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Data analysis 4. Assignment 2

Data

The data I analyzed includes GDP per capita in PPP (constant 2017 dollars) and CO2 emissions per capita for all world countries between 1992 and 2018. The dataset includes 4516 observations.

I dropped 848 missing data points from the dataset. I also dropped 13 countries that had less than 16 years with present data. I chose a threshold of 16 because for me it seemed reasonable. After dropping the missing values and countries with poor coverage, years 1993, 2017 and 2018 disappeared from the dataset.

Findings

The cross-section models for two separate years, 2000 and 2015, show that, on average, every 1 p.p. increase in GDP per capita tends to be followed by a 0.14 p.p. increase in per capita CO2 emissions, controlling for a country. Other models, which compare countries over time and within the cross-sectional units, estimate the average increase in per capita CO2 emissions at approximately 0.65 p.p., on average, for a 1 p.p. higher GDP per capita.

The potential mechanism can be as follows. As per capita GDP grows, the consumption and industrial production increases, which leads to higher CO2 emissions.

The 'cleanness' of industrial production can be a confounder. Dirtier industrial production can cause a lot of emissions but also increase GDP fast. Cleaner industrial production can have lower emissions, but also be less effective at increasing GDP.

Regressions

1) Cross-section OLS

The per capita CO2 emissions were 0.132 p.p. higher, on average, in 2000 for every 1 p.p. increase in GDP per capita, controlling for a country.

<i>Dependent variable: d_Inco2pc</i>	
Cross-section regression 2000	
	(1)
GDP per capita log change, cumulative coeff.	0.132*** (0.000)
Constant	0.017*** (0.000)
Observations	175
R ²	1.000
Adjusted R ²	nan
Residual Std. Error	inf (df=0)
F Statistic	19501977596558170148628194131968.000*** (df=174; 0)
Note:	*p<0.1; **p<0.05; ***p<0.01

2) Cross-section OLS for 2015

The per capita CO2 emissions were 0.149 p.p. higher, on average, in 2015 for every 1 p.p. increase in GDP per capita, controlling for a country.

<i>Dependent variable: d_Inco2pc</i>	
Pooled regression 2015	
	(1)
GDP per capita log change, cumulative coeff.	0.149*** (0.000)
Constant	-0.003*** (0.000)
Observations	176
R ²	1.000
Adjusted R ²	nan
Residual Std. Error	inf (df=0)
F Statistic	175152020865787132682754351693824.000*** (df=175; 0)
Note:	*p<0.1; **p<0.05; ***p<0.01

3) First difference model, with time trend, no lags

A 1 p.p. increase in GDP per capita tends to be followed by 0.61 p.p. increase in CO2 emissions per capita, on average, in the data, relative to the country trend.

Dep. Variable:	d_Inco2pc	R-squared:	0.075
Model:	WLS	Adj. R-squared:	0.074
Method:	Least Squares	F-statistic:	18.55
Date:	Wed, 31 Mar 2021	Prob (F-statistic):	4.87e-08
Time:	14:43:35	Log-Likelihood:	2858.4
No. Observations:	4213	AIC:	-5711.
Df Residuals:	4210	BIC:	-5692.
Df Model:	2		
Covariance Type:	cluster		

	coef	std err	z	P> z	[0.025	0.975]
Intercept	0.1407	0.489	0.288	0.773	-0.817	1.098
d_ingdppc	0.6142	0.102	6.046	0.000	0.415	0.813
year	-7.012e-05	0.000	-0.288	0.774	-0.001	0.000

Omnibus:	1844.627	Durbin-Watson:	1.975
Prob(Omnibus):	0.000	Jarque-Bera (JB):	166438.455
Skew:	1.162	Prob(JB):	0.00
Kurtosis:	33.704	Cond. No.	5.84e+05

4) First difference model, with time trend, 2 year lags

A 1 p.p. increase in GDP per capita tends to be followed by 0.62 p.p. cumulative increase in CO2 emissions per capita, on average, within two years in the data, relative to the country trend.

Dep. Variable:	d_Inco2pc	R-squared:	0.075
Model:	WLS	Adj. R-squared:	0.074
Method:	Least Squares	F-statistic:	9.375
Date:	Wed, 31 Mar 2021	Prob (F-statistic):	6.77e-07
Time:	14:43:35	Log-Likelihood:	2857.1
No. Observations:	4211	AIC:	-5704.
Df Residuals:	4206	BIC:	-5672.
Df Model:	4		
Covariance Type:	cluster		

	coef	std err	z	P> z	[0.025	0.975]
Intercept	0.1525	0.490	0.312	0.755	-0.807	1.112
d_Ingdppc.shift(0)	0.6156	0.102	6.046	0.000	0.416	0.815
d_Ingdppc.shift(1)	-0.0222	0.023	-0.966	0.334	-0.067	0.023
d_Ingdppc.shift(2)	0.0238	0.027	0.879	0.380	-0.029	0.077
year	-7.603e-05	0.000	-0.311	0.756	-0.001	0.000

Omnibus:	1842.843	Durbin-Watson:	1.974
Prob(Omnibus):	0.000	Jarque-Bera (JB):	166181.820
Skew:	1.161	Prob(JB):	0.00
Kurtosis:	33.688	Cond. No.	5.85e+05

5) First difference model, with time trend, 6 year lags

A 1 p.p. increase in GDP per capita tends to be followed by 0.55 p.p. increase in CO2 emissions per capita, on average, within six years in the data, relative to the country trend.

Dep. Variable:	d_lnc2pc	R-squared:	0.076
Model:	WLS	Adj. R-squared:	0.074
Method:	Least Squares	F-statistic:	4.797
Date:	Wed, 31 Mar 2021	Prob (F-statistic):	2.35e-05
Time:	14:43:35	Log-Likelihood:	2875.0
No. Observations:	4207	AIC:	-5732.
Df Residuals:	4198	BIC:	-5675.
Df Model:	8		
Covariance Type:	cluster		

	coef	std err	z	P> z	[0.025	0.975]
Intercept	0.2176	0.479	0.454	0.650	-0.722	1.157
d_lngdppc.shift(0)	0.6194	0.103	5.991	0.000	0.417	0.822
d_lngdppc.shift(1)	-0.0162	0.023	-0.692	0.489	-0.062	0.030
d_lngdppc.shift(2)	0.0237	0.026	0.910	0.363	-0.027	0.075
d_lngdppc.shift(3)	-0.0340	0.030	-1.119	0.263	-0.094	0.026
d_lngdppc.shift(4)	-0.0269	0.025	-1.080	0.280	-0.076	0.022
d_lngdppc.shift(5)	-0.0080	0.031	-0.261	0.794	-0.068	0.052
d_lngdppc.shift(6)	-0.0116	0.028	-0.416	0.678	-0.066	0.043
year	-0.0001	0.000	-0.450	0.653	-0.001	0.000

Omnibus:	1892.331	Durbin-Watson:	1.975
Prob(Omnibus):	0.000	Jarque-Bera (JB):	168685.249
Skew:	1.224	Prob(JB):	0.00
Kurtosis:	33.924	Cond. No.	5.85e+05

6) Fixed effects model with time and country fixed effects

Per capita CO2 emissions tend to be 0.75 p.p. higher, on average, for a 1 p.p. increase in per capita GDP within the data, compared to mean per capita CO2 emissions for a country and within a given year.

Dep. Variable:	Inco2pc	R-squared:	0.2562
Estimator:	PanelOLS	R-squared (Between):	-12.225
No. Observations:	4516	R-squared (Within):	0.3598
Date:	Wed, Mar 31 2021	R-squared (Overall):	-12.315
Time:	14:43:36	Log-likelihood	466.52
Cov. Estimator:	Clustered		
		F-statistic:	1480.9
Entities:	217	P-value	0.0000
Avg Obs:	20.811	Distribution:	F(1,4300)
Min Obs:	0.0000		
Max Obs:	25.000	F-statistic (robust):	22.726
		P-value	0.0000
Time periods:	25	Distribution:	F(1,4300)
Avg Obs:	180.64		
Min Obs:	164.00		
Max Obs:	191.00		

Parameter Estimates

	Parameter	Std. Err.	T-stat	P-value	Lower CI	Upper CI
lngdppc	0.7484	0.1570	4.7672	0.0000	0.4406	1.0562

F-test for Poolability: 178.03

P-value: 0.0000

Distribution: F(214,4300)

7) Long difference

A 1 p.p. increase in GDP per capita tends to be followed by 0.68 p.p. increase in CO2 emissions per capita, on average, between 1993 and 2016 in the data.

Dep. Variable:	d_Inco2pc	R-squared:	0.115
Model:	WLS	Adj. R-squared:	0.113
Method:	Least Squares	F-statistic:	19.93
Date:	Wed, 31 Mar 2021	Prob (F-statistic):	1.43e-05
Time:	14:48:07	Log-Likelihood:	283.89
No. Observations:	340	AIC:	-563.8
Df Residuals:	338	BIC:	-556.1
Df Model:	1		
Covariance Type:	cluster		

	coef	std err	z	P> z 	[0.025	0.975]
Intercept	0.0051	0.006	0.845	0.398	-0.007	0.017
d_Ingdppc	0.6812	0.153	4.464	0.000	0.382	0.980

Omnibus:	104.034	Durbin-Watson:	1.977
Prob(Omnibus):	0.000	Jarque-Bera (JB):	2539.289
Skew:	-0.636	Prob(JB):	0.00
Kurtosis:	16.328	Cond. No.	18.0