# Final Research Paper: Price Elasticity of Gasoline Demand in the Short-run

Bridget Antwiwaa

College of Business, James Madison University

Econ 488: Economics Senior Capstone

Dr. Piyusha Mutreja

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When creating policies relating to climate change, there have been many policies like carbon taxes to help reduce gas consumption. Petroleum is the number one energy fuel that negatively impacts the environment. Therefore, it is essential to understand how sensitive gas demand is to price and income changes—in other words, understanding how consumers react to changes in gasoline prices can be utilized to predict the impact of a policy.

Many studies have been conducted on the short-run price and income elasticity of gasoline demand in the U.S. According to the study done in 2006 by Hughes, Knittel, and Sperling, the result was that the short-run elasticity of gasoline demand was significantly more inelastic in 2006 than in the previous decade. However, Hughes's study was done about 15 years. Gasoline has had many behavioral and structural changes over the past 15 years. Therefore, is the elasticity of demand still inelastic like the study by Hughes? Thus, we will reexamine the short-run elasticity of demand. This paper will look at the short-run price elasticity demands from the current period and compare them to the two past periods. From Nov 1975 to Nov 1980, March 2001 to March 2006, and Nov 2016 to Nov 2021.

**Data Description**

The data retrieved for the research are gasoline consumption, population, gasoline price, personal consumption expenditure, and real disposable income per capita Income. Gasoline consumption is the monthly U.S. product supplied of finished gasoline in thousand barrels per day, and it is retrieved from Energy Information Administration (EIA). Gasoline consumption is converted into gallons using r. The population includes the residential population plus armed forces overseas, retrieved from St. Louis Fed's FRED. The price of gasoline is the CPI-city average data for regular unleaded gasoline, and it is retrieved from the U.S. Bureau of Labor

Statistics (BLS). Personal consumption expenditures are retrieved from FRED, and it measures the prices of goods and services of individuals. Finally, the U.S. real disposable per capita income is retrieved from FRED, and it is seasonally adjusted and measured in billions of chained 2012 dollars. Since the model will be focusing on the short run, the data is monthly from 1975 to 2021. The variables used are per capita monthly gasoline consumption in gallons, real retail price of gasoline in months, and real per capita disposable income in months.

Figure 1 shows the per capita monthly gasoline consumption from 1975 to 2021. Figure 2 shows the real retail gasoline price from 1975 to 2021. Three-time periods consist of 5 years; each is chosen from the graph to measure changes in demand elasticity. The periods are November 1975 to November 1980, March 2001 to March 2006, and November 2016 to November 2021. The three-time periods are chosen to control the impact price will have on estimated elasticity.

Figure 3 shows the real retail price of gasoline for the three-time periods. In period 1 (1975 to 1980), The highest price is \$1.27 per gallon; the lowest price is \$0.24 per gallon. The average monthly gasoline consumption is about 34.4 gallons per month, with a standard deviation of around 3.9 gallons per month. In period 2 (March 2001 and March 2006), the highest price is \$2.93 per gallon, and the lowest price is \$1.13 per gallon. The average gasoline consumption in months is 83.12 gallons per month, with a standard deviation of around 2.8 gallons per month. For period 3 (March 2016 to March 2021), the highest price is \$3.39 per gallon, and the lowest price of \$1.88 per gallon. The average gasoline consumption in months is 107.8 gallons per month, with a standard deviation of around 3.1 gallons per month. The figures are shown below.

**Figure 1: Per capita monthly gasoline consumption from 1975 to 2021**

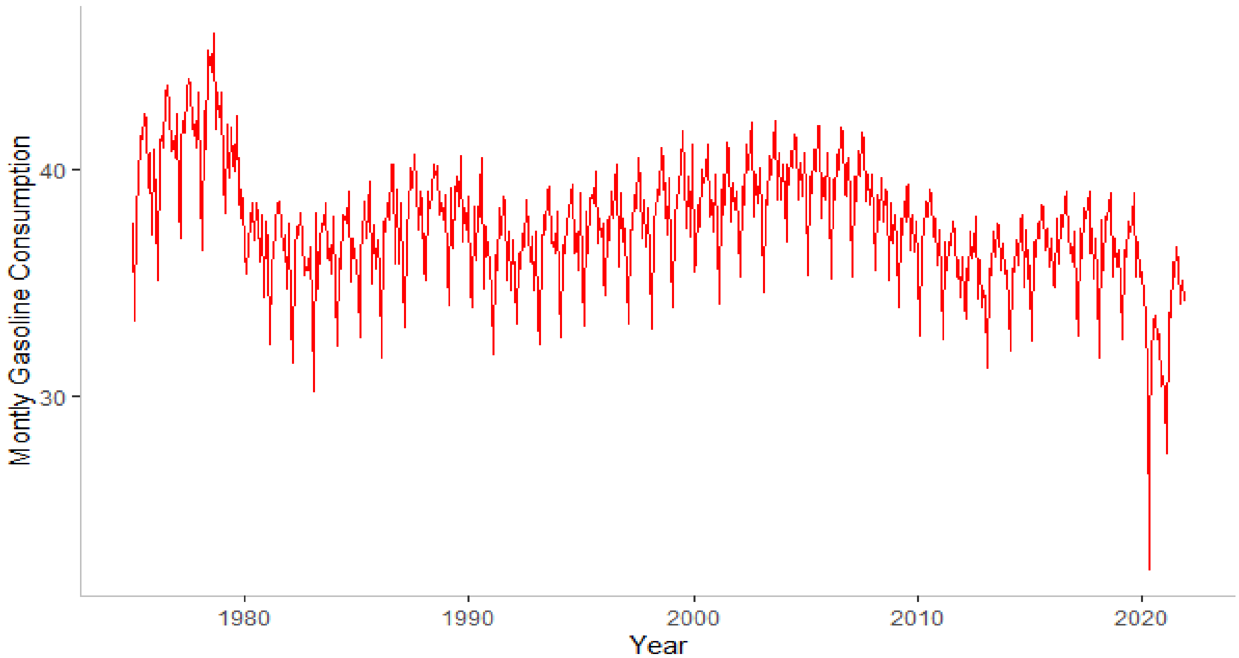


**Figure 2: Real Retail Gasoline Price from 1975 to 2021**

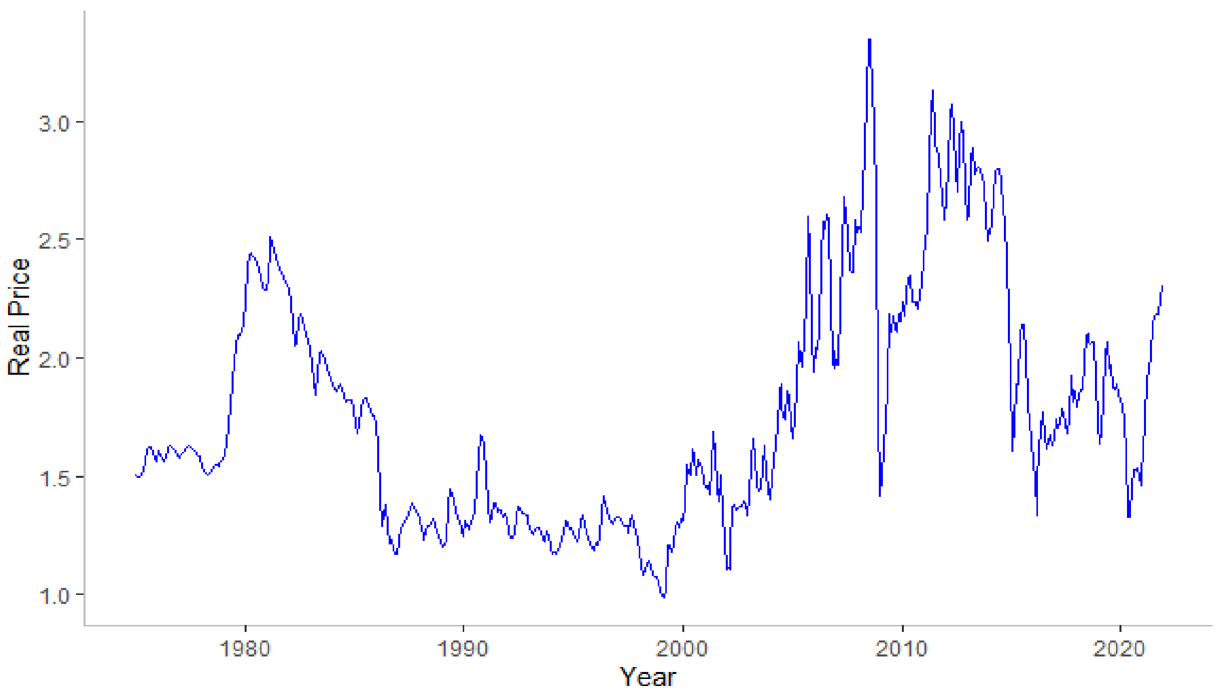

**Figure 3: Real retail gasoline price for 3 periods from Nov 1975 to Nov 1980, March 2001 to March 2006, February 2015 to February 2021**


**Empirical methodology**

$$ln(PCGC) = \beta_0 + \beta_1 ln(rPC) + \beta_2 ln(CPI) + u_1$$

PCGC is the per capita monthly gasoline consumption in gallons, RPC is for the real retail price of gasoline in months, CPI is the real per capita disposable income in months, and $u_1$ is the error term representing the unobserved factor change in months. The price of gasoline and disposable income are rebased on constants between 2000 and 2012. The model will consist of 12 dummy variables from January to November. The dummy variables are to show the seasonal changes seen in gasoline consumption. A double logged model is used since it is a standard model used in past studies like Hughes (2006). Therefore, all the variables are logged, including the monthly dummy variables.

**Results**

The model provided in the methodology section is estimated using the ordinary least squares. Table 1 shows the results of the double logged for the three-time periods. In period one, the R^2 in the model is 0.881, which means the model is a good fit. The R^2 increased in period two to 0.955 but decreased to 0.791 in the recent period. Although the model in period three is lower than in periods one and two, the model still has a good fit.

The demand for gasoline changes as the season changes when accounting for the dummy variables. For instance, during the winter times, gasoline demand is low, and during the summertime, gasoline demand is high. Without looking at the dummy variables, gasoline demand estimates range from -0.309 to 0.524 in period one, -0.042 to 0.554 in period two, and -0.856 to 0.367 in period 3.

In period one, the model predicts that as the monthly real retail price of gasoline increases, the per capita gasoline consumption falls by 0.309 gallons per month. The model also predicts that as real per capita disposable income increases, the per capita gasoline consumption increases by 0.524 gallons per month. In period two, the model predicts that as the monthly real retail price of gasoline increases, the per capita gasoline consumption falls by 0.042 gallons per month. The model also predicts that as real per capita disposable income increases, the per capita gasoline consumption increases by 0.554 gallons per month. However, in period three, the coefficient changes. The model predicts that as the monthly real retail price of gasoline increases, the per capita gasoline consumption increases by 0.367 gallons per month. Conversely, as real per capita disposable income increases, the model predicts per capita gasoline consumption to decrease by 0.856 gallons per month.

**Table 1. OLS Regression Results – Double-log Basic Model**

| | Dependent variable: log(PCGC) 1975-1980 | 2001-2006 | 2016-2021 |
|---|---|---|---|
| log(P) | -0.309*** | -0.042*** | 0.367*** |
| | (0.023) | (0.013) | (0.057) |
| log(Y) | 0.524*** | 0.554*** | -0.856*** |
| | (0.136) | (0.091) | (0.123) |
| Jan | -0.080*** | -0.044*** | -0.033 |
| | (0.016) | (0.007) | (0.032) |
| Feb | -0.130*** | -0.120*** | -0.117*** |
| | (0.016) | (0.007) | (0.032) |
| Mar | -0.019 | -0.007 | 0.017 |
| | (0.016) | (0.007) | (0.032) |
| Apr | -0.023 | -0.025*** | -0.075** |
| | (0.016) | (0.007) | (0.032) |
| May | 0.012 | 0.025*** | -0.0004 |
| | (0.016) | (0.007) | (0.032) |
| Jun | 0.019 | -0.001 | 0.004 |
| | (0.016) | (0.007) | (0.032) |
| Jul | 0.028* | 0.040*** | 0.031 |
| | (0.016) | (0.007) | (0.033) |
| Aug | 0.040** | 0.043*** | 0.035 |
| | (0.016) | (0.007) | (0.032) |
| Sep | -0.029* | -0.039*** | -0.044 |
| | (0.016) | (0.007) | (0.033) |
| Oct | 0.0004 | 0.006 | -0.011 |
| | (0.016) | (0.007) | (0.032) |
| Nov | -0.048*** | -0.033*** | -0.035 |
| | (0.016) | (0.007) | (0.032) |
| $\beta_o$ | -1.200 | -1.965** | 12.315*** |
| | (1.312) | (0.925) | (1.293) |
| Observations | 60 | 60 | 60 |
| R2 | 0.881 | 0.955 | 0.791 |
| Adjusted R2 | 0.847 | 0.942 | 0.732 |
| Residual Std. Error (df = 46) | 0.026 | 0.011 | 0.050 (df = 46) |
| F Statistic (df = 13; 46) | 26.143*** | 74.913*** | 13.419*** (df = 13; 46) |

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

In period three, the results of the coefficient estimates are incredibly high and have different signs compared to the other two time periods. The results of the coefficient estimates could be due to the Covid-19 pandemic. During the Covid-19 pandemic, there was a reduction in price and quantity consumed because of a demand shock. The pandemic had a significant impact on decreasing gasoline consumption during the lockdown. Therefore, the price elasticity for demand may be biased, which also explains why the F-statistic and $R^2$ are lower than the previous years. Furthermore, the results show that the current period is not inelastic like the previous period since the model may be biased.

**Conclusion**

In this paper, we look at the average monthly per capita gasoline consumption and the real retail price of gasoline. We then look at three different periods and compare the current periods to the other periods using the double logged model. The findings in the paper are that the short-run price elasticity of the United States gasoline demand is not inelastic now like in the previous period using the double logged model.

A suggestion for future research on this topic is to consider other factors influencing the model and eliminate biases. That means that the model will account for macroeconomic variables such as the inflation rates. In addition, the model should be tested using other empirical methods such as looking at a linear model, semi-log, and instrumental variables to see if the results are consistent.

# References


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Appendix

**Descriptive Statistics of time period 1 (Nov 1975 to Nov 1980)**

| Statistic | N | Mean | St.Dev | Min | Max |
|---|---|---|---|---|---|
| Real Price of Gas | 60 | 0.796 | 0.235 | 0.586 | 1.271 |
| Disposable Personal Income | 60 | 21,116.200 | 580.397 | 20,012 | 21,908 |
| Gasoline Consumption | 60 | 34.426 | 3.922 | 29.132 | 42.351 |

**Descriptive Statistics of time period 2 (March 2001 to March 2006)**

| Statistic | N | Mean | St.Dev | Min | Max |
|---|---|---|---|---|---|
| Real Price of Gas | 60 | 1.745 | 0.397 | 1.130 | 2.927 |
| Disposable Personal Income | 60 | 35,593.630 | 954.311 | 33,954 | 37,591 |
| Gasoline Consumption | 60 | 83.117 | 2.786 | 79.395 | 88.417 |

**Descriptive Statistics of time period 2 (March 2016 to March 2021)**

| Statistic | N | Mean | St.Dev | Min | Max |
|---|---|---|---|---|---|
| Real Price of Gas | 60 | 2.560 | 0.340 | 1.876 | 3.385 |
| Disposable Personal Income | 60 | 45,415.680 | 2,715.579 | 42,147 | 57,752 |
| Gasoline Consumption | 60 | 109.760 | 3.115 | 104.826 | 117.450 |

# R code

Importing my data

```
data1= read.csv(choose.files(), header = T)
```

calling my data

```
GC = data1$Gasoline.Consumption
PG = data1$Price.of.Gas
rDPI = data1$Disposable.Personal.Income
Pop= data1$population
PCE=data1$Consumption.Expenditures
Infla= data1$Inflation
one.T= data1$One.year.treasury
ten.T= data1$ten.year.treasury
UR = data1$Unemployment.rate
Year = data1$Year
month = data1$Month
date = data1$Date
```

per capital gasoline consumption variable (PCGC)

```
data1$PCGC= (GC*42)/(Pop)
```

real retail price of gasoline (rPG)

```
data2=subset(data1, Year == "2000")
a=mean(data2[,8])
PCE.deflator = PCE/a
data1$rPG = PG/PCE.deflator
```

real per capital disposable income(rCPI)

```
d2=subset(data1, Year == "2012")
b=mean(d2[,8])
PCE12.deflator = PCE/b
data1$rCPI = (PCE12.deflator/PCE.deflator) *rDPI
```

create the 12 dummy variables

```
data1$Jan = ifelse(month==1,1,0)
data1$Feb =ifelse(month==2,1,0)
data1$Mar= ifelse(month==3,1,0)
data1$Apr= ifelse(month==4,1,0)
data1$May= ifelse(month==5,1,0)
data1$Jun= ifelse(month==6,1,0)
data1$Jul= ifelse(month==7,1,0)
data1$Aug= ifelse(month==8,1,0)
data1$Sep= ifelse(month==9,1,0)
data1$Oct= ifelse(month==10,1,0)
data1$Nov= ifelse(month==11,1,0)
data1$Dec= ifelse(month==12,1,0
```

Descriptive statistics of 3 specific time periods

```
date = as.Date(date)
Time.d1 = subset(data1, date>="1975-11-01" & date<="1980-11-01")
Time.d2 = subset(data1, date>="2001-03-01" & date<="2006-03-01")
Time.d3 = subset(data1, date>="2016-11-01" & date<="2021-11-01")
stargazer::stargazer(Time.d1, type = "text")
stargazer::stargazer(Time.d2, type = "text")
stargazer::stargazer(Time.d3, type = "text")
```

Time series graph of the main variables

PCGC graph

```
library(ggplot2)
ggplot()+
  geom_line(data = data1, mapping = aes(x=date,y=PCGC), col = "red")+xlab("Year")+ylab("Montly
Gasoline")+labs(title = "Figure 1. Monthly Per Capita Gasoline Consumption for 1975 to 2021")
```

rPG graph

```
ggplot()+
  geom_line(data = data1, mapping = aes(x=date,y=rPG), col = "blue")+xlab("Year")+ylab("Real Price")+labs(title =
"Figure 2. Real Retail Price for January 1975 to November 2021")
```

Time series graph of the main variables for all the time period

```
Time.d1$obsn = 1:nrow(Time.d1)
Time.d2$obsn = 1:nrow(Time.d2)
Time.d3$obsn = 1:nrow(Time.d3)

windows(width = 12, height = 10)
ggplot(NULL, aes(obsn, rPG))+
  geom_line(data =Time.d1, aes(col = "green"))+
  geom_line(data =Time.d2, aes(col = "purple"))+
  geom_line(data =Time.d3, aes(col = "gold"))+
  scale_color_identity(name = "Subperiods", breaks = c("green", "purple", "gold"), labels =c("Nov75-Nov80",
"Mar01-Mar06", "Feb15-Feb20"), guide = "legend")
```

Estimates of Table 1 Models

```
reg1=lm(log(PCGC)~log(rPG)+log(rCPI)+Jan+Feb+Mar+Apr+May+Jun+Jul+Aug +Sep+Oct+Nov,data = Time.d1)
reg2=lm(log(PCGC)~log(rPG)+log(rCPI)+Jan+Feb+Mar+Apr+May+Jun+Jul+Aug +Sep+Oct+Nov,data = Time.d2)
stargazer::stargazer(reg1,reg2, type = "text")
```

Estimate Elasticities Using Recent Data

```
Covid.reg1=lm(log(PCGC)~log(rPG)+log(rCPI)+Jan+Feb+Mar+Apr+May+Jun+Jul+Aug+Sep+Oct+Nov,data =
Time.d3)
stargazer::stargazer(Covid.reg1,Covid.reg2, type = "text")
```