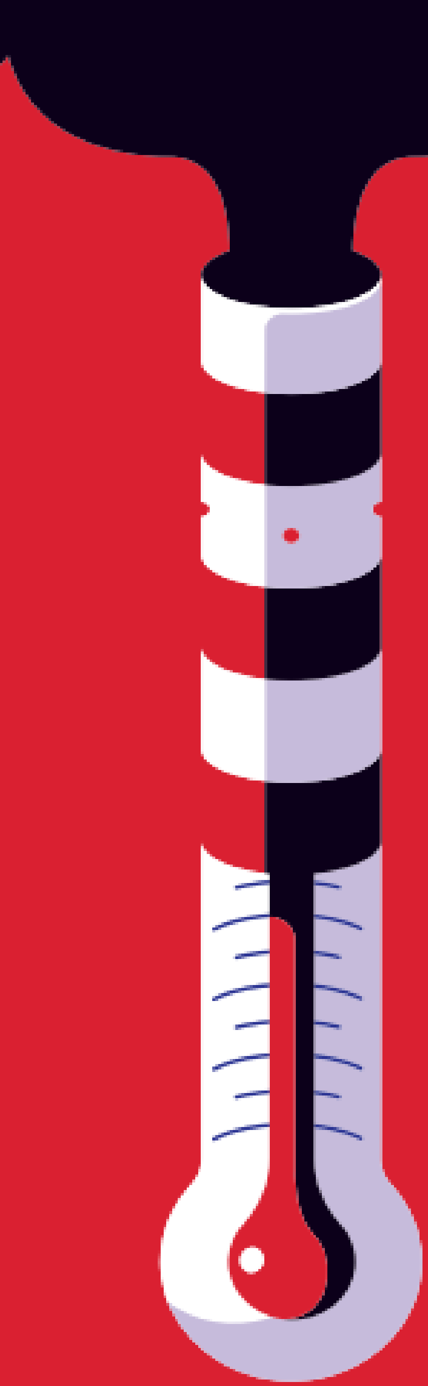
The Heat Is On

The impact of climate regulations on industry productivity



Elie El Hajj
Department of Economics
A !"#$%&$!' (!)*%,% ! .)

Abstract

This paper presents the results of a randomized experiment varying the method of selection of industries, the characteristics of the selected industries and their input towards respecting environmental regulations. I find it extremely important for companies to abide by these governmental climate regulations as they help reach a key milestone in our humanitarian evolution which is sustainable production. All companies that so far doesn't fall under this category will soon follow because even in a perfect working model, non-sustainable industries by definition will soon run out of materials and will have to eventually follow the trend.

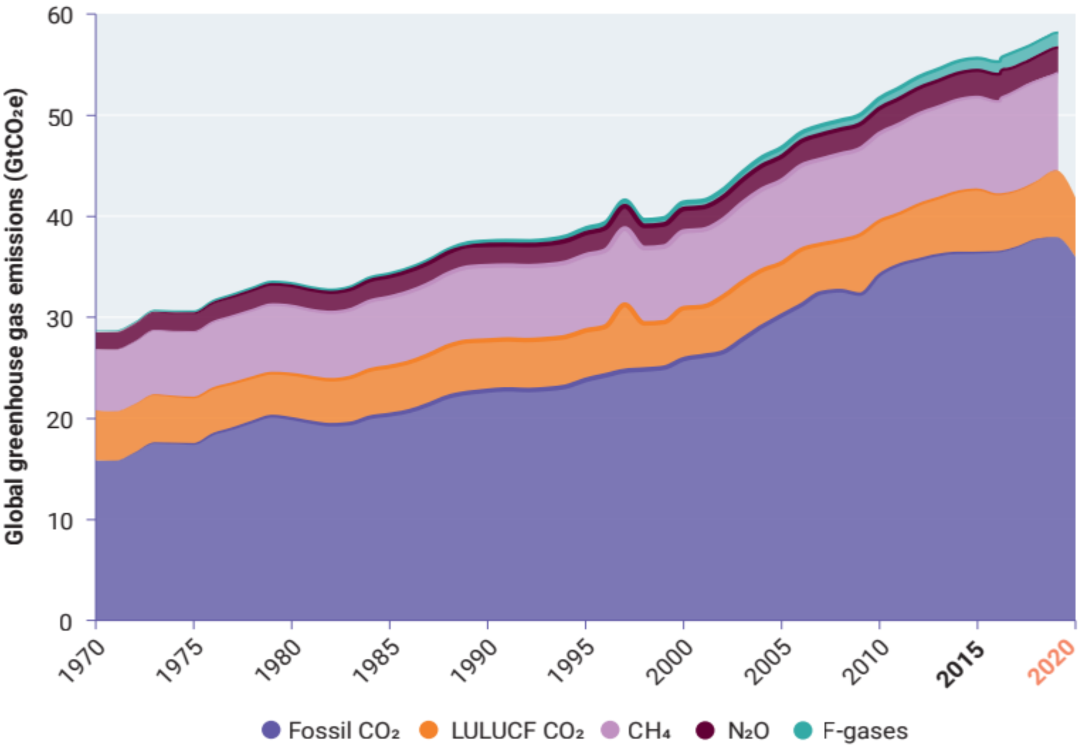
I- Introduction

The paper will elaborate on an approach allowing us to measure the impact of environmental regulations on total factor productivity growth, which is in itself more specific than measuring general growth of an industry and thus requires a structured and well-constructed process. Climate regulations have a direct impact on growth since we already know that many constraints are computed towards the final capital. We estimate these effects using a flexible functional form cost function. For the sake of this paper we will look at five main polluting industries. We are considering polluting industries since green energy industries already fall under the umbrella of clean industries that are abiding by international set regulations related to gas emissions and other variables. The net impact of environmental regulations on total factor productivity growth should be relatively small given that these industries are already under a lot of pressure coming from various nations because of climate change repercussions that have been addressed in the most recent COP26 summit. This paper will be divided into 6 main sections other than the introduction where we will be covering the background motives, the experimental design, the estimating equation, the observable characteristics, the results of our experiences and last but not least a concise conclusion summing up the key points of this document while highlighting the most pertinent marks discovered.

II- Background

The Industrial Revolution started someday within the middle of the 1700s, once the world's population had finally started recovering from the damage caused by the Black Death in the 1300s that killed over seventy five million people. The planet's population exploded, reaching 1 billion by 1800 then doubling once more by 1926. By the start of the twenty first century, it had fully grown again to six billion. it had been coal that shifted the balance of power — using coal as a power supply modified the manner that we tend to checked out industry, from energy generation to manufacturing. We've been using coal since the thirteenth century; however, it wasn't till the 1800s that industrialization took off. Back then, we weren't thinking of the potential impact of burning coal and different fossil fuels to power our new instrumentality and machinery — we were thinking of growing as much, as quick as possible. It's solely in recent years that we've started assessing the type of impact that we've had on the surroundings as an instantaneous result of this exponential growth. There are four primary impact points once it involves industrialization — air, water, soil and habitat. the most important problem is pollution, caused by the smoke and emissions generated by burning fossil fuels. The US EPA regulates over eighty totally different toxins that may be found in industrial pollution, from *asbestos and dioxin to lead and chromium*. In spite of those regulations, industries are among the worst generators of air pollution within the world. pollution is additionally a tangle in these areas, specifically in regions wherever factories are engineered next to natural water sources. These toxins are available in a range of forms — solid, liquid or vaporous — and they all have to ability in contaminating the native water supplies. Even landfills and different waste disposal areas can leach toxins into the local water supply, resulting in pollution as within the case of River Nile. Soil contamination is another drawback that goes hand in hand with manufacture. Lead is the most common form of soil contamination, however other serious metals and virulent chemicals may also leach into the soil and, in turn, contaminate any crops that grow there. Finally, industrialization has caused dramatic home ground destruction. Forests are cut down, and ecosystems are destroyed to create roads, strip mines and gravel pits. Destroying these habitats upsets native ecosystems and ends up in plant and animal extinction if the species are unable to relocate or adapt to their new surroundings.

Figure ES.1. Global greenhouse gas emissions from all sources, 1970–2020



As we can see in Figure ES.1. the global greenhouse emissions are constantly rising. An important chemical to keep in eyesight is CH4. Effectively, methane is one of the deadliest chemicals in our atmosphere. Exponentially, stronger than CO2 with a significant wider impact on the Ozone layer

Figure ES.2. Effect of new or updated nationally determined contributions on 2030 greenhouse gas emissions relative to previous nationally determined contributions

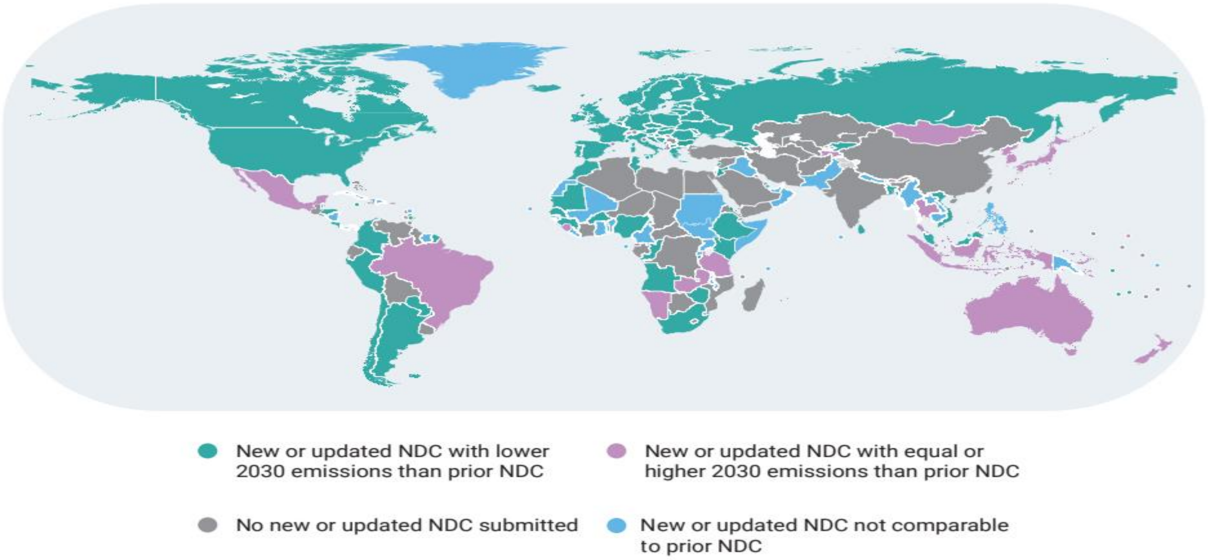
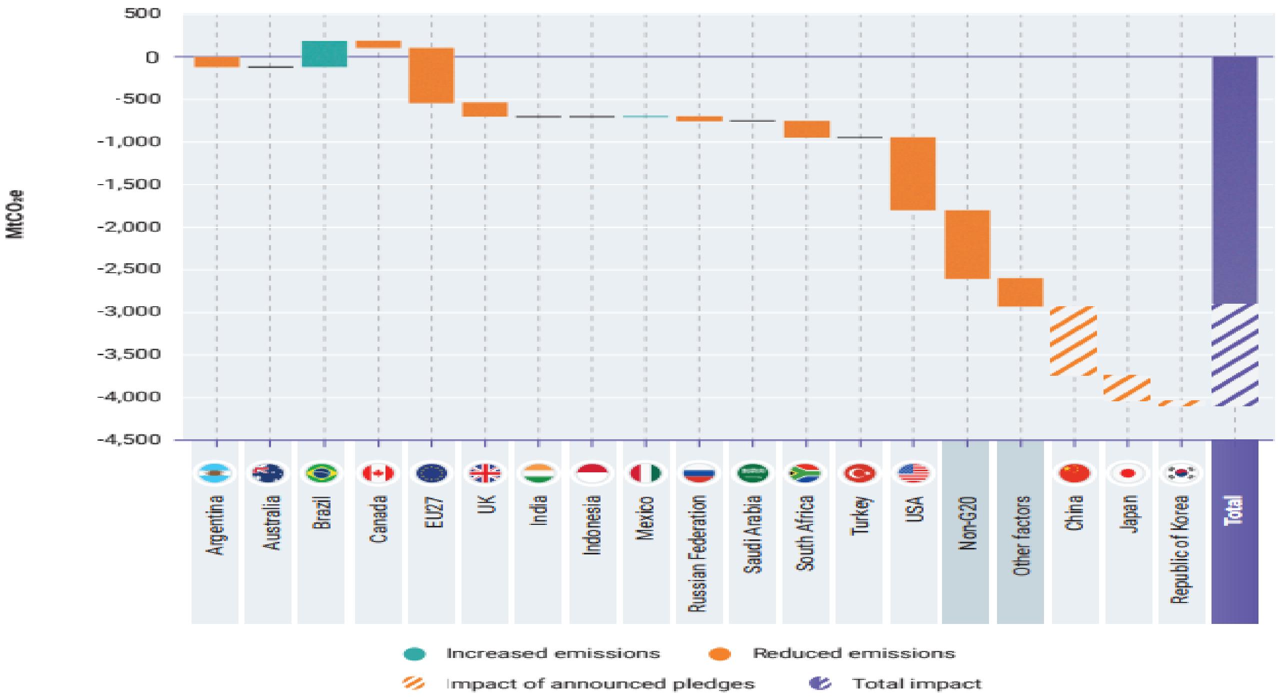


Figure ES.3. Impact of 2030 pledges (nationally determined contributions and other announced pledges) on 2030 global emissions compared with previous nationally determined contribution submissions



When merging both FiguresES.2. and ES.3. we can see clear geographical distribution of countries opting in to adopt anti-emissions steps. We can note that Brazil, Australia and Mexico fall into the same category when mentioning countries that have emissions above the average set, it is important to keep in mind that Australia and Mexico are slightly above the average while Brazil needs to take some strict sanctions to shift this percentage. Some specialists would argue that Brazil can afford to have proportionally higher emissions as it has the Amazon as a center point, others argue that the biggest rainforest in the world is shrinking and thus Brazil should help it instead of overloading it. A crucial factor for our study is the case we see when we look at the parameters of USA. Despite being the leading economy in the world with a GDP roughly around 21 trillion dollars, the United States were still able to drastically reduce their emissions. In other words, USA proved that it is feasible to maintain industry productivity while abiding by climate regulations. Nevertheless, we have to keep in mind that the US was already classified in the Top 5 countries with the highest emissions and so moving out of this podium will require more than just 1 year. To add on, to be able to come up with a general consensus, we will have to check the main industries operating in the US and compare them with other similar scenarios to see if other less capable countries can follow the trend or not.

Figure ES.4. Near-term targets are critical to set global emissions on a clear path towards achieving long-term net-zero targets and stringent climate goals

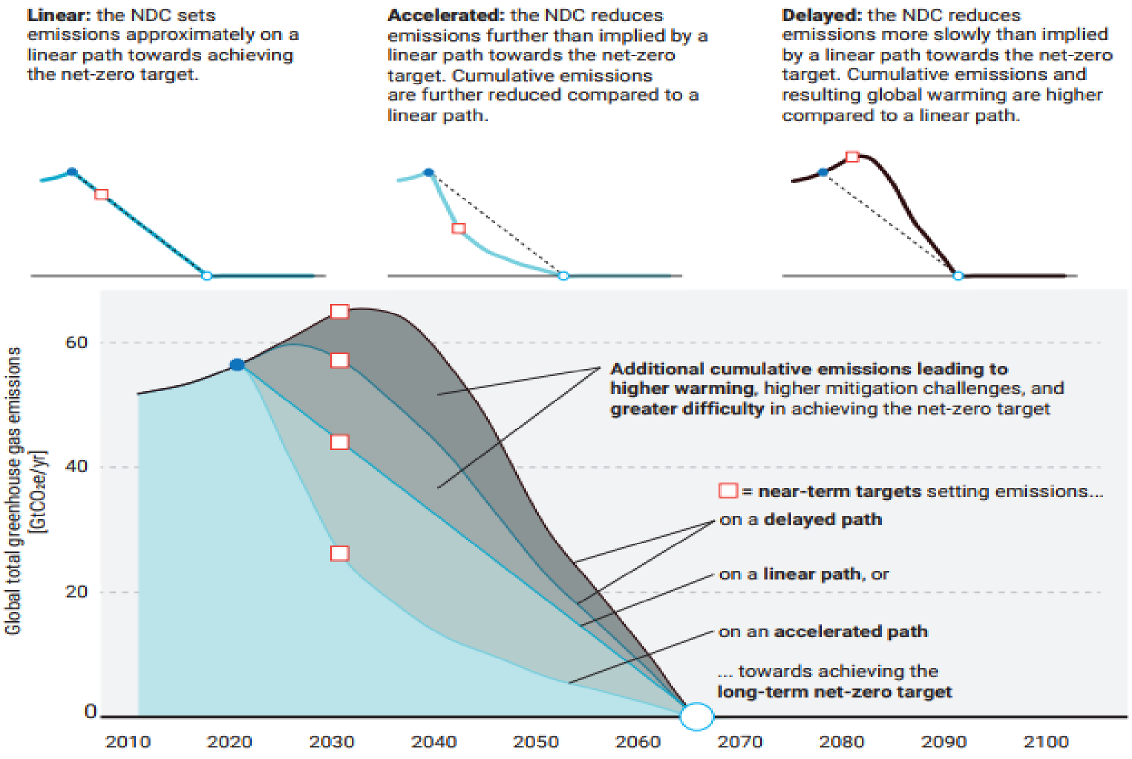
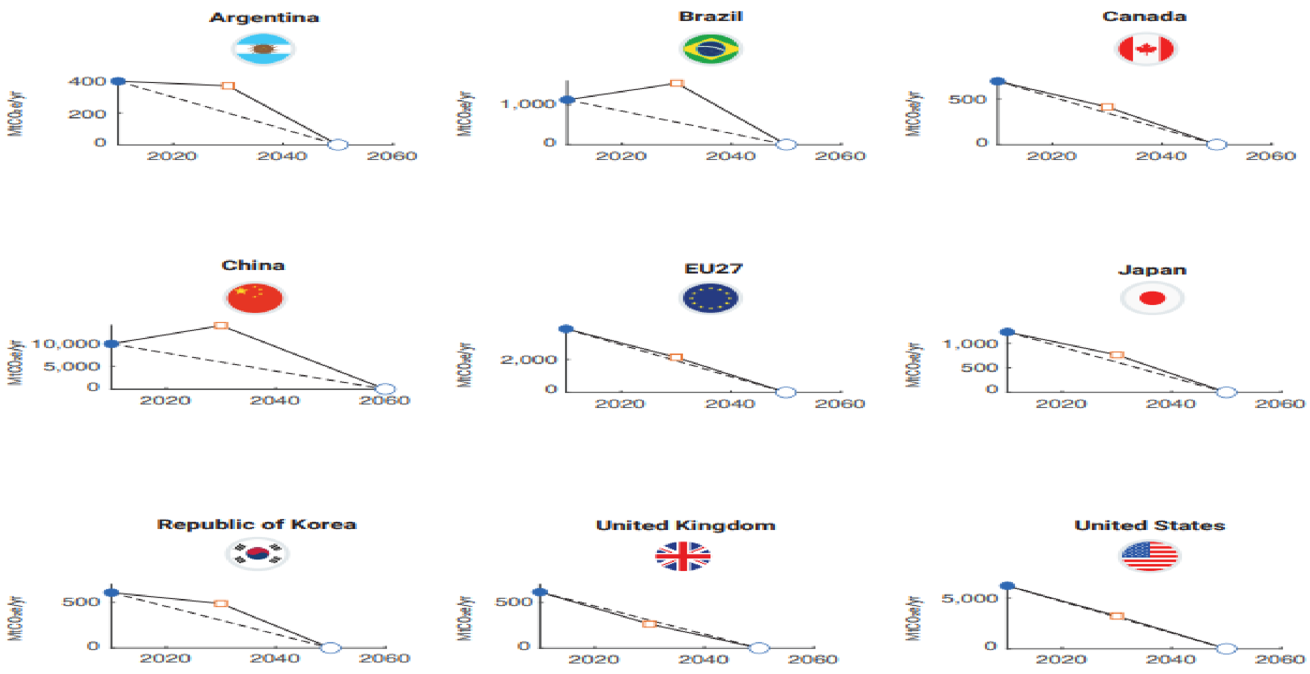


Figure ES.5. Overview of net-zero pathways implied by climate pledges by selected G20 members



As well, when reflecting on Figures ES.4. and ES.5. we notice an alarming factor. Most of the G20 selected countries are delaying the net-zero path. In fact, only the UK has the path slightly accelerated, while the US and the EU27 have linear lines. At first observation, we might think that Brazil ,again, needs to apply stricter regulations which is partially truly, however the main focus should be shifted towards China since it shares a similar graph shape but have a drastically bigger scale.

After a thorough analysis, we can conclude that the steps towards a sustainable future are indeed required since the over pollution of the global ecosystem is evident. We were able to assimilate some countries that have been performing well emissions wise, while being able the maintain good industrial growth. Starting this point of the paper, the topics that shall follow will begin to be more technical.

III- Experimental Design and Framework

Explanations of the productivity slowdown in U.S. manufacturing continue to be debated. Although environmental regulations have been suggested as a possible cause of this decline, there has been little empirical work supporting this claim, particularly at the industry level. In this paper, we examine the effect of environmental regulations on productivity for five industries which are among the most heavily affected by environmental regulations. A model is developed which shows the impact of abatement requirements on industry costs and total factor productivity growth (TFP). The components of productivity growth are determined for the following five U.S. manufacturing industries: Paper; Chemicals; Stone, Clay, and Glass; Iron and Steel; and Non-ferrous metals. To model the impact of environmental regulation on TFP, conventional inputs of labor, capital, energy, and materials are treated as separate from abatement capital, which is a required input for pollution control. We can also deduce from the figures above that there is a clear correlation between climate change, climate regulations and industries productivity. Our main objective through this paper is going to identify this correlation and explain it. I am assuming that climate change regulations affect negatively production. Easier said, when any individual enters a kitchen, they will realize with no major analysis that the kitchen is hot and that some utensils can't be touched with a bare hand and will cause burns otherwise. Similarly, when a neighborhood is experiencing heat waves at a time of the year where this shouldn't be occurring, the citizens will feel that something is wrong without necessarily having a PhD in geology and when many neighborhoods across the world are facing the same phenomenon than a general consensus will be formed about a factor called climate change. We can see here that this reasoning came very naturally and this same reasoning by definition is the root of intuition. If pollutant production is causing climate change than fighting climate change through regulations should decrease production. But, are these 2 truly inversely proportionate ? Moving on, to be able to give a solid model, it is indeed required to understand the selection process and who would self-select into reducing emissions and who would resist that. Starting with the selection process, we would look at every country possessing a strong correlation between production and pollution. In other words, to take this study from the conceptual to the practical, we would simply look at nations with a high GDP + a high pollution indicator. China is a perfect example.

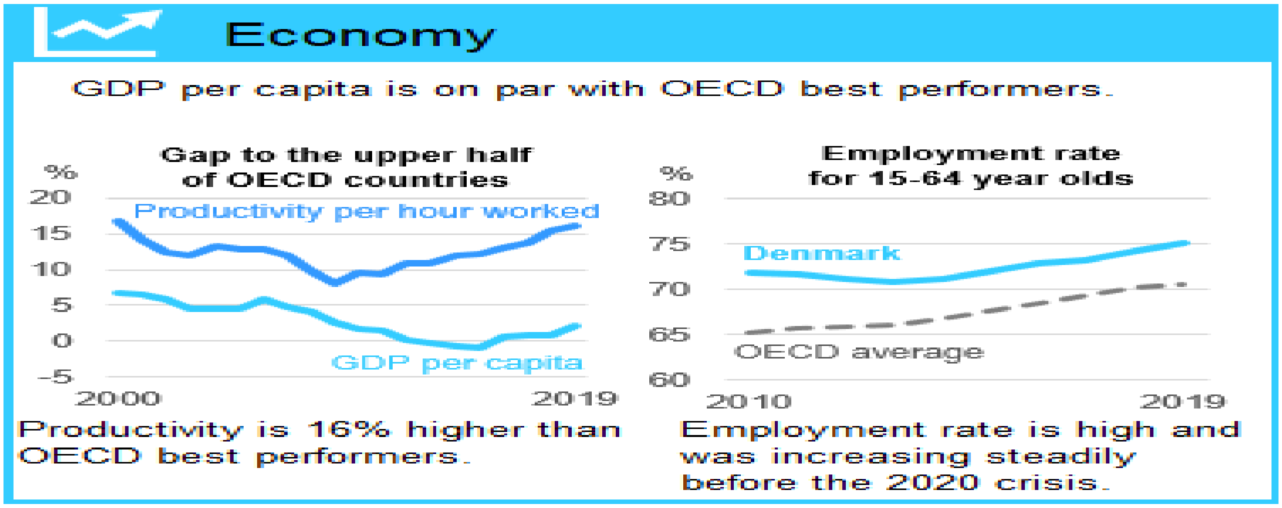
Rank	Name	GDP (IMF '19)
1	United States	22.20 Tn
2	China	15.47 Tn
3	Japan	5.50 Tn
4	Germany	4.16 Tn
5	India	3.26 Tn
6	United Kingdom	2.93 Tn
7	France	2.88 Tn
8	Italy	2.09 Tn
9	Brazil	2.06 Tn
10	Canada	1.83 Tn
11	South Korea	1.74 Tn
12	Russia	1.67 Tn
13	Spain	1.50 Tn
14	Australia	1.48 Tn
15	Mexico	1.30 Tn
16	Indonesia	1.21 Tn
17	Netherlands	954.93 Bn
18	Turkey	809.55 Bn
19	Saudi Arabia	790.06 Bn
20	Switzerland	740.70 Bn

Rank	Country	Total Emissions
1	China	9.04 Bn
2	United States	5.00 Bn
3	India	2.07 Bn
4	Russia	1.47 Bn
5	Japan	1.14 Bn
6	Germany	729.77 Mn
7	South Korea	585.99 Mn
8	Iran	552.40 Mn
9	Canada	549.23 Mn
10	Saudi Arabia	531.46 Mn
11	Brazil	450.79 Mn
12	Mexico	442.31 Mn
13	Indonesia	441.91 Mn
14	South Africa	427.57 Mn
15	United Kingdom	389.75 Mn
16	Australia	380.93 Mn
17	Italy	330.75 Mn
18	Turkey	317.22 Mn
19	France	290.49 Mn
20	Poland	282.40 Mn

From these 2 tables we can derive that countries like USA, China, India and Japan definitely fall under the selection process. Other countries that made the cut can be countries like Russia, who emit emissions proportionally way more than what they produce. France and the UK emit way less that what they produce so studying them would also be interesting to understand what they are doing different and check if its applicable to other nations. Moreover, it’s time to analyze the other constraint, which is countries that would self-resist this model. A perfect example would be

Denmark, effectively, Denmark’s economy has been booming for the last few years and yet it remains one of the cleanest countries in the world in term of gas emissions. Any country that falls under this Danish scenario is automatically excluded from this study. This doesn’t mean that we don’t need to keep an eye on them but rather means that so far, they haven’t reached yet a breaking point of the ratio GDP/Emissions being critical or even considerable.

Some Infographics about Denmark:

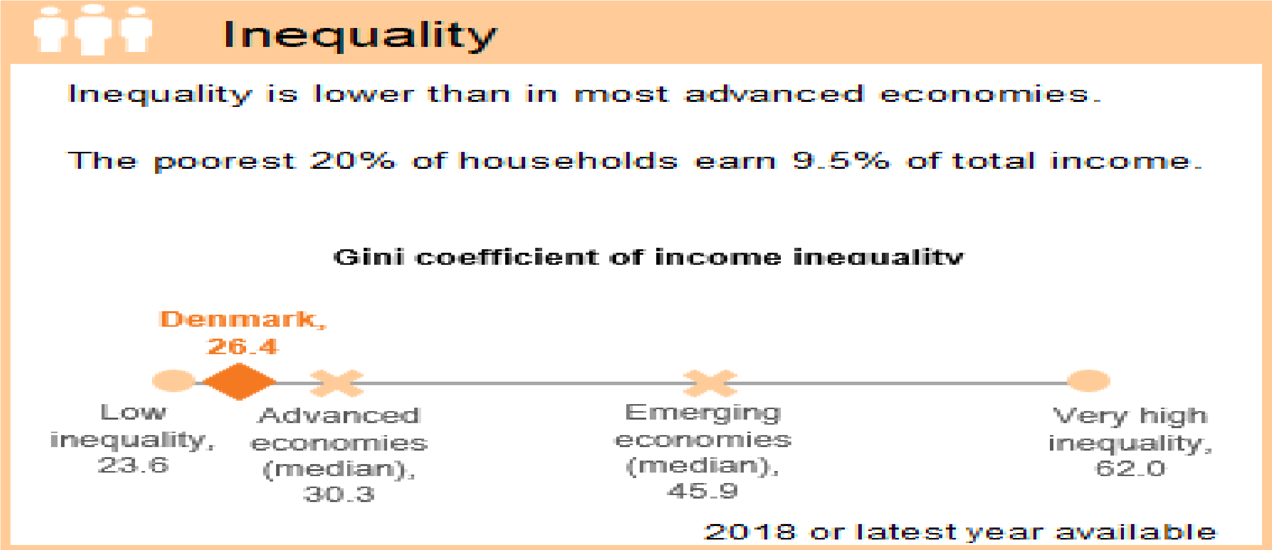


Economy

GDP per capita is on par with OECD best performers.

Productivity is 16% higher than OECD best performers.

Employment rate is high and was increasing steadily before the 2020 crisis.

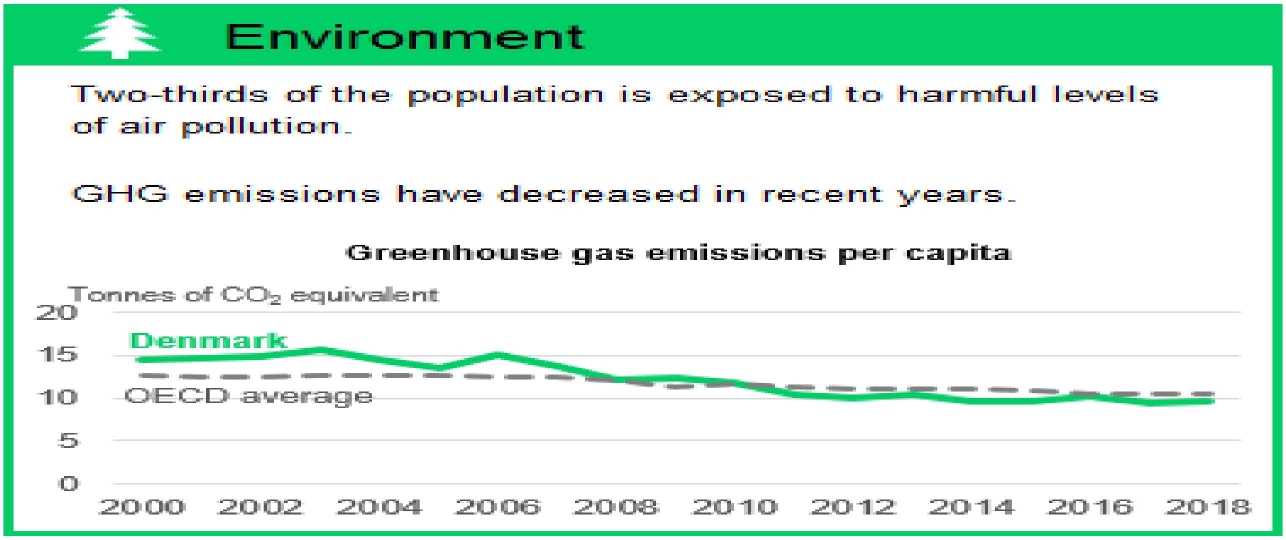


Inequality

Inequality is lower than in most advanced economies.

The poorest 20% of households earn 9.5% of total income.

2018 or latest year available



Environment

Two-thirds of the population is exposed to harmful levels of air pollution.

GHG emissions have decreased in recent years.

IV- Estimating Equation

To estimate the impact of climate change regulations on industries productivity I'll be using the following models:

$F(Q,U,K,L,E,M, t) = 0$. (1)

Q: homogenous output of the firm net of pollution

U: represents pollution

K, L. E and M: productive capital, labor, energy and non-energy materials respectively

t: time

If pollution were unregulated or untaxed, the firm would ignore it and use combinations of the other inputs to produce the revenue generating good, Q. Due to Federal and State regulation, however, firms must also employ techniques for reducing pollution caused by the production of Q. We treat emissions as a function of abatement capital in place, A, and the amounts of capital, labor, energy and materials in production,

$U = U(A, K, L, E, M, t)$. (2)

Combining (1) and (2), we can write the production function for Q as

$Q = Q(A, K, L, M, E, t)$. (3)

where the inputs are used to produce Q or in conjunction with abatement capital to reduce pollution. We assume that the firm minimizes net production costs (C) subject to an exogenous level of production, input prices, abatement capital and technology. Thus, there exists a restricted cost function which is the dual of Eq. (3), which can be written as 4

C = C(Q, Pk, Pl, Pm, Pe, A, t). (4)

where Pk, Pl, Pe, Pm are the prices of productive capital, labor, energy and materials, respectively;

C= $P_L L + P_k K$ + $P_E E$ + $P_M M$ and Q, A and t are as defined above. The theory of duality requires that C be monotonic in Q and linearly homogenous and concave in input prices.

Equation (4) defines the cost of producing the conventional output, Q, in terms of the conventional inputs, K, L, E and M, given the requirements to purchase abatement capital. In this framework, abatement requirements effectively act to shift the cost function, causing the industry to change the combination of inputs used to produce conventional output. The total costs of producing Q are these “indirect” costs plus the direct cost of the abatement capital, $P_A A$ which we call C_A:

C* = C (Q, P_L, P_k, P_E, P_M, A, t) = C_A

**Regression formula:* $y = \alpha + \beta xi + \varepsilon i$

As much elaborated as an approach may seem, there is always room for error and that’s why it is crucial to keep in min endogeneity problems that might surface.

Endogeneity and choice are key issues for analysis on difference. Technically, endogeneity happens once a variable (x) in a regression model is related with the error term (e) within the model. This could occur below a spread of conditions; however, 2 cases are particularly common in inequality research: (1) when vital variables are omitted from the model and (2) when the outcome variable may be a predictor of x and not merely a response to x. A minimum of a part of the latter downside is usually known as “selection.” The previous problem is well-known in social research, several studies use this bias to an advantage. One amongst the foremost common approaches to work mediators of a human process is to estimate a regression model initial with solely the key x variable of interest predicting the result and so estimate a second model that has hypothesized mediators of the relationship. The investigator will then reason the proportion of the whole result of x that's “explained” by the mediators and also the proportion that is still owing to x. The amendment within the constant of x may be a result of omitted variable bias: within the initial model, the omission of mediators led to an overestimate of the direct result of x.

A possible solution to our case can be the measurement of an error. Suppose that a measure of an independent variable is impossible. Instead of observing x*i, what is actually is observed is xi = x*i + Vi → Vi measurement error. The model can be given by: $yi = \alpha + \beta(x*)i + \varepsilon i$ which consequently can be written in terms of observables and error terms as:

$$yi = \alpha + \beta(xi - Vi) + \varepsilon i$$

$$yi = \alpha + \beta xi + (\varepsilon i - \beta Vi)$$

$yi = \alpha + \beta xi + ui$, with ui = $\varepsilon i - \beta Vi$

Since both xi and ui depends on Vi, they are correlated the OLS estimation of β will be biased downward. Measurement error in the dependent variable, yi does not cause endogeneity, though it does increase the variance of the error term.

In our case we’re working on the effect of climate regulations on production and thus an endogeneity problem could be: ability, resources, geographical location, international treaties…

Meaning that, some countries in a perfect working model might be giving different results because of their inability in acquiring top equipment, e.g. Japan and country X could have the same supply chain mechanism for car manufacturing but country X doesn’t have the ability to acquire filters or other “green equipment’s” causing ultimately different results for the same production. Same goes for resources where the quality will surely impact the outcome. Geographical location may force some countries into using some unconventional production methods and international treaties may limit the power of some countries in using some resources despite having them e.g. nuclear, coal, oil treaties…

There is no one way to treat these factors but we discussed above the general method in dealing with them.

V- Observable Characteristics

The 5 producing industries that were selected for study satisfied many criteria which made them suitable. First, all five industries were significant purchasers of abatement capital throughout the amount studied. Also, statistic knowledge for these industries’ output, inputs, their associated costs was obtainable from the Interindustry Forecasting Project at the University of Maryland. Finally, the chosen business aggregates allowed us to derive abatement capital stocks from given sources. The five industries with SIC codes are Papers, Chemicals, Stone – Clay – Glass, Iron – Steel and Non-ferrous metals. An industry-level analysis is an improvement over analysis of productivity of manufacturing as a whole, there's still substantial heterogeneousness inside every of the on top of business aggregates. Every industry produces variety of products, by different processes, with associated and varied pollutants to each air and water. For example, there have been a minimum of 5 different processes in Iron and Steel operations, most of that involve high emissions of particulates into the air. The Chemicals industry produces thousands of different chemicals regarding five major classifications, which embrace Plastics, Industrial Organics, Drugs, and Industrial Inorganics. Most processes for chemical production involve air or pollution or both. Non-ferrous Metals is an air and water polluter; Paper causes primarily water pollution, and Stone, Clay and Glass production and process contributes additional to air pollution. business analysis is suitable for examining the impact of environmental regulation since rules are usually by industry, or method inside industry, and by pollutant. though regulations are formally specific as effluent limits (such as pounds of effluent per ton of product), they sometimes suggest or need the employment of specific technology. However, the EPA imposes these regulations on some processes or product and not others. For example, till the Nineteen Eighties there were just about no water rules for pollution from the assembly of organic chemicals. however alternative components of the chemical business, appreciate inorganics, are fairly heavily regulated. Stone, Clay and Glass, Iron and Steel, and Non-ferrous Metals have invariably been visible polluters, and thus a target for early regulation by native and federal regulators. Hence, the environmental regulations two-faced by every industry are a composite of regulations on different product and processes, and frequently involve reduction of quite one pollutant. Abatement capital series. Paper and Chemicals abatement capital stocks data are taken directly from the Bureau of Economic Analysis's real stocks of "Plant and Equipment for Air and Water pollution Abatement in the U.S." The opposite 3 industries examined during this study don't correspond specifically to the industries on that BEA printed capital stock knowledge. The Census abatement capital expenditure data are published annually. We created the capital series by assuming no that there was no initial stocks and by using BEA depreciation rates for abatement equipment. We determined the annual percentages the Stone, Clay, and Glass, Iron and Steel, and Other Non-ferrous Metals stocks were of the more aggregated Other Durables sector as calculated from the Census data. These percentages were then applied to the BEA stock series for Other Durables to get the data we used for our three industries. Wage bill and the price of labor. The National Income and Product Accounts (NIPA). The wage bills for Paper, Chemicals, and Stone, Clay, and Glass are the GPO numbers on wages, salaries, and fringe benefits. Using the data from EE on total employment (TE), total production workers (TP), average weekly hours for production workers (AWH), and the assumption that non-production workers work a constant 40 hours per week, we were able to construct total manhours for these three industries. The price of labor used in the regressions is total labor compensation divided by total man-hours. Our Iron and Steel and Non-ferrous Metals industries are combined in one of the GPO industries, Fabricated Metals. To break out our two industries, we constructed a time series on average hourly earnings for non-production workers for all manufacturing using data from NIPA.

Productive capital stock and the user cost of capital. Productive capital consists of structure capital and equipment capital, less abatement capital. Structures capital was taken from Capital Stock Estimates for Input-Output Industries: Methods and Data published by BLS. The structures price deflator was also taken from this source. Equipment capital for each industry was derived from time series data on constant dollar gross investment compiled and supplied by the Interindustry Fore casting Project of the University of Maryland. The method of constructing the equipment stock is a variation of the perpetual inventory method. The productive capital referred to in the paper is the sum of structures capital and equipment capital less abatement capital. The price of capital used in the study is a weighted average of the user cost of equipment (UCE) and the user cost of structures (UCS), where the weights are the relative proportions of structures and equipment in total productive capital. The respective formulas are given by

$UCE = Peq(R + Deq)*(l - TZeq - C)/(l - T)$

$UCS = Ps(R + Ds)*(l - TZs)/(l - T)$,

where

Peq = equipment price deflator

Ps = structures price deflator

R = Moody’s BAA domestic corporation bond yields

Deq = physical depreciation rate for equipment

Ds = physical depreciation rate for structures

T = corporate tax rate

C = investment tax credit

Zeq = present value of stream of depreciation of equipment

Zs = present value of stream of depreciation of structures.

Energy consumption and prices were taken from an energy accounts tape provided by the Bureau of Industrial Economics. The data come from a Jack Fawcett report to DOE called “National Energy Accounts” More recent data were taken from the various issues of the Annual Survey of Manufacturers Fuels and Electric Energy Consumed.

Line		1998				1999				2000			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
1	**Wages and salaries**	4074.9	4145.5	4217.4	4288.7	4364.6	4409.3	4473.7	4584.1	4751.5	4779.1	4871.3	4898
2	**Private industries**	3385.1	3448.1	3511.8	3576.2	3646.5	3682.3	3735.1	3832.7	3986.3	4000.5	4087.5	4106.4
3	Goods-producing industries	1017.7	1028.8	1037.4	1050.3	1066.2	1072.6	1085.3	1109.6	1159.5	1147.5	1168.2	1161.9
4	Manufacturing	751.8	757.1	759.2	765.1	774.5	776.9	786.5	800.2	838.7	823.6	840	828.8
5	Distributive industries	925.4	941	960.5	976.9	1001.7	1012	1027	1053.8	1080	1093.2	1108.2	1113.4
6	Service industries	1442	1478.3	1513.9	1549	1578.6	1597.7	1622.7	1669.3	1746.8	1759.8	1811.1	1831.1
7	**Government**	689.8	697.4	705.6	712.4	718.1	727	738.6	751.4	765.2	778.6	783.8	791.5

Wages and Salaries by Industry

Line		2019				2020				2021		
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3
1	**Corporate profits with inventory valuation and capital consumption adjustments**	2297.2	2387	2381.8	2405.1	2169.5	1942.6	2435.4	2427.5	2551.4	2819.2	2940.6
2	**Domestic industries**	1799.2	1858.1	1859.3	1901	1690.4	1534.3	1981	1950.5	2085	2359	2440.4
3	Financial1	501.8	514.3	503.1	508.4	452.1	465.6	466.7	483.7	485	537.8	551.5
4	Nonfinancial	1297.4	1343.8	1356.2	1392.6	1238.4	1068.7	1514.3	1466.8	1600	1821.3	1888.8
5	**Rest of the world**	498	528.9	522.5	504.2	479.1	408.3	454.5	477	466.4	460.2	500.3
6	Receipts from the rest of the world	841.7	883.5	868.1	865.4	781.6	667.5	783.3	831.1	865.3	892.7	935.7
7	Less: Payments to the rest of the world	343.7	354.6	345.6	361.2	302.6	259.2	328.8	354.1	398.9	432.5	435.5
8	**Corporate profits with inventory valuation adjustment**	2214.9	2279.6	2255.3	2268.6	2081.9	1864	2360.5	2357.2	2461.8	2747.7	2898.3
9	**Domestic industries**	1716.8	1750.6	1732.8	1764.5	1602.8	1455.7	1906	1880.1	1995.4	2287.6	2398
10	Financial	522.2	540.1	532.2	538.3	486	500.6	502.4	521	519.9	576.9	597.1
11	Federal Reserve banks	61.1	68	64	63.3	81.6	89.7	106.1	94.4	83.9	114.4	124
12	Other financial2	461.1	472	468.1	475	404.5	410.9	396.4	426.6	436	462.5	473.1
13	Nonfinancial	1194.6	1210.5	1200.6	1226.2	1116.8	955.1	1403.6	1359.1	1475.6	1710.7	1801
14	Utilities	16.4	13.5	4.3	-3.3	0.6	11.1	10.4	19.6	20.9	11.9	---
15	Manufacturing	339.5	350.6	365.6	367.1	340.9	246.9	362.3	365.3	401.9	450.5	---
16	Durable goods	189.6	188.6	176.5	179	180.7	133.1	222.3	218	234.7	248.1	---
17	Fabricated metal products	22.8	22.2	20.9	21.9	24.1	11.5	27.2	27.7	26.6	25.3	---
18	Machinery	19.8	26.6	28	29	24.4	18.4	36.4	32.3	32.5	33.1	---
19	Computer and electronic products	67.6	61.5	56.1	62.3	64.4	63.4	63	77	93.1	97.8	---
20	Electrical equipment, appliances, and components	5	4.1	4.2	3.9	2.3	6.3	10.4	7.2	7.1	4	---
21	Motor vehicles, bodies and trailers, and parts	3.3	5.8	5.6	3.2	7.9	6.6	8.9	-1.1	-3	-10.7	---
22	Other durable goods3	71.2	68.4	61.7	58.6	57.6	26.8	76.4	74.8	78.4	98.6	---
23	Nondurable goods	149.9	162.1	189.1	188.2	160.3	113.8	140	147.3	167.2	202.3	---
24	Food and beverage and tobacco products	50.9	52.3	58.1	59.7	65.4	76.2	78.7	78.7	79.3	75.1	---
25	Petroleum and coal products	11.1	14	24.9	16.9	1.2	-45.6	-55.6	-51.7	-21	2.7	---
26	Chemical products	58.8	64.7	72.4	75.9	69.8	70.3	78.6	79.6	72.9	90.7	---
27	Other nondurable goods4	29.1	31.1	33.8	35.7	23.9	13	38.3	40.7	36	33.8	---

28	Wholesale trade	117.6	110.7	123.4	119.6	131.9	101.4	125.4	136.2	112.6	137.6	---
29	Retail trade	144.5	153.6	158.2	180.3	171.2	209.7	250.2	242.9	280.2	307.6	---
30	Transportation and warehousing	38.3	35.2	39.2	37.6	22.8	6.5	22.7	24.8	34.5	64.4	---
31	Information	133.7	139	104.9	133.4	126.5	112	143.4	157.7	161	175.5	---
32	Other nonfinancial5	404.7	408	404.9	391.5	322.9	267.6	489.2	412.5	464.4	563.3	---
33	**Rest of the world**	498	528.9	522.5	504.2	479.1	408.3	454.5	477	466.4	460.2	500.3

Corporate Profits by Industry

Country	CO2 Emissions per capita (tons)	CO2 Emissions (tons, 2016)	Population (2016)
China	7.38	10,432,751,400	1,414,049,351
United States	15.52	5,011,686,600	323,015,995
India	1.91	2,533,638,100	1,324,517,249
Russia	11.44	1,661,899,300	145,275,383
Japan	9.70	1,239,592,060	127,763,265
Germany	9.44	775,752,190	82,193,768
Canada	18.58	675,918,610	36,382,944
Iran	8.08	642,560,030	79,563,989
South Korea	11.85	604,043,830	50,983,457
Indonesia	2.03	530,035,650	261,556,381
Saudi Arabia	15.94	517,079,407	32,443,447
Brazil	2.25	462,994,920	206,163,053
Mexico	3.58	441,412,750	123,333,376
Australia	17.10	414,988,700	24,262,712

Country	CO2 Emissions per capita (tons)	CO2 Emissions (tons, 2016)	Population (2016)
South Africa	6.95	390,557,850	56,207,646
Turkey	4.61	368,122,740	79,827,871
United Kingdom	5.55	367,860,350	66,297,944
Italy	5.90	358,139,550	60,663,060
France	5.13	331,533,320	64,667,596
Poland	7.81	296,659,670	37,989,220
Taiwan	11.72	276,724,868	23,618,200
Thailand	3.93	271,040,160	68,971,308
Malaysia	8.68	266,251,542	30,684,654
Spain	5.40	251,892,320	46,634,140
Ukraine	5.22	233,220,080	44,713,702
Kazakhstan	13.01	231,919,540	17,830,901
Egypt	2.32	219,377,350	94,447,073
United Arab Emirates	23.37	218,788,684	9,360,980
Vietnam	2.20	206,042,140	93,640,422
Argentina	4.61	200,708,270	43,508,460

Average CO2 emissions per capita

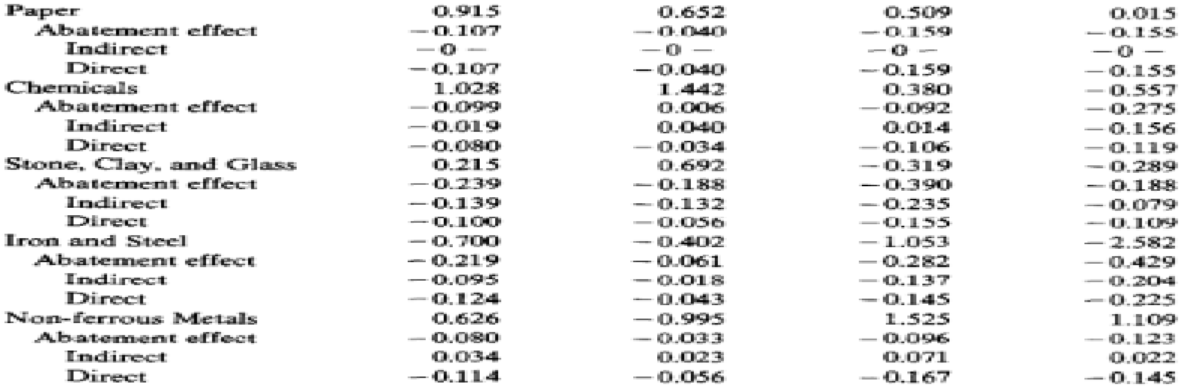
PS. These tables are just samples from the rest of data used or looked into, everything used was cited with its source above.

VI- Results

	β_A	T_{AA}	T_{LA}	T_{KA}	T_{EA}	T_{MA}
Chemicals	0.0029	-0.0046	-0.0299	-0.0015	0.0597	-0.0312
	(0.0005)	(0.0008)	(0.0177)	(0.0093)	(0.0128)	(0.0187)
Stone, clay and glass	0.0020	-0.0019	0.0346	0.0003	0.0088	-0.0431
	(0.0002)	(0.0002)	(0.0104)	(0.0039)	(0.0044)	(0.0100)
Iron and Steel	0.0012	-0.0006	0.0084	0.0258	0.0171	-0.0513
	(0.0132)	(0.0003)	(0.0132)	(0.0111)	(0.0090)	(0.0189)
Non-ferrous metals	0.0023	-0.0022	-0.0043	0.0155	0.0036	-0.0148
	(0.0004)	(0.0004)	(0.0025)	(0.0017)	(0.0012)	(0.0031)
Paper	-	-	-	-	-	-

NB. Standard errors are in brackets

Average Productivity Growth and the Direct and Indirect Effect of Abatement Requirements



Paper	0.915	0.652	0.509	0.015
Abatement effect	−0.107	−0.040	−0.159	−0.155
Indirect	−0 −	−0 −	−0 −	−0 −
Direct	−0.107	−0.040	−0.159	−0.155
Chemicals	1.028	1.442	0.380	−0.557
Abatement effect	−0.099	0.006	−0.092	−0.275
Indirect	−0.019	0.040	0.014	−0.156
Direct	−0.080	−0.034	−0.106	−0.119
Stone, Clay, and Glass	0.215	0.692	−0.319	−0.289
Abatement effect	−0.239	−0.188	−0.390	−0.188
Indirect	−0.139	−0.132	−0.235	−0.079
Direct	−0.100	−0.056	−0.155	−0.109
Iron and Steel	−0.700	−0.402	−1.053	−2.582
Abatement effect	−0.219	−0.061	−0.282	−0.429
Indirect	−0.095	−0.018	−0.137	−0.204
Direct	−0.124	−0.043	−0.145	−0.225
Non-ferrous Metals	0.626	−0.995	1.525	1.109
Abatement effect	−0.080	−0.033	−0.096	−0.123
Indirect	0.034	0.023	0.071	0.022
Direct	−0.114	−0.056	−0.167	−0.145

Differences in TFP and Abatement Contributions to TFP

	Average % point change in TFP	**Average % point change productivity due to abatement effect**	**% of TFP decline due to abatement**
Paper	-0.39	-0.117	30%
Chemicals	-1.531	-0.184	12%
Stone, clay and glass	-0.996	-0.101	10.1%
Iron and steel	-1.416	-0.153	10.8%
Non ferocious metal	+2.312	-0.077	-

VII- Conclusion

We have examined the impact of requirements to get abatement equipment on total factor productivity for five industries. We've separated the impact of abatement on productivity into two components: the direct effect which measures the direct cost of the abatement equipment, and also the indirect effect which measures the change within the way conventional inputs are accustomed to produce the merchandise. Whereas the direct effect unambiguously reduces TFP by increasing costs with no increase within the manufactured output, the indirect effect may be positive, negative, or zero. We find that the indirect abatement effect varies substantially by industry. Some industries, like Non-ferrous Metals and Chemicals, are literally capable of ameliorating a minimum of a part of the productivity costs of environmental regulations through changes in other inputs. These processes changes may play a greater role as firms try to answer future controls. All industries show abatement to be energy and capital using, but the difference occurs in their labor employment response. In general, the indirect effect is smaller than the direct effect. Also, we discover that abatement requirements may have accounted for a few of the slowdown in productivity growth. The proportion of the reduction in productivity growth because of abatement varies between 30 and 10% across the industries examined here. These results show the effect of environmental controls to be somewhat smaller than previous evidence suggests. an editorial published by The Sources of economic process within the US wattage Industry found that average annual productivity growth fell within the electric utilities industry thanks to environmental regulations. However, electric utilities are known to be one in all the foremost regulated industries. For the economy as a full, average annual productivity fell by between 0.05 and 0.25 percentage points as a result of direct environmental control expenditure. The results for the industries examined here in the later period, show that productivity fell between 0.12 and 0.43 percentage points because of the direct and indirect effect of abatement requirements. We should expect environmental regulations to be a crucial factor with shifting down impact towards TFP, in these industries which are most heavily regulated. Thus, even for the foremost heavily affected industries, environmental regulations may have reduced productivity growth, but don't account for the bulk of the decline in TFP. Finally, we should always emphasize that our analysis doesn't understand of the “output” resulting from abatement. A real productivity measure should account for the advantages from reducing pollution similarly because the costs. Unfortunately, it's difficult to account for these benefits in an industry analysis if benefits are non-linear with regard to emission changes, and where pollution reduction is going on across such a lot of pollutants.

Bibliography:

List of countries and GDP. (n.d.). Retrieved December 7, 2021, from https://site-stats.org/details/list-of-countries-and-gdp/.

Carbon footprint by country 2021. (n.d.). Retrieved December 7, 2021, from https://worldpopulationreview.com/country-rankings/carbon-footprint-by-country.

Denmark Economic Snapshot. OECD. (n.d.). Retrieved December 7, 2021, from https://www.oecd.org/economy/denmark-economic-snapshot/.

Endogeneity. Endogeneity - an overview | ScienceDirect Topics. (n.d.). Retrieved December 7, 2021, from https://www.sciencedirect.com/topics/psychology/endogeneity.

National Economic Accounts. National Economic Accounts | U.S. Bureau of Economic Analysis (BEA). (n.d.). Retrieved December 7, 2021, from https://www.bea.gov/data/economic-accounts/national.

U.S. Bureau of Economic Analysis (BEA). (n.d.). Retrieved December 7, 2021, from https://www.bea.gov/system/files/2018-12/trans318.txt.