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Price Elasticity of Demand in the U.S. Gasoline Market: Limitations of Simple Annual Calculations

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Abstract. This study examines the limitations of using a simple annual price elasticity of demand calculation to measure consumer response in the U.S. gasoline market. Gasoline demand matters for both business pricing and public policy because consumers rely on gasoline for commuting and daily travel, yet they may not adjust consumption quickly when prices change. Using U.S. Energy Information Administration data from 2022 and 2023, the paper compares annual retail gasoline prices with finished motor gasoline product supplied, applies the midpoint elasticity method, and uses a simple linear demand model to interpret the price and quantity relationship. The annual result shows that the average gasoline price fell from about $4.059 to $3.635 per gallon, while product supplied increased only slightly from about 8,810 to 8,945 thousand barrels per day. The estimated PED is about -0.138, which indicates strongly inelastic demand. Further discussion using monthly comparisons suggests that annual averages may hide short-term consumer responses and mix price effects with seasonality, income, travel habits, and vehicle technology. The study concludes that PED remains useful for describing gasoline demand, but simple two-year estimates should be interpreted carefully when supporting pricing or policy decisions.

Keywords: Price elasticity of demand, gasoline market, data aggregation, demand inelasticity, United States

1. Introduction

Price changes change the way consumers make buying choices, how much money companies make, and how well public policies work. But a price change that is the same size does not cause proportional changes in how much people want to buy for every type of good. For goods that have easy to find substitutes, or things people do not have to buy right away, consumers usually react a lot when prices move. For daily necessities like gasoline, which people need for getting to work and moving around basic needs, households can rarely cut their use very much over a short period. To put a number on how much demand responds to price changes, economics uses the idea of price elasticity of demand (PED).

PED is a core tool that companies use for pricing strategies and that governments use when making policy. It helps companies figure out how changing prices will change their total revenue, and it also helps governments check what impacts energy taxes and transport policies will have. The basic ideas behind PED first came from Alfred Marshall's work on the elasticity of wants, which set

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up the base for how looking at modern demand analysis [1]. Early studies that pulled together data on global gasoline demand all around the world found that elasticity estimates change in clear ways based on what time period you look at, what country you are looking at, and how you calculate it. Short-run elasticity is always smaller than the numbers you get for the long run [2, 3]. A newer meta-analysis that came out in 2024 checks these same patterns again and points out new things that affect current elasticity levels, like how many electric vehicles people are buying now [4].

But putting simple PED calculations to use in the real world still runs into some big problems. In theory, PED is defined based on the idea that all other things that change demand would stay the same, but in actual cases, price, how much people buy, and other factors like people's income, car technology, and how people travel usually change at the same time. This makes it really hard to separate out just the effect of price changes on demand from the changes that happen in other related variables. Some newer studies have already pointed out that how detailed the data is, how you set up the model, and whether you missed any control variables can all change the estimated elasticity a lot [5-7]. For example, if you use daily or monthly data that has a high frequency, you usually get bigger elasticity numbers than you would get from yearly data that's been put together. That is because the short-term changes consumers make don't get averaged out over longer times [5, 7].

This paper looks at the U. S. Gasoline market, and checks how much real price reaction a simple two-year yearly PED calculation can get when other things that change demand are changing too. It compares results you get from put-together yearly data with what you find from methods that use higher-frequency data, and talks about how picking different data and leaving out some factors affects the final estimated numbers. This analysis doesn't say PED has no value in theory, but it does make clearer what limits it has when you use it in practice, and gives more careful reference points for people who make decisions in the real world.

2. Methodology

2.1. Dataset

This study uses data from the U.S. gasoline market that were publicly released by the U.S. Energy Information Administration (EIA) [8, 9]. It covers 2022 to 2023 for the basic annual analysis, with additional monthly data included for more detailed comparisons. The main variables examined are the retail price of gasoline and the amount of finished motor gasoline product supplied.

The retail price variable measures the average price of all grades and all formulations of retail gasoline across the U.S., measured in dollars per gallon. The product supplied variable, measured in thousand barrels per day, is used as a proxy for actual gasoline consumption because it indicates how much gasoline enters the domestic market. For the more detailed extended analysis, 24 monthly observations are included, covering January 2022 to December 2023.

All raw data are obtained directly from the EIA's official public statistics, so only limited data cleaning and preparation are required. Annual values are calculated as averages across the whole calendar year, while monthly values retain their original seasonal variation to preserve short-term information in the data. No outliers are removed in the baseline calculation, in order to keep the results consistent with the common simple two-point comparison methods used in basic analysis.

2.2. Models

This paper uses the midpoint elasticity formula to work out PED between two observation points. Different from the simple point elasticity formula, this one uses the average value of the two prices

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and two quantities as the base to calculate percentage change, which cuts down the bias that comes from picking which point is the starting point. The formula writes PED as the ratio between the percentage change of quantity demanded and the percentage change of price.

Besides calculating elasticity, this paper sets up a linear demand function to show that price and quantity have an inverse relationship. The function is written as quantity equals a fixed number minus a slope coefficient times price, and the slope shows the absolute change in quantity when price changes by one unit. This linear framework also let do total revenue analysis: for inelastic demand, an increase in price usually leads to higher total revenue because the percentage decrease in quantity demanded is smaller than the percentage increase in price. In contrast, a decrease in price may reduce total revenue. Total revenue is calculated as $TR = P \times Q$, where P represents price and Q represents quantity demanded. However, this relationship assumes that other factors affecting demand remain unchanged. In the real gasoline market, factors such as income, seasonal travel patterns, and vehicle efficiency may also influence consumption. Therefore, this model is mainly used to explain the relationship between price, quantity, and total revenue, rather than to prove a direct causal relationship.

3. Results and discussion

3.1. Results

Calculating baseline results using the 2022 and 2023 yearly average data obtained from EIA, the average price paid at the pump for gasoline went down from $4.059 a gallon in 2022 to $3.635 a gallon in 2023. Using the midpoint method, this represents roughly an 11.02% drop. At the same time, the average daily amount of gasoline supplied went up from 8,810 thousand barrels to 8,945 thousand barrels, representing a percentage increase of around 1.52%. Dividing the percentage change in supplied quantity by the percentage change in price gives a baseline PED estimate of around −0.138. Because the absolute value is much lower than 1, the result shows that demand for gasoline in the US was highly inelastic across this two-year period. This result was obtained from a comparison of the annual aggregated data. Applying the same calculation to monthly data from matching year-over-year periods produces noticeably larger elasticity values. For instance, the PED estimate between January 2022 and January 2023 is around −0.21. Calculations over shorter three-month time frames produce estimates between −0.18 and −0.27. Averaging all 12 month-over-month comparison pairs in the dataset gives an average elasticity estimate of roughly −0.22. This is about 60% larger in absolute value than the annual two-point estimate. After accounting for seasonal patterns and linear time trends in the monthly dataset, the adjusted estimate for price elasticity falls to around −0.17. This number is still larger than the annual baseline, although it is smaller than the unadjusted estimates based on monthly data. This confirms that seasonal changes in demand and underlying trends in consumption explain some of the gap between the annual and monthly results.

3.2. Discussion

The baseline annual estimate of minus 0.138 lines up with what people normally think: gasoline is a necessary thing that people still buy in roughly the same amounts even when price changes quickly. This outcome matches what earlier studies have said, that the short-run elasticity for US gasoline in the 2000s was really low [4], and it sits right in the range of numbers that recent meta-analyses have put together [6].

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The difference between the annual and monthly estimates shows that putting all data together affects how measure elasticity a good bit. The smaller annual number comes about because averaging over a whole year evens out short-term price changes and the changes in demand that go with them. This result backs up newer work that talks about bias from putting data together when measuring elasticity [10], and it shows that data collected over longer time periods usually makes how people respond to short-run price changes look smaller than it actually is.

The gap between unadjusted and adjusted monthly estimates also shows that when you leave out other things that change demand, it messes up simple PED calculations. Seasonal travel habits, slow growth in people's incomes, and gradual changes in how efficient car fleets are all change how much gasoline people want, even when the price doesn't move. If you don't account for these things, the link you see between price and how much people buy mixes up the effect of price and the effect of other factors, which gives you elasticity estimates that are off.

It is important to point out a few limitations here. First of all, the products used are only a stand-in for final consumption, so they don't catch changes in how much inventory people hold or differences between regional markets. Second, the study only looks at data from two years, which makes it harder to tell the difference between changes that are cyclical and changes that are structural. The third issue is that the simple adjusted model that used only accounts for basic seasonal changes and general trends, and it misses more complex factors like how many people are buying electric vehicles or what remote work patterns look like [8].

Future studies on this topic can get better results than the analysis if they use longer time frames, add more detailed control variables, and use more advanced statistical methods to separate out the actual causal effects on prices. Overall, the findings show that even though simple two-point annual PED calculations do correctly show that gasoline demand is inelastic, they only give you a really rough idea of how it works. That means when people use them for making pricing choices or policy decisions, they need to be really careful when reading what the numbers say.

4. Conclusion

This paper examined whether a simple annual calculation of price elasticity of demand can accurately describe consumer response in the U.S. gasoline market. The study focused on the gap between the theoretical meaning of PED and its practical use with real market data, where price, quantity, and other demand factors often change at the same time. By using EIA gasoline price and product supplied data from 2022 and 2023, the analysis calculated a baseline annual elasticity and compared it with evidence from monthly patterns and adjusted discussion.

The main method was the midpoint elasticity calculation, supported by a simple linear demand model and revenue interpretation. The annual estimate of about -0.138 shows that gasoline demand was strongly inelastic during the period. This result fits the nature of gasoline as a daily necessity, since many consumers cannot immediately reduce commuting or essential travel when prices change. However, the comparison with monthly estimates also shows that annual data can smooth out short-term reactions and make demand appear less responsive than it actually is.

The study therefore concludes that simple PED calculations are useful as a first description, but they should not be treated as a complete causal explanation. Future research should use longer monthly datasets, clearer consumption measures, regional data, and control variables such as income, seasonality, vehicle efficiency, remote work, and electric vehicle adoption.

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