Falling Prices: Does This Cause Purchases to Be Delayed or Speed Up? Evidence From the Gasoline Market

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When teaching macroeconomics, students intuitively know why macroeconomists stress the dangers of inflation, but question why economists will say deflation is worse. To explain macroeconomists will almost always point to Japan's "Lost decade", a spiral of declining economic activity intertwined with declining prices. Their claim is that the deflation was a principle driver for the deepening recession as declining prices could cause consumers not to purchase more (as the law of demand would normally expect) but rather less in anticipation of even lower prices to come. This paper looked at the empirical evidence from the energy sector, specifically gasoline sales during the 2013-2015 time period and verified that there is evidence that some US consumers did indeed delay purchases even if they ultimately bought more.

Keywords: economic downturn, oil price, gasoline price, economic recession, law of demand, consumer expectations, deflation

INTRODUCTION

The fear of deflation haunts the policy decisions of central banks around the world (IMF, 2022). In particular, they fear that during a deflationary period, consumers will react by delaying planned purchase in hopes of even lower prices in the future, thus further hurting GDP growth and thereby creating a further recessionary downward spiral.

In the mid-2010s, economists and international news media were particularly worried about negative Consumer Price Indices (CPIs) or deflation happening in Europe (New York Times 2014, 2015; The Wall Street Journal 2014, 2015; The Economist, 2014, 2015; Bloomberg Business Week 2014, 2015). The plausible fear was that deflation, by itself, would cause a regional, if not global, recession.

While there is no question that during the lost decade in Japan, recession and deflation both happened simultaneously, there is little empirical evidence in the literature of causation or even to what extent the supposed underlying consumer behavior actually existed. In this paper, we examine if the supposed delaying purchase behavior actually exists or if lowering prices actually escalates purchase decisions.

We are able to achieve this analysis by looking at consumer gasoline purchases made in the United States. As background, during the last decade (2010-2020), there was a large increase in oil production caused by technological advances in "fracking" and "directional drilling" (Soeder, 2018). This, is turn, provided a sustained period of declining prices in energy. We have obtained and analyzed consumer

gasoline purchase data in the United State for nine consecutive quarters 2013Q1 through 2015Q1. This data is during the period of declining gas and oil prices.

THEORETICAL PERSPECTIVE

Prices are indirectly related to quantity demanded for almost all goods and services. The law of demand (and supply) is the foundation for almost all market transactions that take place around the world. This concept, as taught in an introductory economics course, works perfectly well when studied with the overarching assumption of *ceteris paribus*, everything else constant. And deflation, based on the law of demand, should encourage consumers to buy more since the same amount of monetary units goes further in purchasing quantity of goods and services.

Macroeconomists believe that in the long-run, changes in the price level should not matter and that if overall price levels change (but the relative prices to each other do not), the same purchase and consumption levels should prevail. This belief, however, is not practical in the short-run as there may be a lag in price adjustments, or because of wealth effects of nominally denominated household savings and/or debt instruments. As we take a step forward to the intermediate level in the macroeconomic environment, there is a theory that when prices may fall in the current period then the quantity bought may fall too. This may happen predominantly because falling prices have an impact on consumers' expectations of future prices. A reduction in price during the current period may cause consumers to believe that prices will be falling to a new lower level in the future, thus encouraging them to delay their purchase. This delay would have an undesirable effect of a reduction in quantity bought and sold from the sellers' perspective. The research questions that we explore in this study are.

1. Do consumers delay their purchases as long as possible to capture a lower price in the future?
2. Do consumers, by seeing a lower price, speed up purchases that would otherwise happen later?

The price developments in the energy sector have provided for a controlled environment to test the theory at a level of one individual product purchased frequently by consumers. Consumer decisions on buying gasoline can be attributed to two different pieces of information: one being the current retail price of gasoline, and the other being the media reports on the changes in the wholesale price of crude. The latter forms an expectation of gasoline price in the near future. For instance, a price point of three dollars per gallon for gasoline at the gas station should encourage a consumer to purchase more gasoline as compared to the time period when price was three dollars and fifty cents per gallon. This increase in purchases being the result of consumers increasing their driving, or choosing to do so with a less fuel-efficient vehicle. However, a consumer witnessing a further reduction in crude prices may come to the conclusion that prices could fall further so (s)he, being a rational consumer, should wait for a few days and only fill up when absolutely necessary. This kind of behavior, backed by rationality, would have the tendency to lead gasoline consumers to potentially purchase gasoline less frequently but result in higher fuel totals (as measured by gallons purchased per customer transaction) when they did fill-up.

If we see that consumers are delaying gasoline purchases as prices are dropping, and if that drop is bigger than the increase in purchases due to regular price elasticity then the risk of deflation in the economy as a whole contributing to a recession is serious. It is also possible that consumers buy more gasoline because prices are less so driving more becomes less expensive and increases. If this is true, then deflation should actually encourage consumers to spend more and boost the economic output and thus would thus not be a contributing factor to escalating a recession or dropping measures of economic activity. Our research will address this, at least for the energy sector of the Gross Domestic Product (GDP).

REVIEW OF THE LITERATURE

The observed correlation of a country's price levels and overall economic activity (as measured by GDP) has been studied extensively for decades in the academic literature (Lucas, 1973; Grier and Perry, 2000; Ball and Mankiw, 1992). A well-researched perspective is that, based upon that correlation, deflation, or expectation of deflation, may be enough to slow down economic growth or bring about economic

contraction (Possen, 2000; Mussy, 2005; Sau, 2018). Guerrero and Parker (2006), using macroeconomic data during pre (15 nations) and post-World War II (94 nations), find empirical evidence of bidirectional causality between deflation and recession. However, Atkeson and Kehoe (2004) found no evidence supporting this belief when they analyzed data for 17 countries over a 100-year period. Inflation, by itself, can be a problematic issue for economies with costs of its own (Fischer, 1981; Holland, 1995). However, a constant rate of steady inflation has been preferred over both high inflation and deflation.

Consumer expectations regarding prices have been leading monetary and fiscal policy, as well as industry decision making (Bianchi & Melosi, 2017). The rationality of these expectations and how these expectations may be measured has been at the center of all this discussion (Batchelor, 1986; Batchelor and Orr, 1988; Mankiw, Reis, and Wolfers, 2003; Ehrmann, Pfajfar, and Santoro, 2015; D'Acunto, Hoang, and Weber, 2015).

In this research we use empirical "microeconomic" data from the retail gasoline industry to investigate if the theoretical microeconomic rationale macroeconomists use to imply causality actually occurs, or if is overwhelmed by the basic law of demand that indicates for normal goods, lower prices would increase, not decrease sales. Studying and understanding consumer purchasing behavior in a highly deflationary energy market will likely give us guidance as to what happens in other sectors. We believe that this sector shares general characteristics with most markets in which consumers spend their budgets (necessity goods, inelastic demand, stable supply, major portion of budgets, etc.). The results are thus likely to be extendable to interpret how consumers are, in general, making purchase decisions given the present-day price expectations.

OUR MODEL

We assume that there are two types of purchasers, those that fill up with a "fixed dollar" amount each time (e.g. put $20 of gas in the tank at each purchase), and those that "fill up" their tank when purchasing gasoline.

When we look at individual purchases of the "fixed dollar" type, we by definition observe purchases that have an elasticity of 1.0. That is, a 1.0% drop in pump price will increase the transaction purchase volume by an identical amount. This increase in per-transaction purchase volume is related to the sales price, NOT due to the expected direction of future fuel prices. Although it is possible that these "fixed dollar" purchasers may actually delay their fuel purchases being willing to let the fuel tank become emptier before refueling. As an outside observer however, we would not be able to detect this by looking at the per-transaction volume.

The other consumer type is the individual who "fills up" the tank when purchasing. For these customers, if they have delayed purchasing for any reason, the next transaction size will be larger. In contrast, if the driver speeds up the purchase (possibly by seeing a low gas station price), the transaction volume would decrease. Unlike, the "fixed dollar" purchaser, these driver's transaction size may be influenced by expectations of future gas prices and the expected direction thereof. In a steady state environment, these drivers would be expected to have the same transaction volume regardless of the price level.

Based on these assumptions, the following hypotheses are developed.

Hypothesis

Research Hypothesis 1a: *Consumers delay their purchases of necessity goods and services when prices are falling to wait for a lower price, which causes an economy to slow down.*

Alternative Hypothesis 1a: *Purchases of necessity goods and services are not significantly affected by price changes.*

Hypothesis 1b: *Consumers speed up their purchases of necessity goods and services when they see falling prices. The excitement of seeing a low price might escalate their purchase. This would have a positive impact on an economy.*

Alternative Hypothesis 1b: *Purchases of necessity goods and services are not significantly affected by price changes.*

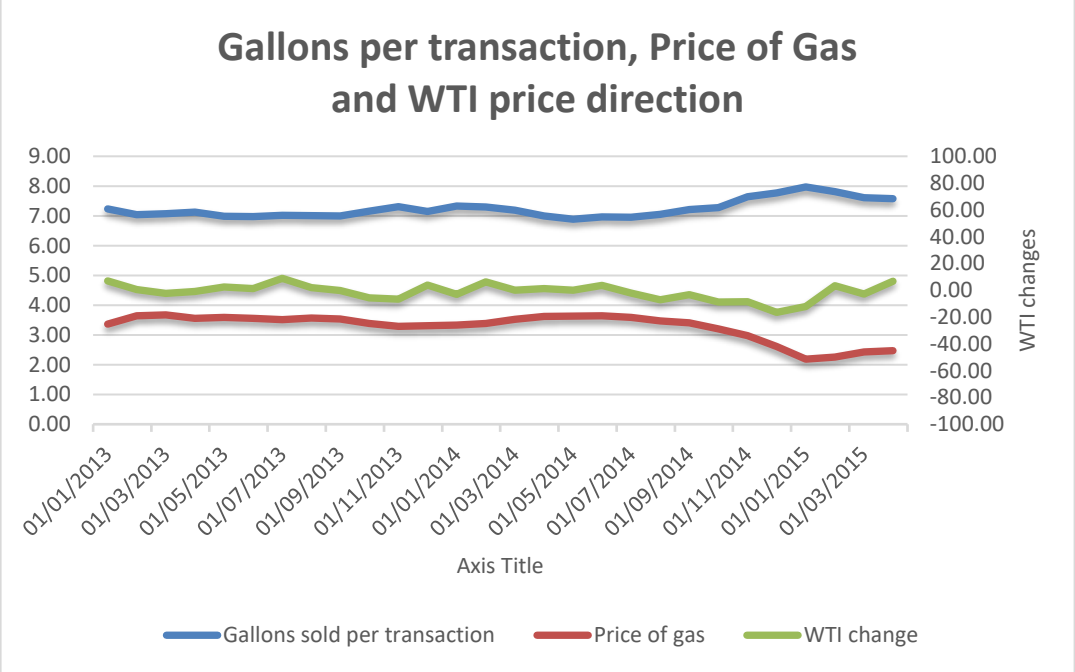
Hypothesis 2: *Impact of Hypothesis #1a is large enough to overwhelm the elastic impacts of lower prices, causing the net amount of purchases to decline*

Alternative Hypothesis 2: *Purchases of necessity goods and services are not significantly affected by price changes.*

DATA, METHODOLOGY AND ANALYSIS

Consumer spending on gasoline represents a significant portion of American's overall consumer budget. The reason is that gasoline purchases are considered as a necessity for most consumers in today's society. By using the gasoline market as a proxy for consumer spending behavior towards most purchases of necessity goods, we can draw statistical conclusions as to how consumers react to lowering prices.

FIGURE 1
U.S. RETAIL GASOLINE PRICE AND SALES MOVEMENTS WITH WTI CHANGES



In order to perform our analysis, we looked at sales data provided by CSX, LLC which collects and investigates sales data from several large gasoline retailer chains. The dataset includes aggregate data on the monthly sales of gasoline at over 5,800 retail gasoline stores run by 96 separate firms in the nation from January 2013 to April 2015. The monthly data fields of greatest interest to us were, total aggregate gasoline sales, average pump transaction price, and the average amount of gasoline purchased per transaction. Since retail gasoline price changes are a byproduct of the changes in prices of crude oil, we also looked at the monthly West Texas Intermediate (WTI) crude price reported by the Energy Information Administration

(EIA). Figure 1 above depicts these variables in a line graph to allow for a visual comparison of movements in the price of gasoline per gallon in the United States (red line measured across vertical axis on the left), the retail sales per customer transaction (blue line measured across vertical axis on the left) and the month to month price changes in the WTI (green line measured across vertical axis on the right) during the study period.

Regression 1: Gallons Purchased per Customer Transaction vs. Gas Prices per Gallon

In this linear regression model, we look at the average gallons per sale. Our hypothesis we are testing would expect a negative correlation, if only due to the subset of purchasers who use the fixed $ fill up strategy.

$$G = m_1 P + b + \varepsilon \quad (1)$$

where G is Gallons sold per transaction and P is Price of gasoline per gallon.

Table 1 shows the result of this regression.

TABLE 1
GALLONS PURCHASED PER CUSTOMER TRANSACTION WITH PRICE PER GALLON

Regression Statistics						
Multiple R	0.945361					
R Square	0.893708					
Adjusted R^2	0.88962					
Standard Error	0.097797					
Observations	28					
ANOVA						
	df	*SS*	*MS*	*F*	*Significance F*	
Regression	1	2.090836	2.090836	218.6093	3.61E-14	
Residual	26	0.248671	0.009564			
Total	27	2.339507				
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	9.254405	0.137859	67.12951	1.13E-30	8.971032	9.537778
Price/Gallon	-0.61668	0.041709	-14.7854	3.61E-14	-0.70242	-0.53095

A statistically significant negative correlation would explain that a change in the price of gasoline in one direction causes a change in the number of gallons purchased per customer transaction in the other direction, thus supporting the assumptions that there are a sizeable number of fixed $ purchasers and/or that fill up customers indeed delay purchases over this time period. Had the entire population be fixed dollar purchaser, a unit price-elasticity would give an expected coefficient of -0.33. This is outside the actual coefficient of -0.62 (95 percent coefficient interval with a -0.53 to -0.70), it implies that there is a substantial number of fill-up customers. These fill up customers must be delaying purchases to get these results.

Regression 2: Gallons Purchased per Customer Transaction vs. Gas Prices per Gallon and Direction of WTI Energy Price Movements

We then added to Regression 1 a second independent variable, which is the short-term direction energy prices are moving. Initially, we used the month over month change in pump prices as the extra independent variable. This analysis was then repeated using the change in WTI prices from the previous month to replace the month-to-month gas price change, under the theory that WTI are more likely a leading indicator of

future gas price directions. The results of the regression were similar. We present the WTI model here because the R-Squares and Adjusted R-Squares reflect a better fit.

$$G = m_1 P + m_2(\Delta\text{WTI}) + \varepsilon \quad (2)$$

where G is Gallons sold per transaction, P is Price of gasoline per gallon, and $\boldsymbol{\Delta}$WTI is change in the price of West Texas Intermediate (crude oil).

Table 2 shows the results of this regression.

TABLE 2
GALLONS PURCHASED PER CUSTOMER TRANSACTION WITH PRICE PER GALLON AND CHANGES IN EST TEXAS INTERMEDIATE PRICE

Regression Statistics						
Multiple R	0.956833					
R Square	0.91553					
Adjusted R^2	0.908772					
Standard Error	0.088909					
Observations	28					
ANOVA						
	df	*SS*	*MS*	*F*	*Significance F*	
Regression	2	2.141888	1.070944	135.481	3.84E-14	
Residual	25	0.197619	0.007905			
Total	27	2.339507				
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	9.145118	0.132502	69.01859	4.69E-30	8.872224	9.418011
Price of gas	-0.58574	0.039825	-14.7077	8.17E-14	-0.66776	-0.50372
Price change WTI	-0.57756	0.227267	-2.54133	0.017623	-1.04563	-0.1095

A statistically significant negative coefficient of the WTI price change direction would be consistent with the theory that deflation may cause a delay in purchases, which is a key component to macroeconomists' angst over deflationary periods.

RESULTS

The regression using size of transaction as the dependent variable shows a statistically significant increase in per-visit transaction value when the pump when prices are lower and when the gas prices are actively falling from one period to the next. The fact that we see a per transaction volume increase is consistent with what would expect when a sizeable subset of the consumers are "fixed dollar" purchasers. The fact that we also see a statistically significant impact based upon the "direction" price changes are happening shows that the "fill-up" purchasers are indeed delaying their purchases when they see energy

prices dropping. That is, they will drive longer between fill ups and make bigger purchases when their car gas tanks are emptier. When prices are increasing, they tend to fill up earlier.

The price of gasoline during the period and the change in price of WTI from the previous period, explain the number of gallons sold per transaction in a multiple linear regression. The regression statistics with the significant levels are presented in Table 1 and Table 2.

The results for both coefficients (the price of gasoline during the period and the change in WTI price compared to the previous period) are negative. This implies that as price of gasoline is lower during the current period, a higher amount of gasoline per transaction is sold. And, if there is a negative change in WTI prices from the previous period, a higher amount of gasoline is bought at the pump per transaction. Hence, both variables lead to the same conclusion: when prices are low and there was an expectation from the previous period (as measured by lower WTI price) on the part of the consumers that price might be lower during this period, consumers tend to wait to fill up. The result is an increase in the number of gallons filled up per transaction at the pump. All results are statistically significant with a high R^2 of 0.916 (adjusted R^2 of 0.909).

CONCLUSION

This analysis, by means of empirical research, enhances the understanding as to how consumers behave under different price scenarios. At least in this model, for this aspect of the economy, the overall purchases due to lower prices is stronger than the reduced purchases due to product purchase delays. The data does, however, verify that this product purchase delay, does indeed happen. The interpretation of global issues affecting local consumers is valuable for industry decision makers in the long term. At a more specific level, economists can play a key role by making informed decisions in price volatile industry environments. As an implication for future research, the study has the potential for providing fodder for an analysis of market structure dynamics and macroeconomic trends.

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