Estimation of Energy Demand in the Argentina Using Econometric Model

by Pravin Ubale (m2021eccss010)

Argentina's total primary energy mix is dominated by natural gas (55%) and oil (33%), with bioenergy contributing 5%, and hydropower and nuclear another 3% each. Argentina has the 2nd largest reserve of shale gas and the 4th largest reserve of shale oil worldwide. In 2019, the country produced 500,000 bpd of oil, of which 89,000 bpd was exported, but the country remains a net importer of oil products[1].

Argentina currently produces 3.1% and 1.5% of the total global consumption of crude oil and natural gas, respectively. On the demand side, this country has traditionally consumed a significant share of their own crude oil and natural gas production, and this share of domestic consumption is increasing sharply, raising questions over the future of energy consumption in Argentina. Due to the growing population, higher standards of living, accelerated growth of energy intensive industries, and highly subsidized energy prices, demand for oil and gas has almost doubled in Argentina.

The following statistical model estimates the energy demand in Argentina:

$$E=GDP^{\propto} * POP^{\beta} * T^{\delta} * EI^{\rho} \text{ ……..(1)}$$

where E, GDP, Pop, T, and EI indicate the total energy demand per capita, per capita GDP, population, total trade, and energy intensity, respectively. The model projects the macroeconomics and demographic data to estimate energy demand based on oil products, natural gas, and electricity consumption in the region. Taking the natural logarithms of Eq. (1) and adding a random error term produce the following equation:

$$\ln E = \alpha \ln GDP + \beta \ln Pop + \delta \ln T + \rho \ln EI + U \text{……..(2)}$$

[1] *https://www.iea.org/countries/argentina*

where U is the random error term. The dataset contains annual observation over the period 1971–2014. The source of energy demand, intensity data and all other is the World Bank Data portal[2].

Year	Energy Demand[Mtoe] per capita	GDP per capita[Thousands USD]	Population [Millions]	Trade [Billions USD]	Energy Intensity[Mtoe/ BnUSD]
1971	1.387005018	1.372374174	24.259564	4.199999962	0.04166031068
1972	1.387082441	1.40886538	24.653172	4.875000027	0.03993557769
1973	1.420336101	2.09702283	25.056475	7.000000238	0.02703136605
1974	1.425813178	2.844863312	25.462305	9.555555329	0.01968355344
1975	1.389270184	2.027337202	25.865775	6.189189038	0.02649324953
1976	1.416108614	1.948224686	26.264681	7.725000362	0.02767485742
1977	1.432138871	2.129708361	26.661397	9.619999753	0.02522214946
1978	1.438345775	2.146364959	27.061041	8.319672048	0.02476368285
1979	1.496102951	2.520920716	27.471046	8.892473167	0.0216036482
1980	1.498781246	2.758834816	27.896532	8.885771635	0.0194743215
1981	1.440780275	2.776322088	28.338514	11.24526336	0.01831263472
1982	1.426351271	2.927897357	28.79455	13.16165159	0.01691844135
1983	1.429280328	3.553377509	29.262049	15.5840455	0.01374584157
1984	1.456768897	2.659708242	29.737097	9.765000247	0.01841866257
1985	1.368433193	2.926126485	30.216284	15.92333374	0.0154770951
1986	1.428876297	3.613621709	30.698964	16.06999976	0.01288036665
1987	1.483772164	3.562876059	31.184411	17.16476204	0.01335454079
1988	1.510833723	3.985192469	31.668939	19.86931803	0.0119710944
1989	1.446657733	2.383867471	32.148137	15.049799	0.01887677829
1990	1.412179959	4.333483372	32.618648	21.18993429	0.009990493771
1991	1.435484571	5.735359981	33.079002	26.09229219	0.007566332965
1992	1.48934786	6.823538837	33.52932	33.70280678	0.006509711359
1993	1.474306893	6.969119729	33.970103	38.40696697	0.006227490971
1994	1.548623393	7.483140334	34.402669	46.68506	0.006015473093
1995	1.551745214	7.408708664	34.828168	51.016549	0.006013776265
1996	1.589917556	7.721354105	35.246376	58.5298	0.005842068774
1997	1.621909095	8.213125127	35.657438	68.3421	0.005538191058

[2] *https://data.worldbank.org/*

1998	1.658495772	8.289507568	36.063451	69.8045	0.005547768792
1999	1.668225144	7.774736203	36.467218	60.625	0.005883914688
2000	1.669526337	7.708099115	36.870796	64.2938364	0.005874399396
2001	1.570897501	7.208373114	37.275644	58.7163002	0.005846358398
2002	1.510313443	2.593404563	37.681743	40.80243413	0.015454887
2003	1.598789625	3.3498063	38.087866	51.8574039	0.01253097853
2004	1.728214092	4.277721573	38.49197	67.00366893	0.01049578412
2005	1.720674023	5.109852245	38.892924	80.59041792	0.008658041533
2006	1.853041761	5.919012338	39.289876	94.03099324	0.007968109678
2007	1.858391843	7.245446857	39.684303	117.7298573	0.006463285769
2008	1.937641515	9.020873323	40.080159	146.0791128	0.005359143805
2009	1.865337356	8.225137583	40.482786	113.4022239	0.005602009278
2010	1.928652357	10.38596443	40.788453	148.146802	0.004552708951
2011	1.952051053	12.8488642	41.26149	186.6501067	0.003681980855
2012	1.93680354	13.08266433	41.733271	166.6695413	0.003547373736
2013	1.967021678	13.08025473	42.202935	161.9306627	0.003563282782
2014	2.029922825	12.33479825	42.6695	149.5105436	0.003856824905

By extending a standard OLS regression to find the coefficients in Eq. (2), the following results can be obtained (Table 1). Therefore, Eq. (1) can be rewritten as follows:

$$E=GDP^{0.01} * POP^{0.04} * T^{0.03} * EI^{0.06} \text{.....(3)}$$

For every 1% increase in the population and per capita GDP, energy consumption increased by 0.04% and 0.01%, respectively. Next, for every 1% increase in energy intensity, energy consumption increased by as much as 0.06%. The results reveal that population increase results in more production and consumption activities, which, in turn, raises energy consumption and emissions. The growth in energy intensity has contributed to the higher energy consumption in Argentina.

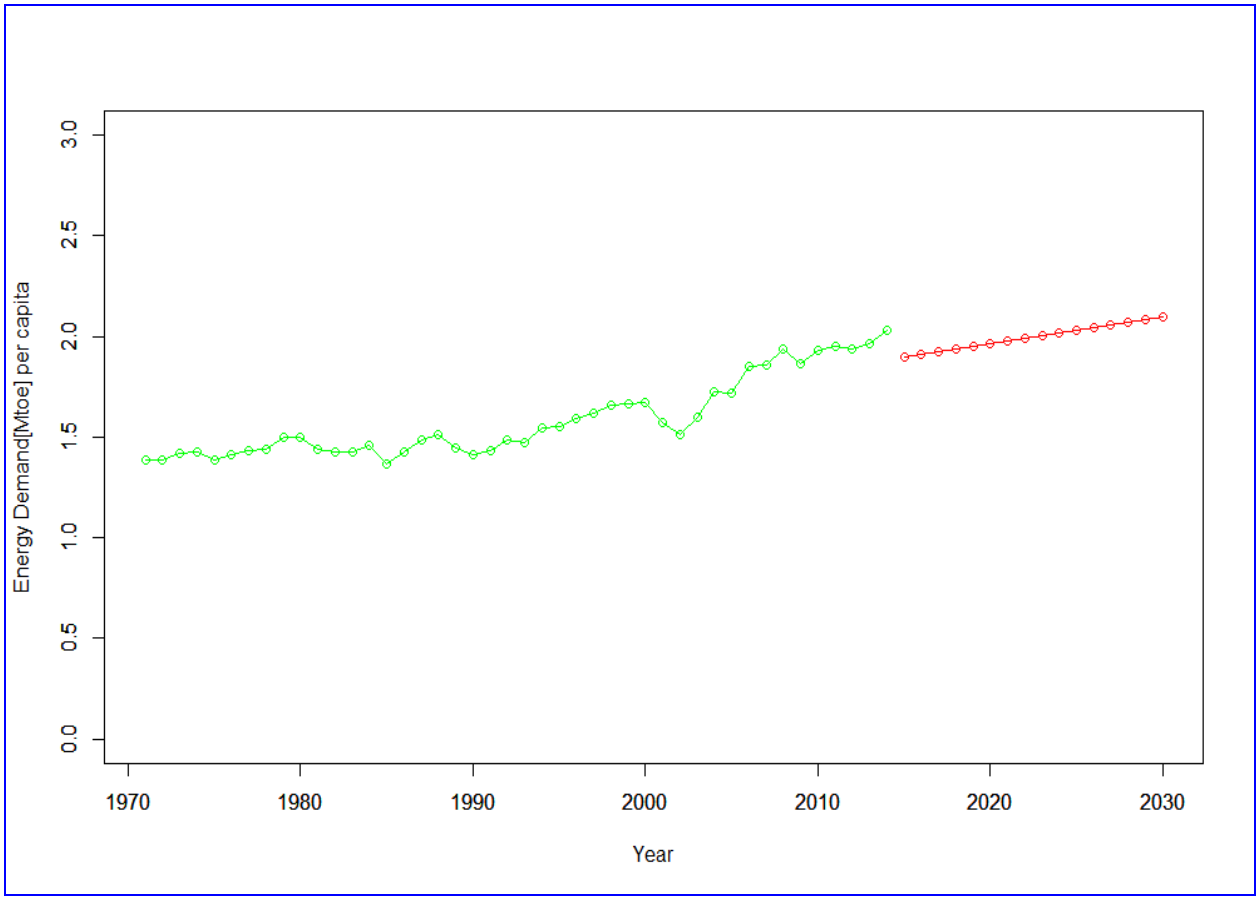

Fig.1

Using Eq. 3 , Fig.1 shows the future projection of energy demand in Argentina, assuming an annual average growth rate by 7%, 1.4%, 6.2%, and 0.3% for the per capita GDP, population, trade, and energy intensity, respectively.

Appendix:

A. Source Code[R]

```
library(readxl)
Data<- read_excel("argentina.xlsx")
plot(Data$Year,Data$EnergyUseMtoe,type="l")
h=lm(Data$EnergyUseMtoe~Data$Year)
summary(h)
h$coefficients
slope=summary(h)$coefficients[2,1]
interP=summary(h)$coefficients[1,1]
TY=2015:2030
EY=slope*TY+interP

plot(Data$Year,Data$EnergyUseMtoe,
    xlim=c(1971,2030),ylim=c(0,3),
    xlab = "Year", ylab = "Energy Demand[Mtoe] per capita",col="green",
    type="o")
par(new=T)
plot(TY,EY,
    xlim=c(1971,2030),ylim=c(0,3),col="red",
    xlab = " ", ylab = " ",
    type="o")

X=as.matrix(Data[,3:6])
Y=as.matrix(Data[,2])
k=lm(Y~X)
summary(k)

LX=log(X)
LY=log(Y)
j=lm(LY~LX)
summary(j)
```

B. Results of the statistical model

R2 = 0.999			
	Coefficients	Standard error	t stat
Ln GDP	0.01	0.0071	7.804
Ln Pop	0.04	0.0046	1.5
Ln T	0.03	0.00054	1
Ln EI	0.06	0.0858	14.23