SDG Goals an Unjust Burden on Developing Countries

A causal study to determine the Treatment Effect

Pruthvi Reddy Panati

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Chapter 1

Introduction

Sustainable development has quickly become one of the most important goals for every single unit of the world economy to consider, be it industries, small manufacturers, governments, countries, everyone. It is today an established fact that the environment is eroding and that human capitalistic needs are the cause of it. But a capitalistic economy is also the path that is believed to bring equality among people by eliminating social class, eliminate poverty and provide equal opportunities to everyone. When this is the case, sustainable development is our mechanism to take care of our planet and environment while ensuring that there is continual societal progress of bringing equality and access to opportunity to everyone and pulling people out of poverty.

Under the Paris Agreement within the United Nations Framework Convention on Climate Change (UNFCCC) there are higher or more ambitious targets for developing countries than for developed countries in regards to Sustainable Development Goals (SDG), the reason being that developed countries risk their economic viability (jobs loss) in making the quick transition, whereas developed country have the opportunity to set up industries within sustainable tenets as they grow.

The primary research question is to quantitatively establish the fact that the cost of sustainable development is higher, and hence less probable, for developing

countries than it is for developed countries. To establish this I wish to use consumer products packaging or CO2 emissions as an industry/example to compare costs between a developed and a developing country, draw a causal graph (like a bayesian network) and establish the elements that drive/affect the sustainable development of consumer packaging goods, find the most causal element of the network and use it to establish the cost to SDG and then compare it among a developed and a developing country.

The world needs a capitalistic economy to bring equality among people by eliminating social class, eliminating poverty and providing equal opportunities to everyone and to grow we need more economic activity and the economic activity has to be sustainable so we do not affect our environment the way we have in the last few decades. With this established, how should the world prioritize so that there is continuous progress being made towards transitioning into sustainable development practices? The United Nations as a part of its Paris Agreement within the United Nations Framework Convention on Climate Change (UNFCCC) signed on 22nd April 2016 agreed that there will be sustainable development goals that each country is required to meet in the stipulated time-frame.

These SDG goals are harsh on developing countries who already have challenges in continuing economic practices what made them a developing country in the first place. Now adding to them the list of ambitious goals would affect their progress and hence at the risk of rising global poverty. This research tries to establish that the SDG goals are affecting the growth and development of developing countries and it is of impact to the developed countries. The research plans to use consumer packaging data and the consequently generated waste pr CO2 emissions etc. as an instrument variable to see what has been the change in the sustainability of this and if the exogenous variation in this variable can define the endogeneity in the GDP growth of a country. This data is compared between two groups of developed and developing countries to establish causally that SDG goals are negatively affecting developing countries. A secondary hypothesis, conclusions

for which can be drawn from the same study, would be to see if it also affects developing countries negatively in its intrinsic nature.

The study expects to find that the regression coefficient between Instrument variable, non-sustainable consumer packaging waste or the CO2 emissions and economic growth rate to be negative for those set of countries that have met the SDG goals in the years since the 2016 Paris Agreement and when controlled for the other exogenous variables i.e SDG goals met the effect should still be the same and significant.

Chapter 2

Literature Review

Economic development of developing countries is primarily associated with poverty reduction and creation of a larger middle class, urbanizing with minimum environmental impact. Now add to these goals the volume of people who live in these tenets the challenge compounds exponentially. Today 1.89 billion people, or nearly 24% of the world's population lives in poverty and 46.4% of the population live in less developed countries (not even developed countries) and about 90% of population growth in the next 3-4 decades is expected in developing countries.[Sar22][OLD20]

Now with this background imagine the needs of this population as they grow to a middle-class economic status, it would be of immense stress on natural resources on the planet, certainly, which are challenges to be dealt with resource management and development.[NA14] But the problem we need to actively think of a solution for and solve is that how are we going to manufacture goods that are consumed today in the urban parts of the world and in developed countries which are certainly something that the developing countries will increasingly consume as they grow a larger middle-class and come out of poverty, things like packaged milk, bread etc.[HCL$^+$20] [VSB20]

The global waste statistics disclose that the US is the largest contributor of municipal solid waste across the world that produces 12% of global municipal

waste and represents only 4% of the global population. In contrast, India and China generate 27% of global waste and carry 36% of the global population (World Bank, 2019) [JSKH21]. United Nations, where sustainable development is linked with sustainable development goal-12 "responsible consumption and production", and target 12.4 makes obvious reference to "achieve the environmentally sound management of chemicals and all wastes throughout their life cycle" [ZD21]

In this research I am particularly interested in arguing that sustainable development is crucial for developing countries and as much a priority as uplifting people out of poverty but, laying the onus of major innovation and first-movers expectation at the feet of developed countries for whom the transition will come at a lower economic cost that it is for developing countries [AER22] Although recycling industry in the US has shown an increasing trend in both ecological and economic aspects, yet it is far behind their maximum potentials [AS20]. Indicators of these SDG goals can be seen to be the same for all countries although the goal in itself may be different (UN, 2020). [AZC21]

The study that is really close to what I want to conduct in my research is the [RAL+21]. This study estimates the material recycling effect on environmental quality and economic development in the United States. Few studies have been studied through national scale material recycling, environmental, and economic indicators.[AES+22] This study employs a novel bootstrapping auto-regressive distributed lag modeling for investigating the attributes' causality interrelationships. [BM90] This study utilizes quarterly data from 1990 to 2018 to confirm an unidirectional causality from material recycling to economic growth, carbon emissions, and energy efficiency.[FLLW21] [AW21] [Chu21]

I wish to use a similar methodology, but with additive regression trees probably but this depends on the data I will manage to find.[Hal09] The above study also uses bootstrapping method as a re-sampling technique to achieve an exemplary amount of data which I probably will not have the need for, but it depends on the data. This study utilizes quarterly data of USA spans from Q1-1990 to Q4-2017,

which include: CO2 emissions (CO2) in metric tons per capita; MSW recycling (RCY) in tons; energy efficiency (EEF)3; economic growth measured as gross domestic product (constant 2010 US$) (GDP).

At the moment I have not yet found suitable data as I wish for both the waste generation and economic survey data for a bunch of countries that are both developing countries and developed countries. [PSYW21] Preferably I want my economic survey data to be split pre and post Paris Agreement UNFCCC signed on 2 April 2016 the pre data can be between periods 2010-2016 and the post data between 2017-2019 before the world was hit by the pandemic and both SDG goal and waste generation along with economic indicators were taken by a storm.[BK22]

Chapter 3

Research Design & Methodology

Most economics study anchor themselves around the design of experiment, if it is an a Randomized Control Trial, or around the method used, in cases where it is largely Observational Study or is a Quasi-Experimental Study. The idea being that if the methodology or the design framework is justified, they Key aspects of this Design and methodology of this study are

- Stratification or Grouping of countries
- Instrument Variable justification for using the choice of Economic Indicator
- Difference-in-Difference to quantify the Average Causal Effect

3.1 Stratification

For this study, my interest is to understand, analyze, reason and then argue why the cost of specific SDG goals are detrimental to developing countries. The hypothesis largely being that the resources that needs to be shifted to keep up the GDP growth rate will slow down the improvement in lifting people out of poverty, providing people with food, clothing, basic housing and healthcare needs. The hypothesis is also that the cost it takes to develop new technologies is a huge burden which will shift resources to place that are not essentially the fastest job producing industries.

A developing country is one where the process of economic development has started but not completed. In developing countries, most people are compelled to live below the poverty line. They're usually characterized by General Poverty, Rapid population growth, High dependence on agriculture,under-utilization of natural resources, Primary commodity export dependence, Import of high-tech good from developed countries, Dualistic economics, Existence of unemployment, Human Development Index and most certainly the Gross national Income which is a close metric to GDP per capita is used both by UN and World Bank.

Hence to stratify the countries, The standard guidance or classification of Developed vs developing countries was not going to take us in the right direction. Here I use empirical methods to do this classification. I looked at a bunch of economic indicators beginning year 2000 to 2010 in one time series and 2010 to 2019 in another (I avoid the year 2020 since pandemic effect starts coming into effect).

Economic indicators such as Access to clean fuels, Independence of financial institutions, social insurance programs [1] , adequacy of social insurance programs, availability and share of consumption on the known wealth generating natural resources [2]. Moreover aspects of events such as civil war, protests, public displeasure and faith in government and trust int he election process etc. were also considered.

Apart from this, the World Bank data variables are a bit limited and sometimes controversial which when used in stratification may become the source for bias. At the moment, in my research proposal, the waste generation data is to be approximated based on the number of consumer goods produced/taxed within a country. This approach itself is not the most accurate but given the fact that waste generation data is not well-sourced, this is probably the best way to interpolate

[1]Social insurance programs are universally funded through payroll deductions or taxes and are available to anyone who has paid into the system. These payroll taxes are earmarked for these specific programs, not general taxation.

[2]The 17 rare earth elements are: lanthanum (La), cerium (Ce), praseodymium (Pr), neodymium (Nd), promethium (Pm), samarium (Sm), europium (Eu), gadolinium (Gd), terbium (Tb), dysprosium (Dy), holmium (Ho), erbium (Er), thulium (Tm), ytterbium (Yb), lutetium (Lu), scandium (Sc), and yttrium (Y).

Developing Countries	**Developed Countries**
Argentina	Australia
Bangladesh	Austria
Brazil	Belgium
Ehiopia	Canada
Eritrea	Croatia
India	France
Indonesia	Germany
Jordan	Greece
Kenya	Hungary
Lebanon	Italy
Malaysia	Japan
Mexico	Latvia
Morocco	Norway
Myanmar	Poland
Namibia	Romania
Nepal	Slovakia
Oman	Spain
Peru	United Kingdom
Philippines	United States Of America
Qatar	
Republic Of Korea	
South Africa	
Thailand	
Turkey	
Zimbabwe	

Table 3.1: List of Developed and Developing countries chosen in this study

this value.

Some of the key variables that are most crucial with a brief description are- Amount of Consumer goods produced- This is to be obtained from state consumption records which countries and their economy branches should be logging somewhere. Non-recyclable (unsustainable) waste generated- Unsustainable waste that is generated from consumer goods. This is to approximated based on some research as to what is an average amount of waste that is generated per consumer good (Weight per Good). SDG as a Share of GDP- We need to approximate down to a figure on how much is each country in each of these subgroups committed to and how has it changed over time.

3.2 Instrument Variable

In this study, use the IV approach along with stratification to group countries into groups of close properties. I plan to use all economic indicators captured in the world bank (World Bank, 2019) reports between the years 2010-2019. But given the diverse and widely spread out nature countries even after clustering them into Developed and Developing, regressing them will not be an effective technique, hence I plan to use additive regression trees so that we improve the explanatory power of our variable to see effective values from which inference can be drawn.

Instrument variable (IV) approach is a very effective Causal Inference technique, variables called instruments are used to determine an exogenous part of the variability from the endogenous predictor. In other words, this approach allows the use of only that part of the variation in the predictor that is "arguably random" i.e., is not related with unobservable factors affecting both predictor and outcome. This approach allows researchers to effectively estimate the causal relationship between the outcome and the predictor. [AK91][AI16]

Using an Instrumental Variable, in my case the amount of industrial CO2 emissions and Atmospheric levels of CO2 [3], to establish that the SDG goals are a

[3]Atmospheric levels of CO2 will control for the fact if the CO2 levels are not really coming

burden on a Developing country and contrast it with a Developed country.

In this research, we will use exogenous variation in waste production as an instrument variable to predict the economic performance of both developed and developing countries and compare them to establish the above research hypothesis Find data on how much waste is generated in two sets of countries- Developed and Developing countries. Gain specificity/approximation as to how much of it is packaging waste.

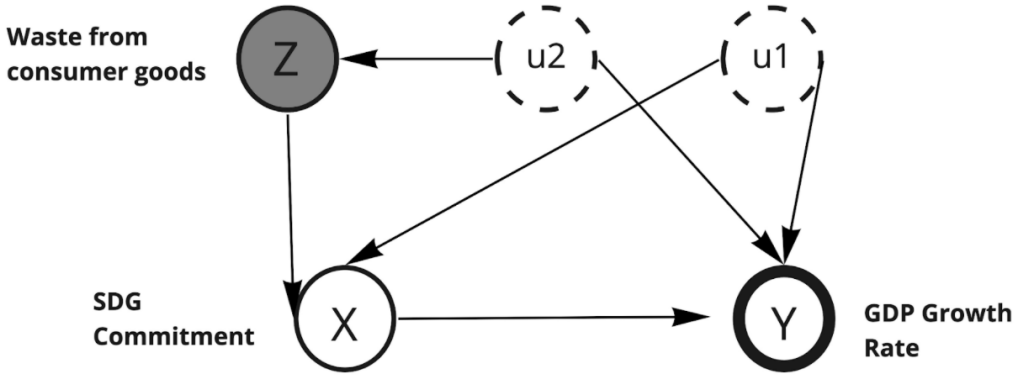

Figure 3.1: A DAG to show the effect of Waste on SDG

See what share of it is made out of sustainable products.Stratify countries bases on their Economic Status and the sustainable waste share[ATW19] . As shown in the Causal DAG below, try to establish there are no unobserved confounders U1- May require a few regression outputs to establish this fact Finally, use the Instrument Variable to regress the causal state Y $\tilde{X}$ + Z Do this for all/both of the strata, depending on how it is stratified. Compare them in tables and graphs. Interpret the results and draft conclusions.[AW21]

The reason for choosing this study design is to argue if this research is needed or not, the first reasoning is that how else can it be established that developing countries, when they focus on ambitious SDG targets, let other crucial elements of a rapidly growing country i.e education, social housing, healthcare for all and jobs creation which are essential to lifting people out of poverty, slip away back to poor status, which made these countries be a developing nation in the first place.

from industrial growth but are coming from let's say farming and stubble burning

There are certain limitations with the IV approach- Every violation of the main assumption of IV will naturally result in a biased estimator. [AIR96] More interesting is that only a small violation of this assumption will result in large bias in the case of a weak instrument because of its multiplicative effect in the estimator [AK91]

The instrumental variable approach for controlling unobserved sources of variability is the mirror opposite of the propensity score method for controlling observed variables [AIR96] [WM99]. Unlike an observed control variable, an instrumental variable is assumed not to have any direct effect on the outcome. Instead, the instrumental variable is thought to influence only the selection into the treatment condition. In other words, the effect of the instrumental variable on the dependent measure is entirely mediated via its effect on treatment assignment

3.2.1 Difference-in-Difference(DiD)

The difference-in-differences design is an early quasi-experimental identification strategy for estimating causal effects it essentially is older than the methods of Randomized control trials, given the the foundation idea was to compare two groups pre and post and intervention, hence a quasi-experimental study. This is sometimes called a "natural experiment" because it is based on naturally occurring variation in some treatment variable that affects only some units over time. Some of the good difference-in-differences designs are derived or perceived to be some kind of natural experiment.(Snow 1885)

Differently from the case of randomized experiments that allow for a simple comparison of treatment and control groups, DiD is an evaluation method used in non-experimental settings. Other members of this "family" are matching, synthetic control and regression discontinuity. The goal of these methods is to estimate the causal effects of a program when treatment assignment is non-random; hence, there is no obvious control group[1]. Although random assignment of treatment is prevalent in medical studies and has become more common also in the

social sciences, through e.g. pilot studies of policy interventions, most real-life situations involve non-random assignment. Examples include the introduction of new laws, government policies and regulatio

Average treatment effect on the Treated

$$E[Y(1) - y(0)] = E[Y|T = 1] - E[Y|T = 0]$$

For Difference-in-differences to work, parallel trends must hold. what that means is all the variation should not change the gap between control and treated states at the same time. it may not be the formal test of parallel]l trends, researchers often look at whether the gap between treated and control states is constant in pre-treatment years.

Hence to use the actual numbers of the "sustainable" changes that a developing country has made in the last 4 years since the Paris Agreement within the United Nations Framework Convention on Climate Change (UNFCCC) and establish that focusing on steep SDG targets are coming at a cost to a developing country, and the cost is slipping back into poverty.Traditionally these models have been estimated using fixed effects for group and time period, i.e. "two-way" fixed effects. However, this approach with difference-in-difference can heavily bias results if treatment effects differ across groups, and alternate estimators are preferred

An impact evaluation provides evidence that a certain hard established policies that were to meet the requirement of the government imposition checks if it has delivered impacts that are expected to be produced. [MH21] stated that a quasi-experimental approach is an empirical intervention study used to estimate an intervention's causal impact or test causal hypotheses. The most frequently used quasi-experiment approach is Differences in Differences (DID), along with maybe Instrument Variable which are based on a combination of before - after and treatment - control group comparisons ([FdO19]; World Bank 2021). There has been use of Difference in Difference (DID) in several policy and program eval-

uation and effectiveness of it overall along with measurements to have a conclusion inn a empirical sense.

However, although the DID method is popular among various research fields, it is not without limitations.[BDM03] Causal inference poses many challenges in DID designs. mention that the great appeal for DID estimation comes from its simplicity and potential to circumvent many of the endogeneity problems that arise when comparing heterogeneous groups. [WSBG18] supported [BDM03] view, they stated that the Difference in Difference (DID) design was not an ideal alternative for randomized experiments, but it often signifies as a viable way to learn about causal relationships. They further concluded that multiple quasi-experimental techniques might be an essential support for the Difference in Difference (DID) approach.

$$Y(post) - Y(pre) = Y(t = 1) - Y(t = 0) = \tau$$

Finally the Causal graph or the Directed Acyclic Graph given the data I have collected and the model and methods I am going to follow and apply is as below

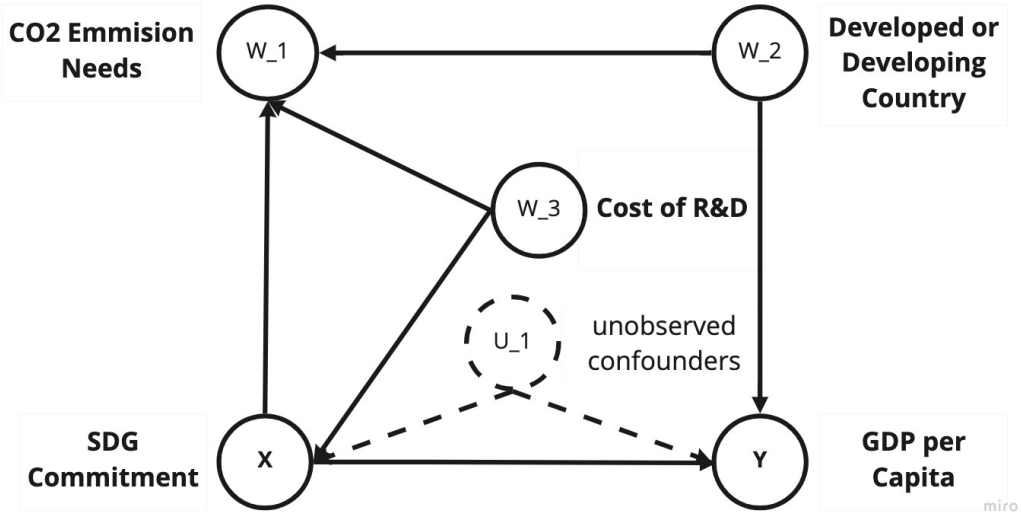

Figure 3.2: A DAG to show the effect of Waste on SDG

Our interest is to find the effect of **SDG Commitment** (X) on **GDP Growth Rate** (Y). We do not have a quantify able method to measure **SDG Commit-**

ment (X) hence we look for a variable that is **CO2 emission** (W_1) that is the instrument variable, partly only given SDG goals are multifaceted and we're focused on variables out of goal 12 and 14 of the SDG goals in the UN charter. We then have **Economy type** (W_2) which confounds with the the CO2 emission needs and the GDP per capita. I will explain each of this variables in the next section. Apart from this we have **RnD costs or budgets** (W_3) which determine how much a country is willing to spend on SDG goals pertaining to CO2 emission controlling.

Chapter 4

Data Exploration

In this section let's explore the data that we'll need to conduct this analysis, largely the data can be grouped in two sets- Specific goal tracking based on the SDG goals that were determined at Paris Climate Accord (PCA) and the Economic indicators that are best representation of the effect we hypothesized. In making both these choices, a lot of exploration and deliberation has gone into the sources for the SDG tracker data is the UN's SDG global tracker website and for the Economic Indicators it is the World Banks Data bank website. For both these data sets, I decided to choose the time frame of year 2000 to 2019.

4.1 SDG Goals

For SDG goals I largely relied on the UN's own statistics website, especially the Department of Economic and Social Affairs and their data portal [1] here one could browse and query specific metric that is coded and numbered for what part and subpart of the SDG goal it indicates and its relevant metric and its definition.

For the entire Analysis after plenty of explorations trial and errors my choice was narrowed down to **Goal 12** which proscribes to "Ensure sustainable consumption and production patterns" and more specifically the sub-goal **12.5** which proscribes "By 2030, substantially reduce waste generation through prevention,

[1] https://unstats.un.org/sdgs/dataportal/database

reduction, recycling and reuse". [2] But this goal the data collection was extremely poor in terms of years that has data and also countries that report this data.

Which made me shift focus to **Goal 9** which proscribes "Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation" and more specifically under Goal 9 the specific metric o **9.4** which proscribes to measure and see change in " By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action in accordance with their respective capabilities" [3]. As you can see both these required immediate action since there was only a 15 year timeline for this from when the Paris Climate Change accord was signed.

4.1.1 Atmospheric CO2 Levels (AtmCO2)

The fist measurement under the Goal 9.4 is the atmospheric levels of CO2 i.e Carbon dioxide emissions from fuel combustion (millions of tonnes) and measure with a certain limitations as in "Manufacturing excl. coke and refined petroleum products and repair and installation of machinery and equipment".

In the plots we can see that that after 2014 there was a increase mostly for developing countries and developed countries continued to fall, but seemingly not as rapidly as before. The pre-post difference between developed and Developing country (i.e the Difference-in-Difference estimator) seems to be much larger for developed countries.

4.1.2 Manufacturing Value Added (MFG-VA)

The second measurement under the Goal 9.4 is the Carbon dioxide emissions per unit of manufacturing value added (kilogrammes of CO2 per constant 2015 United

[2] https://unstats.un.org/sdgs/indicators/Global%20Indicator
[3] https://unstats.un.org/sdgs/indicators/Global%20Indicator

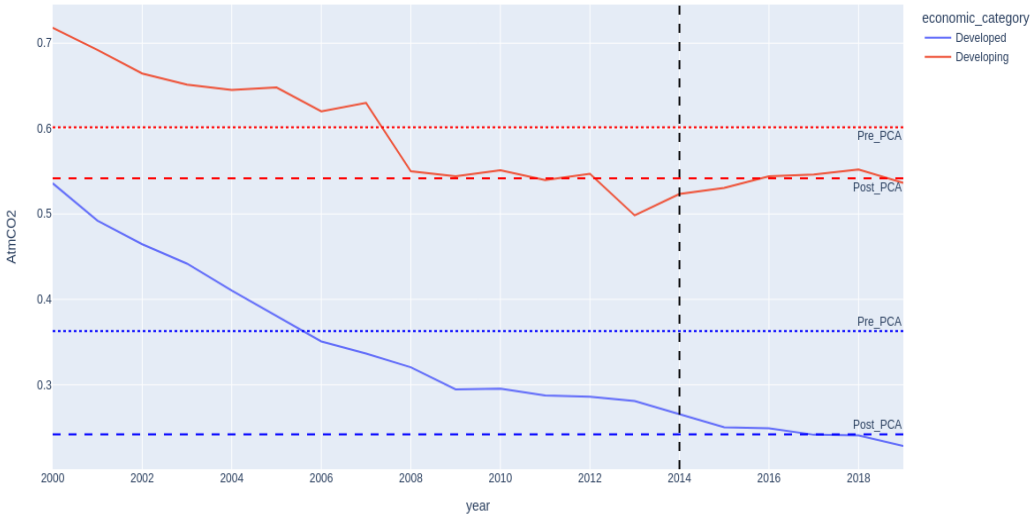

Figure 4.1: Atmospheric CO2 levels with pre-post annotation among groups

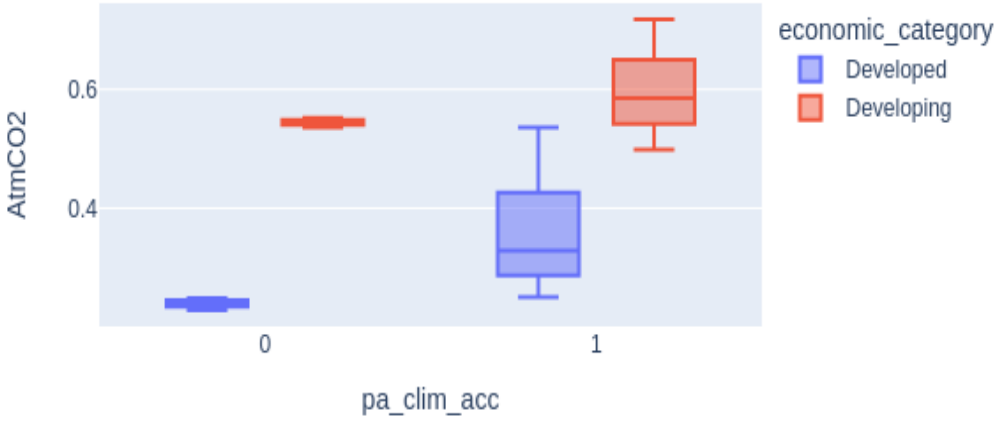

Figure 4.2: Group means of Atmospheric CO2 levels compared

States dollars) and measure with a certain limitations as in "Manufacturing excl. coke and refined petroleum products and repair and installation of machinery and equipment".

Figure 4.3: Manufacturing Value added with pre-post annotation among groups

In the plots we can see that that graphs that after 2014 there was a increase before a fall for developed countries and developing countries continued to fall, but seemingly not as rapidly as before. The pre-post difference between developed and Developing country (i.e the Difference-in-Difference estimator) seems to be not that different.

4.1.3 CO2 Emission as a fraction of GDP ($CO2GDP$)

The second measurement under the Goal 9.4 is the Carbon dioxide emissions per unit of GDP PPP (kilogrammes of CO2 per constant 2017 United States dollars) and measure with a certain limitations as in "Manufacturing excl. coke and refined petroleum products and repair and installation of machinery and equipment".

In the plots we can see that that after 2014 there was a sharp fall or a decrease for developed countries (could be from economic growth too) and developing countries continued to fall, but seemingly not as rapidly as before. The pre-post differ-

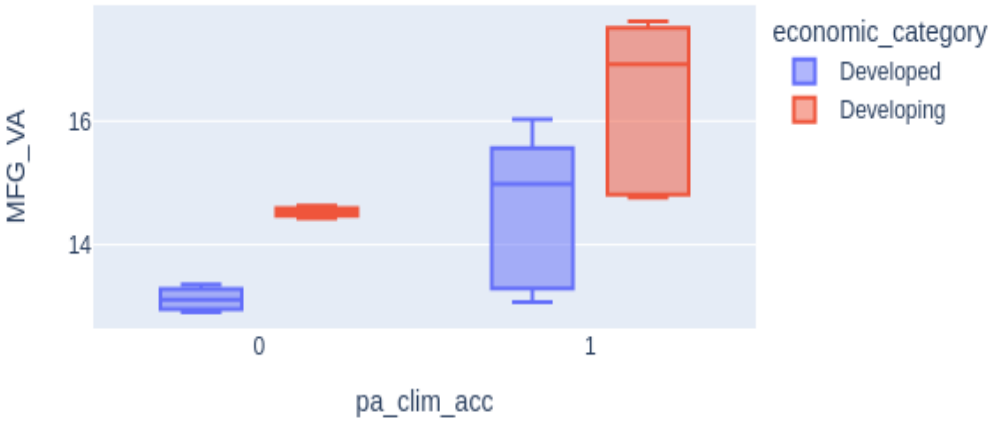

Figure 4.4: Group means of MFG value added compared

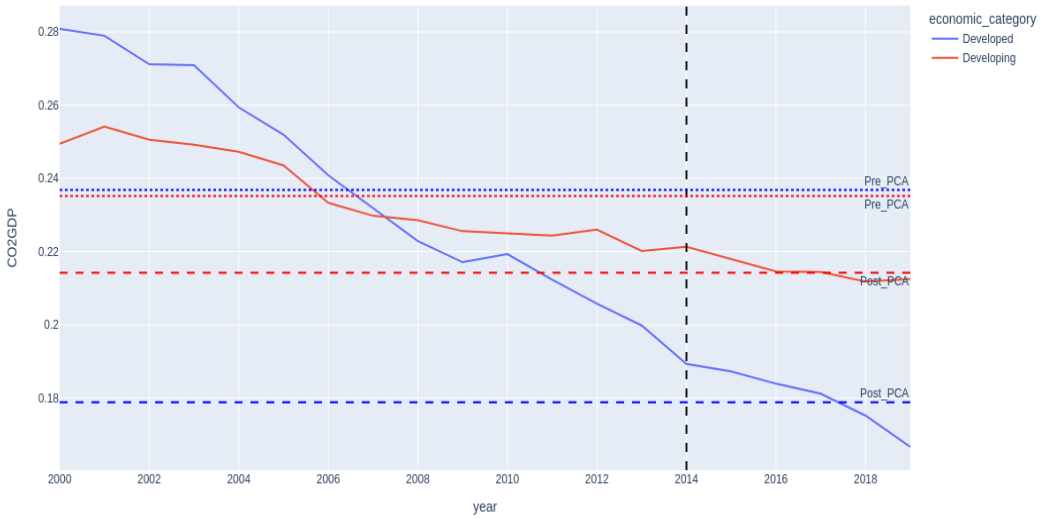

Figure 4.5: CO2 per GDP with pre-post annotation among groups

ence between developed and Developing country (i.e the Difference-in-Difference estimator) is huge for developed countries when compared to developing countries.

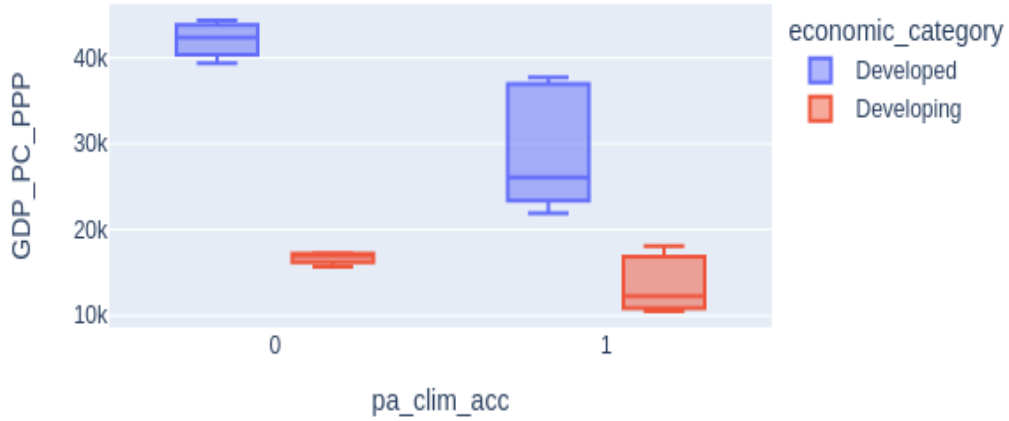

Figure 4.6: Group means of Atmospheric CO2 levels compared

4.2 Economic Indicators

For Economic Indicators the data source was World bank's Global database with all World Development Indicators [4] data available there.

4.2.1 GDP per capita with Purchase Power Parity (GDP-PC-PPP)

The economic indicator of my choice was the GDP per Capita adjusted for Purchase Power. Purchasing power parity (PPP) allows for economists to compare economic productivity and standards of living between countries given the currencies and its interactions. The method is used to compare economic productivity and standards of living between countries is purchasing power parity (PPP). PPP is an economic theory that compares different countries' currencies through a "basket of goods" approach. The World bank calculates it in a certain specific way-

[4]https://databank.worldbank.org/source/world-development-indicatorsa

It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. Data are in constant 2011 international dollars.

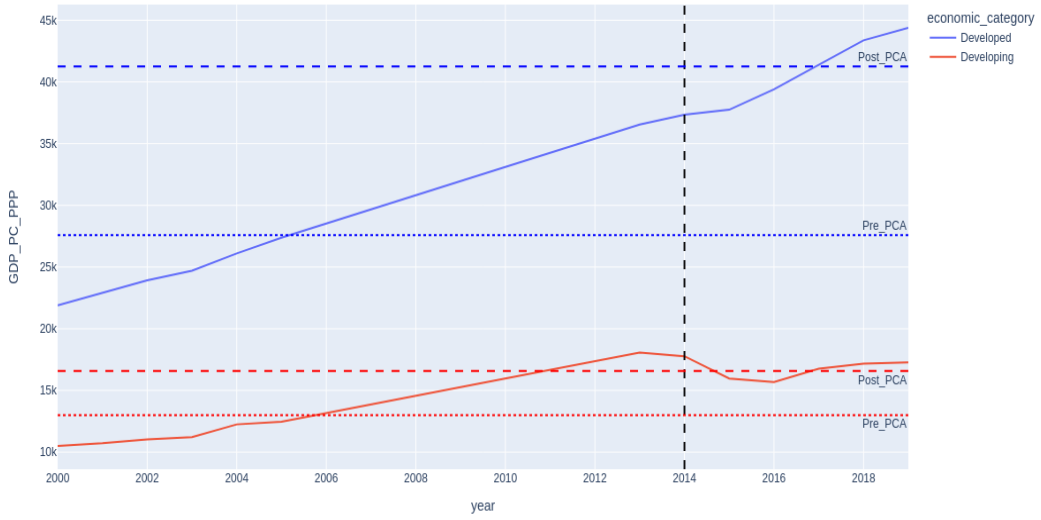

Figure 4.7: GDP per capita (PPP) with pre-post annotation among groups

If we inspect the graphs of this Economic Indicator we can clearly see that the Developed countries after experiencing a small unproductive year around 2014 when Paris Climate Change accord is signed, they continued to grow at pace as before. Contrast this to Developing countries they do not seem to seem to grow at the same pace as before. This can be seen in the box plot where when we compare the means we see that the difference is growing.

4.2.2 GDP per Employed (GDP-PEMP)

GDP per employed in any economy helps us to just adjust for the employment rates, we know that the characteristic of developing country is to have higher unemployment or higher engagement in farming which often is not tracked as an employment. This choice of economic indicator was to largely balance the effect of growing employment in a developing country and most of these employment is in industrialization which is lifting people from farm to factories.

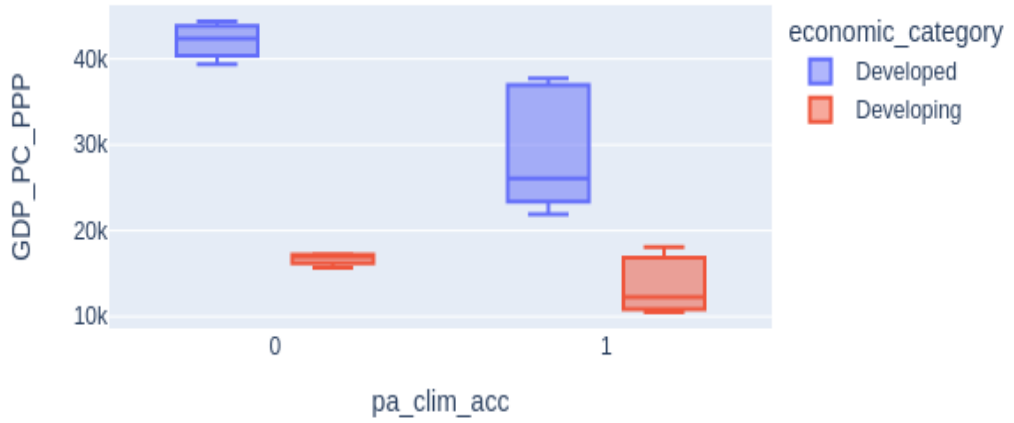

Figure 4.8: Group means of Atmospheric GDP per capita (PPP) compared

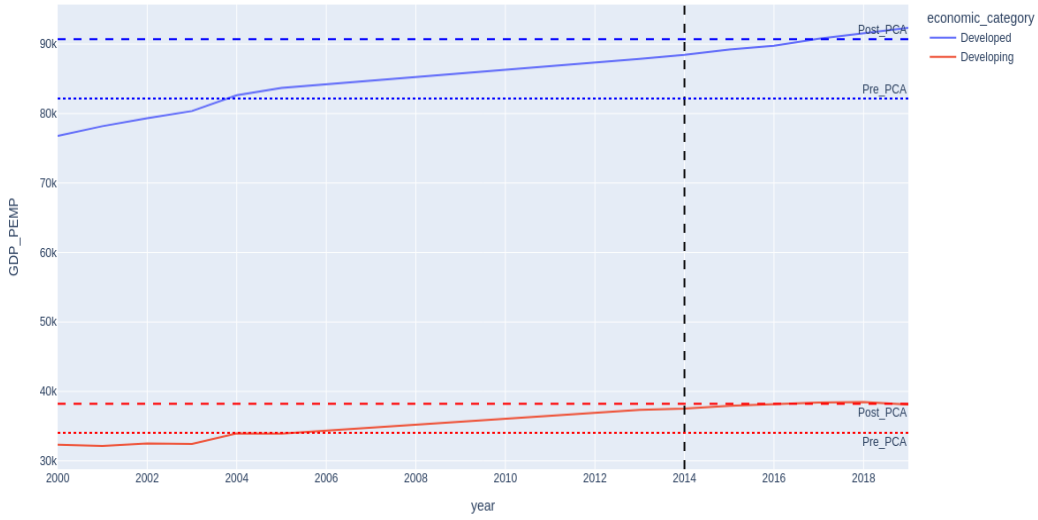

Figure 4.9: GDP per Employed with pre-post annotation among groups

If we Interpret this metric the groups of developed and developing countries are further apart, the gap is larger and similar trends follow where post PCA the growth is not as sharp as before for developing countries and the growth in Developed countries continues with the same trajectory.

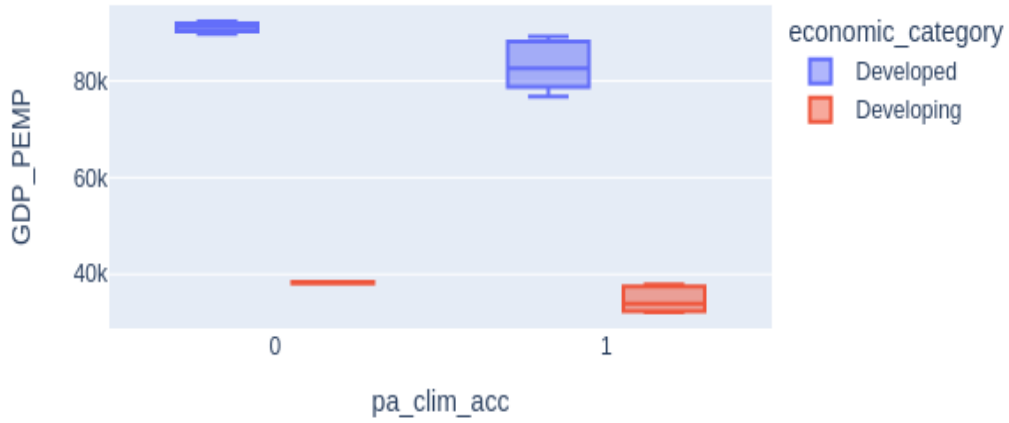

Figure 4.10: Group means of GDP per Employed compared

Chapter 5

Results and Conclusion

5.1 Effect CO2GDP on GDP per Capita

Post adjusting and justifying for the instrument variable (shown in appendix) and then running the model with our X and Y as desired while controlling for the un-confounded variables we are able to run a simple OLS regression to measure the Average Causal Effect.

From observing the table we see that that model has a very good explanatory power int he R-squared value at 99% which indicates great model completeness and robust estimate. Then we see for all the variables we have a p-value of less than 0.05 which is sound statistical significance, but maybe the model isn't that complete since many p-values are at 0.00 especially CO2GDP variable. The interpretation for other variables are that a person was on an average making more money before Paris Climate Change Accord that they do after i.e exactly by $2139 dollars. The interaction terms tells us that a person from a developed country is making more money than one from Developing world post the PCA 2014 agreement i.e $4251 dollars.

Dep. Variable:	GDP_PC_PPP	**R-squared:**		0.997
Model:	OLS	**Adj. R-squared:**		0.996
	coef	**std err**	**t**	**P> |t|**
Intercept	-2.608e+05	1.4e+05	-1.861	0.078
CO2GDP	-1.421e+05	1.37e+04	-10.388	0.000
year	162.6057	68.389	2.378	0.028
econ_cat	-2.022e+04	705.584	-28.650	0.000
pa_clim_acc	-2139.4676	577.782	-3.703	0.001
econ_cat:pa_clim_acc	4251.8178	815.927	5.211	0.000

Table 5.1: DiD results GDP-PC-PPP & CO2GDP

5.2 Effect AtmCO2 on GDP per Capita

Post adjusting and justifying for the instrument variable (shown in appendix) and then running the model with our X and Y as desired while controlling for the un-confounded variables we are able to run a simple OLS regression to measure the Average Causal Effect.

From observing the table we see that that model has a very good explanatory power int the R-squared value at 98% which indicates great model completeness and robust estimate. Then we see for all the variables we have a p-value of less than 0.05 which is sound statistical significance, but maybe the model isn't that complete since many p-values are at 0.00 especially AtmCO2 variable. The AtmCO2 values tells us that with increase in AtmCO2 levels the GDP per capita drops by a small but statistically significant margin. The economic category variable tells us that the Developing country is certainly making less GDP per capita as per our intuition and understanding an the characteristics of a developing country.

The interpretation for other variables are that a person was on an average making more money before Paris Climate Change Accord that they do after i.e exactly by $5092 dollars. The interaction terms tells us that a person from a developed country is making more money than one from Developing world post the PCA 2014 agreement i.e $6726 dollars. The year variable has no significance. And the year is not a factor in determining the change since it is insignificant.

But the categorical Paris Climate Change Accord variable is significant indicating that the year variable was maybe redundant and to be removed from the model.

Dep. Variable:	GDP_PC_PPP	**R-squared:**		0.985
Model:	OLS	**Adj. R-squared:**		0.982
	coef	**std err**	**t**	**P> |t|**
Intercept	-2.81e+05	4.96e+05	-0.566	0.577
AtmCO2	-4.27e+04	1.57e+04	-2.713	0.013
year	165.2362	244.050	0.677	0.506
econ_cat	-1.24e+04	4915.893	-2.522	0.020
pa_clim_acc	-5092.6215	1181.436	-4.311	0.000
econ_cat:pa_clim_acc	6726.8443	1773.159	3.794	0.001

Table 5.2: DiD results GDP-PC-PP & CO2GDP

This leads us to a good conclusion which proves to us at least on one economic indicator front that there is a parity in how the SDG goals have affected the GDP per capita trends in the developed vs. developing world. Finding our proxy variable through the IV estimator or the right SDG goal that we empirically chose and combining that with the Difference-in-difference average Causal Effect estimator gives us the the exact effect size.

Chapter 6

Discussion and Future Studies

This study can be summarized by saying that Developing countries are taking up steeper targets on SDG goals which is costing them GDP per capita growth. This we saw through a proxy variable in difference-in-difference based study. We used a particular Goal of the SGD goals which is 14.1 there are many other parts to the SDG goals which are more important for Developing country that it is for a developed county. For example No poverty, Zero Hunger, Clean water and Sanitation which are of immediate importance and effect for Developing countries. But in the context of this study we focused on what was agreed as goals on the climate front of the SDG and what actions each country has taken.

On the methods front, A DiD or an IV method are quasi-experiments at best if not for observational studies, the robustness in our variables and the power of the confounders and the controlling of it along with the time invariant attributes of our data set can all be improved, there are plenty of examples out there where a bunch of economic indicators were thrown at a matching algorithm to stratify countries, we could use that cluster differently and study the effects of different groups to improve our Causal estimate in a unsupervised learning fashion.

Appendix A

Appendix

A.1 DiD results GDP-PC-PPP & CO2GDP

Dep. Variable:	GDP_PC_PPP	**R-squared:**	0.997
Model:	OLS	**Adj. R-squared:**	0.996
Method:	Least Squares	**F-statistic:**	1283.
Date:	Wed, 11 May 2022	**Prob (F-statistic):**	2.37e-24
Time:	08:09:55	**Log-Likelihood:**	-203.94
No. Observations:	26	**AIC:**	419.9
Df Residuals:	20	**BIC:**	427.4
Df Model:	5		

	coef	**std err**	**t**	**P> |t|**
Intercept	-2.608e+05	1.4e+05	-1.861	0.078
CO2GDP	-1.421e+05	1.37e+04	-10.388	0.000
year	162.6057	68.389	2.378	0.028
econ_cat	-2.022e+04	705.584	-28.650	0.000
pa_clim_acc	-2139.4676	577.782	-3.703	0.001
econ_cat:pa_clim_acc	4251.8178	815.927	5.211	0.000

Omnibus:	10.240	**Durbin-Watson:**	1.778
Prob(Omnibus):	0.006	**Jarque-Bera (JB):**	8.583
Skew:	-1.141	**Prob(JB):**	0.0137
Kurtosis:	4.647	**Cond. No.**	2.05e+06

A.2 DiD results GDP-PEMP & CO2GDP

Dep. Variable:	GDP_PEMP	**R-squared:**	0.999
Model:	OLS	**Adj. R-squared:**	0.999
Method:	Least Squares	**F-statistic:**	6077.
Date:	Wed, 11 May 2022	**Prob (F-statistic):**	4.30e-31
Time:	08:29:01	**Log-Likelihood:**	-205.20
No. Observations:	26	**AIC:**	422.4
Df Residuals:	20	**BIC:**	429.9
Df Model:	5		

	coef	**std err**	**t**	**P> |t|**
Intercept	-3.132e+05	1.47e+05	-2.129	0.046
CO2GDP	-8.33e+04	1.44e+04	-5.802	0.000
year	207.6724	71.783	2.893	0.009
econ_cat	-4.977e+04	740.597	-67.204	0.000
pa_clim_acc	-299.6750	606.453	-0.494	0.627
econ_cat:pa_clim_acc	959.7292	856.415	1.121	0.276

Omnibus:	6.613	**Durbin-Watson:**	0.875
Prob(Omnibus):	0.037	**Jarque-Bera (JB):**	6.403
Skew:	0.450	**Prob(JB):**	0.0407
Kurtosis:	5.258	**Cond. No.**	2.05e+06

A.3 GDP-PC-PPP & AtmCO2

Dep. Variable:	GDP_PC_PPP	**R-squared:**	0.985
Model:	OLS	**Adj. R-squared:**	0.982
Method:	Least Squares	**F-statistic:**	271.4
Date:	Wed, 11 May 2022	**Prob (F-statistic):**	1.16e-17
Time:	08:35:20	**Log-Likelihood:**	-223.99
No. Observations:	26	**AIC:**	460.0
Df Residuals:	20	**BIC:**	467.5
Df Model:	5		

	coef	**std err**	**t**	**P> |t|**
Intercept	-2.81e+05	4.96e+05	-0.566	0.577
AtmCO2	-4.27e+04	1.57e+04	-2.713	0.013
year	165.2362	244.050	0.677	0.506
econ_cat	-1.24e+04	4915.893	-2.522	0.020
pa_clim_acc	-5092.6215	1181.436	-4.311	0.000
econ_cat:pa_clim_acc	6726.8443	1773.159	3.794	0.001

Omnibus:	1.509	**Durbin-Watson:**	1.070
Prob(Omnibus):	0.470	**Jarque-Bera (JB):**	0.962
Skew:	0.019	**Prob(JB):**	0.618
Kurtosis:	2.059	**Cond. No.**	3.34e+06

A.4 GDP-PEMP & AtmCO2

Dep. Variable:	GDP_PEMP	**R-squared:**	0.999
Model:	OLS	**Adj. R-squared:**	0.999
Method:	Least Squares	**F-statistic:**	4695.
Date:	Wed, 11 May 2022	**Prob (F-statistic):**	5.67e-30
Time:	08:38:37	**Log-Likelihood:**	-208.55
No. Observations:	26	**AIC:**	429.1
Df Residuals:	20	**BIC:**	436.7
Df Model:	5		

	coef	**std err**	**t**	**P> |t|**
Intercept	1.39e+05	2.74e+05	0.507	0.618
AtmCO2	-4.026e+04	8691.385	-4.632	0.000
year	-18.9332	134.778	-0.140	0.890
econ_cat	-4.055e+04	2714.837	-14.935	0.000
pa_clim_acc	-2269.7508	652.456	-3.479	0.002
econ_cat:pa_clim_acc	1235.8591	979.240	1.262	0.221

Omnibus:	0.916	**Durbin-Watson:**	1.392
Prob(Omnibus):	0.632	**Jarque-Bera (JB):**	0.243
Skew:	-0.212	**Prob(JB):**	0.886
Kurtosis:	3.212	**Cond. No.**	3.34e+06

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