DACSS 603 - Final Project Check-In #2

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Research Question

Question 1

Does GDP have a positive effect on renewable energy generation/consumption?

Question 2

Does Nuclear energy generation/consumption affect renewabole energy and GDP per capita's effect?

Hypothesis

Hypothesis 1

Null: GDP per Capita has no effect on renewable generation/consumption Alternative: As GDP per Capita increases, renewable generation/consumption increases

Hypothesis 2

Null: Nuclear consumption/generation has no effect on renewable generation/consumption Alternative: Nuclear consumption/generation has a positive effect on renewable consumption/generation

Read in Packages

```
library(ggplot2)
library(stats)
library(dplyr)
```

```
Attaching package: 'dplyr'

The following objects are masked from 'package:stats':

    filter, lag
```

```
The following objects are masked from 'package:base':

    intersect, setdiff, setequal, union
```

```
library(stargazer)
```

```
Please cite as:

 Hlavac, Marek (2022). stargazer: Well-Formatted Regression and Summary Statistics Tables.

 R package version 5.2.3. https://CRAN.R-project.org/package=stargazer
```

```
library(effects)
```

```
Loading required package: carData

lattice theme set by effectsTheme()
See ?effectsTheme for details.
```

Read in Data

```
data <- read.csv('https://raw.githubusercontent.com/rfordatascience/tidytuesday/master/data/2023/
```

Manipulate Data

```
data1 <- data %>%
  mutate(gdp_per_capita = gdp/population) %>%
  na.omit()

View(data1)
```

Linear Models - Generation

Model Creation

```
lm_generation_1 <- lm(renewables_electricity ~ gdp_per_capita, data = data1)
summary(lm_generation_1)
```

```
Call:
lm(formula = renewables_electricity ~ gdp_per_capita, data = data1)
```

```
Residuals:
    Min      1Q  Median      3Q     Max
-199.55 -129.96   -5.32  109.65  459.41

Coefficients:
                 Estimate Std. Error t value Pr(>|t|)
(Intercept)    -81.329269  43.180999  -1.883   0.0621 .
gdp_per_capita   0.008121   0.001201   6.760 5.31e-10 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 158.4 on 120 degrees of freedom
Multiple R-squared:  0.2758,    Adjusted R-squared:  0.2697
F-statistic: 45.69 on 1 and 120 DF,  p-value: 5.309e-10
```

```
lm_generation_2 <- lm(renewables_electricity ~ gdp_per_capita + nuclear_electricity, data = data1
summary(lm_generation_2)
```

```
Call:
lm(formula = renewables_electricity ~ gdp_per_capita + nuclear_electricity,
    data = data1)

Residuals:
   Min     1Q Median     3Q    Max
-218.2 -103.8  -45.2  101.6  428.9

Coefficients:
                     Estimate Std. Error t value Pr(>|t|)
(Intercept)          0.143472  46.079263   0.003 0.997521
gdp_per_capita       0.004235   0.001523   2.781 0.006301 **
nuclear_electricity  0.257792   0.067143   3.839 0.000199 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 150 on 119 degrees of freedom
Multiple R-squared:  0.3556,    Adjusted R-squared:  0.3448
F-statistic: 32.83 on 2 and 119 DF,  p-value: 4.416e-12
```

```
lm_generation_3 <- lm(renewables_electricity ~ gdp_per_capita * nuclear_electricity, data = data1
summary(lm_generation_3)
```

```
Call:
lm(formula = renewables_electricity ~ gdp_per_capita * nuclear_electricity,
    data = data1)
```

```
Residuals:
    Min      1Q  Median      3Q     Max
-159.97  -89.57  -50.79   58.27  405.32

Coefficients:
                                   Estimate Std. Error t value Pr(>|t|)
(Intercept)                       5.228e+01  4.101e+01   1.275  0.20491
gdp_per_capita                    4.065e-03  1.327e-03   3.063  0.00272 **
nuclear_electricity              -2.206e+00  4.001e-01  -5.515 2.09e-07 ***
gdp_per_capita:nuclear_electricity  4.957e-05  7.961e-06   6.226 7.57e-09 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 130.7 on 118 degrees of freedom
Multiple R-squared:  0.5149,    Adjusted R-squared:  0.5026
F-statistic: 41.76 on 3 and 118 DF,  p-value: < 2.2e-16
```

```
stargazer(lm_generation_1, lm_generation_2, lm_generation_3, type = "text")
```

```
================================================================================================
=========
                                                Dependent variable:
                                    ------------------------------------------------------------
---------
                                                renewables_electricity
                                          (1)                    (2)                    (3)
------------------------------------------------------------------------------------------------
---------
gdp_per_capita                          0.008***               0.004***
0.004***
                                         (0.001)                (0.002)
(0.001)

nuclear_electricity                                            0.258***
-2.206***
                                                               (0.067)
(0.400)

gdp_per_capita:nuclear_electricity
0.00005***

(0.00001)

Constant                                -81.329*                0.143                  52.278
                                        (43.181)               (46.079)
(41.011)

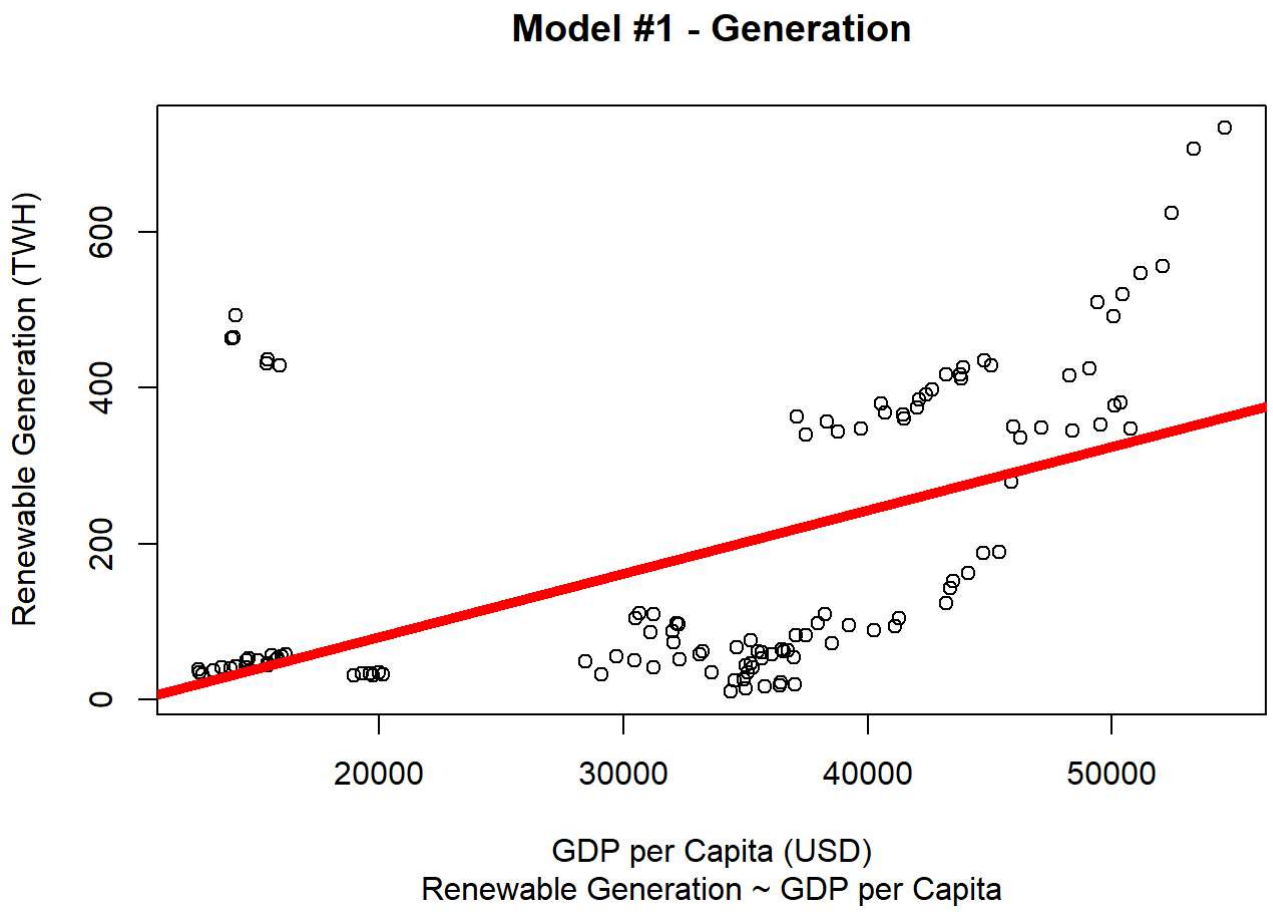
------------------------------------------------------------------------------------------------
---------
```

```
Observations                    122                 122                 122
R2                            0.276               0.356               0.515
Adjusted R2                   0.270               0.345               0.503
Residual Std. Error     158.388 (df = 120)  150.030 (df = 119)  130.716 (df
= 118)
F Statistic          45.692*** (df = 1; 120) 32.833*** (df = 2; 119) 41.757*** (df
= 3; 118)
=============================================================================================
=========
Note:                                                         *p<0.1; **p<0.05;
***p<0.01
```

Visualizations - Generation

Model 1

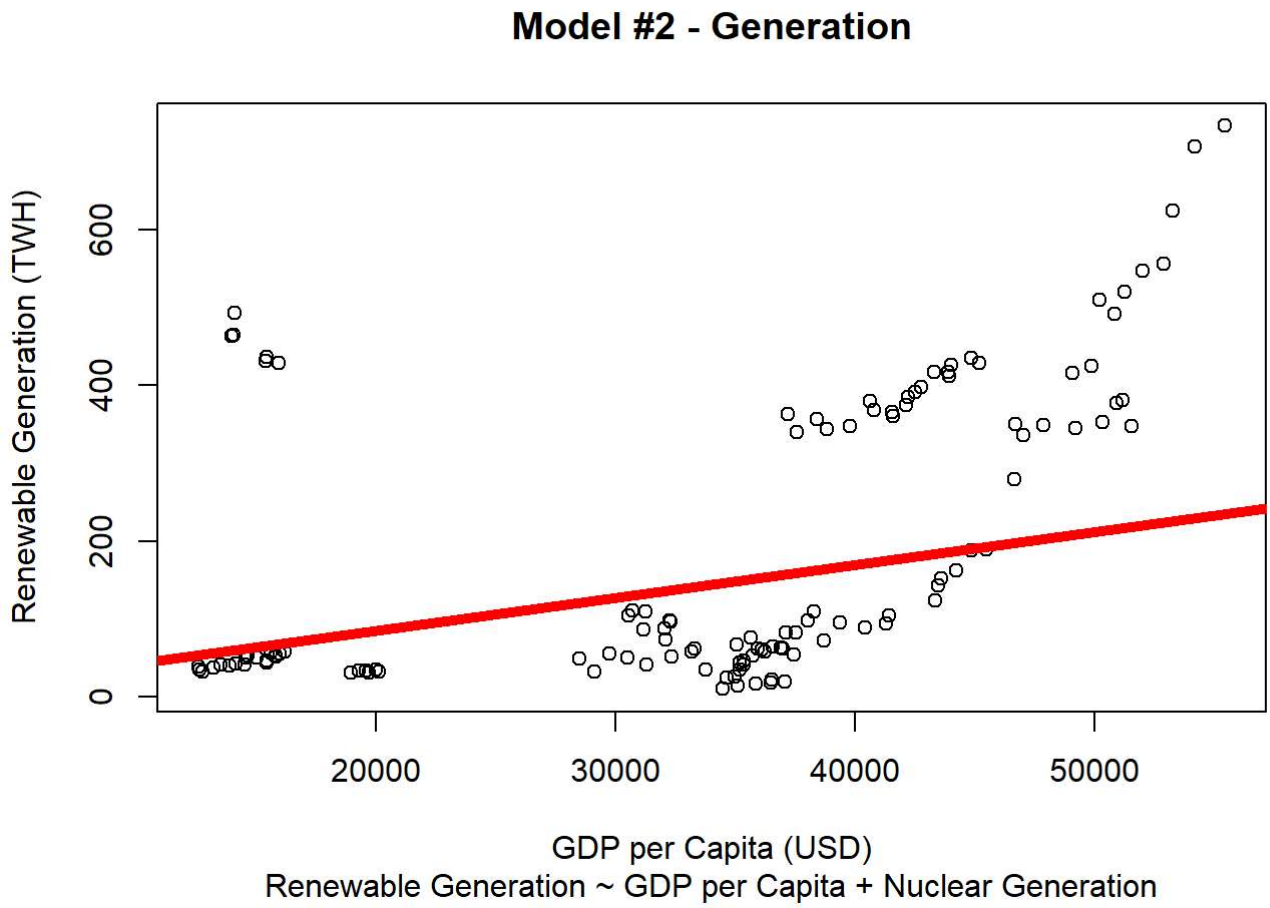
```
plot(x = data1$gdp_per_capita, y = data1$renewables_electricity,
     main = "Model #1 - Generation", sub = "Renewable Generation ~ GDP per Capita",
     xlab = "GDP per Capita (USD)", ylab = "Renewable Generation (TWH)")
abline(lm_generation_1, col = "red", lwd = 5)
```



Model 2

```
plot(x = data1$gdp_per_capita + data1$nuclear_electricity, y = data1$renewables_electricity,
     main = "Model #2 - Generation", sub = "Renewable Generation ~ GDP per Capita + Nuclear Gener
     xlab = "GDP per Capita (USD)", ylab = "Renewable Generation (TWH)")
abline(lm_generation_2, col = "red", lwd = 5)
```

```
Warning in abline(lm_generation_2, col = "red", lwd = 5): only using the first
two of 3 regression coefficients
```



Model 3

```
plot_model_3_gen <- predictorEffect("gdp_per_capita", lm_generation_3)
as.data.frame(plot_model_3_gen)
```

	gdp_per_capita	nuclear_electricity	fit	se	lower
1	12600	5	95.5861468	26.22865	43.646271
2	13400	5	99.0362890	25.39431	48.748646
3	14300	5	102.9176990	24.47671	54.447152
4	15200	5	106.7991089	23.58389	60.096585
5	16000	5	110.2492511	22.81343	65.072446

6	16900	5	114.1306611	21.97569	70.612821
7	17700	5	117.5808032	21.25964	75.480923
8	18600	5	121.4622132	20.48995	80.886536
9	19500	5	125.3436232	19.76248	86.208523
10	20300	5	128.7937653	19.15520	90.861257
11	21200	5	132.6751753	18.52099	95.998580
12	22000	5	136.1253175	18.00504	100.470427
13	22900	5	140.0067274	17.48355	105.384543
14	23700	5	143.4568696	17.07683	109.640102
15	24600	5	147.3382796	16.68827	114.290963
16	25500	5	151.2196895	16.37775	118.787278
17	26300	5	154.6698317	16.17092	122.647011
18	27200	5	158.5512417	16.01932	126.828628
19	28000	5	162.0013839	15.95855	130.399114
20	28900	5	165.8827938	15.97444	134.249053
21	29700	5	169.3329360	16.06326	137.523310
22	30600	5	173.2143460	16.24572	141.043406
23	31500	5	177.0957559	16.51274	144.396042
24	32300	5	180.5458981	16.81785	147.241970
25	33200	5	184.4273081	17.23296	150.301358
26	34000	5	187.8774502	17.66164	152.902597
27	34900	5	191.7588602	18.20592	155.706174
28	35700	5	195.2090024	18.74042	158.097879
29	36600	5	199.0904123	19.39363	160.685748
30	37500	5	202.9718223	20.09663	163.175015
31	38300	5	206.4219645	20.75925	165.313001
32	39200	5	210.3033744	21.54288	167.642603
33	40000	5	213.7535166	22.27008	169.652702
34	40900	5	217.6349266	23.11911	171.852797
35	41800	5	221.5163365	23.99755	173.994660
36	42600	5	224.9664787	24.80054	175.854649
37	43500	5	228.8478887	25.72632	177.902770
38	44300	5	232.2980309	26.56722	179.687701
39	45200	5	236.1794408	27.53146	181.659655
40	46000	5	239.6295830	28.40324	183.383444
41	46900	5	243.5109930	29.39890	185.293166
42	47800	5	247.3924029	30.40887	187.174570
43	48600	5	250.8425451	31.31750	188.825369
44	49500	5	254.7239551	32.35084	190.660478
45	50300	5	258.1740973	33.27841	192.273784
46	51200	5	262.0555072	34.33120	194.070382
47	52000	5	265.5056494	35.27458	195.652382
48	52900	5	269.3870594	36.34367	197.416705
49	53800	5	273.2684693	37.42032	199.166042
50	54600	5	276.7186115	38.38319	200.709447
51	12600	200	-212.8726289	59.64707	-330.990059
52	13400	200	-201.6901509	58.07059	-316.685733
53	14300	200	-189.1098631	56.30149	-300.602136
54	15200	200	-176.5295754	54.53751	-284.528693
55	16000	200	-165.3470974	52.97425	-270.250533
56	16900	200	-152.7668096	51.22142	-254.199159

57	17700	200	-141.5843316	49.66904	-239.942550
58	18600	200	-129.0040438	47.92970	-223.917890
59	19500	200	-116.4237561	46.19867	-207.909693
60	20300	200	-105.2412780	44.66774	-193.695555
61	21200	200	-92.6609903	42.95518	-177.723943
62	22000	200	-81.4785123	41.44256	-163.546073
63	22900	200	-68.8982245	39.75308	-147.620137
64	23700	200	-57.7157465	38.26349	-133.487867
65	24600	200	-45.1354587	36.60321	-117.619784
66	25500	200	-32.5551710	34.96162	-101.788691
67	26300	200	-21.3726930	33.52032	-87.752056
68	27200	200	-8.7924052	31.92196	-72.006572
69	28000	200	2.3900728	30.52470	-58.057148
70	28900	200	14.9703606	28.98339	-42.424638
71	29700	200	26.1528386	27.64474	-28.591272
72	30600	200	38.7331264	26.17997	-13.110342
73	31500	200	51.3134141	24.76628	2.269431
74	32300	200	62.4958921	23.56000	15.840679
75	33200	200	75.0761799	22.26952	30.976472
76	34000	200	86.2586579	21.19163	44.293469
77	34900	200	98.8389457	20.07044	59.094002
78	35700	200	110.0214237	19.16834	72.062899
79	36600	200	122.6017115	18.27684	86.408600
80	37500	200	135.1819992	17.53508	100.457761
81	38300	200	146.3644772	17.01739	112.665420
82	39200	200	158.9447650	16.61047	126.051513
83	40000	200	170.1272430	16.41550	137.620075
84	40900	200	182.7075308	16.39100	150.248884
85	41800	200	195.2878185	16.57347	162.467837
86	42600	200	206.4702965	16.90417	172.995442
87	43500	200	219.0505843	17.45410	184.486708
88	44300	200	230.2330623	18.08772	194.414458
89	45200	200	242.8133501	18.94572	205.295671
90	46000	200	253.9958281	19.82193	214.743015
91	46900	200	266.5761159	20.91802	225.152749
92	47800	200	279.1564036	22.11418	235.364315
93	48600	200	290.3388816	23.24898	244.299563
94	49500	200	302.9191694	24.59408	254.216205
95	50300	200	314.1016474	25.84175	262.927955
96	51200	200	326.6819352	27.29522	272.629971
97	52000	200	337.8644132	28.62525	281.178621
98	52900	200	350.4447009	30.15822	290.723219
99	53800	200	363.0249887	31.72459	300.201654
100	54600	200	374.2074667	33.14115	308.578965
101	12600	400	-529.2406040	116.91150	-760.757207
102	13400	400	-510.1275251	114.20353	-736.281602
103	14300	400	-488.6253114	111.15891	-708.750214
104	15200	400	-467.1230977	108.11641	-681.223025
105	16000	400	-448.0100188	105.41390	-656.758233
106	16900	400	-426.5078051	102.37592	-629.240008
107	17700	400	-407.3947263	99.67778	-604.783861

108	18600	400	-385.8925125	96.64515	-577.276216
109	19500	400	-364.3902988	93.61575	-549.774962
110	20300	400	-345.2772200	90.92591	-525.335285
111	21200	400	-323.7750063	87.90353	-497.847924
112	22000	400	-304.6619274	85.22055	-473.421818
113	22900	400	-283.1597137	82.20666	-445.951289
114	23700	400	-264.0466348	79.53204	-421.541726
115	24600	400	-242.5444211	76.52858	-394.091848
116	25500	400	-221.0422074	73.53163	-366.654850
117	26300	400	-201.9291285	70.87380	-342.278540
118	27200	400	-180.4269148	67.89150	-314.870578
119	28000	400	-161.3138359	65.24836	-290.523359
120	28900	400	-139.8116222	62.28479	-263.152470
121	29700	400	-120.6985434	59.66059	-238.842750
122	30600	400	-99.1963296	56.72140	-211.520146
123	31500	400	-77.6941159	53.79821	-184.229209
124	32300	400	-58.5810371	51.21545	-160.001567
125	33200	400	-37.0788233	48.33049	-132.786361
126	34000	400	-17.9657445	45.78766	-108.637775
127	34900	400	3.5364692	42.95590	-81.527908
128	35700	400	22.6495481	40.46950	-57.491075
129	36600	400	44.1517618	37.71425	-30.532728
130	37500	400	65.6539755	35.01353	-3.682356
131	38300	400	84.7670544	32.66961	20.072334
132	39200	400	106.2692681	30.11264	46.638042
133	40000	400	125.3823470	27.92892	70.075479
134	40900	400	146.8845607	25.60034	96.188916
135	41800	400	168.3867744	23.44628	121.956750
136	42600	400	187.4998533	21.72019	144.487963
137	43500	400	209.0020670	20.05000	169.297610
138	44300	400	228.1151458	18.86634	190.754658
139	45200	400	249.6173596	17.94602	214.079356
140	46000	400	268.7304384	17.54690	233.982798
141	46900	400	290.2326521	17.60397	255.372007
142	47800	400	311.7348659	18.19075	275.712223
143	48600	400	330.8479447	19.11864	292.987827
144	49500	400	352.3501584	20.55265	311.650316
145	50300	400	371.4632373	22.11172	327.676007
146	51200	400	392.9654510	24.11850	345.204247
147	52000	400	412.0785299	26.07905	360.434909
148	52900	400	433.5807436	28.43899	377.263809
149	53800	400	455.0829573	30.92625	393.840564
150	54600	400	474.1960362	33.22096	408.409482
151	12600	600	-845.6085791	176.17225	-1194.477588
152	13400	600	-818.5648994	172.25764	-1159.681930
153	14300	600	-788.1407597	167.85541	-1120.540166
154	15200	600	-757.7166200	163.45510	-1081.402227
155	16000	600	-730.6729403	159.54547	-1046.616414
156	16900	600	-700.2488007	155.14927	-1007.486595
157	17700	600	-673.2051210	151.24358	-972.708588
158	18600	600	-642.7809813	146.85218	-933.588283

159	19500	600	-612.3568416	142.46367	-894.473692
160	20300	600	-585.3131619	138.56541	-859.710402
161	21200	600	-554.8890222	134.18313	-820.608146
162	22000	600	-527.8453425	130.29093	-785.856849
163	22900	600	-497.4212028	125.91612	-746.769397
164	23700	600	-470.3775231	122.03123	-712.032575
165	24600	600	-439.9533835	117.66549	-672.963093
166	25500	600	-409.5292438	113.30537	-633.904723
167	26300	600	-382.4855641	109.43496	-599.196574
168	27200	600	-352.0614244	105.08736	-560.163009
169	28000	600	-325.0177447	101.22941	-525.479543
170	28900	600	-294.5936050	96.89759	-486.477208
171	29700	600	-267.5499253	93.05547	-451.825093
172	30600	600	-237.1257856	88.74387	-412.862802
173	31500	600	-206.7016460	84.44535	-373.926435
174	32300	600	-179.6579663	80.63714	-339.341448
175	33200	600	-149.2338266	76.36947	-300.466172
176	34000	600	-122.1901469	72.59314	-265.944325
177	34900	600	-91.7660072	68.36752	-227.152301
178	35700	600	-64.7223275	64.63530	-192.717824
179	36600	600	-34.2981878	60.46884	-154.042953
180	37500	600	-3.8740482	56.34385	-115.450213
181	38300	600	23.1696316	52.71989	-81.230095
182	39200	600	53.5937712	48.70257	-42.850572
183	40000	600	80.6374509	45.19773	-8.866353
184	40900	600	111.0615906	41.34964	29.178038
185	41800	600	141.4857303	37.63167	66.964783
186	42600	600	168.5294100	34.47011	100.269210
187	43500	600	198.9535497	31.12784	137.311948
188	44300	600	225.9972294	28.40997	169.737763
189	45200	600	256.4213690	25.73490	205.459261
190	46000	600	283.4650488	23.80349	236.327652
191	46900	600	313.8891884	22.27487	269.778874
192	47800	600	344.3133281	21.56675	301.605300
193	48600	600	371.3570078	21.69326	328.398456
194	49500	600	401.7811475	22.67061	356.887165
195	50300	600	428.8248272	24.19849	380.905224
196	51200	600	459.2489669	26.52039	406.731373
197	52000	600	486.2926466	29.00136	428.862050
198	52900	600	516.7167862	32.14418	453.062567
199	53800	600	547.1409259	35.56414	476.714256
200	54600	600	574.1846056	38.77767	497.394271
201	12600	800	-1161.9765542	235.92977	-1629.181724
202	13400	800	-1127.0022736	230.78766	-1584.024669
203	14300	800	-1087.6562080	225.00503	-1533.227419
204	15200	800	-1048.3101424	219.22495	-1482.435226
205	16000	800	-1013.3358618	214.08941	-1437.291185
206	16900	800	-973.9897962	208.31474	-1386.509700
207	17700	800	-939.0155156	203.18440	-1341.375935
208	18600	800	-899.6694500	197.41604	-1290.606956
209	19500	800	-860.3233844	191.65147	-1239.845464

210	20300	800	-825.3491038	186.53086	-1194.730986	
211	21200	800	-786.0030382	180.77442	-1143.985610	
212	22000	800	-751.0287576	175.66171	-1098.886768	
213	22900	800	-711.6826920	169.91500	-1048.160646	
214	23700	800	-676.7084115	164.81177	-1003.080583	
215	24600	800	-637.3623458	159.07680	-952.377717	
216	25500	800	-598.0162802	153.34906	-901.689168	
217	26300	800	-563.0419996	148.26448	-856.646042	
218	27200	800	-523.6959340	142.55281	-805.989298	
219	28000	800	-488.7216535	137.48416	-760.977713	
220	28900	800	-449.3755878	131.79256	-710.360728	
221	29700	800	-414.4013073	126.74398	-665.388896	
222	30600	800	-375.0552416	121.07791	-614.822467	
223	31500	800	-335.7091760	115.42825	-564.288537	
224	32300	800	-300.7348955	110.42215	-519.400805	
225	33200	800	-261.3888298	104.81083	-468.942807	
226	34000	800	-226.4145493	99.84411	-424.133079	
227	34900	800	-187.0684837	94.28439	-373.777245	
228	35700	800	-152.0942031	89.37142	-329.073955	
229	36600	800	-112.7481375	83.88319	-278.859692	
230	37500	800	-73.4020718	78.44441	-228.743353	
231	38300	800	-38.4277913	73.66030	-184.295247	
232	39200	800	0.9182743	68.34775	-134.428876	
233	40000	800	35.8925549	63.70163	-90.254025	
234	40900	800	75.2386205	58.58252	-40.770721	
235	41800	800	114.5846862	53.60898	8.424314	
236	42600	800	149.5589667	49.34588	51.840685	
237	43500	800	188.9050323	44.78243	100.223630	
238	44300	800	223.8793129	40.99668	142.694728	
239	45200	800	263.2253785	37.14319	189.671748	
240	46000	800	298.1996591	34.19132	230.491534	
241	46900	800	337.5457247	31.56540	275.037636	
242	47800	800	376.8917903	29.86134	317.758200	
243	48600	800	411.8660709	29.25303	353.937109	
244	49500	800	451.2121365	29.65644	392.484321	
245	50300	800	486.1864171	30.94692	424.903082	
246	51200	800	525.5324827	33.31540	459.558927	
247	52000	800	560.5067633	36.08728	489.044124	
248	52900	800	599.8528289	39.78611	521.065502	
249	53800	800	639.1988945	43.94968	552.166565	
250	54600	800	674.1731751	47.94330	579.232380	

	upper
1	147.5260224
2	149.3239322
3	151.3882463
4	153.5016326
5	155.4260561
6	157.6485012
7	159.6806834
8	162.0378902
9	164.4787235

```
10   166.7262735
11   169.3517705
12   171.7802083
13   174.6289118
14   177.2736372
15   180.3855961
16   183.6521014
17   186.6926527
18   190.2738554
19   193.6036536
20   197.5165347
21   201.1425620
22   205.3852857
23   209.7954696
24   213.8498261
25   218.5532583
26   222.8523032
27   227.8115459
28   232.3201262
29   237.4950770
30   242.7686298
31   247.5309277
32   252.9641458
33   257.8543317
34   263.4170563
35   269.0380134
36   274.0783088
37   279.7930079
38   284.9083603
39   290.6992264
40   295.8757218
41   301.7288196
42   307.6102359
43   312.8597210
44   318.7874324
45   324.0744109
46   330.0406328
47   335.3589172
48   341.3574140
49   347.3708965
50   352.7277757
51   -94.7551990
52   -86.6945686
53   -77.6175906
54   -68.5304580
55   -60.4436617
56   -51.3344600
57   -43.2261129
58   -34.0901980
59   -24.9378188
60   -16.7870011
```

```
61    -7.5980377
62     0.5890481
63     9.8236878
64    18.0563739
65    27.3488668
66    36.6783490
67    45.0066698
68    54.4217614
69    62.8372940
70    72.3653588
71    80.8969497
72    90.5765943
73   100.3573972
74   109.1511053
75   119.1758877
76   128.2238465
77   138.5838897
78   147.9799482
79   158.7948229
80   169.9062370
81   180.0635342
82   191.8380169
83   202.6344109
84   215.1661776
85   228.1078000
86   239.9451509
87   253.6144601
88   266.0516663
89   280.3310291
90   293.2486407
91   307.9994831
92   322.9484924
93   336.3782003
94   351.6221340
95   365.2753395
96   380.7338997
97   394.5502055
98   410.1661826
99   425.8483229
100  439.8359686
101 -297.7240015
102 -283.9734488
103 -268.5004091
104 -253.0231699
105 -239.2618044
106 -223.7756027
107 -210.0055916
108 -194.5088094
109 -179.0056358
110 -165.2191549
111 -149.7020885
```

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112 -135.9020364
113 -120.3681379
114 -106.5515432
115  -90.9969940
116  -75.4295652
117  -61.5797173
118  -45.9832517
119  -32.1043129
120  -16.4707749
121   -2.5543369
122   13.1274868
123   28.8409772
124   42.8394929
125   58.6287139
126   72.7062861
127   88.6008469
128  102.7901708
129  118.8362520
130  134.9903070
131  149.4617749
132  165.9004938
133  180.6892153
134  197.5802050
135  214.8167984
136  230.5117432
137  248.7065238
138  265.4756338
139  285.1553634
140  303.4780786
141  325.0932976
142  347.7575089
143  368.7080627
144  393.0500011
145  415.2504674
146  440.7266552
147  463.7221507
148  489.8976781
149  516.3253508
150  539.9825899
151 -496.7395705
152 -477.4478693
153 -455.7413538
154 -434.0310134
155 -414.7294662
156 -393.0110060
157 -373.7016543
158 -351.9736792
159 -330.2399909
160 -310.9159218
161 -289.1698986
162 -269.8338356
```

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163 -248.0730090
164 -228.7224715
165 -206.9436738
166 -185.1537645
167 -165.7745543
168 -143.9598399
169 -124.5559462
170 -102.7100019
171  -83.2747575
172  -61.3887697
173  -39.4768569
174  -19.9744847
175    1.9985191
176   21.5640313
177   43.6202869
178   63.2731689
179   85.4465774
180  107.7021166
181  127.5693580
182  150.0381148
183  170.1412547
184  192.9451433
185  216.0066775
186  236.7896101
187  260.5951515
188  282.2566958
189  307.3834775
190  330.6024451
191  357.9995030
192  387.0213559
193  414.3155592
194  446.6751304
195  476.7444300
196  511.7665610
197  543.7232435
198  580.3710053
199  617.5675956
200  650.9749399
201 -694.7713840
202 -669.9798783
203 -642.0849969
204 -614.1850592
205 -589.3805384
206 -561.4698922
207 -536.6550960
208 -508.7319441
209 -480.8013043
210 -455.9672217
211 -428.0204663
212 -403.1707476
213 -375.2047383
```

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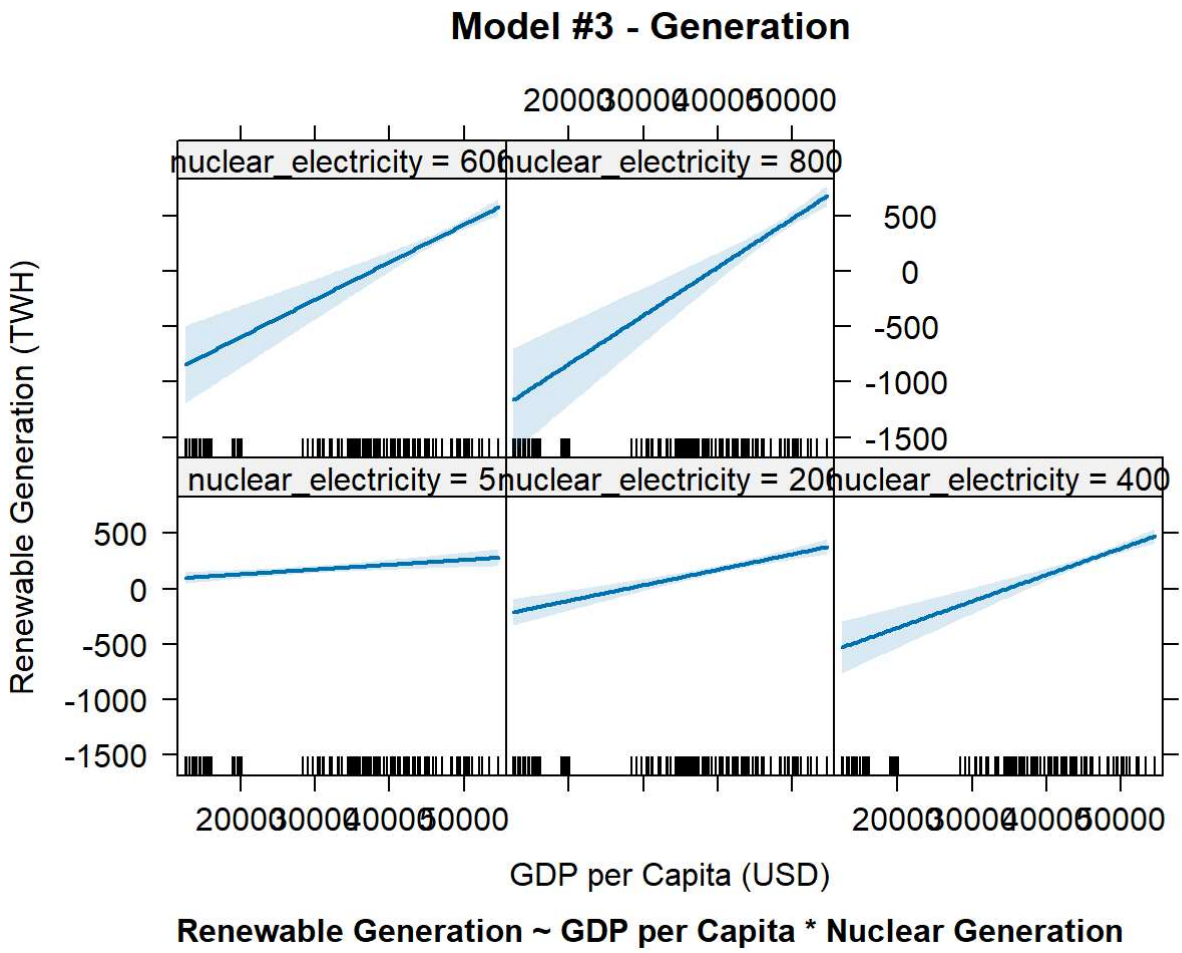
214 -350.3362397
215 -322.3469749
216 -294.3433924
217 -269.4379576
218 -241.4025696
219 -216.4655937
220 -188.3904476
221 -163.4137187
222 -135.2880166
223 -107.1298149
224  -82.0689858
225  -53.8348529
226  -28.6960199
227   -0.3597227
228   24.8855490
229   53.3634168
230   81.9392096
231  107.4396640
232  136.2654243
233  162.0391346
234  191.2479620
235  220.7450579
236  247.2772485
237  277.5864343
238  305.0638982
239  336.7790092
240  365.9077841
241  400.0538132
242  436.0253809
243  469.7950331
244  509.9399519
245  547.4697525
246  591.5060386
247  631.9694021
248  678.6401557
249  726.2312244
250  769.1139705
```

```
plot(plot_model_3_gen, main = "Model #3 - Generation", sub = "Renewable Generation ~ GDP per Capi
     xlab = "GDP per Capita (USD)", ylab = "Renewable Generation (TWH)")
```



Linear Models - Consumption

Model Creation

```
lm_consumption_1 <- lm(renewables_consumption ~ gdp_per_capita, data = data1)
summary(lm_consumption_1)
```

```
Call:
lm(formula = renewables_consumption ~ gdp_per_capita, data = data1)

Residuals:
    Min      1Q  Median      3Q     Max
-621.55 -412.71  -16.63  273.32 1504.01

Coefficients:
                Estimate Std. Error t value Pr(>|t|)
(Intercept)    -3.075e+02  1.390e+02  -2.213   0.0288 *
gdp_per_capita  2.681e-02  3.866e-03   6.933 2.22e-10 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
Residual standard error: 509.7 on 120 degrees of freedom
Multiple R-squared:  0.286, Adjusted R-squared:  0.2801
F-statistic: 48.07 on 1 and 120 DF,  p-value: 2.219e-10
```

```
lm_consumption_2 <- lm(renewables_consumption ~ gdp_per_capita + nuclear_consumption, data = data1
summary(lm_consumption_2)
```

```
Call:
lm(formula = renewables_consumption ~ gdp_per_capita + nuclear_consumption,
    data = data1)

Residuals:
   Min     1Q Median     3Q    Max
-716.0 -294.7 -134.5  435.3 1386.4

Coefficients:
                     Estimate Std. Error t value Pr(>|t|)
(Intercept)         7.887e+00  1.433e+02   0.055   0.9562
gdp_per_capita      1.179e-02  4.716e-03   2.500   0.0138 *
nuclear_consumption 3.556e-01  7.353e-02   4.836    4e-06 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 467.9 on 119 degrees of freedom
Multiple R-squared:  0.4033,    Adjusted R-squared:  0.3933
F-statistic: 40.21 on 2 and 119 DF,  p-value: 4.549e-14
```

```
lm_consumption_3 <- lm(renewables_consumption ~ gdp_per_capita * nuclear_consumption, data = data1
summary(lm_consumption_3)
```

```
Call:
lm(formula = renewables_consumption ~ gdp_per_capita * nuclear_consumption,
    data = data1)

Residuals:
   Min     1Q Median     3Q    Max
-547.4 -255.4 -180.0  204.9 1302.2

Coefficients:
                                   Estimate Std. Error t value Pr(>|t|)
(Intercept)                       1.912e+02  1.245e+02   1.535  0.12747
gdp_per_capita                    1.070e-02  4.007e-03   2.671  0.00864 **
nuclear_consumption              -2.590e+00  4.337e-01  -5.972 2.54e-08 ***
gdp_per_capita:nuclear_consumption  5.956e-05  8.677e-06   6.864 3.32e-10 ***
---
```

```
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 397.3 on 118 degrees of freedom
Multiple R-squared:  0.5735,    Adjusted R-squared:  0.5627
F-statistic:  52.9 on 3 and 118 DF,  p-value: < 2.2e-16
```

```
stargazer(lm_consumption_1, lm_consumption_2, lm_consumption_3, type = "text")
```

```
================================================================================================
=========
                                                Dependent variable:
                                    ---------------------------------------------------------
---------
                                                renewables_consumption
                                          (1)                  (2)                  (3)
------------------------------------------------------------------------------------------------
---------
gdp_per_capita                          0.027***             0.012**
0.011***
                                         (0.004)             (0.005)
(0.004)

nuclear_consumption                                          0.356***
-2.590***
                                                             (0.074)
(0.434)

gdp_per_capita:nuclear_consumption
0.0001***

(0.00001)

Constant                               -307.488**             7.887
191.151
                                        (138.965)           (143.274)
(124.531)

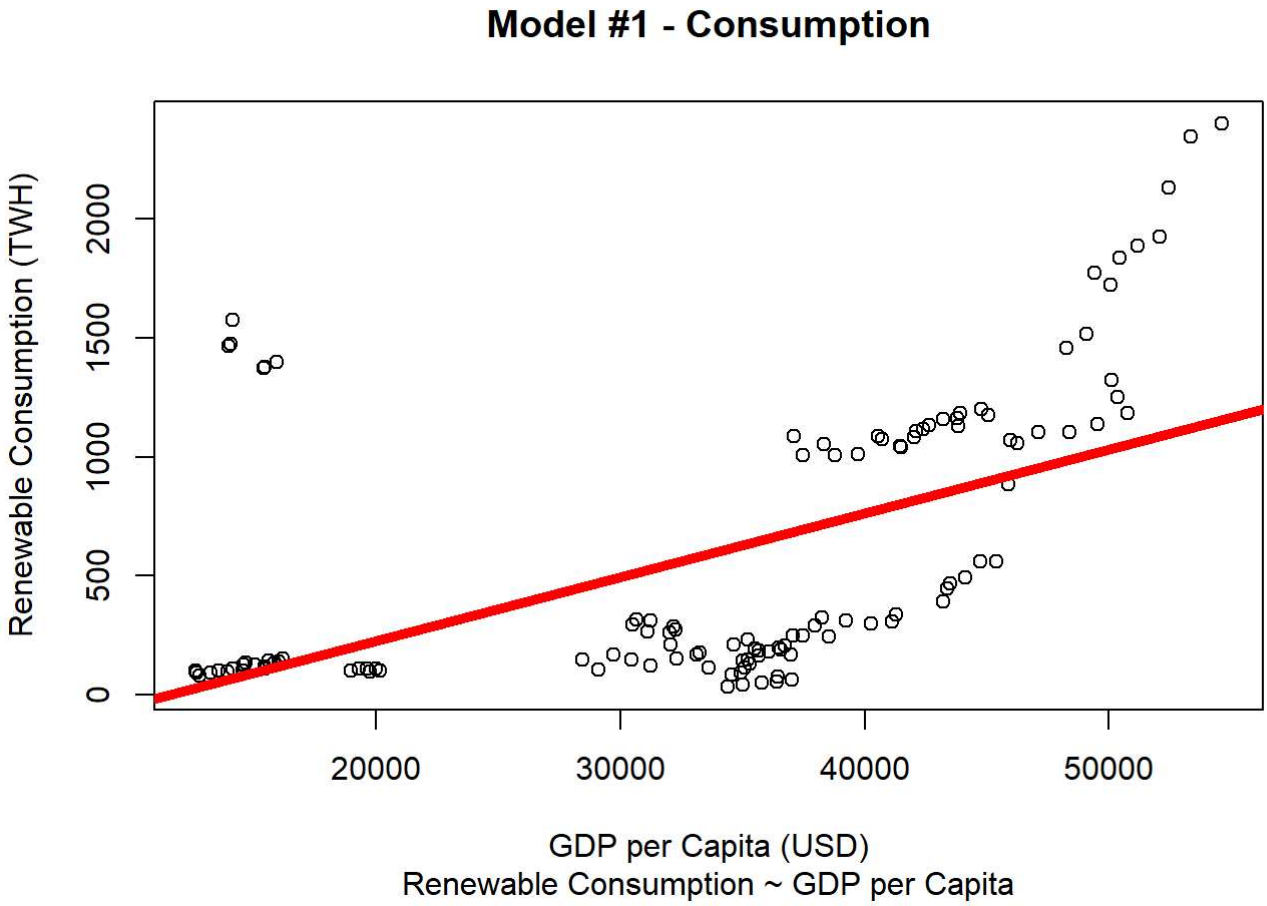
------------------------------------------------------------------------------------------------
---------
Observations                              122                  122                  122
R2                                       0.286                0.403                0.574
Adjusted R2                              0.280                0.393                0.563
Residual Std. Error                509.723 (df = 120)   467.938 (df = 119)   397.263 (df
= 118)
F Statistic                       48.071*** (df = 1; 120) 40.214*** (df = 2; 119) 52.899*** (df
= 3; 118)
================================================================================================
=========
```

```
Note:                                                    *p<0.1; **p<0.05;
***p<0.01
```

Visualizations - Consumption

Model 1

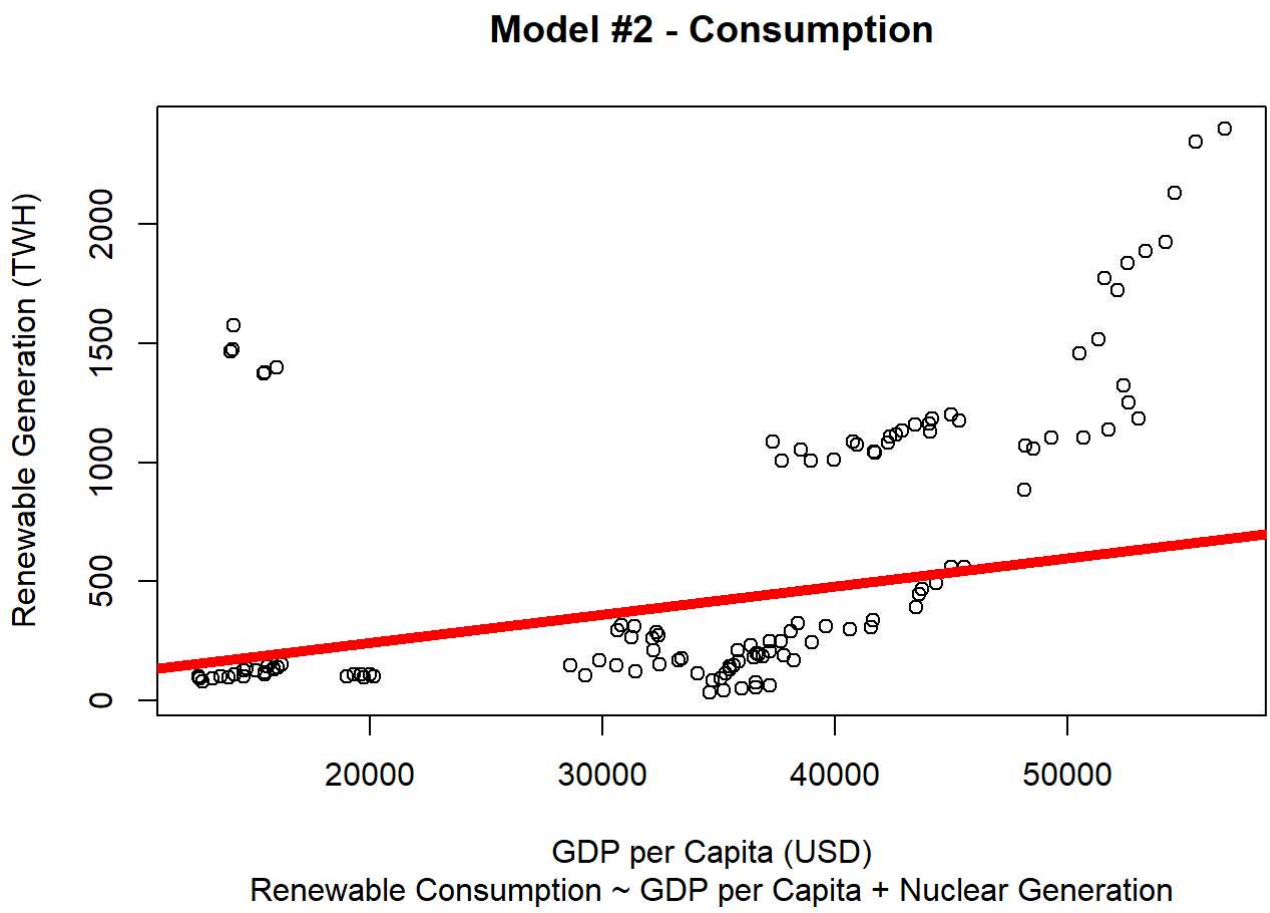
```
plot(x = data1$gdp_per_capita, y = data1$renewables_consumption,
     main = "Model #1 - Consumption", sub = "Renewable Consumption ~ GDP per Capita",
     xlab = "GDP per Capita (USD)", ylab = "Renewable Consumption (TWH)")
abline(lm_consumption_1, col = "red", lwd = 5)
```



Model 2

```
plot(x = data1$gdp_per_capita + data1$nuclear_consumption, y = data1$renewables_consumption,
     main = "Model #2 - Consumption", sub = "Renewable Consumption ~ GDP per Capita + Nuclear Gen
     xlab = "GDP per Capita (USD)", ylab = "Renewable Generation (TWH)")
abline(lm_consumption_2, col = "red", lwd = 5)
```

```
Warning in abline(lm_consumption_2, col = "red", lwd = 5): only using the first
two of 3 regression coefficients
```



Model 3

```
plot_model_3_cons <- predictorEffect("gdp_per_capita", lm_consumption_3)
as.data.frame(plot_model_3_cons)
```

	gdp_per_capita	nuclear_consumption	fit	se	lower
1	12600	14	300.22206	79.70685	142.380803
2	13400	14	309.44931	77.17294	156.625891
3	14300	14	319.82997	74.38400	172.529397
4	15200	14	330.21062	71.66776	188.288957
5	16000	14	339.43787	69.32125	202.162923
6	16900	14	349.81853	66.76660	217.602495
7	17700	14	359.04578	64.57980	231.160186
8	18600	14	369.42644	62.22498	246.204038
9	19500	14	379.80709	59.99429	261.002065
10	20300	14	389.03434	58.12724	273.926577
11	21200	14	399.41500	56.17115	288.180834
12	22000	14	408.64225	54.57347	300.571925
13	22900	14	419.02290	52.95035	314.166799
14	23700	14	428.25015	51.67600	325.917605

15	24600	14	438.63081	50.44739	338.731234
16	25500	14	449.01147	49.45139	351.084244
17	26300	14	458.23872	48.77293	361.655040
18	27200	14	468.61937	48.25302	373.065259
19	28000	14	477.84662	48.01371	382.766410
20	28900	14	488.22728	47.99923	393.175738
21	29700	14	497.45453	48.21299	401.979685
22	30600	14	507.83518	48.70479	411.386437
23	31500	14	518.21584	49.45494	420.281593
24	32300	14	527.44309	50.32938	427.777223
25	33200	14	537.82374	51.53383	435.772741
26	34000	14	547.05099	52.78820	442.515986
27	34900	14	557.43165	54.39060	449.723447
28	35700	14	566.65890	55.97143	455.820233
29	36600	14	577.03956	57.91027	462.361461
30	37500	14	587.42021	60.00306	468.597815
31	38300	14	596.64746	61.97999	473.910211
32	39200	14	607.02812	64.32217	479.652705
33	40000	14	616.25537	66.49885	484.569533
34	40900	14	626.63602	69.04328	489.911525
35	41800	14	637.01668	71.67861	495.073525
36	42600	14	646.24393	74.08959	499.526377
37	43500	14	656.62459	76.87112	504.398842
38	44300	14	665.85184	79.39910	508.619998
39	45200	14	676.23249	82.29930	513.257481
40	46000	14	685.45974	84.92247	517.290125
41	46900	14	695.84040	87.91950	521.735860
42	47800	14	706.22105	90.96054	526.094429
43	48600	14	715.44830	93.69717	529.902394
44	49500	14	725.82896	96.81010	534.118600
45	50300	14	735.05621	99.60492	537.811341
46	51200	14	745.43686	102.77758	541.909270
47	52000	14	754.66411	105.62093	545.505920
48	52900	14	765.04477	108.84358	549.504842
49	53800	14	775.42543	112.08943	553.457834
50	54600	14	784.65268	114.99252	556.936189
51	12600	590	-759.29366	189.16468	-1133.891232
52	13400	590	-722.62208	184.25353	-1087.494239
53	14300	590	-681.36657	178.74113	-1035.322676
54	15200	590	-640.11105	173.24337	-983.180078
55	16000	590	-603.43948	168.36990	-936.857713
56	16900	590	-562.18396	162.90383	-884.777901
57	17700	590	-525.51239	158.06127	-838.516738
58	18600	590	-484.25687	152.63345	-786.512645
59	19500	590	-443.00135	147.22912	-734.555083
60	20300	590	-406.32978	142.44716	-688.413928
61	21200	590	-365.07426	137.09487	-636.559418
62	22000	590	-328.40269	132.36438	-590.520200
63	22900	590	-287.14717	127.07677	-538.793774
64	23700	590	-250.47560	122.41071	-492.882121
65	24600	590	-209.22008	117.20462	-441.317139

66	25500	590	-167.96456	112.05047	-389.854988
67	26300	590	-131.29299	107.51863	-344.209139
68	27200	590	-90.03747	102.48417	-292.984022
69	28000	590	-53.36590	98.07395	-247.579025
70	28900	590	-12.11038	93.19665	-196.665125
71	29700	590	24.56119	88.94751	-151.579094
72	30600	590	65.81671	84.28014	-101.080907
73	31500	590	107.07223	79.75252	-50.859474
74	32300	590	143.74380	75.86554	-6.490634
75	33200	590	184.99932	71.67475	43.063796
76	34000	590	221.67089	68.13908	86.736960
77	34900	590	262.92641	64.41265	135.371823
78	35700	590	299.59798	61.36124	178.086022
79	36600	590	340.85350	58.27198	225.459122
80	37500	590	382.10902	55.60473	271.996520
81	38300	590	418.78059	53.63926	312.560244
82	39200	590	460.03611	51.94034	357.180086
83	40000	590	496.70768	50.92771	395.856942
84	40900	590	537.96320	50.38479	438.187600
85	41800	590	579.21872	50.49220	479.230405
86	42600	590	615.89029	51.13089	514.637196
87	43500	590	657.14581	52.43635	553.307565
88	44300	590	693.81738	54.08349	586.717345
89	45200	590	735.07290	56.43219	623.321797
90	46000	590	771.74447	58.91174	655.083182
91	46900	590	812.99999	62.08484	690.055096
92	47800	590	854.25550	65.60719	724.335413
93	48600	590	890.92708	68.98824	754.311581
94	49500	590	932.18259	73.03094	787.561444
95	50300	590	968.85417	76.80586	816.757647
96	51200	590	1010.10968	81.22591	849.260270
97	52000	590	1046.78126	85.28668	877.890408
98	52900	590	1088.03677	89.98162	909.848670
99	53800	590	1129.29229	94.79139	941.579542
100	54600	590	1165.96386	99.14963	969.620601
101	12600	1200	-1881.35024	379.16246	-2632.195132
102	13400	1200	-1815.61436	370.44784	-2549.201951
103	14300	1200	-1741.66151	360.64925	-2455.845203
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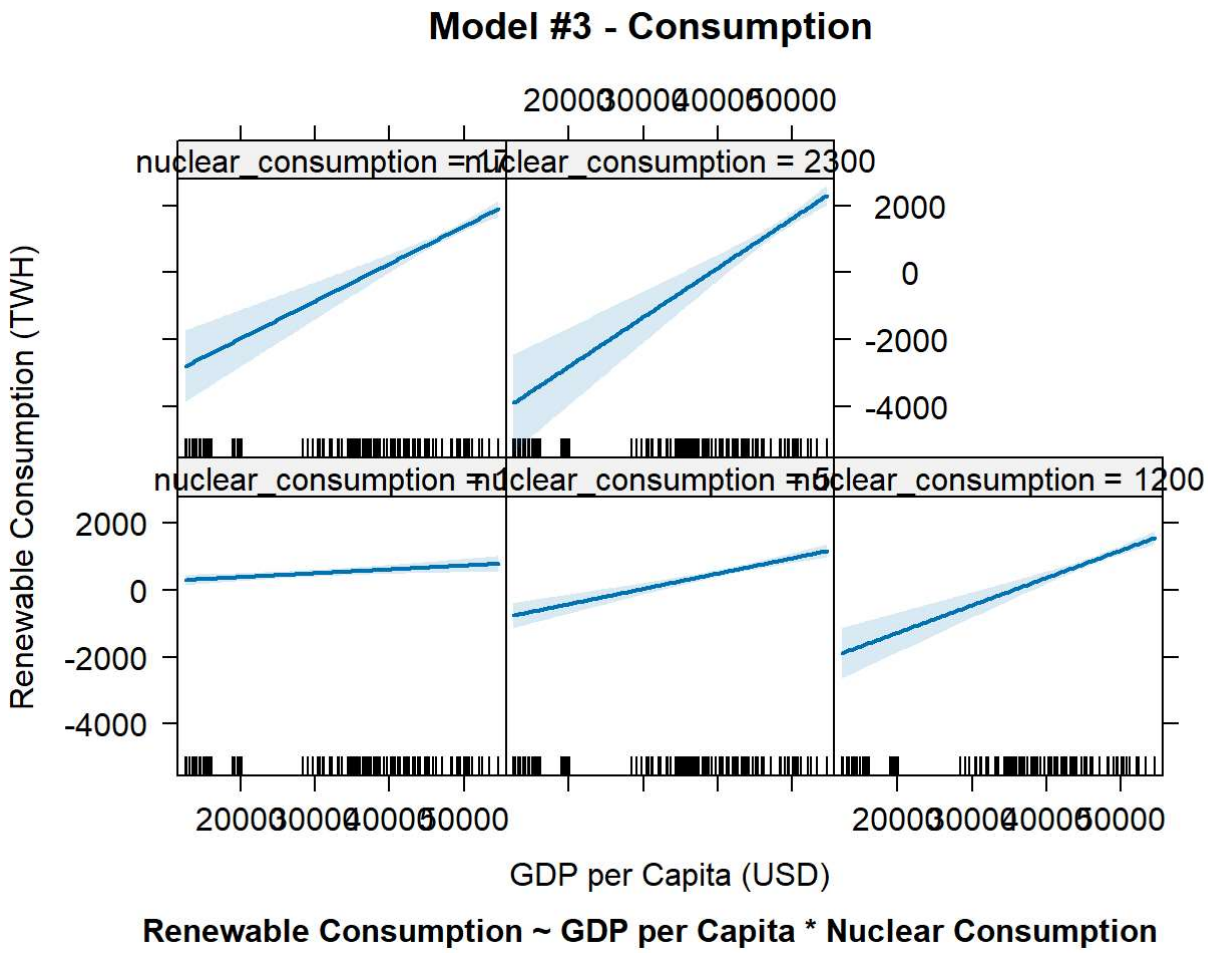

Discussion

GDP per Capita

Generation

As GDP per Capita increases, so does renewable energy generation (Coef = 0.008). As well, the model is statistically significant (p-value = 0.001).

Consumption

Consumption shows similar results to the Generation results, but the relationship between GDP per Capita and Renewable consumption is higher, but with a lower statistical significance.

Coef = 0.027, p-value = 0.004

GDP per Capita + Nuclear

Generation

The addition of Nuclear energy maintains the existing relationship between GDP per Capita and renewable generation.

Coef = 0.004, p-value =0.258

Nuclear generation shows positive relationship with renewable generation

Coef = 0.258 , p-value = 0.067

Consumption

presents similar results as generation, but a stronger relationship for both explanatory variables.

GDP Per Capita Coef = 0.012, p-value = 0.005

Nuclear consumption Coef = 0.356, p-value = 0.074

GDP per Capita * Nuclear

In both cases, as nuclear consumption/generation increases, there is a positive effect on the growth of GDP per Capita's effect on renewable consumption/generation.

Conclusion

We will reject the null hypothesis due to their being an effect by our explanatory variable for both Hypotheses.

Hypothesis #1

Hypothesis is correct if only taking GDP per Capita into account in model.

Hypothesis #2

Hypothesis is correct. Nuclear has positive relationship and effect on renewable energy.