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# **Water Use and Abuse in the United States: behavioural patterns behind excess water consumption and an argument for an efficient demand side remedy**

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## **ABSTRACT**

The last decade saw severe drought in the south-eastern United States, which presented questions about the ways in which Americans use water and the best ways for government entities to handle future drought. During and after the droughts, researchers examined existing literature on water over-consumption and conducted new studies to explore water use and related behaviour. We review the predominant work on the factors that influence household water consumption, the different methods by which government agencies can combat over-consumption, and argue for the demand-side approach of structured rate increases to limit superfluous use of water. An inclining block rate structure both forces consumers to contemplate water use before and during droughts and punishes excessive use through economic means.

## **Part 1: Behavioural Factors Influencing Household Water Consumption**

### **Introduction**

Given the uncertainty of supply and the national growing demand for water, the need for efficiency in water use is significant. However, managing the demand for water requires knowledge of how people use water, as well as in the relationship between psychological and behavioural aspects of water consumption (Gregory & Di Leo, 2003, p. 1262).

This paper examines existing literature on factors affecting water consumption including but not limited to: income, environmental awareness, and government regulation. Specifically, it investigates the psychological elements affecting people's behaviour, and then discusses water management methods to reduce water usage. By understanding psychological factors affecting water consumption, water-managing entities may develop more efficient and sustainable policies.

### **Literature Review**

Obstacles to accurately interpreting and explaining existing literature on water consumption are threefold. First, the bulk of relevant research takes the form of non-peer reviewed technical reports, case studies and consultancy reports (Gregory & Di Leo, 2003, pp. 1262-63). Second, the implementation and outcomes of water conservation measures tend to be context specific such that generalizations are difficult to draw a meaningful framework for future applications (Atwood, Kreutzweiser, & Loe, 2007, p. 428). Third, while issue specific factors constrain water conservation strategies, their theoretical underpinnings are derived from general theories of consumer behaviour developed in non-water contexts (e.g., household recycling, household energy conservation, private goods consumption, etc.).

Models of household water use behaviour, derived from the studies discussed below attempt to predict household water consumption. The success of household water demand management strategies depends on how well we understand the way people think about water and water use. Is water conservation more likely when individuals believe that water is scarce or when they perceive that other consumers are also conserving water?

Studies conducted before, during, and after the southeast drought of 2007-2008 identify a range of factors influencing household water use. Below is a discussion of those factors, including: 1) personal characteristics (e.g., subjective norm, behavioural control, attitude toward the behaviour) (Gregory & Di Leo, 2003, pp. 1261-1296); 2) environmental values and conservation attitudes; and Socio-economic factors (e.g., income, household composition, age, gender, education, etc.) (Jorgensen, Graymore, & O'Toole, 2009, p. 229); 3) Institutional trust (i.e., trust in the water provider) (Corral-Verdugo et al., 2002, pp. 533-35; Heiman, 2002, p. 84); and 4) Inter-personal trust (i.e., trust in other consumers) (Corral-Verdugo et al., 2002, pp. 527-28, 533-34).

### **Psychological Factors**

Gary D. Gregory and Michael Di Leo (2003) studied the existing theory in social and environmental psychology and developed a model to study important predictors of water consumption (pp. 1261–1296). Their study explored relationships between various psychological aspects and water consumption. A review of past research findings allowed them to develop a model that measures the effects of stimuli (e.g., environmental awareness), reasoned processes (e.g., attitudes, personal involvement), unreasoned processes (e.g., habits), and situational influences (e.g., income and household size) on water consumption behaviour (pp. 1262, 1267).

The following factors have predictive ability on water consumption behaviour: environmental awareness, personal involvement, demographic characteristics, and habits and reflexes. Additionally, households with lower water usage and that display greater awareness of water conservation issues are more highly involved in the decision to use water and tend to form habits associated with lower usage levels. These results are consistent with past research that attitudes toward water usage appear to be poor predictors of water consumption behaviour. After controlling for situational factors (e.g., household size), Gregory and Di Leo (2003) findings substantiated the role of personal involvement and habit formation in explaining water consumption (pp. 1266-67, 1277, 1280-86).

The results of Gregory's and Di Leo's (2003) study did not generally support past findings. From existing studies, Gregory and Di Leo found that pro-conservationists are younger and more highly educated than are non-conservationists. Also, higher income families tend to be more involved in pro-environmental activities, have greater concern for the environment, and participate to a greater extent in conservation activities than do lower income families (p. 1267). This finding was also reflected in a study which found that people with a high income, more education, and high status jobs were more likely to

engage in water saving practices (Berk et al., 1993, p. 236, 242-43). However, Gregory's and Di Leo's (2003) results indicated that households with greater awareness and involvement in the decision to use water were older, had lower income and educational levels, and had fewer people living in the household. They assumed the discrepancy between past findings and their findings may be a result of household life cycles, or the different phases of collective household members experience over time (p. 1283).

When behaviours are habitual, it is challenging to change people's attitudes towards their actions. Much of the relevant work in environmental psychology focuses on reasoned influences, such as attitude change, even though the literature cited suggests a weak link between general attitudes and environmental behaviour. Only recently has research on past behaviour habits achieved popularity in environmental psychology. Gregory and Di Leo (2003) suggest that when strong habits exist, persuasive efforts to change attitudes may have little effect on behaviour. Conversely, increasing the level of personal involvement can lead to the consideration of alternative choices and the weakening of existing habits. According to behavioural decision theory, understanding the factors that maintain routine responses is a first step toward developing successful intervention strategies to change habitual behaviour (p. 1285).

Persuasive communications can serve as stimuli to change one's predisposition toward a particular behaviour or motivate one to become more involved in the behavioural process. As Gregory and Di Leo (2003) concluded, "a greater understanding of how awareness affects both reasoned and unreasoned influences will enable water-management authorities to devise more effective environmental awareness campaigns to encourage water conservation behaviour," (p. 1286). Although research in environmental behaviour is abundant, past studies attempting to link psychological variables to conservation behaviour produced mixed findings and are inconclusive. Moreover, the ambiguity of those results could be due to the fact that such research has concentrated on recycling and electricity conservation, with relatively few studies investigating the psychological aspects of household water usage (pp. 1262-63).

### **The Trust Factor**

Conservation motives significantly reduce annual water consumption. University of Sonora Professor Victor Corral-Verdugo, Frias-Armenta, Perez-Urias, Orduna-Cabrera, and Espinoza-Gallego (2002) investigated the factors influencing Mexican citizens' water use and found that people must trust each other and those who supply them water before they will reduce their usage (pp. 527-535). Conservation motives included

reducing the amount of money spent on water, social norms (i.e., neighbours try to conserve water), and wanting to comply with conservation campaigns (p. 530).

People's perception of the amount of water used by those around them often influences their own usage. Corral-Verdugo et al.'s (2002) model found that the perception that others were wasting water decreased conservation motives and resulted in increased water consumption. If people do not trust others to conserve water, they will use this to justify their own lack of motivation to conserve, which results in their own higher water consumption (pp. 527-28, 533-34). Similar to Dr. Garrett Hardin's Tragedy of the Commons, the shared resource, in this case grassland is depleted through self-interested actions. The tragedy of the commons is a dilemma arising from multiple individuals, acting independently and rationally concerning their individual self-interest, but ultimately depleting a shared limited resource even though it is contrary to everyone's interest in the long run. The individual's rational behaviour leads to a situation in which everyone is worse off than they might have been otherwise (Hardin, as cited in Jorgensen et al., 2009, p. 229).

Hardin's classic example is a hypothetical situation about herders sharing a common parcel of land on which they are all entitled to let their cows graze. It is in each herder's interest to put each succeeding cow he acquires onto the land, even if the carrying capacity of the common is exceeded and it is temporarily or permanently damaged as a result. The herder receives all of the benefits from an additional cow, but the entire group collectively shares the damage. If all herders make this individually rational economic decision, the common will be depleted or even destroyed to the detriment of all (Jorgensen et al., 2009, p. 229).

For efficient usage, people must also trust that the water authority is doing all it can to provide enough water. If the public believes water agencies are untrustworthy, they may be unreceptive to initiatives that managers propose as a means of conserving water and securing supply (Corral-Verdugo et al., 2002, pp. 533-35). Water conservation by the public requires institutional trust; willingness to conserve increases with governmental conservation efforts and supply increases (Heiman, 2002, p. 84). People are more willing to save water when they believe the water authority and government are also doing their part to ensure supplies.

The Corral-Verdugo et al. (2002) study also found a disparity between perceived and actual consumption in different sectors. Participants thought that city dwellers use a higher percentage of the water supply than they actually do (31% compared to 8.5%) and farmers use less than they actually do (24% compared to 83.3%) (p. 532). These findings

demonstrate that people's perceptions of how others use water are not in line with reality. Furthermore, their perceptions of how others use water can impact their own water use. When individuals surveyed did not trust others to save water, they felt no obligation to save water themselves. This model suggests that actual water use is influenced by perceptions of how others use water, both wasting and conserving.

### **A Human Connection to Nature**

The problem of overconsumption may also stem from a disconnect between people and nature. Law professor Eric Freyogle, an authority on the issues of human interaction with nature, candidly summed up this gap in the relationship: "We are disconnected from nature in our ethics, our knowledge and understanding, and our behaviour." Freyogle believes Americans engage in environmentally harmful land activities because we lack an environmental ethic that values nature. Instead, we "should seek ecological health in our land practices;" we place too much value on self-gratification, individualism, and "consumeristic" consumption (Arnold, 2005, p. 10171).

### **Public Perception of Water**

Another systemic factor influencing overconsumption is the general public's knowledge deficiency on the most basic information about water. The public's perception of its role in causing or helping to resolve water supply and quality problems is poorly developed. Approximately three-fourths of the public is concerned about household water supply, one-third believes that their supply is "not as safe as it should be," forty percent believe that standards for protecting drinking water quality should be "stricter," and less than one-third of the public know the major sources of water pollution in their communities. Most do not think that runoff from farms, parking lots, or even residences are a major cause of water pollution (Feldman, 2007, p. 276).

### **Outdoor Water Uses**

Outside water use behaviours are important targets for changes in water consumption. Michael Loh and Peter Coghlan (2003) studied water use in Perth, Australia, and found that inside water use is relatively stable across seasons, socioeconomic groups and housing types (p. 1). The only differences were dependent on household size and appliance ownership. Additionally, 56% of Perth's household water use is for purposes outside the dwelling (pp. 25, 27).

Professor Geoff Syme, Blair Nancarrow, and Clive Seligman, (2000) specifically investigated outdoor water use and discovered that lifestyle (e.g., importance to lifestyle

of large garden, large lawn, green home environment, etc.), recreation in the garden, and enjoyment of gardening are all interrelated and contribute to higher water use (pp. 539-78). Syme et al. (1990-1991) measured homeowner's attitudes against their actual water consumption for a year. They found that attitudes pertaining to garden importance as a house investment and a source of recreation, expenditure on garden, and attitude toward water price were all significant predictors of household water use (pp. 167-68).

People exercise greater choice in reducing outdoor uses of water than indoor uses. A plurality of studies show that people are more conscientious in reducing lawn irrigation or washing cars than they are in showering or flushing toilets. Effective demand-side management strategies should focus on changing garden water use behaviours among households that highly value gardens, in combination with increasing prices (Feldman, 2007, p. 299).

### **Promoting Behavioural Change in Water Use**

By understanding the effects of psychological factors on consumption, water management authorities can better identify solutions. Having identified factors influencing water behaviour, we now examine methods to change behaviour. In the process of encouraging behaviour change, we recommend employing demand-side strategies.

Communication gives people a reason to cooperate in reducing water usage because it gives them the opportunity to make explicit commitments and promises about what they will do. More specifically, it offers an opportunity for moral persuasion, or an appeal to what people believe is the right thing to do. Communication facilitates cooperation. Cooperation increases significantly when individuals are given the chance to talk with each other. Communication and cooperation provide communities with a sense of social responsibility; individuals recognize a shared interest and trust that their neighbours will also conserve water (Atwood et al., 2007, p. 534). Cooperation provides the individual consumer with a group identity. Group identity in turn encourages cooperation among members.

The availability of water saving technologies is essential. Clarke and Brown (2006) investigated the receptivity within a community to using alternative water sources and technologies and found that demographic influence was weak, but the ability and capacity of individuals to acquire and apply household water saving and reuse measures is a fundamental factor for behavioural change (pp. 251-58). Upon further investigation, they discovered that simply having the ability to purchase more water saving devices contributed to water saving behaviours.

Education is also important; “the public is generally inclined to learn more about water problems if the opportunity to do so is afforded them” (Feldman, 2007, p. 277). David Feldman (2007), author of *Water Policy for Sustainable Development*, argues that education helps teach consumers and the public what is involved in keeping water flowing from the faucet. Conservation alone may not be enough, but ignorance is a significant factor in over usage. Encouraging conservation is difficult because the general public is unsure where and how it derives its water and thus fails to realize its role in water demand and its potential role in saving water (p. 299). Conservation requires education and greater information about water use and the public’s effect on the water supply. Water providers can employ a dissemination of knowledge to inform consumers about the need to change behaviours relating to conserving water, and give them suggestions on how to do so.

### **Part I - Conclusion**

Part one of this paper reviewed five major models of household water consumption, and found that while many studies highlighted different factors acting on water use behaviour, none of them attributed all of the variation in water use to the factors they examined. There are other variables impacting water use that this paper has not yet visited.

Trust is an important factor that has not been fully explored but that can be useful in the development of effective water management strategies. Trust in the water authority and trust among community members (including residents, farmers, and industry) to take steps to reduce their water consumption will increase the likelihood that people will actively reduce their own water use. Therefore, these two kinds of trust are essential to engender a water saving response from the whole community and to ensure the success of water demand programs. But how can we measure trust? Further investigation is needed to determine the exact role that trust plays in determining household water use behaviour.

We now address questions about the interactions between water management pricing strategies, water restrictions, restrictions in water supply, and individual motivations to conserve water, for practical, broad applications.



## **Part 2: Conservation through Water Management Policies**

There are three major players in water management: the people and organizations who use water; the entities that distribute it; and the different levels of government that regulate it. This section discusses the major methods by which that last group, the regulating agencies, deal with excess water consumption, especially during droughts. They must balance the psychological and sociological factors behind water consumption against the need to conserve water. After detailing the methods of water management, a way in which regulating bodies may both conserve water and generate revenue to help prepare for future water shortages will be proposed.

### **Methods of Water Management**

There are four major methods of water management: mandatory restrictions on usage; rebates and giveaways; educational programs; and rate increases. Each method has benefits and detriments, but one method, rate increases, has far-reaching economic and financial benefits that outweigh its detriments and allow government agencies to restrict water use in a transparent, efficient way.

#### **Mandatory Restrictions**

Water regulating entities may restrict water use by residents and businesses using criminal penalties such as fines as a disincentive to excessive usage. This is a very common method of regulation, and several urban areas in the southeast United States employed mandatory restrictions during the drought of the late 2000s. Several cities banned lawn irrigation. The City of Raleigh, North Carolina banned most car washing, filling new swimming pools, and serving drinking water at restaurants unless requested by diners (Manuel, 2008, pp. A 170-171). In Georgia, Governor Sonny Perdue urged Georgians “to make their dry lawns and dirty cars a badge of honour” in October of 2007 (P A 170).

The advantage of mandatory restrictions on water usage is that it usually works — at least in the short run. The fear of legal penalties prevents citizens from using water for any non-essential purposes. Northern Georgia, including Atlanta, experienced a 13.3% decrease in water usage from 2007 to 2008 after implementing restrictions on use (Manuel, 2008, p. A 170).

The major disadvantages of mandatory restrictions are two-fold. First, they are only successful in the short run. Political pressure from upset water users can coerce elected officials to alleviate the severity of the restrictions, or lift them entirely. Policy makers,

understandably weary of a dissatisfied constituency, are vulnerable to the whims of those who want to use more water than is reasonably available during a severe drought. After Georgia's initial success with mandatory restrictions, the state completely dropped all penalties against power plants, citing the importance of the state's power grid (Manuel, 2008, p. A 170). Giving in to such pressure can curb governmental efforts to conserve water.

The second disadvantage of mandatory restrictions is the fatal flaw that exists in many types of criminal penalties: if individuals believe that the benefit of breaking the law outweighs the consequences, they will break the law. A wealthy homeowner who has acres of property (the type of person likely to need lots of water to irrigate her lawn and landscaping) may have the resources to pay a fine for excessive use. Conversely, to an indigent person who lives in a small apartment and does not own a vehicle, the fine is not only un-payable but also irrelevant; he or she will never violate a restriction against irrigating residential property. Policymakers can curtail this disadvantage by implementing harsh penalties against excessive water use, but then they must face the threat of a disgruntled constituency.

### **Rebates and Giveaways**

Devices such as low-flow toilets, shower heads, and faucet aerators can significantly reduce household water usage, and many regulating agencies either directly offer rebates or subsidize the use of water conserving products. Low flow products successfully reduce usage, but have historically shown mixed results due to government budgetary constraints or the sheer severity of a drought. After discovering that fitting existing homes with water saving devices reduced household usage by about 46%, the City of Tampa offered citizens \$100 on low-flow toilets. From 1993–2005, the subsidy helped replace 33,765 toilets and saved about 434 million gallons of water each year. However, the program costs \$3,000,000 during those twelve years, and ended in 2008 due to budget constraints (Manuel, 2008, p. A 170). Santa Barbara, CA, in the middle of a severe drought in 1988, gave away free low-flow showerheads and offered rebates for low-flow toilets. However, the drought (during which rainfall levels fluctuated from 94 percent to 30 percent of historical norms) persisted, and the city eventually took up more severe methods of regulation, including increased rates and mandatory restrictions (Renwick & Archibald, 1998, p. 348). Water saving household devices are certainly a part of the long term solutions, but they cannot combat a drought in the short run.

## **Educational Programs**

Different levels of government sometimes organize educational programs to teach citizens why they should conserve water and how to do so. For example, the EPA funds the “WaterSense” program, which shows attendees how to cut their usage by 20% (Manuel, 2008, p. A 170). Major problems with these programs (or any government-ran educational program) are that: 1) they often require participation, or at least high amounts of reading, effort, etc., which discourages working adults from partaking; and 2) people do not always trust government entities to instruct them on how to use a resource such as water.

The fourth method of reducing usage is increasing the monetary costs of water. Economists contend that as prices increase, the quantity demanded, or amount of water used, will decrease (Mankiw, 2009, p. 7). Therefore, as water suppliers increase prices, people should use less water. Several municipalities used this method successfully during the recent drought in the south-eastern United States, and it is arguably the most efficient solution to over-consumption in both the long term and the short term.

Conservation-minded rate increases commonly take two forms: inclining block rates or seasonal rates. The former charges water users an increasing rate as their usage increases. (Figure 1 shows a simplified hypothetical schedule to demonstrate the desired effect of inclining block rates.) Regulating bodies can increase the overall price of water so that any amount used during a drought costs more than water prior to a drought. Seasonal rate increase prices by larger amounts at times of the year when aquifers and streams are especially vulnerable. Either way, regulators can encourage citizens to conserve water by threat of higher costs (Georgia Environmental Protection, 2007, pp. 8-9; Borisova & Rawls, 2010, pp. 16-17).

The obvious detriment of increasing water rates is the risk of a disgruntled citizenry. As with mandatory restrictions, Americans do not like government entities affecting their household budgets. While restrictions regulate their actions, increased rates act on their wallets. However, the nature of increased rates makes it less offensive than mandatory restrictions because it gives water users some freedom to control how much regulation affects them; if they conserve water, they will not be charged higher rates. It is not as intrusive as Raleigh’s “water police” citing people as criminals.

## Efficiency of Rate Increases

A rate increase can have the benefit of decreasing water usage (see above), but it also can be an important tool for government agencies to raise funds. Those funds could be used to directly combat the effects of drought, or for any other public welfare project.

Governments raise revenue through taxes, and a government-imposed rate increase for water is a type of tax. In Figure 2 (Appendices), a population's aggregate demand (D1) for water is a downward sloping line because people will consume less water as prices increase. It is a steep line because the demand for water is 'price inelastic', meaning that changes in price do not have as great an impact on water as on some goods. It is, however, somewhat affected by price changes. Notice also that there is never a point at which consumption equals zero (D1 never crosses the horizontal [price] axis); no matter how expensive, people still need water. In this hypothetical, water costs one dollar per gallon (P1), and consumers will purchase fifty gallons (Q1) at that price. Everything else remaining equal, that is the amount of water citizens will use. In Figure 3 (Appendices), a regulating entity has doubled the price (P1 to P2), and quantity demanded has subsequently fallen to forty gallons (Q2).

A major criticism against rate increases is the inelastic nature of water. However, water is not perfectly inelastic, and is therefore still sensitive to price changes. Rainfall and temperatures determine the supply of water, but utility providers exercise some control over it because of their ability to use dams/reservoirs and by controlling the amount of water they extract and process for human consumption. In the hypothetical, the rate increase has successfully decreased water usage. The decreased quantity of water demanded illustrated in Figure 4 (Appendices) is a simplified but realistic representation of the effectiveness of rate increases in "real world" scenarios. Figure 4 illustrates the revenue generated by charges attached to water rates. This amount can also be found with a simple equation: *Quantity X Price of the Increase = Revenue*. In this hypothetical,  $40 \times 1 = \$40$ . In an actual city, county, or state-wide economy, this would obviously be a very large amount. Legislative bodies, when enacting a rate increase, can earmark future revenue generated by the increase to benefit the people who pay the rates. If water users can see direct benefits from the extra funds they pay, they may not be so quick to condemn rate increases. They will still not want to pay more for water, so usage should decrease, but they may be more willing to accept governmental action, even if it means financial consequences to individuals.

## Possible Use of Revenue Generated from Rate Increases

Revenue generated by increased rates should be spent mitigating the effect of current and future drought. The former can be achieved through bailouts for industries hard hit by drought (e.g. local agriculture and tourism) and the former through investing in sources of electricity that are not derived from water or fossil fuels. The benefit of promoting non-hydroelectric energy in hydroelectricity dependant drought-prone regions is obvious: during times of drought, the source of the region's electricity often dries up with the rest of the region's water. The reasons for promoting non-fossil fuel sources of power in those regions are not as obvious but just as vital.

Drought in the twenty first century is part of a cycle that begins and ends with fossil fuels. The burning of fossil fuels and the consequential warming of the planet's atmosphere lead to higher average temperatures, which in turn lead to higher rates of evaporation. Evaporation, when spread over an entire region, dramatically worsens the effects of a drought. The problem becomes not only the lack of rainfall, but also the decreasing amount of water already held in groundwater, lakes, and streams. As that water decreases, hydroelectric sources fail, and energy providers are forced to compensate by burning fossil fuels (Manuel, 2008, pp. A 168, 170). Revenue generated from rate increases could be used to promote alternative fuel sources. The alternative sources can be used now to alleviate the current state of global warming, and later, in times of drought, to offset the loss of hydroelectricity.

## Conclusion

There are four major methods of water management to reduce water usage during droughts; of those four methods, increasing rates that citizens pay for water is the most viable in the long term. Not only can it decrease water usage, but it can also increase revenue. Government entities can use the additional revenue to benefit the people who contributed to it: and should use it to curtail the effects of future drought.

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## Appendices

Figure 1

Hypothetical Simplified Inclining Block Rate Structure			
Gallons of Water	Rate	Change from Starting Price	Price Max
0-100	\$.01/gal	--	\$1.00
100-200	\$.02/gal	+100%	\$4.00
200-300	\$.03/gal	+200%	\$9.00
300-400	\$.04/gal	+300%	\$16.00
400-500	\$.05/gal	+400%	\$25.00



Figure 2

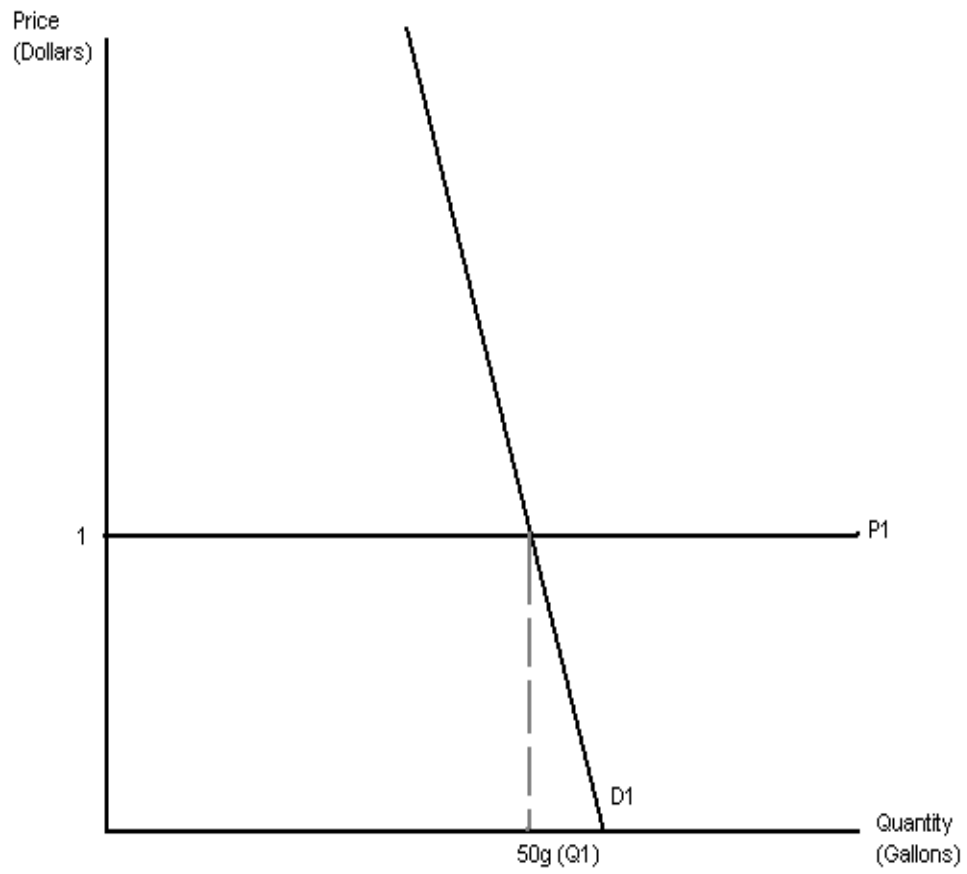


Figure 3

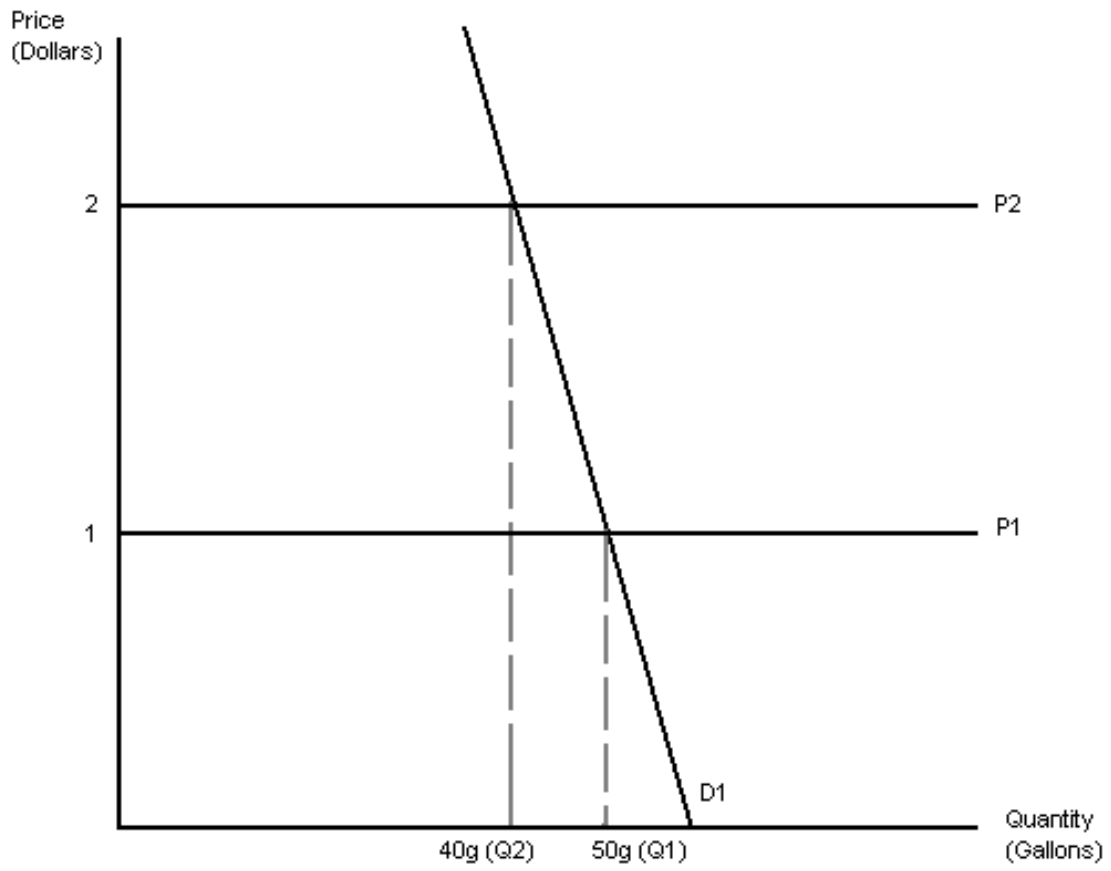


Figure 4

