The emission effects and the correlation between them and USA's GDP

MSc in

International and European Economic Studies

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1. Environmental standards

Attaining and maintaining clean air is an exceedingly difficult policy task. In the United States, for example, an estimated 27,000 major stationary sources of air pollution are subject to control as well as hundreds of thousands of more minor sources. Many distinct production processes emit many different types of pollutants.

The resulting damages range from minimal effects on plants and vegetation to the possible modification of the earth’s climate. The policy response to this problem has been continually evolving. The Clean Air Act Amendments of 1970 set a bold new direction that has been retained and refined by subsequent acts. By virtue of that act, the federal government assumed a much larger and much more vigorous direct role. The U.S. Environmental Protection Agency (EPA) was created to implement and oversee this massive attempt to control the injection of pollutants into the nation’s air. Individually tailored strategies were created to deal with mobile and stationary sources.

Conventional pollutants are relatively common substances, found in almost all parts of the country, and are thought, on the basis of research, to be dangerous only in high concentrations. In the United States, these pollutants are called criteria pollutants because the Act requires the EPA to produce “criteria documents” to be used in setting acceptable standards for these pollutants. These documents summarize and evaluate all of the existing research on the various health and environmental effects associated with these pollutants. The central focus of air pollution control during the 1970s was on criteria pollutants.

The Clean Air Act, which was last amended in 1990, requires EPA to set National Ambient Air Quality Standards (40 CFR part 50) for pollutants considered harmful to public health and the environment. The Clean Air Act identifies two types of national ambient air quality standards. **Primary standards** provide public health protection, including protecting the health of "sensitive" populations such as asthmatics, children, and the elderly. **Secondary standards** provide public welfare protection, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings.

Pollutant		Primary/ Secondary	Averaging Time	Level	Form
Carbon Monoxide (CO)		primary	8 hours	9 ppm	Not to be exceeded more than once per year
			1 hour	35 ppm	
Lead (Pb)		primary and secondary	Rolling 3 month average	0.15 µg/m3	Not to be exceeded
Nitrogen Dioxide (NO2)		primary	1 hour	100 ppb	98th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		primary and secondary	1 year	53 ppb	Annual Mean
Ozone (O3)		primary and secondary	8 hours	0.070 ppm	Annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years
	PM2.5	primary	1 year	12.0 µg/m3	annual mean, averaged over 3 years

Particle Pollution (PM)		secondary	1 year	15.0 μg/m3	annual mean, averaged over 3 years
		primary and secondary	24 hours	35 μg/m3	98th percentile, averaged over 3 years
	PM10	primary and secondary	24 hours	150 μg/m3	Not to be exceeded more than once per year on average over 3 years
Sulfur Dioxide (SO_2)		primary	1 hour	75 ppb	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		secondary	3 hours	0.5 ppm	Not to be exceeded more than once per year

2. Climate Change and Air Pollution

Air Pollution is the high concentration of air pollutants which harm the human health and the environment. In the recent years a lot of actions had been taken in order to decrease air pollutants' concentration that will lead to better air quality but still the concentration is too high. According to studies, more than 90% of people are exposed to pollutants at concentration higher than air quality levels leading from respiratory problems to premature death. For example, in European Union, studies show that the life expectancy is reduced by more than 8 months. Air pollution is also damaging the environment causing acidification (more CO_2 is absorbed into the oceans with an increase of 2 billion tonnes per year), eutrophication (a body of water becomes overly enriched with minerals and nutrients which induce excessive growth of algae) and crop damage.

Air Pollution can be caused either by anthropogenic or natural process. Examples of anthropogenic air pollution are fossil fuels combustion for electricity, transportation, industries and households, industrial processes which are used by chemical and mineral industries, agriculture and waste treatment. Natural pollution comes from volcanic eruptions, windblown dust, sea-salt and volatile organic compounds. According to IPCC more than a half of the increase in the global temperature was caused by anthropogenic forcing that led to a change in the global water cycle, surface melting of the Greenland ice, retreat of glaciers and decrease in snow cover, Arctic sea-ice loss, upper ocean warming and the rise of the global mean sea level around 20.3cm altering hydrological system affecting the quality and the quantity of the water.

Air pollution affected weather conditions causing extreme phenomena such as the number of cold days and nights to be decreased and the number of warm days and nights to be increased, an increase in the heat waves frequency and changes in the global surface temperature extremes which led to heat waves, droughts, floods, cyclones and wildfires. There's also a decrease in cold-related deaths and an increase in warm-related deaths. According to NASA, global temperature was increased by 1.1 degree Celsius since 1880, Arctic Ice minimum was reduced to 12.8% per decade, Ice Sheets were reduced to 413 gigatones per year, Carbon dioxide was increased by 410 parts per million and sea level was increased by 3.3 meters per year.

Scientists reported that if pollution continues the long-term effects will be that Earth will become warmer, the warmer conditions will result that some regions will become dryer while some other will be wetter, the sea level will rise due to the melt of the glaciers, some crops may extinct while others will respond favourably or change location, they're will be frost-free season, growing season will lengthen, hurricanes will be stronger and more intense of category 4 and 5 and Arctic will become ice-free.

There're two ways to respond to climate change, the first is mitigation and the second is adaptation. Mitigation is the human intervention to reduce and stabilize the levels of heat trapping greenhouse gases in the atmosphere in order to allow ecosystem to adapt naturally to climate change and enhance the sinks of greenhouse gases. The goal of mitigation is to avoid human interference with climate change in order to ensure that food production isn't threatened and enable economic development in a sustainable way. Adaptation is adapting life in a continuously changing climate which involves adjustment to actual or expected future climate such as managing extreme disasters, protection of coastal areas from sea-level rise, better management in land and forests, making plans for water availability, development of resilient crop varieties and protection of energy and public infrastructure.

2.1.Nitrogen oxides

Many chemical species of nitrogen oxides (NOx) exist, but the air pollutant species which affect human health is nitrogen dioxide (NO2). Nitrogen dioxide is soluble in water, reddish brown in colour, and a strong oxidant. Nitrogen dioxide is an important atmospheric trace gas, not only because it affects human health but also because (a) it absorbs visible solar radiation and contributes to impaired atmospheric visibility; (b) it's an absorber of visible radiation which it could have a potential direct role in global climate change if its concentrations were to become high enough; (c) it is, along with nitric oxide (NO), a chief regulator of the oxidizing capacity of the free troposphere by controlling the build-up and fate of radical species, including hydroxyl radicals; and (d) it plays a critical role in determining ozone (O3) concentrations in the troposphere because the photolysis of nitrogen dioxide is the only key initiator of the photochemical formation of ozone, whether in polluted or unpolluted atmosphere.

On a global scale, emissions of nitrogen oxides from human activities far outweigh those generated by natural sources. Natural sources include intrusion of stratospheric nitrogen oxides, bacterial, volcanic action and lightning. Although natural emissions are distributed over the entire surface of the earth, the resulting background of atmospheric concentrations are very small. The major source of anthropogenic emissions of nitrogen oxides into the atmosphere is the combustion of fossil fuels in stationary sources (heating, power generation) and in motor vehicles (internal combustion engines). Nitrogen oxides are found in the air through vehicle exhaust, emissions from coal-fired power plants and appliances that burn fossil fuels, cigarette's smoke, and secondhand smoke and in some consumable products such as cigarettes, vehicles and home heating appliances.

NOx and Human Health

Studies with animals have shown that several weeks to months of exposure to nitrogen dioxide concentrations of less than 1880 μg/m3 (1 ppm) causes a plethora of effects, primarily in the lungs but also in other organs such as the spleen and liver and in blood. Both reversible and irreversible lung effects have been observed. Structural changes range from a change in cell types in the tracheobronchial and pulmonary regions (lowest reported level 640 μg/m3) to emphysema-like effects (at concentrations much higher than ambient). Biochemical changes often reflect cellular alterations (lowest reported levels for several studies 380–750 μg/m3 (0.2–0.4 ppm) but isolated cases of lower effective concentrations). Nitrogen dioxide levels as low as 940 μg/m3 (0.5 ppm) also increase susceptibility to bacterial and viral infection of the lung. Children (5–12 years old) are estimated to have a 20% increased risk for respiratory symptoms and diseases for each increase in nitrogen dioxide concentration of 28.3 μg/m3 (2-week average) where the weekly average concentrations are in the range 15–128 μg/m3 or possibly higher. The observed effects, however, cannot clearly be attributed to one or another of either the repeated short-term high-level peak exposures or long-term exposures in the range of the stated weekly averages (or possibly both).

Small, statistically significant, reversible effects on lung function and airway responsiveness have been observed in mild asthmatics during a 30-minute exposure to nitrogen dioxide concentrations of 380–560 μg/m3 (0.2–0.3 ppm). The sequelae of repetitive exposures of such individuals or the impact of single exposures on more severe asthmatics are not known. In most animal experiments, however, 1–6 months of exposure to Nitrogen dioxide concentrations of 560–940 μg/m3 are required to produce changes in lung structure, lung metabolism and lung defences against bacterial infection. Thus, it is prudent to avoid exposures in humans, because repetitive exposures in animals lead to adverse effects.

Animal toxicology studies of lung host defence and morphology suggest that peak concentrations contribute more to the toxicity of nitrogen dioxide than does duration, although duration is still important. Nitrogen dioxide puts children at increased risk for respiratory illness. This is of concern because repeated lung infections in children can cause lung damage later in life.

NOx and the Environment

High levels of NOx can have a negative effect on vegetation, including leaf damage and reduced growth. It can make vegetation more susceptible to disease and frost damage. A study of the effect of nitrogen dioxide and ammonia (NH3) on the habitat of Epping Forest has revealed that the pollution is likely to significantly influence ecosystem's health in the forest. The study demonstrated that local traffic emissions contribute substantially to the exceeding of the critical levels and critical loads in the area. The critical level for the protection of vegetation is 30 μg/m3 measured as an annual average. NOx also reacts with other pollutants in the presence of sunlight to form ozone which can damage vegetation at high concentrations.

More environmental problems are caused by NOx pollution. In the presence of rain, nitrogen oxides form nitric acid, contributing to the acid rain problem. Additionally, NOx deposition in the oceans provides phytoplankton with nutrients, worsening the problem of red tides and other harmful algae blooms.

2.2. Sulphur Oxides

Sulphur dioxide (SO2) at high concentration is considered one of the indicators of decreasing air quality. It is formed primarily from the combustion of sulphur-containing fuels, it can affect the human health and it has a negative impact on the environment. On concentration from 800 to 2600 mg/m3, SO2 has a characteristic odour. Emissions of sulphur compound are significantly higher in winter than in summer period, because of the use of fossil fuels for house heating. Winter smog appears most frequently in central, south and south-east Europe. Government in these regions led a campaign in order to decrease the use of vehicles in central city parts. Concentration of this air pollutant in west-European cities significantly decreased from 1970's and then.

Urban and industrial regions have higher concentrations of sulphur dioxide where the rated concentration in urban areas is 0.01-0.02 ppm, but momentary concentration can be much higher. One-hour concentration can be bigger than 4-7 times of the rated annual concentration. Cities which have rated concentration from 0, 10 ppm can expect concentrations from 0.4-0.7 ppm in most adverse days and 1-2 ppm in most adverse hours. Concentrations of sulphur dioxide from 1 ppm do not result visible reaction. Higher concentration is irritable and concentration of more than 10 ppm can cause eye conjunctivitis and seriously irritation of mucous tissues and respiratory organs. Concentrations from 400 to 500 ppm (accidental concentration) are very dangerous and can be lethal. As maximal allowed concentration is 150 mg/m3. The greatest problem is the existence of synergism between sulphur and most of the other pollution materials.

SO2 and Human Health

Exposure to sulphur dioxide in the ambient air has been associated with reduced lung function, increased incidence of respiratory symptoms and diseases, irritation of the eyes, nose, and throat, and premature mortality. Children, the elderly, and those already suffering from respiratory ailments, such as asthmatics, are at high risk. Impacts in human health appear to be linked especially to brief exposures to ambient concentrations above 1,000 µg/ m3 (acute exposures measured over 10 minutes). Some epidemiologic studies, however, have shown an association between relatively low annual mean levels and excess mortality. It is not clear whether long-term effects are related simply to annual mean values or to repeated exposures to peak values.

Sulphur Oxides and the Environment

Sulphur oxide emissions cause adverse impacts to vegetation, including forests and agricultural crops. Studies in the United States and elsewhere have shown that plants exposed to high ambient concentrations of sulphur dioxide may lose their foliage, become less productive, or die prematurely. Some species are much more sensitive to exposure than others. Plants in the immediate vicinity of emissions sources are more vulnerable. Studies have shown that the most sensitive species of plants begin to demonstrate visible signs of injury at concentrations of about 1,850 µg/m3 for 1 hour, 500 µg/m3 for 8 hours, and 40 µg/m3 for the growing season (Smith 1981, cited in NAPAP 1990). In studies carried out in Canada, chronic effects on pine forest growth were prominent where concentrations of sulphur dioxide in air averaged 44 µg/m3.

2.3. Carbon Dioxide

Carbon dioxide (CO2) is one of the gases in our atmosphere and it is generated both by natural processes and human activities. Commercially, CO2 is used as a refrigerant (dry ice is solid CO2), in beverage carbonation, and in fire extinguishers. Most of the commercial CO2 is recovered as a by-product of other processes, such as the production of ethanol by fermentation and the manufacture of ammonia. Carbon dioxide is released into our atmosphere when carbon-containing fossil fuels such as oil, natural gas, and coal are burning. As a result of the tremendous world-wide consumption of such fossil fuels, the amount of CO2 in the atmosphere has increased over the past two centuries, now rising at a rate of about 2-3 ppm per year.

The release of CO2 from Construction, Technology, and Steel sites that produce relatively low ambient concentrations of CO2 for prolonged periods, high concentrations of CO2 in relatively anoxic environments (which could result from a catastrophic release) for short periods, and intermediate concentrations of CO2 under normoxic or hypoxic conditions could pose health risks for human population. The release of CO2 in a significant amount is especially hazardous because CO2 is colourless and odourless unless it is present at very high concentrations over 40%. Identification of CO2 intoxication is generally by the exclusion of other toxicants and disease conditions because symptomology is not unique to CO2. Preliminary evaluation of CO2 effects in human populations suggests that acute exposure to CO2 concentrations under 3% and prolonged exposure to concentrations under 1% may significantly affect health in the general population.

CO2 and Sensitive Populations

The following is a preliminary identification of some human populations potentially sensitive to the effects of CO_2. The CO_2 concentration and the O_2 concentration can interact in these and other human populations to alter responses to CO_2. Cerebral Disease & Trauma Patients: CO_2 is a very potent cerebrovascular dilator. For each 1 mm Hg change in $PaCO_2$, CBF globally increases by 1-2 mL/100 g-min. CO_2 exposure can seriously compromise patients in coma or with head injury, increased intracranial pressure or bleeding or expanding lesions. Elevation of $PaCO_2$ can further dilate cerebral vessels already dilated by anoxia.

Individuals Performing Complex Tasks: CO_2 can significantly diminish performance on tasks requiring psychomotor coordination, visual perception, attention and rapid response.

Infants & Children: Infants and children breathe more air than adults relative to their body size and thus they tend to be more susceptible to respiratory exposures. The vasodilator effects and enhanced ventilation could contribute to rapid loss of body heat.

Medicated Patients: Respiratory centre stimulation by CO_2 is depressed by anoxia and by various drugs such as alcohol, anaesthetics, morphine, barbiturates, etc. In these cases, compensatory mechanisms do not protect and symptomology does not alert the individual to the presence of high CO_2 levels.

Panic Disorder Patients: Panic disorder patients experience an increased frequency of panic attacks at 5% CO_2. Anxiety and somatic symptoms also are significantly increased and are similar to those experienced by healthy subjects exposed to 7.5% CO_2. Panic attack and significant anxiety can affect the ability of the individual to exercise appropriate judgment in dangerous situations.

Pulmonary & Coronary Disease Patients: CO_2 exposure can increase pulmonary pressure as well as systemic blood pressure and should be avoided in individuals with systemic or pulmonary hypertension. The rise in cardiac work during CO_2 inhalation could jeopardize patients with coronary artery disease and those with heart failure.

CO_2 and the Environment

Carbon dioxide is a naturally occurring gas, a by-product of burning fossil fuels and biomass and a result of land-use changes and other industrial processes. It is the principal anthropogenic gas that is considered to affect the Earth's radiative balance (IPCC, 2007). For this reason, it is believed that there is a close correlation between CO_2 and the change of the Earth's temperature. The way this relation has been established is largely based on plotting the average temperature anomalies and the amount of CO_2 present in the atmosphere versus time. According to studies one can see that from 1850's to 1910's the temperature gradient is essentially 0, then there is an increase in the temperature gradient for the next 30 years, from 1940's to 1980's the gradient is again essentially 0 and finally, there is a definite increase of about 0.6 °C in the mean global temperature since 1980's.

2.4. Carbon Monoxide

Carbon monoxide (CO) is a non-irritating, colourless, odourless gas produced by incomplete burning of carbon containing fossil fuels. The normal concentration in atmosphere is less than 0.001% and a concentration of 0.1% can be lethal. CO causes thousands of sudden deaths each year. Patients who survive the initial poisoning can develop delayed neurologic dysfunction, which occurs in 14-40% of serious cases. CO is commonly encountered as a poison in our environment and a leading cause of poisoning worldwide. Poisoning can be acute, subacute and chronic. The Carbon Monoxide appears with a variety of things such as oil, wood, or gas furnaces/boilers, space heaters (kerosene heaters), gas or oil water heaters, gas stoves, gas dryers, fireplaces and wood stoves, charcoal grills, automobiles, lawn mowers, leaf blowers, snowmobiles, and other gas-powered equipment.

CO and Human Health

The exposure in high rates of carbon monoxide can affect lungs both in morphology and lung function. Chevalier et al. (1966) exposed 10 subjects to 5700 mg carbon monoxide/m3 (5000 ppm) for 2–3 min until carboxyhaemoglobin levels reached 4%. Measurements of pulmonary function and exercise studies were performed before and after exposure. Inspiratory capacity and total lung capacity decreased 7.5% ($P< 0.05$) and 2.1% ($P < 0.02$), respectively, whereas maximum breathing capacity increased 5.7% ($P < 0.05$) following exposure. In addition, high rates of carbon monoxide cause changes in behaviour in humans. Based on meta-analysis of Benignus (1994), 18–25% carboxyhaemoglobin levels in healthy sedentary persons would be required to produce a 10% decrement in behaviour. Other problems relate to vision motor and sensorimotor performance vigilance.

2.5. Greenhouse Gasses

Many chemical compounds in the atmosphere act as greenhouse gases. These gases allow sunlight (shortwave radiation) to freely pass through the Earth's atmosphere in order to heat the land and oceans and the warmed Earth releases this heat in the form of infrared light (longwave radiation), invisible to human eyes.

Some of the infrared light released by the Earth passes through the atmosphere back into space. However, greenhouse gases will not let all the infrared light pass through the atmosphere; they absorb some and radiate it back down to the Earth. This phenomenon is called the greenhouse effect which is naturally occurring and keeps the Earth's surface warm, that's why it is vital to our survival on Earth. Without the greenhouse effect, the Earth's average surface temperature would be about 60° Fahrenheit colder (15,56 C), and our current way of life would be impossible. We know that several gases in the atmosphere can absorb heat and these greenhouse gases are produced both by natural processes and by human activities. The primary ones are Carbon dioxide (CO_2), Methane (CH_4), Nitrous oxide (N_2O) and industrial gases, including hydrofluorocarbons, perfluorocarbons, and Sulphur hexafluoride.

Water vapour is the most abundant greenhouse gas and plays an important role in regulating the climate. Changes in water vapour from human activities such as irrigation and deforestation can directly affect temperatures at the Earth's surface. However, because human emissions of water vapour do not significantly change water vapour levels in the atmosphere, water vapour is not counted in the United States or international greenhouse gas inventories.

3. The Economy of United States of America

The US has the most technologically powerful economy in the world, with a per capita GDP of $57,300. US firms are at or near the forefront in technological advances, especially in computers, pharmaceuticals, and medical, aerospace, and military equipment; however, their advantage has narrowed since the end of World War II. Based on a comparison of GDP measured at purchasing power parity conversion rates, the US economy in 2014, having stood as the largest in the world for more than a century, slipped into second place behind China, which has more than tripled the US growth rate for each year of the past four decades.

In the US, private individuals and business firms make most of the decisions, and the federal and state governments buy needed goods and services predominantly in the private marketplace. US business firms enjoy greater flexibility than their counterparts in Western Europe and Japan in decisions to expand capital plant, to lay off surplus workers, and to develop new products. At the same time, businesses face higher barriers to enter their rivals' home markets than foreign firms face entering US markets.

Real Estate, renting, and leasing constitutes the largest sector of the United States' economy with the GDP value added of $1.898 trillion accounting for 13% of the national GDP. The sector contributes to the economy in two fronts; the first being through consumer spending through rent and payment of household utilities, and the other being through residential investment which encompasses the construction of new housing units, broker fees, and residential remodeling. Also known as the housing sector, the industry plays an integral role in the US economy and the industry's impact was best displayed during the 2008 recession where a nationwide decline in home prices triggered America's worst economic recession in the 21st century. The housing sector also plays a critical role in employment with over 1.9 million people working in the real estate, renting and leasing industry.

The State and Local Government have a combined GDP value added of $1.336 trillion to become the second largest GDP contributor representing 9% of the total US GDP. Government spending is classified into two components government investment and government final consumption expenditure. Government investment is defined as the government spending used to finance projects with future or long-term benefits such as spending on research as well as spending on infrastructure. Government final consumption, on the other hand, is the government's spending on items for direct consumption. State and local government spending are usually financed through taxation or domestic and international borrowing.

The Finance and Insurance sector is another top GDP contributor in the United States with the industry having a GDP value added of $1.159 trillion which is equivalent to 8% of the total GDP. The Finance and Insurance industry is made up of four distinct sectors which include insurance carriers, credit intermediation and Federal Reserve banks, commodity contracts and securities, and trusts and funds and other financial vehicles. The growth of the finance and insurance industry is critical to the US economy as it helps in the facilitation of US exports. The industry is also estimated to directly employ over 5 million people in the United States which is equivalent to 4% of the nation's total employment.

The Health and Social Care industry in the country has a GDP value added of $1.136 trillion and represents 8% of the national GDP. Healthcare, in particular, was a key component of the two sectors with America's spending on healthcare per capita being the largest in the world at $8,608. Increasing obesity and non-communicable diseases such as cancer saw Americans spending more on curative, rehabilitative, and preventative care.

Durable Manufacturing is classified as the manufacturing sector engaged in the production of durable products such as computers, automobiles, firearms, sports equipment, house appliances, and aircraft which are characterized by long durations between purchases and are usually rentable. The durable manufacturing industry in the United States has a GDP value added of $910 billion which represents 6% of the national GDP. The sector is highly volatile and is affected by local and international factors such as global oil prices as well as the performance of the US dollar on international money markets. The durable manufacturing industry plays a significant role in employment in the US economy with over 349,000 of Americans being either directly or indirectly employed in the industry.

The retail trade industry in the United States has a GDP value added of $905 billion which is equivalent to 6% of the total GDP. The industry encompasses the retailing process which is the final stage in the distribution of commodities to the final consumer. The retail industry features fixed store retailers which are characterized by walk-in by customers who purchase merchandise for household or personal consumption. The retail industry is the largest employer in the United States economy with the sector being responsible for 10% of the total employment in the country. Data from the National Retail Federation shows that the industry accounts directly or indirectly for over 15 million jobs. The sector also features online retailers such as Amazon and eBay who make millions of dollars in sales each day.

Wholesale Trade involves the bulk distribution of commodities from producers to retailers or bulk consumers such as institutions and other wholesalers. Wholesalers are characterized by not spending on advertising targeted to the general public, and they do not have their own premises. Similarly, they are not designed for walk-in customers. The Wholesale industry in the United States has a GDP value added of $845 billion which is equivalent to 6% of the total GDP. The industry is also a significant employer with over 5.7 million people or 4% of total employment in the US being employed in wholesale trade.

The non-durable manufacturing industry is involved in the production of nondurable commodities, which may be defined as all products with a lifespan of less than three years and include gasoline, electricity, and clothing among others. Non-durable manufacturing is an important economic pillar in the United States and has a GDP value added of $821 billion which translates to 6% of the national GDP. While the non-durable manufacturing sector is less valuable than durable manufacturing, it employs way more people than durable manufacturing accounting for 4.4 million jobs compared to 349,000 jobs from durable manufacturing.

The Federal Government comes in ninth position with a GDP value added of $658 billion which accounts for 5% of the total GDP. The Federal Government is a key employer in the economy and employs about 2.795 million Americans who are employed by the Federal Government. Healthcare, social security, and education take up the lion’s share of Federal Government investments accounting 25%, 24%, and 15% of the annual investments respectively.

The Information industry encompasses companies and institutions which engage in the production, transmission, processing, storing, and selling of information which includes media companies, data processing companies, law firms, and telephone companies among others. The information industry is a key pillar of the US economy and has GDP value added of $646 billion which is equivalent to 4% of the total GDP. The sector is responsible for the employment of 2% of the total labor force in the United States totaling about 2.7 million jobs.

Imported oil accounts for nearly 55% of US consumption and oil has a major impact on the overall health of the economy. Crude oil prices doubled between 2001 and 2006, the year home prices peaked; higher gasoline prices ate into consumers' budgets and many individuals fell behind in their mortgage payments. Oil prices climbed another 50% between 2006 and 2008, and bank foreclosures more than doubled in the same period. Besides dampening the housing market, soaring oil prices caused a drop in the value of the dollar and a deterioration in the US merchandise trade deficit, which peaked at $840 billion in 2008. Because the US economy is energy-intensive, falling oil prices since 2013 have alleviated many of the problems the earlier increases had created.

Long-term problems for the US include stagnation of wages for lower-income families, inadequate investment in deteriorating infrastructure, rapidly rising medical and pension costs of an aging population, energy shortages, and sizable current account and budget deficits.

4. The connection between Air emissions and USA’s GDP

4.1. Carbon dioxide (CO_2)

First, we correlate USA's GDP and Carbon dioxide two times for different periods (1970-2016 and 1970-2006). In the first correlation we notice that both the coefficient of determination (R^2, the proportion of total variation of outcomes explained by the model) and adjusted R^2 are under 0,5 which means that the coefficients are too weak.

ΈΞΟΔΟΣ ΣΥΜΠΕΡΑΣΜΑΤΟΣ

Στατιστικά παλινδρόμησης	
Πολλαπλό R	0,664055335
R Τετράγωνο	0,440969487
Προσαρμοσμένο R Τετράγωνο	0,428546587
Τυπικό σφάλμα	344,8778244
Μέγεθος δείγμα	47

ΑΝΑΛΥΣΗ ΔΙΑΚΥΜΑΝΣΗΣ

	βαθμοί ελευθερίας	*SS*	*MS*	*F*	*Σημαντικότητα F*
Παλινδρόμηση	1	4221979,118	4221979	35,4965	3,60558E-07
Υπόλοιπο	45	5352332,12	118940,7		
Σύνολο	46	9574311,238			

	Συντελεστές	*Τυπικό σφάλμα*	*t*	*τιμή-P*	*Κατώτερο 95%*	*Υψηλότερο 95%*	*Κατώτερο 95,0%*	*Υψηλότερο 95,0%*
Τεταγμένη επί την αρχή	4522,93104	90,44205757	50,00916	4,39E-41	4340,771386	4705,090695	4340,771386	4705,090695
Μεταβλητή X 1	5,5605E-05	9,333E-06	5,957894	3,61E-07	3,68074E-05	7,44026E-05	3,68074E-05	7,44026E-05

On the other hand, on the second correlation for CO2 the coefficient of determination and adjusted R^2 are over 0,8 which means that the correlation until 2006 between CO2 and real GDP are too strong. That difference can only be explained through the latest technology which separates the growth of GDP from CO2 consumption.

ΈΞΟΔΟΣ ΣΥΜΠΕΡΑΣΜΑΤΟΣ

Στατιστικά παλινδρόμησης	
Πολλαπλό R	0,914495333
R Τετράγωνο	0,836301714
Προσαρμοσμένο R Τετράγωνο	0,831877436
Τυπικό σφάλμα	1698813,593
Μέγεθος δείγμα	39

ΑΝΑΛΥΣΗ ΔΙΑΚΥΜΑΝΣΗΣ

	βαθμοί ελευθερίας	*SS*	*MS*	*F*	*Σημαντικότητα F*
Παλινδρόμηση	1	5,45522E+14	5,46E+14	189,0256	4,08682E-16
Υπόλοιπο	37	1,06781E+14	2,89E+12		
Σύνολο	38	6,52303E+14			

	Συντελεστές	*Τυπικό σφάλμα*	*t*	*τιμή-P*	*Κατώτερο 95%*	*Υψηλότερο 95%*	*Κατώτερο 95,0%*	*Υψηλότερο 95,0%*
Τεταγμένη επί την αρχή	-31573172,95	2768764,241	-11,4033	1,14E-13	-37183222,18	-25963123,71	-37183222,18	-25963123,71
Μεταβλητή X 1	7643,848491	555,9705421	13,74866	4,09E-16	6517,345169	8770,351813	6517,345169	8770,351813

4.2. Carbon monoxide (CO)

In our second correlation we use the Carbon monoxide with USA GDP. There the coefficient of determination and adjusted R^2 are over 95% which means which means almost all movements of GDP are completely explained by movements of Carbon monoxide.

ΈΞΟΔΟΣ ΣΥΜΠΕΡΑΣΜΑΤΟΣ

Στατιστικά παλινδρόμησης	
Πολλαπλό R	0,978665405
R Τετράγωνο	0,957785975
Προσαρμοσμένο R Τετράγωνο	0,956162359
Τυπικό σφάλμα	5650,931018
Μέγεθος δείγματος	28

ΑΝΑΛΥΣΗ ΔΙΑΚΥΜΑΝΣΗΣ

	βαθμοί ελευθερίας	SS	MS	F	Σημαντικότητα F
Παλινδρόμηση	1	18837578278	1,88E+10	589,909	2,13747E-19
Υπόλοιπο	26	830258555,5	31933021		
Σύνολο	27	19667836834			

	Συντελεστές	Τυπικό σφάλμα	t	τιμή-P	Κατώτερο 95%	Υψηλότερο 95%	Κατώτερο 95,0%	Υψηλότερο 95,0%
Τεταγμένη επί την αρχή	157418,7645	3325,354576	47,33894	9,26E-27	150583,4003	164254,1288	150583,4003	164254,1288
Μεταβλητή X 1	-0,006314218	0,000259972	-24,288	2,14E-19	-0,006848599	-0,005779838	-0,006848599	-0,005779838

4.3. Nitrogen oxides (NOx)

The following correlation is between Nitrogen oxides and USA GDP. We notice that both R-squared and adjusted R^2 are near 100%. So, like the Carbon monoxide the Nitrogen oxides movements explains all movements of GDP.

ΈΞΟΔΟΣ ΣΥΜΠΕΡΑΣΜΑΤΟΣ

Στατιστικά παλινδρόμησης	
Πολλαπλό R	0,970829761
R Τετράγωνο	0,942510426
Προσαρμοσμένο R Τετράγωνο	0,940299288
Τυπικό σφάλμα	1136,553836
Μέγεθος δείγματος	28

ΑΝΑΛΥΣΗ ΔΙΑΚΥΜΑΝΣΗΣ

	βαθμοί ελευθερί	SS	MS	F	Σημαντικότητα F
Παλινδρόμηση	1	550618046,5	5,51E+08	426,25591	1,19358E-17
Υπόλοιπο	26	33585620,15	1291755		
Σύνολο	27	584203666,7			

	Συντελεστές	Τυπικό σφάλμα	t	τιμή-P	Κατώτερο 95%	Υψηλότερο 95%	Κατώτερο 95,0%	Υψηλότερο 95,0%
Τεταγμένη επί την αρχή	30854,7874	668,8180207	46,13331	1,797E-26	29480,01227	32229,56253	29480,01227	32229,56253
Μεταβλητή X 1	-0,00107952	5,22874E-05	-20,646	1,194E-17	-0,001187002	-0,000972046	-0,001187002	-0,000972046

4.4. Volatile organic compounds (VOC)

The next correlation is between Volatile organic compounds and GDP of USA. In that the coefficient of determination and adjusted R^2 are over 0,8 which means that the correlation until 2006 between CO2 and real GDP are too strong.

ΈΞΟΔΟΣ ΣΥΜΠΕΡΑΣΜΑΤΟΣ

Στατιστικά παλινδρόμησης	
Πολλαπλό R	0,925817963
R Τετράγωνο	0,857138901
Προσαρμοσμένο R Τετράγωνο	0,851644244
Τυπικό σφάλμα	1053,398923
Μέγεθος δείγματος	28

ΑΝΑΛΥΣΗ ΔΙΑΚΥΜΑΝΣΗΣ

	βαθμοί ελευθερίας	*SS*	*MS*	*F*	*Σημαντικότητα F*
Παλινδρόμηση	1	173099697,4	1,73E+08	155,995	1,71824E-12
Υπόλοιπο	26	28850881,56	1109649		
Σύνολο	27	201950579			

	Συντελεστές	*Τυπικό σφάλμα*	*t*	*τιμή-P*	*Κατώτερο 95%*	*Υψηλότερο 95%*	*Κατώτερο 95,0%*	*Υψηλότερο 95,0%*
Τεταγμένη επί την αρχή	23073,10798	619,8845673	37,22162	4,4E-24	21798,917	24347,29896	21798,917	24347,29896
Μεταβλητή X 1	-0,000605278	4,84618E-05	-12,4898	1,72E-12	-0,000704893	-0,000505664	-0,000704893	-0,000505664

4.5. Greenhouse gas (GHG)

The following correlation is between Greenhouse gasses and USA GDP for two periods (from 1990 to 2017 and from 1990 to 2008). In the first correlation both the coefficient of determination and adjusted are R^2 close to zero which means that there is no correlation between those two variables.

ΈΞΟΔΟΣ ΣΥΜΠΕΡΑΣΜΑΤΟΣ

Στατιστικά παλινδρόμησης	
Πολλαπλό R	0,063057425
R Τετράγωνο	0,003976239
Προσαρμοσμένο R Τετράγωνο	-0,034332367
Τυπικό σφάλμα	333120,2715
Μέγεθος δείγματος	28

ΑΝΑΛΥΣΗ ΔΙΑΚΥΜΑΝΣΗΣ

	βαθμοί ελευθερίας	*SS*	*MS*	*F*	*Σημαντικότητα F*
Παλινδρόμηση	1	11518030713	1,15E+10	0,103795	0,749898466
Υπόλοιπο	26	2,8852E+12	1,11E+11		
Σύνολο	27	2,89672E+12			

	Συντελεστές	*Τυπικό σφάλμα*	*t*	*τιμή-P*	*Κατώτερο 95%*	*Υψηλότερο 95%*	*Κατώτερο 95,0%*	*Υψηλότερο 95,0%*
Τεταγμένη επί την αρχή	6803073,266	196028,4094	34,70453	2,62E-23	6400131,099	7206015,432	6400131,099	7206015,432
Μεταβλητή X 1	0,004937376	0,01532527	0,322172	0,749898	-0,026564167	0,036438919	-0,026564167	0,036438919

At the second correlation both the R-squared and adjusted R-squared are near 80% which means that the correlation until 2006 between CO2 and real GDP are too strong. The only logic explanation between those two correlations is the technological effect in Greenhouse Gasses.

ΈΞΟΔΟΣ ΣΥΜΠΕΡΑΣΜΑΤΟΣ

Στατιστικά παλινδρόμησης	
Πολλαπλό R	0,897997838
R Τετράγωνο	0,806400117
Προσαρμοσμένο R Τετράγωνο	0,795011888
Τυπικό σφάλμα	158581,5011
Μέγεθος δείγματς	19

ΑΝΑΛΥΣΗ ΔΙΑΚΥΜΑΝΣΗΣ

	βαθμοί ελευθερίας	*SS*	*MS*	*F*	*Σημαντικότητα F*
Παλινδρόμηση	1	1,78074E+12	1,78E+12	70,80997	1,82142E-07
Υπόλοιπο	17	4,27518E+11	2,51E+10		
Σύνολο	18	2,20825E+12			

	Συντελεστές	*Τυπικό σφάλμα*	*t*	*τιμή-P*	*Κατώτερο 95%*	*Υψηλότερο 95%*	*Κατώτερο 95,0%*	*Υψηλότερο 95,0%*
Τεταγμένη επί την αρχή	5867813,001	134171,1564	43,73379	6,52E-19	5584736,605	6150889,397	5584736,605	6150889,397
Μεταβλητή X 1	0,110281305	0,013105533	8,414866	1,82E-07	0,082631047	0,137931563	0,082631047	0,137931563

4.6. Sulphur oxides (SOx)

Finally, we correlate the SOx with USA's GDP. The R-squared is near 100% which means that all movements of GDP are completely explained by movements of Sulphur oxides.

ΈΞΟΔΟΣ ΣΥΜΠΕΡΑΣΜΑΤΟΣ

Στατιστικά παλινδρόμησης	
Πολλαπλό R	0,984873054
R Τετράγωνο	0,969974932
Προσαρμοσμένο R Τετράγωνο	0,968820122
Τυπικό σφάλμα	1062,738806
Μέγεθος δείγματς	28

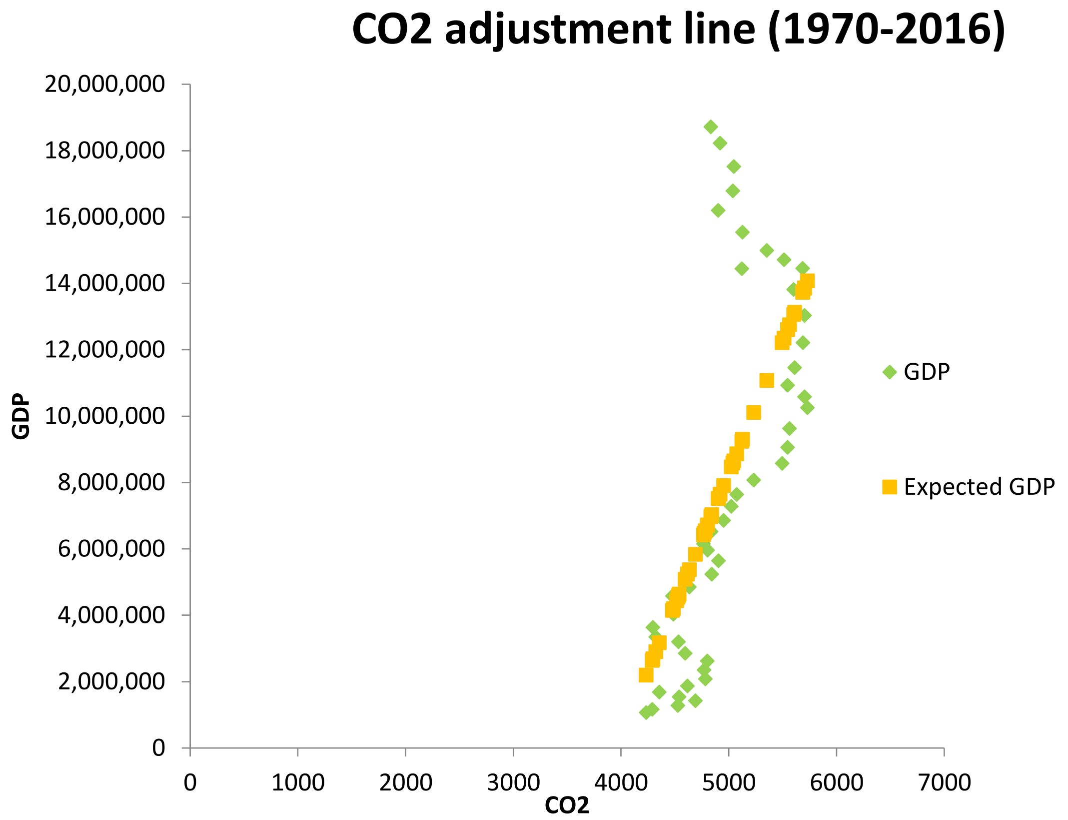
ΑΝΑΛΥΣΗ ΔΙΑΚΥΜΑΝΣΗΣ

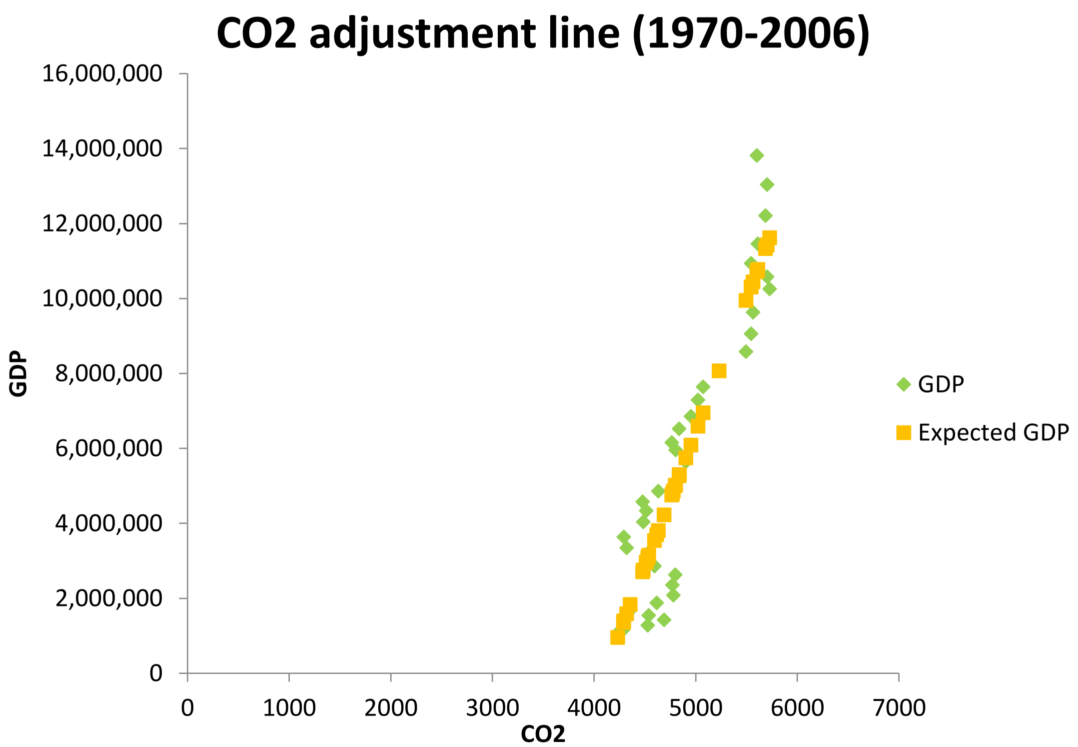
	βαθμοί ελευθερία	*SS*	*MS*	*F*	*Σημαντικότητα F*
Παλινδρόμηση	1	948643292,8	9,49E+08	839,9431	2,53344E-21
Υπόλοιπο	26	29364758,02	1129414		
Σύνολο	27	978008050,8			

	Συντελεστές	*Τυπικό σφάλμα*	*t*	*τιμή-P*	*Κατώτερο 95%*	*ηλότερο 9:*	*Κατώτερο 95,0%*	*Υψηλότερο 95,0%*
Τεταγμένη επί την αρχή	29324,0685	625,3807277	46,88995	1,18E-26	28038,58	30609,56	28038,58	30609,55699
Μεταβλητή X 1	-0,001416963	4,88915E-05	-28,9818	2,53E-21	-0,001517461	-0,00132	-0,001517461	-0,001316465

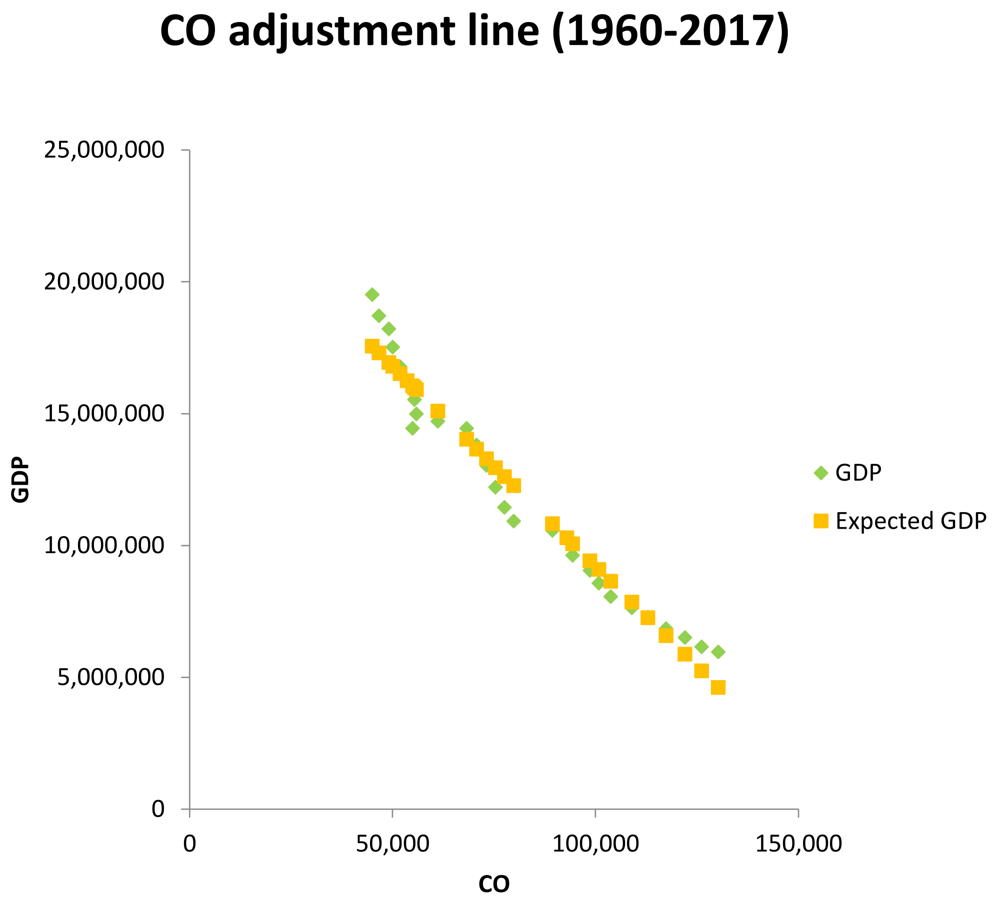
We can see more clearly the previous results in the following charts:

4.1. Carbon dioxide (CO2)

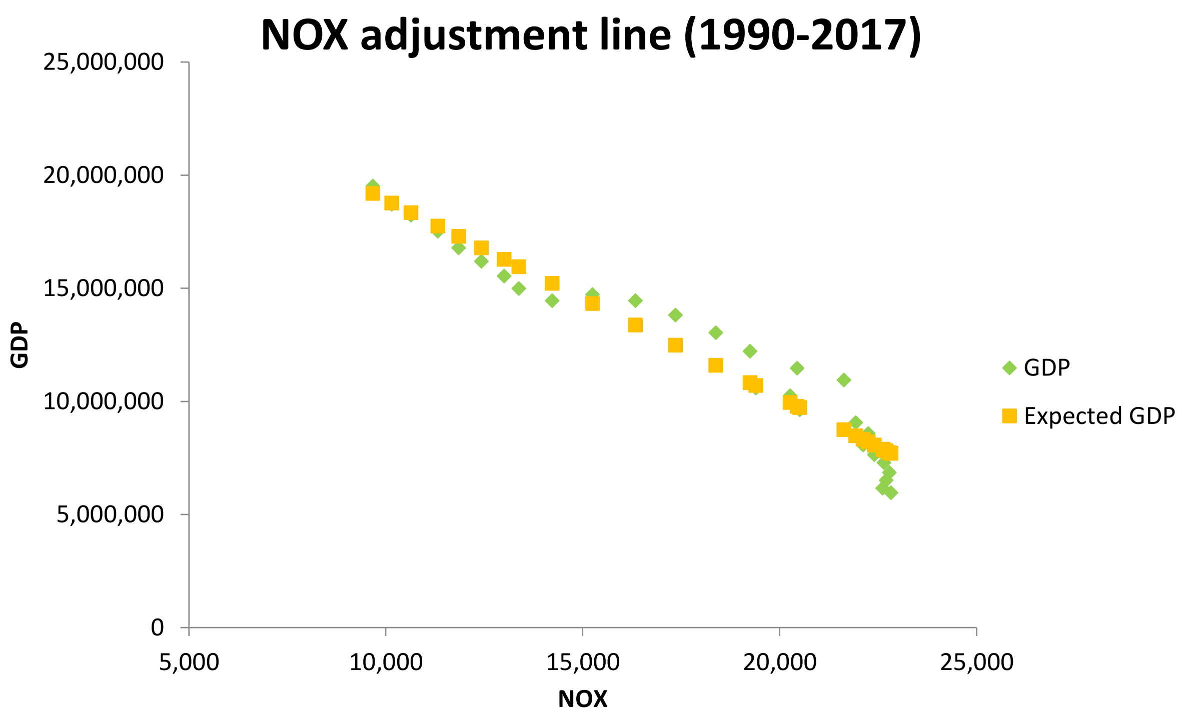




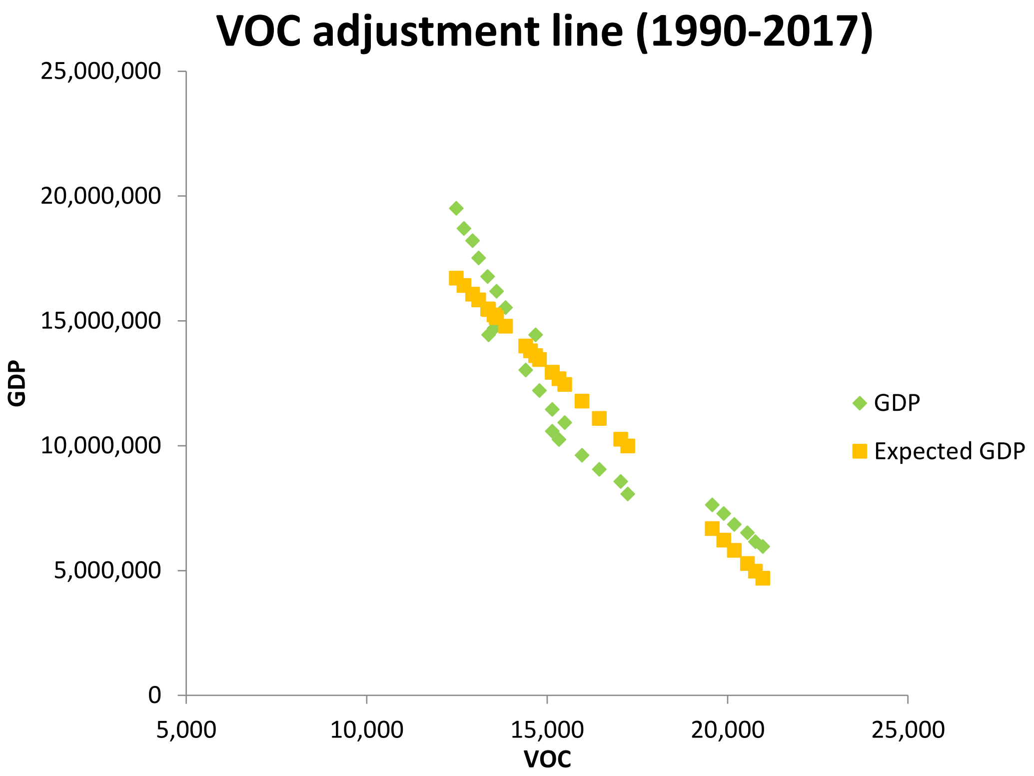
4.2. Carbon monoxide (CO)



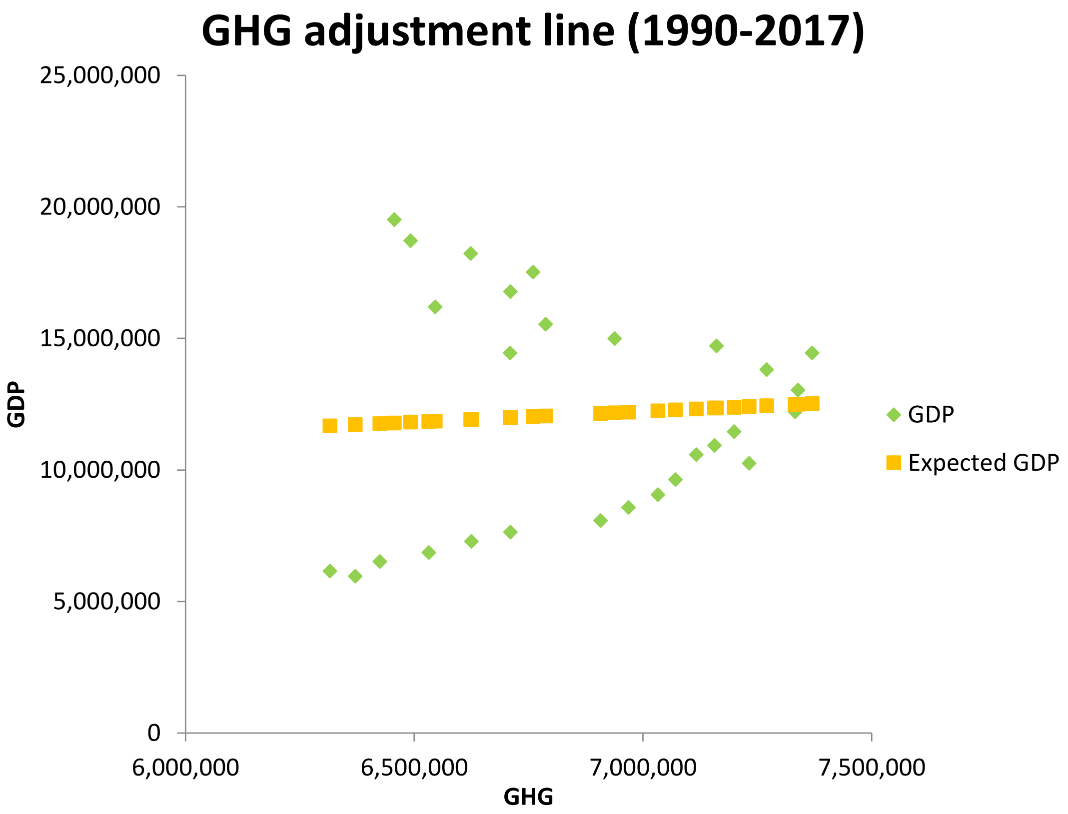
4.3. Nitrogen oxides (NOx)

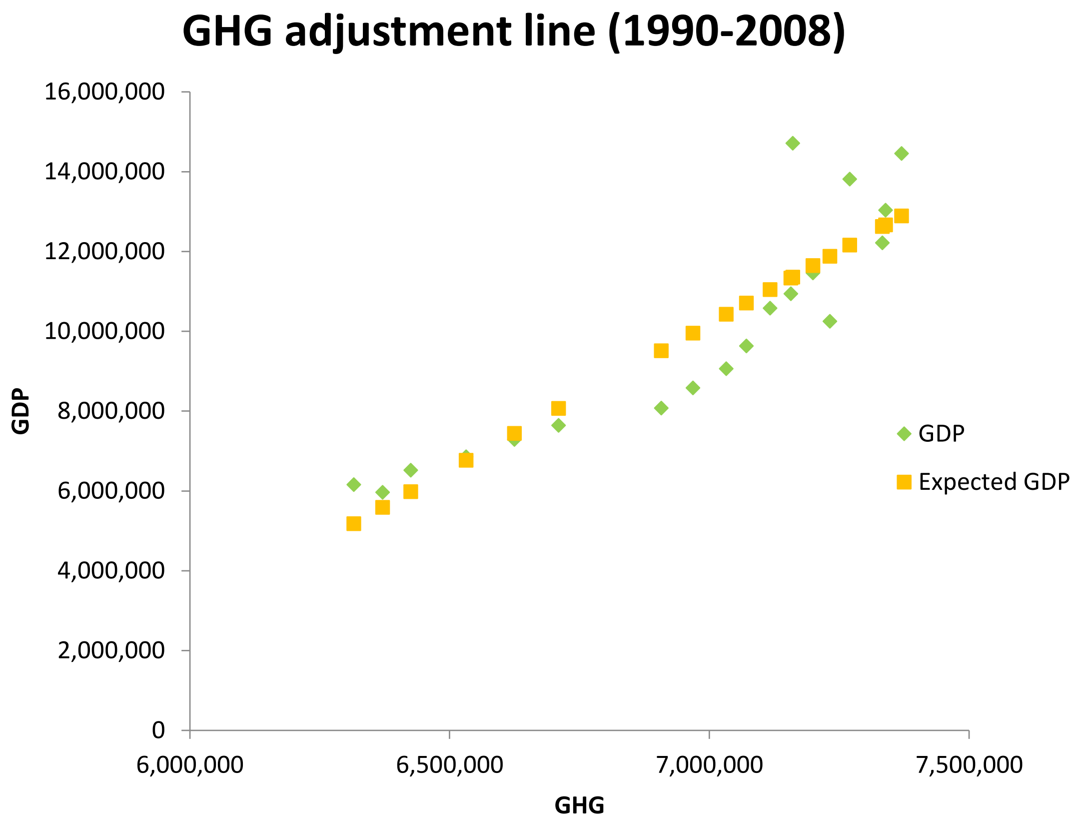


4.4. Volatile organic compounds (VOC)

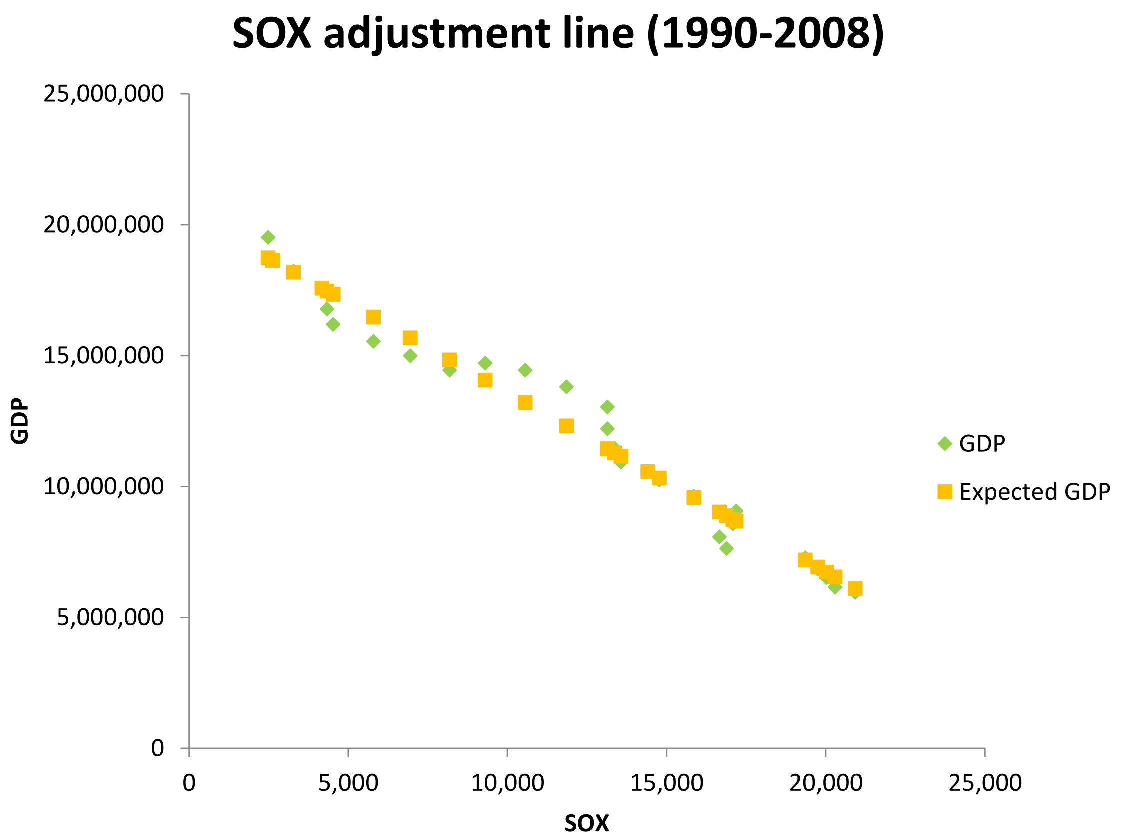


4.5. Greenhouse gas (GHG)





4.6. Sulphur oxides (SOx)



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