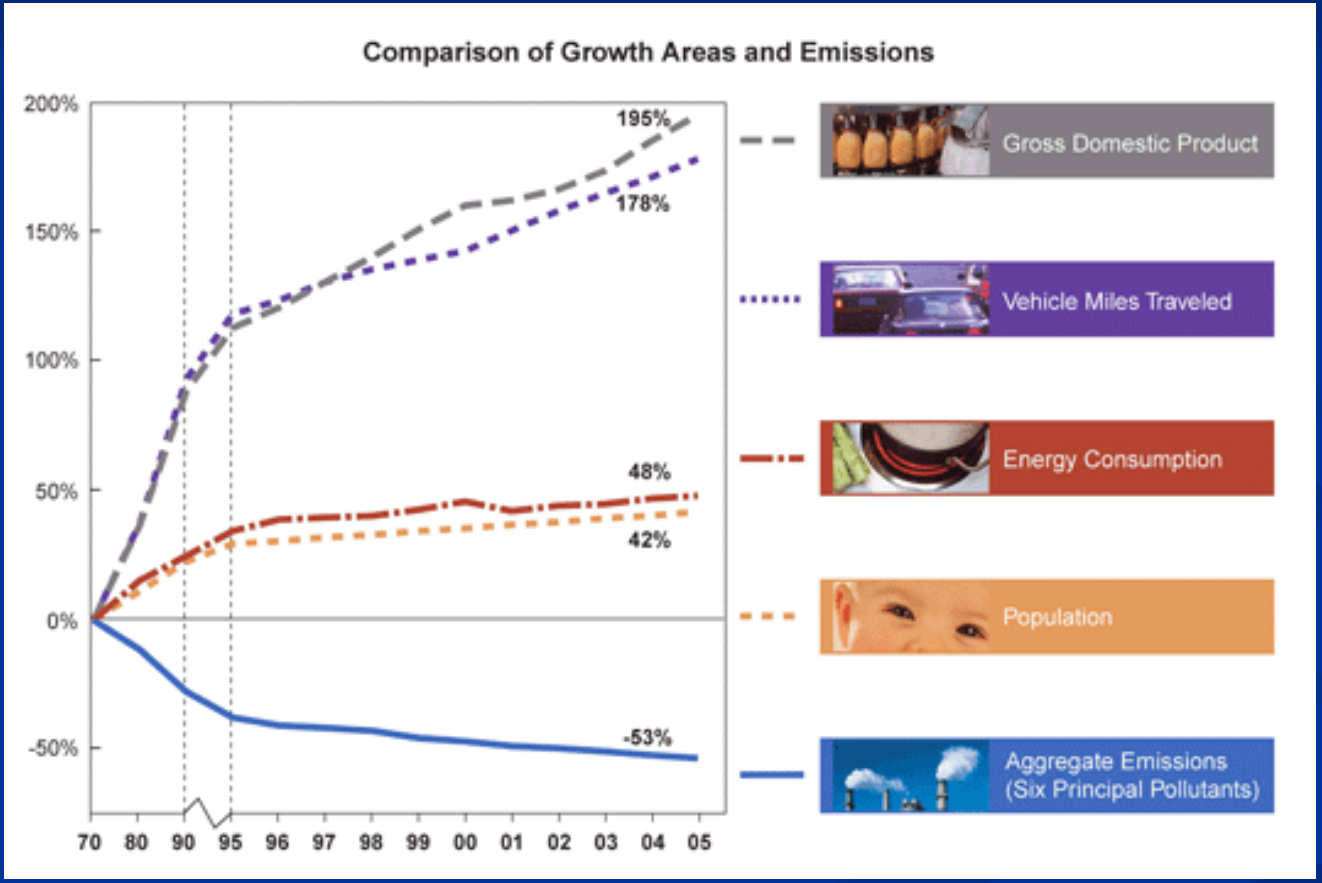
Background:

- Many methods have been used to estimate emission trends for future years. The Economic Growth and Analysis System (EGAS) is used to help estimate growth or decrease in emissions based on projected economic activity changes. The EGAS has been found to be problematic when forecasting for stationary non- Electrical Generating Unit (EGU) sources.

Background:


Comparison of Growth Areas and Emissions
200%
150%
100%
50%
0%
-50%
195%
178%
48%
42%
-53%
70 80 90 95 96 97 98 99 00 01 02 03 04 05
Gross Domestic Product
Vehicle Miles Traveled
Energy Consumption
Population
Aggregate Emissions
(Six Principal Pollutants)

Background:

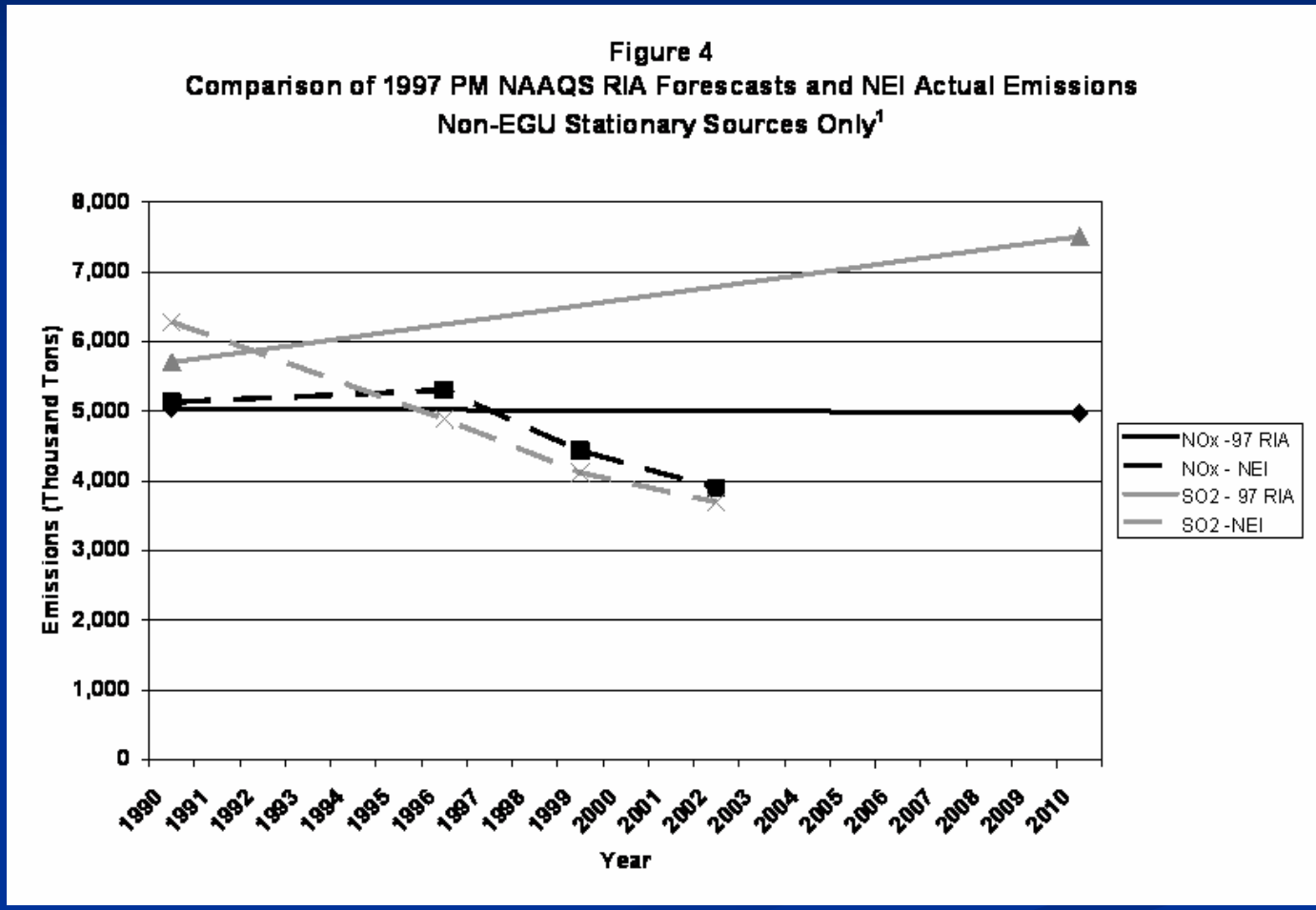


Figure 4
Comparison of 1997 PM NAAQS RIA Forecasts and NEI Actual Emissions
Non-EGU Stationary Sources Only[1]
Emissions (Thousand Tons)
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
Year
NOx -97 RIA
NOx - NEI
SO2 - 97 RIA
SO2 -NEI

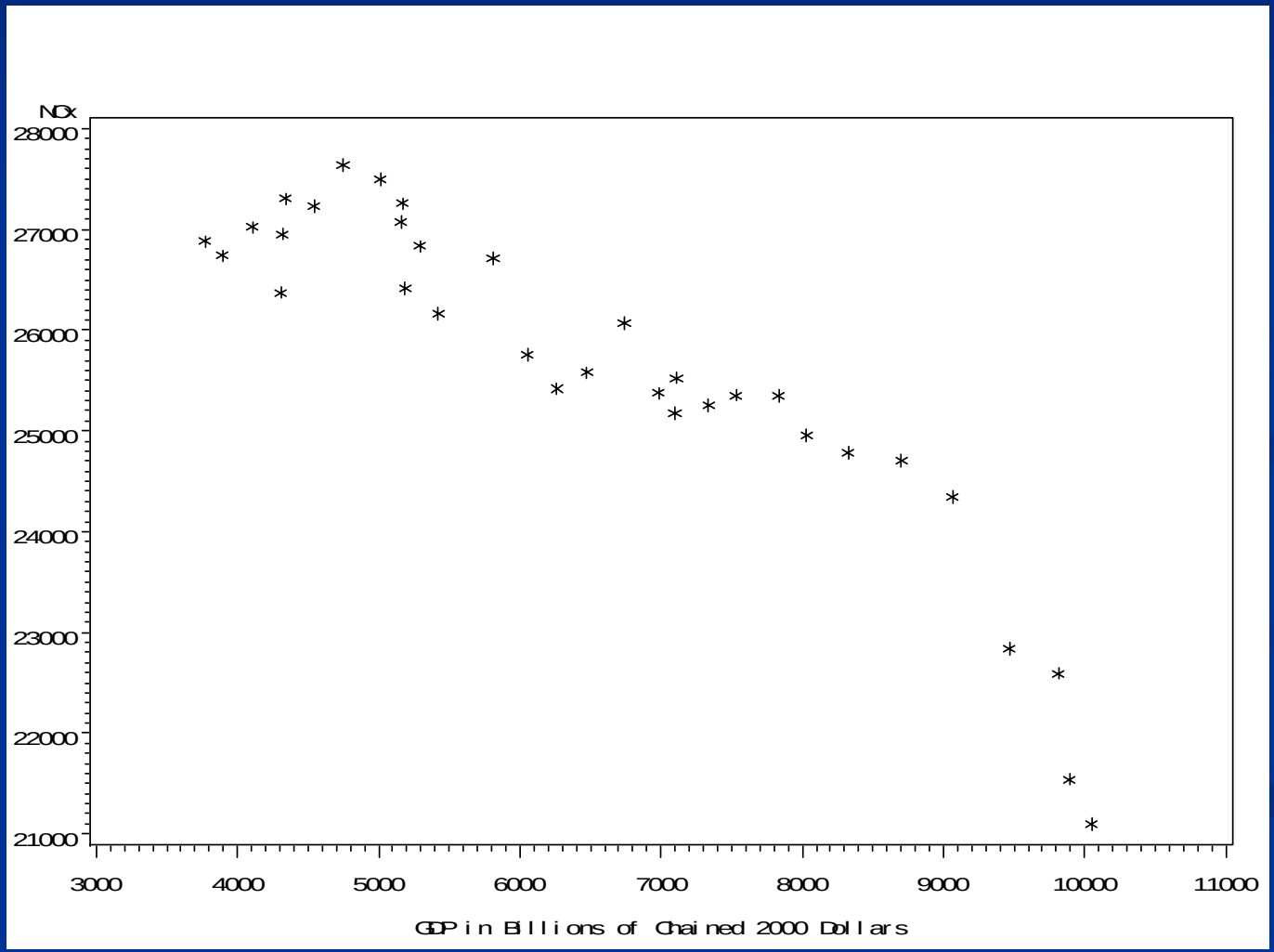
Background:

- The future projections are inconsistent with the historical data. The current approach used to forecast emission trends begins with a base year and grows according to growth in the GDP. Compared with historical data, it overestimates future emissions by not taking future technological change into account.

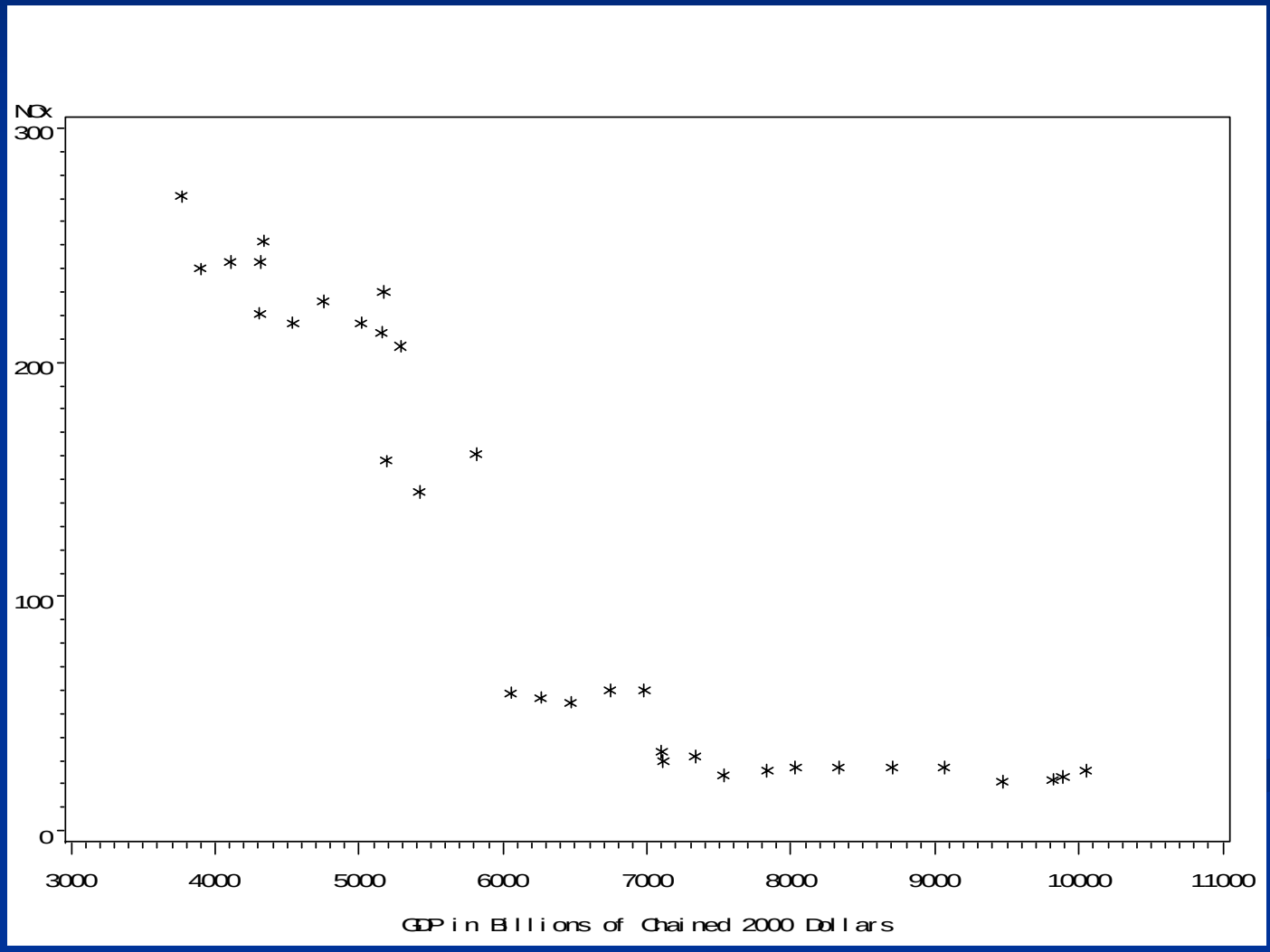
Phase 1 Analyses:

- Creation of Scatter Plots and Correlation Matrices showing the relationship between Real Dollar GDP and NOx Emissions
- Note:
  - NOx measured in thousand short tons
  - Real GDP measured in billions of chained 2000 dollars

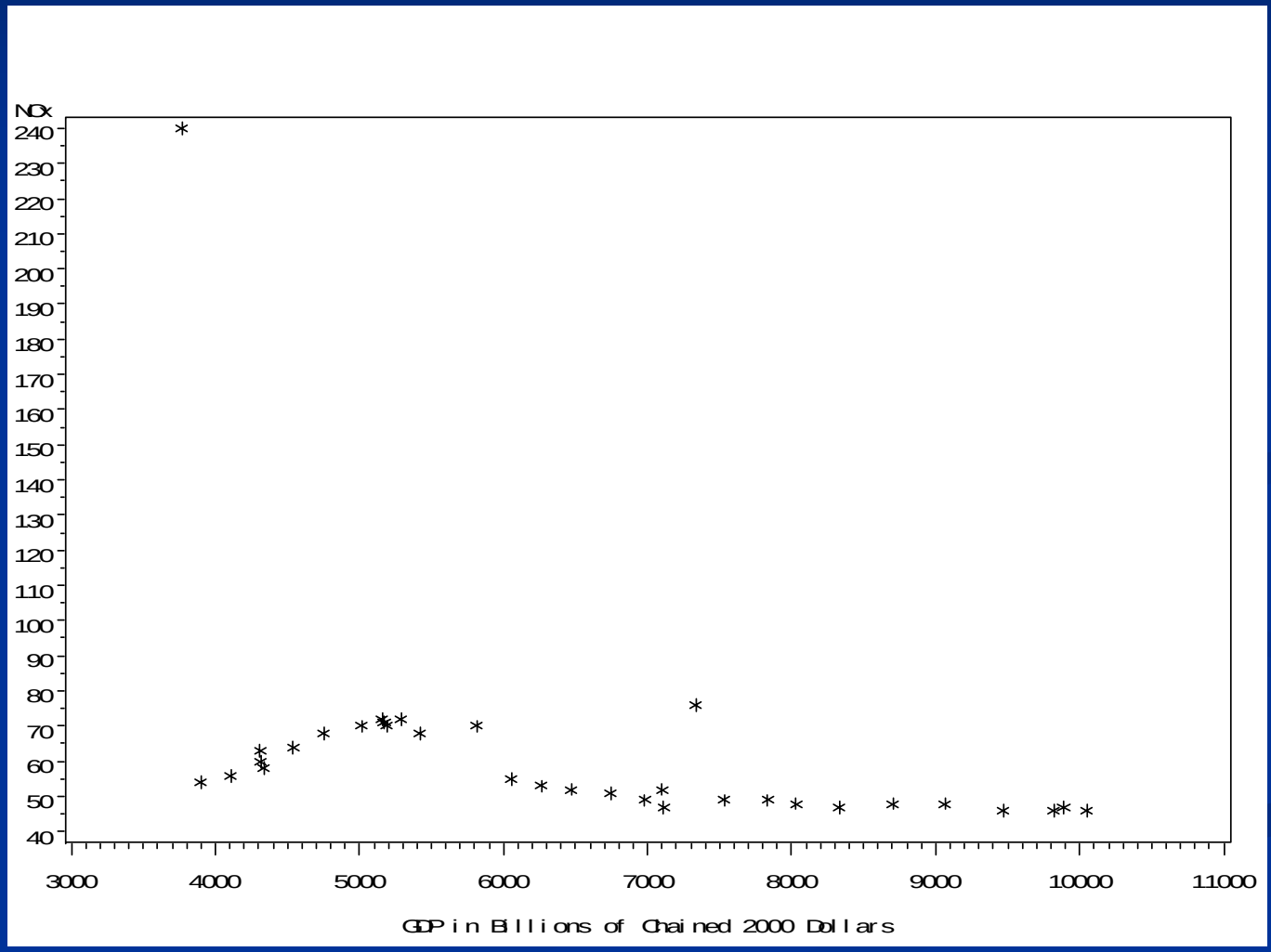
Scatter Plot: Total NOx Emissions vs. Real Dollar GDP



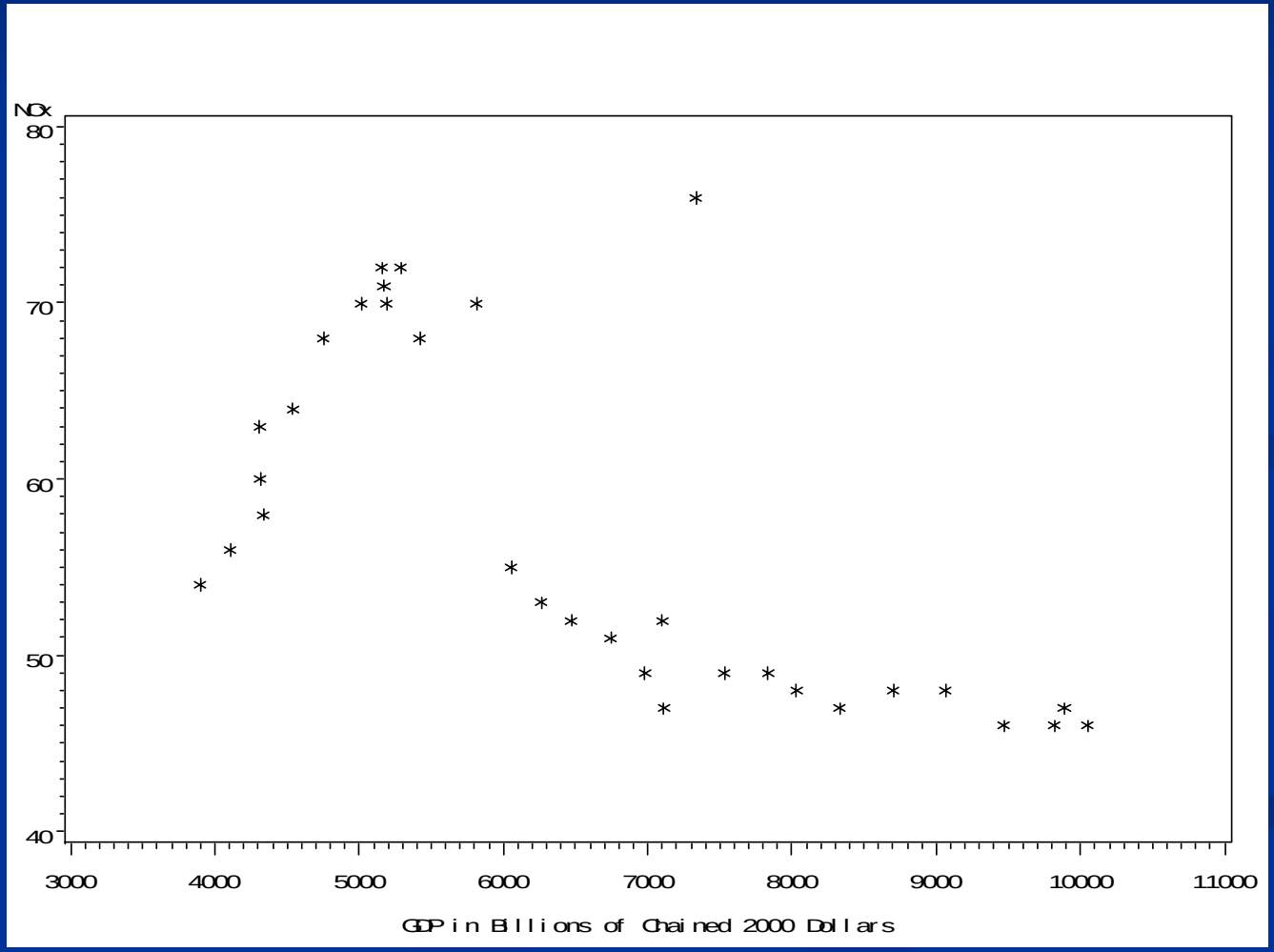
Scatter Plot: Chemical Manufacturing NOx Emissions vs. Real Dollar GDP



Scatter Plot: Petroleum Refineries NOx Emissions vs. Real Dollar GDP



Scatter Plot: Petroleum Refineries NOx Emissions vs. Real Dollar GDP (without data from 1970)



Correlation Coefficients

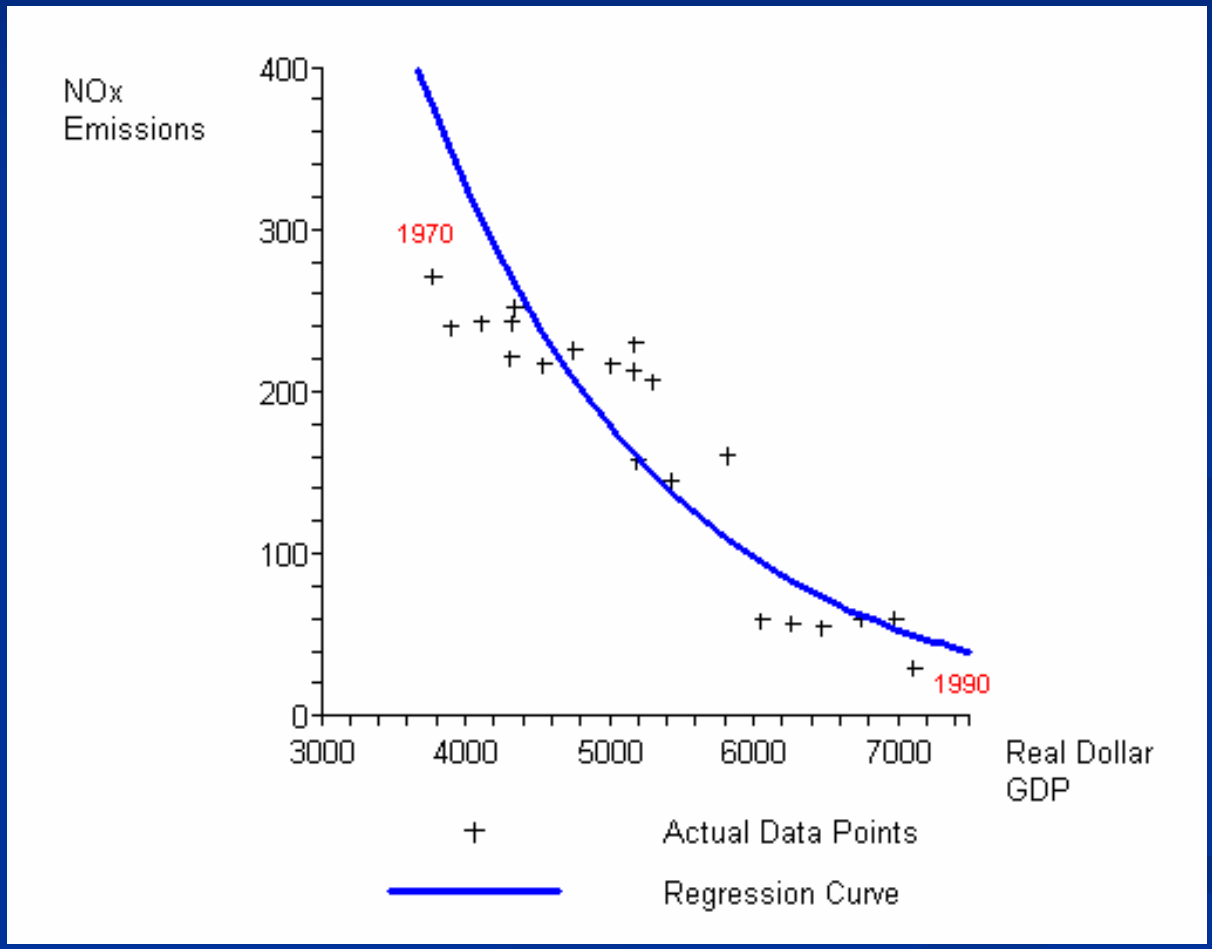
	Total NOx Emissions	Chemical Manu.	Petroleum Refineries	Petroleum Refineries (without data from 1970)
Real Dollar GDP	-0.91654	-0.89768	-0.43416	-0.67395

Phase 2 Analysis: Chemical Manufacturing Sector

- Focus on a particular Non-EGU sector: Chemical and Allied Product Manufacturing Sector
- Creation of regression line using data from 1970 through 1990
- Comparison of regression model with current EPA approach and proposed EPA approach for data from 1990 to 2002

Plot of Regression Model Based on Emissions Data from 1970-1990:

(Chemical Manufacturing Sector)



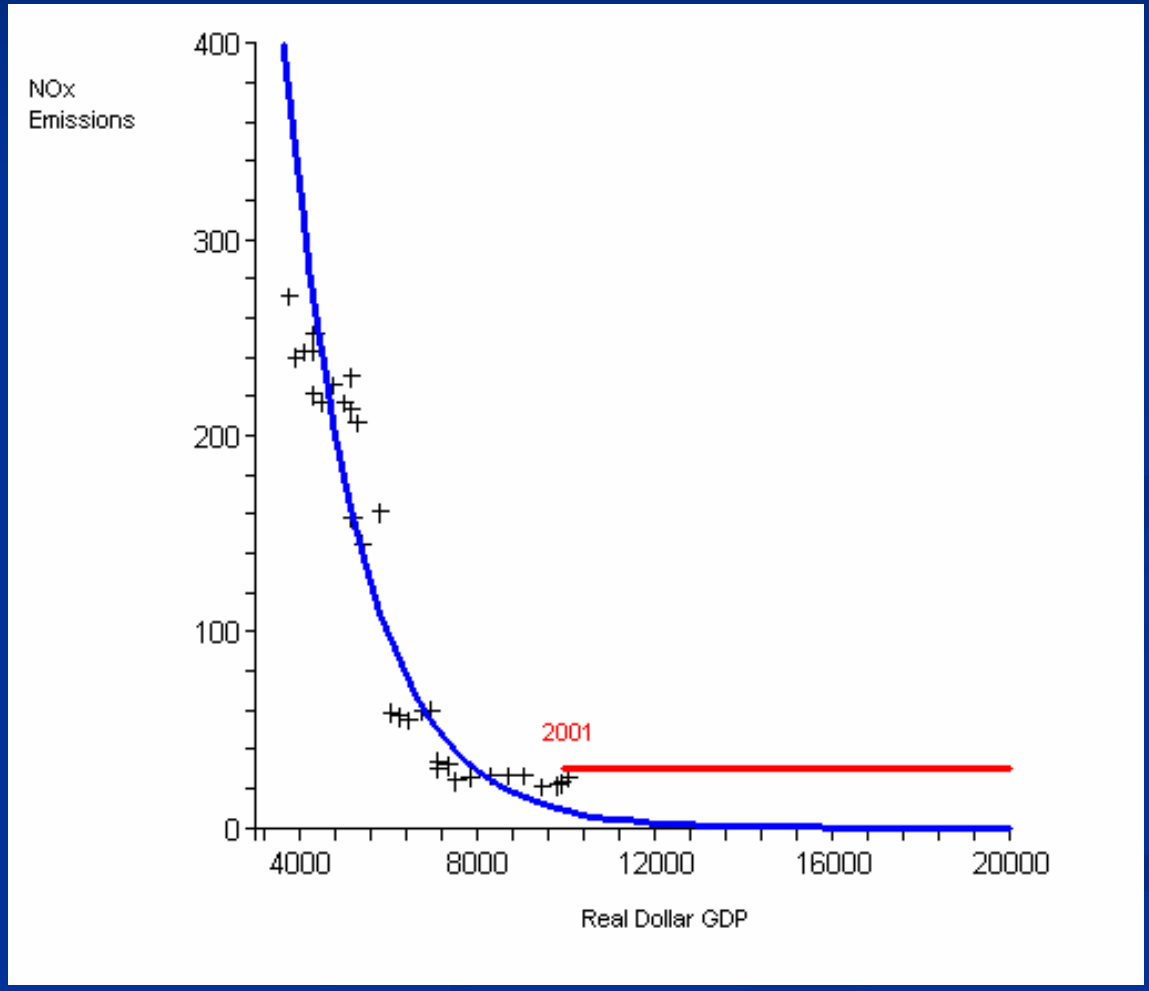
Regression Model Based on Emissions Data from 1970-1990:

(Chemical Manufacturing Sector)

- **Equation of Regression Model:**
- ln(Y)= 8.1861 + -0.0006*X
- Y=NOx Emissions from the Chemical Manufacturing Sector (thousand short tons)
- X=Real Dollar GDP (billions of chained 2000 dollars)
- R^2 Value= 0.8387

Regression Model vs. Proposed EPA "Interim" Approach

(Chemical Manufacturing Sector)

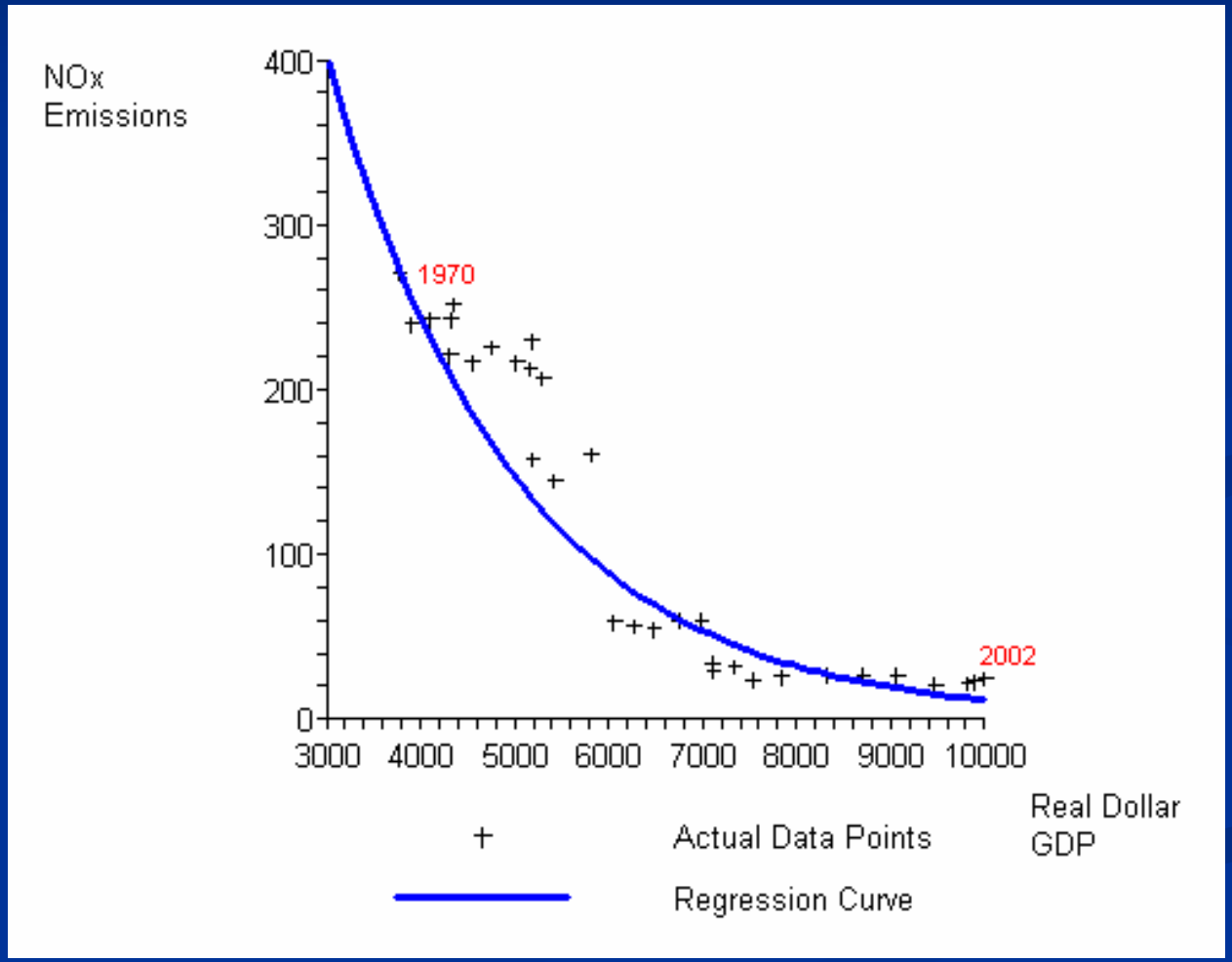


Regression Model vs. Proposed EPA Approach vs. Current EPA Approach

- KEY:
- Blue= Regression Model Based on Emissions Data from 1970-1990
- Red= Proposed EPA "Interim" Approach: Assumes no further increase or decrease in emissions: applied to a base year of 2001

Final Regression Model: Using Data from 1970-2002

(Chemical Manufacturing Sector)



Regression Model Based on Emissions Data from 1970-2002:

(Chemical Manufacturing Sector)

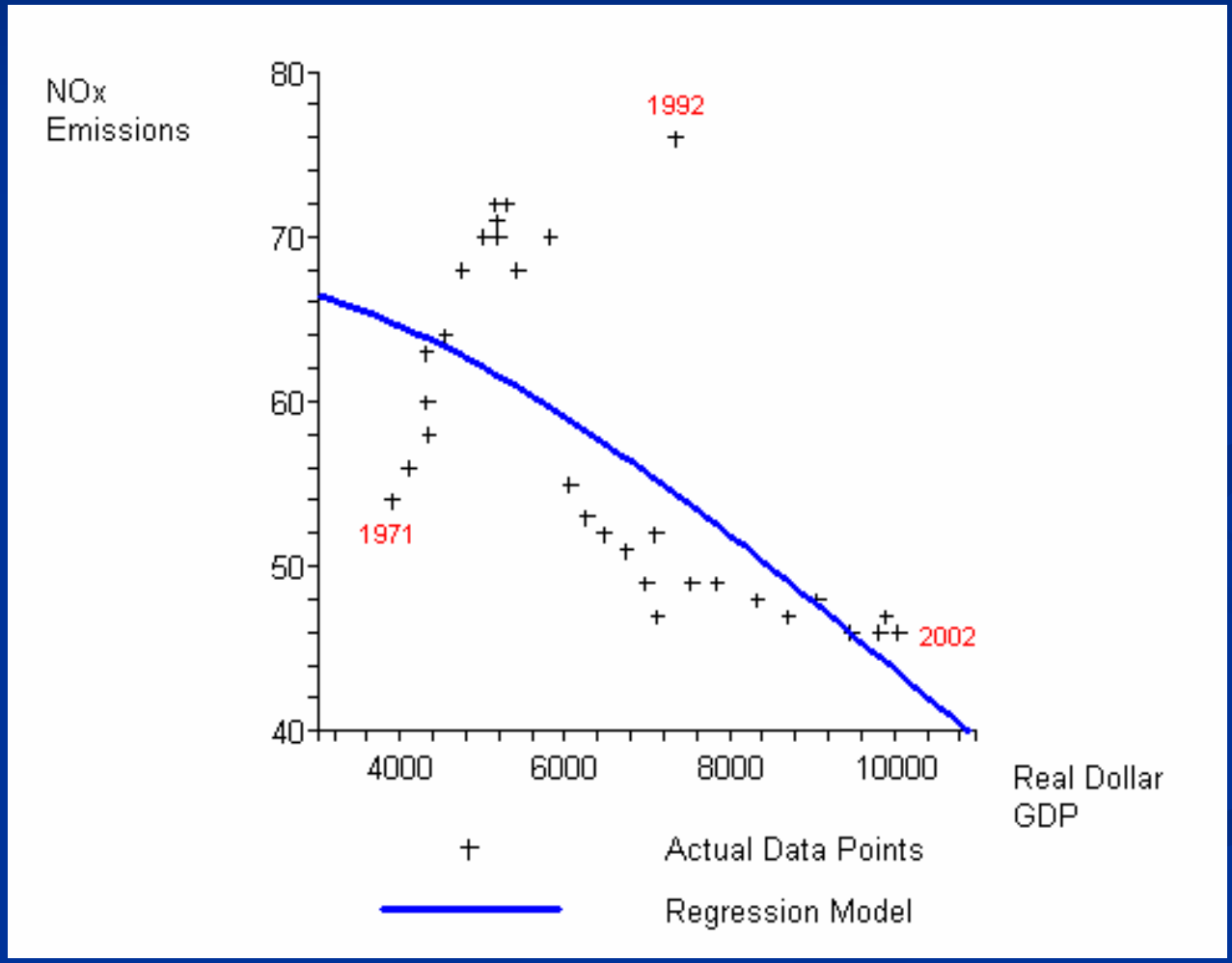
- **Equation of Regression Model:**
- ln(Y)= 7.4886 + -0.0005*X
- Y=NOx Emissions from the Chemical Manufacturing Sector (thousand short tons)
- X=Real Dollar GDP (billions of chained 2000 dollars)
- R^2 Value= 0.8770

Phase 3 Analyses: Petroleum Refineries Sector

- Focus on a particular Non-EGU sector: Petroleum Refineries Sector
- Creation of regression line using data from 1971 through 2002 (dropping data from 1970)
- Comparison of regression model with Proposed EPA "Interim" approach

Regression Model Using all Available Data:

(Petroleum Refineries Sector)



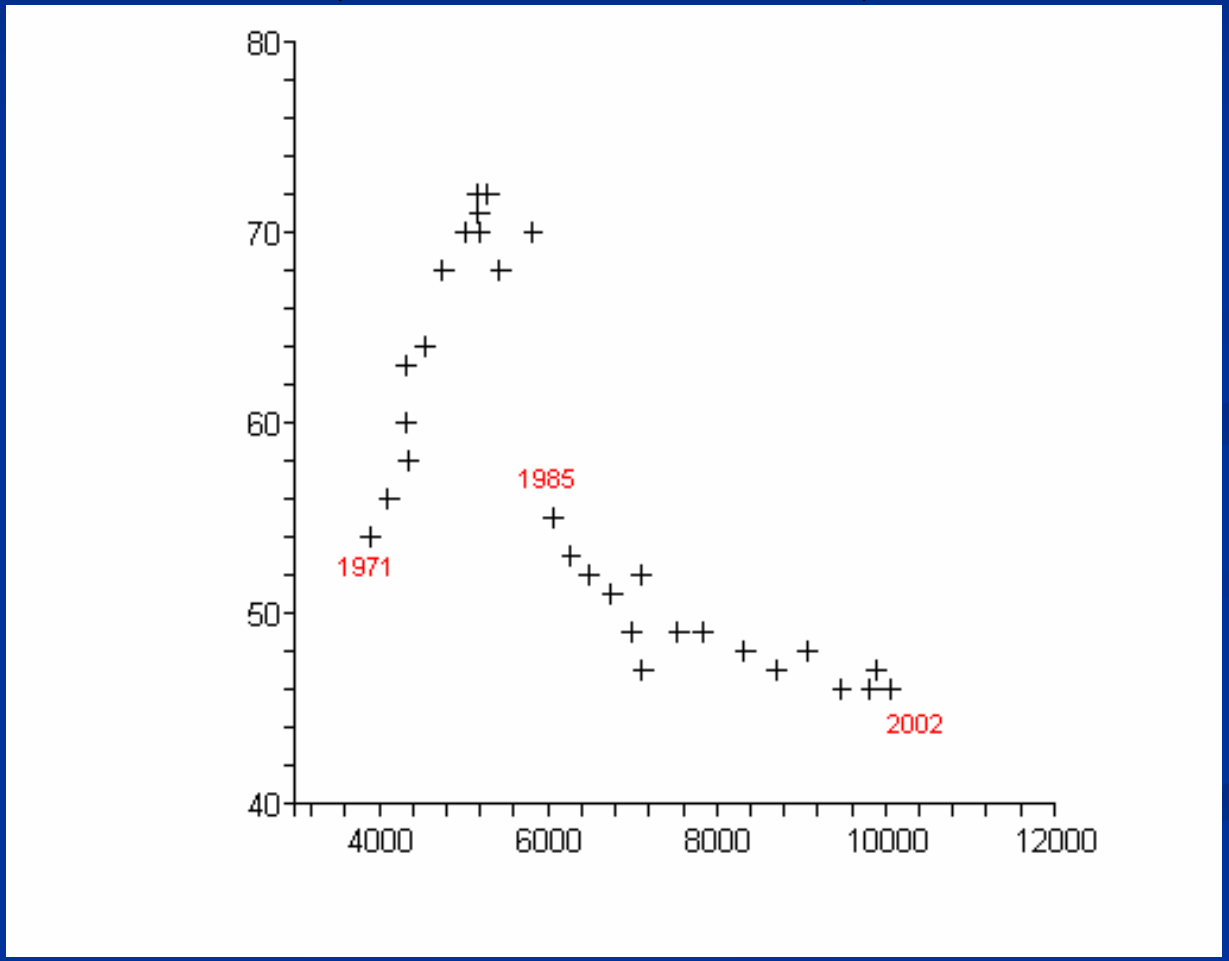
Regression Model Based on Emissions Data from 1970-2002:

(Petroleum Refineries Sector)

- **Equation of Regression Model:**
- ln(Y)= 4.22327 + 6.71e-6*X + -5.11142e-9*(X^2)
- Y=NOx Emissions from the Petroleum Refineries Sector (thousand short tons)
- X=Real Dollar GDP (billions of chained 2000 dollars)
- X^2=Real Dollar GDP*Real Dollar GDP
- R^2 Value= 0.5124

Analysis of Petroleum Refineries Sector: 1971-2002

(1992 Removed)



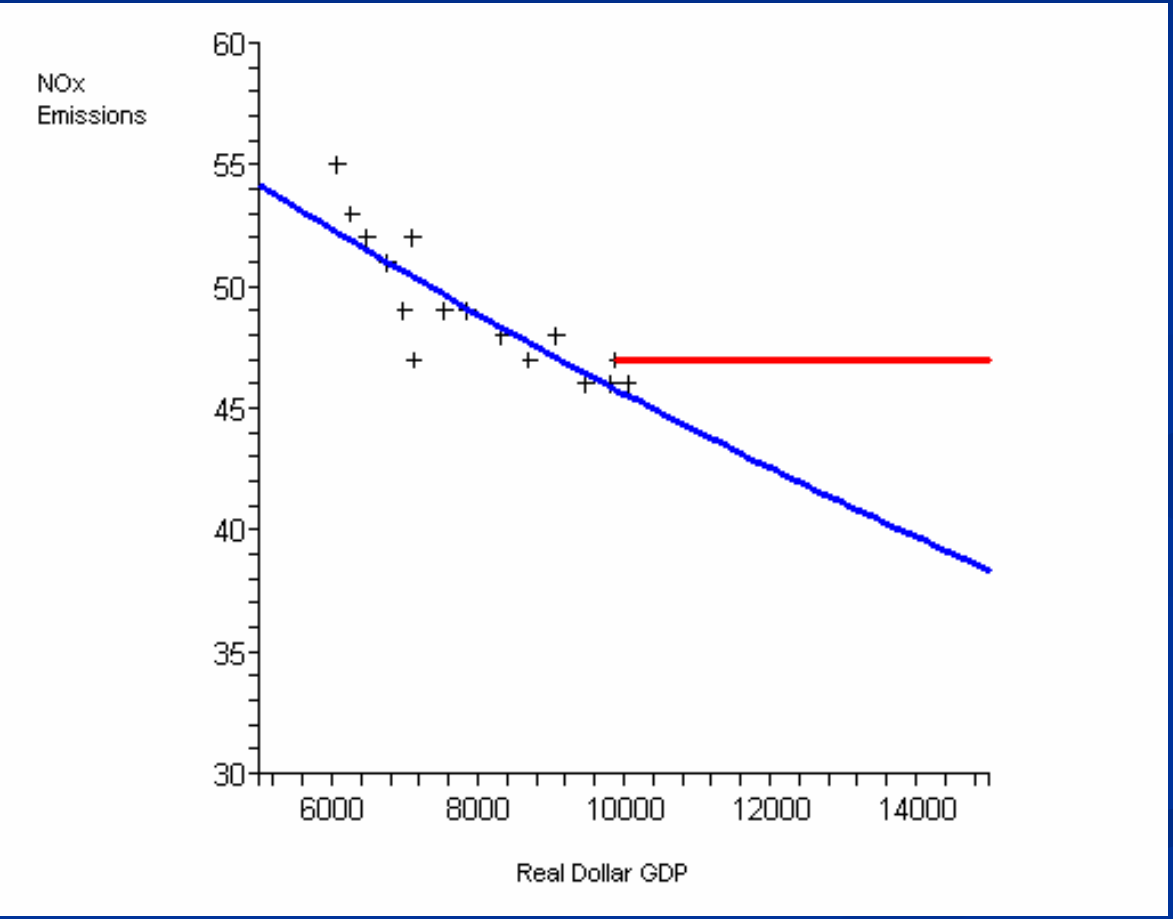
Observations About Petroleum Refineries Sector

- From 1971 to 1984 the data appear to be following one model
- After 1984 the data appear to be following a different model
- Doesn't make sense to fit one regression model to the entire set of data
- We chose instead to look at the data from 1985 until 2002

Possible Explanation of Petroleum Refineries Sector Data

- In 1973 the EPA began attempt to reduce the amount of lead in gasoline
- The plan was a gradual reduction in the amount of lead in gasoline to one tenth of a gram per gallon by 1986
- This could explain why the data changes around 1985 and 1986

Regression Model vs. Proposed EPA "Interim" Approach
(Petroleum Refineries Sector)

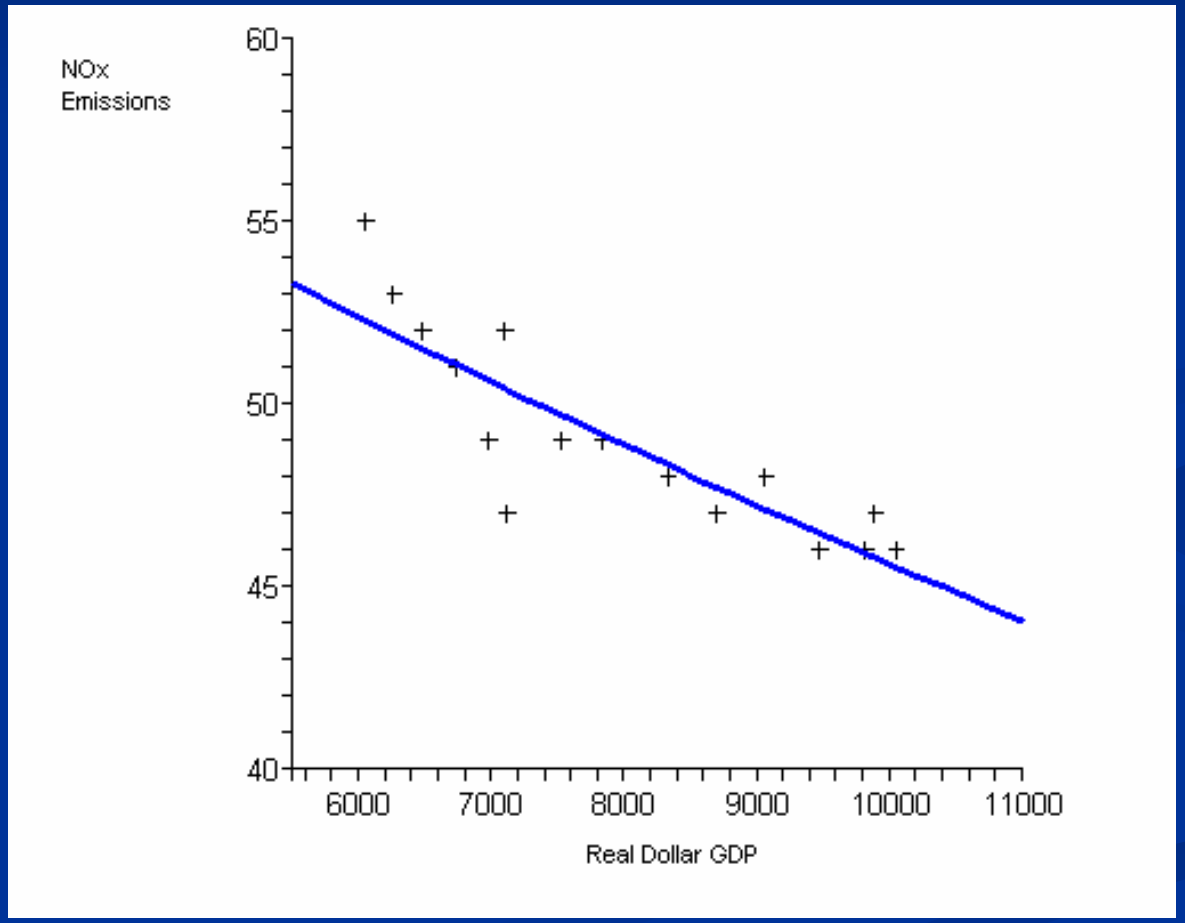


Regression Model vs. Proposed EPA Approach vs. Current EPA Approach

- KEY:
- Blue= Regression Model Based on Emissions Data from 1985-2002; (1992 removed)
- Red= Proposed EPA "Interim" Approach: Assumes no further increase or decrease in emissions

Regression Model Based on Emissions Data from 1985-2002:

(Petroleum Refineries Sector)



Regression Model Based on Emissions Data from 1985-2002:

(Petroleum Refineries Sector)

- **Equation of Regression Model:**
- ln(Y)= 4.16562+ -.00003454*X
- Y=NOx Emissions from the Petroleum Refineries Sector (thousand short tons)
- X=Real Dollar GDP (billions of chained 2000 dollars)
- R^2 Value= 0.7309

Phase 3:
President's Energy Plan

- Develop a Future Projection Model based upon the impact of the President's Energy Plan- 20 percent reduction in oil consumption by 2017 for the Petroleum Refineries Sector
- Key Assumption: A 20 percent reduction in oil consumption implies a 20 percent reduction in NOx Emissions for the Petroleum Refineries Sector

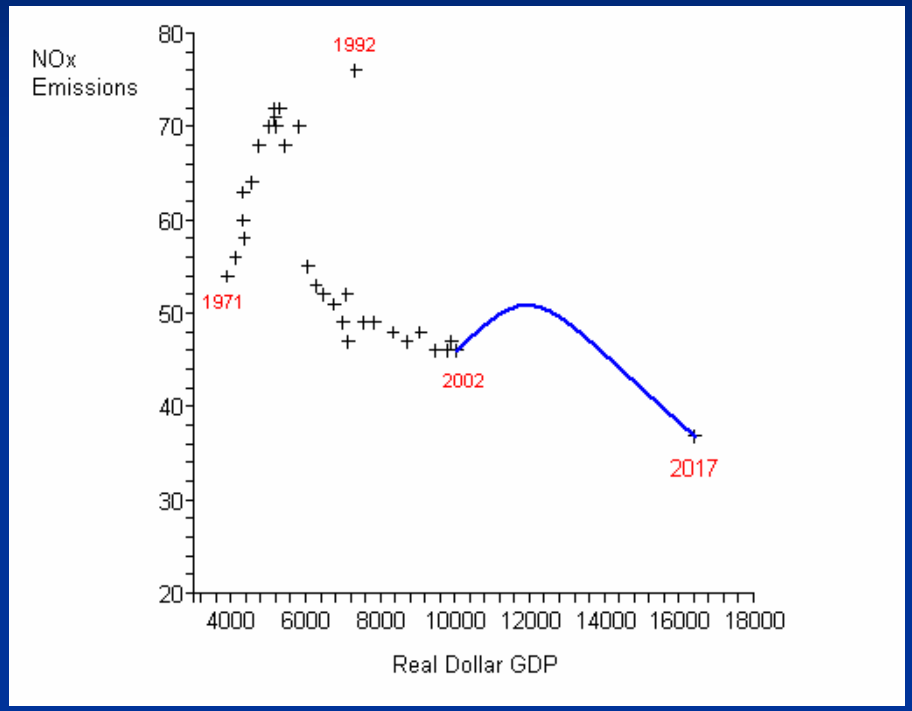
President's Energy Plan: Projected Models

- Assumptions:
  - No new refineries are created in the United States
  - Gas comes from overseas (India, Europe, etc.)
  - Cars become more fuel efficient
  - Ethanol, Bio-diesel, and Hybrids are used more frequently
  - Refined gasoline equals 80% of the 2007 total by 2017

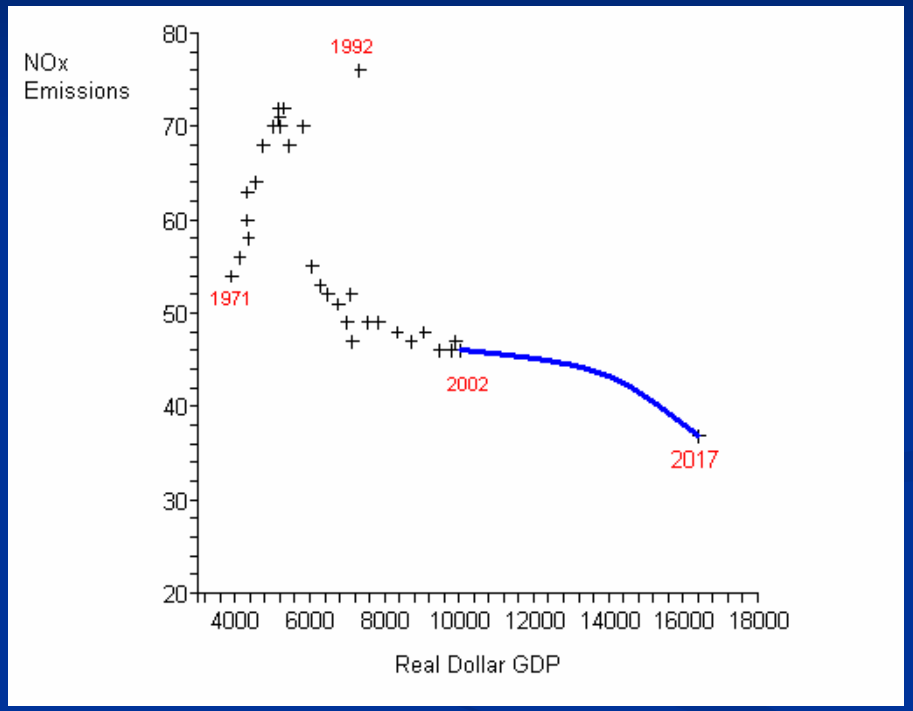
President's Energy Plan: Projected Models

- Model #1:
  - Assumptions:
    - Demand for gas grows in the short term and drives NOx Emissions higher than the 2007 level. Eventually the NOx Emissions decline until they reach 80% of the 2007 level by 2017
- Model #2:
  - Assumptions:
    - Demand for gas does not exceed the amount from 2007. Instead a slow decrease in NOx Emissions occur before reaching 80% of the 2007 level by 2017

President's Energy Plan: Projected Models



- **Model #1**



- **Model #2**

Note: GDP Projections based on data from USDA Economic Research Service

Recommendations:

- Chemical Manufacturing and Petroleum Refineries Sectors:
  - Investigate what technological innovations or new policies caused the growth of NOx emissions to remain fairly constant after 1990 in both of these sectors
- Choose a new Stationary Non-EGU sector to analyze
  - See if after 1990 the NOx emissions also become fairly constant and investigate possible reasons

Recommendations:

- Investigate effect of the Clean Air Act (CAA) Emission Controls on NOx emissions in all three sectors