Comments on the California Energy Commission's

Fuel Delivery Temperature Study

Kevin M. Murphy[1] & Robert H. Topel[2]

University of Chicago

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I. Introduction

The CEC's *Fuel Delivery Temperature Study*[3] is a cost-benefit analysis of the prospective mandatory introduction of Automatic Temperature Control (ATC) devices at retail service stations in California. The purpose of the study is to provide informed guidance and recommendations to California lawmakers, who wish to understand the implications for public welfare of alternative methods of measuring and dispensing fuels to retail buyers. What follows is a review and commentary on the economic analysis contained in the draft CEC *Study* dated November 2008. This commentary is designed to provide feedback to the staff and assist them as they finalize the project.

By way of background, retail stations now dispense gasoline and diesel fuels to consumers as volumetric (231 cubic inches) gallons. Like other liquids, these fuels expand as temperature rises. As a rule of thumb, each 15°F increase in the temperature of gasoline increases the size of a given amount of gasoline by about 1 percent—for example, a volumetric gallon of gasoline measured at 60° would expand from 231 cu in to about 233.3 cu in if the temperature of the fuel increased to 75°. Other things equal, this means that a volumetric gallon of fuel contains less energy as the temperature of the fuel rises. In the example just given, a volumetric gallon of gasoline dispensed at 75° contains about 1 percent less energy than an otherwise identical volumetric gallon dispensed at 60°.

The central issue for public policy is whether there would be a net social benefit from requiring that retail transactions also be conducted in terms of a temperature-adjusted "net"

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[1] George J. Stigler Distinguished Service Professor of Economics, Department of Economics and Booth School of Business, University of Chicago; Principal Chicago Partners.
[2] Isidore and Gladys J. Brown Professor of Economics, Booth School of Business, University of Chicago; Director, George J. Stigler Center for the Study of the Economy and the State; Director, University of Chicago Energy Initiative; Principal, Chicago Partners.
[3] Schremp, Gordon, 2008. *Fuel Delivery Temperature Study*, California Energy Commission, CEC-600-2008-012-SF.

gallon. As recognized in the CEC *Study*, there are costs of such a mandate: all retail service stations in California would be required to invest in ATC equipment, which would have to be maintained, replaced and monitored for the indefinite future. These costs largely will be passed on to consumers in terms of higher prices, so it is important to properly assess the balance of potential benefits of ATC against costs. As the *Study* put it: *If ATC was mandated, would the overall cost to businesses and governmental agencies to implement and oversee the program outweigh any potential benefits?*[4] As indicated in Tables 7 & 8 of the *Study*, the basic answer to this question is "yes." We agree.

The CEC *Study* correctly identifies the key issues related to ATC. The issues and the staff's conclusions on those issues are reflected in the various columns of Tables 7 and 8 (page 79):

1. The Staff has concluded that the average temperature of fuel dispensed in California is higher than 60 degrees. A shift to ATC will reduce the number of measured "gallons" sold by changing the definition of a "gallon", but consumers will not receive any monetary benefit from this redefinition. ("Retained Retail Motorist Benefits" are zero in all years.)

2. The dispensed temperature of fuel varies across retailers at a point in time, and also over time as ambient temperatures rise or fall, and as other factors influencing temperature change. A switch to ATC will change the information available to consumers. The *Study* correctly concludes that the benefits of this increased "transparency" are, at most, small. In particular, the Study estimates that statewide "Increased Transparency Benefits" are about $3.2 million per year, or about 17/1000 of one cent per gallon.)

3. The capital and recurring costs of ATC equipment will be passed on to consumers in the form of higher prices for fuels and, possibly, in higher prices for other products sold at service stations. ("Initial and Reoccurring Industry Costs" columns and discussion on page 78.)

4. In both the "Low Cost" and "High Cost" scenarios considered in the *Study*, the costs of ATC outweigh the benefits. ("Net Costs or Benefit" is negative in all years.)

These conclusions are largely correct, but we have three concerns about certain statements and analyses within the draft *Study*. First, the *Study's* discussion of a revenue shift and subsequent revenue "recapture" in the calculation of "Retained Retail Motorist Benefits" does not correctly reflect the underlying economics. Second, some of the *Study's* specific

[4] *Study*, p4.

calculations including the discussion of revenue shift and recapture are subject to misinterpretation, and so we wish to clarify these analyses. Third, we believe the *Study* should be clearer on a central economic point: Market prices for fuel are determined by supply and demand, neither of which is materially changed by a shift to ATC. As a result, a switch to ATC would impose significant costs on the retail distribution of fuel, with virtually no offsetting benefits for consumers. The following discussion elaborates on these points.

II. The Economics of ATC

Currently, retail transactions for fuel are made in terms of 'gross" gallons that contain exactly 231 cubic inches of fuel. Under ATC transactions would occur on a "net" basis so that a "gallon" dispensed at retail would contain a variable number of cubic inches depending on the temperature of the fuel at the time it is dispensed. The amount of fuel dispensed would be calculated so that each "gallon" would occupy 231 cubic inches if it was heated or cooled to the reference temperature of 60 degrees.

From an economic perspective, it is helpful to break the ATC issue down into three components. Each of these components has unique economic features and requires different economic tools. In particular, a switch to ATC generates three effects.

- According to the fuel temperature study cited in the staff report, the average temperature of gasoline dispensed in California during the 12 months from April 2007 through March 2008 was 71.1 degrees. As outlined above, with ATC in place, gallons sold at retail would be normalized to a 60 degree standard. As a result, the switch to ATC would increase the <u>average</u> size of a "gallon" dispensed at retail from 231 cubic inches to roughly 233.3 cubic inches. We refer to this first effect of the introduction of ATC at retail as "changing the unit of measure."
- Second, the introduction of ATC will change the information available to consumers. With ATC the size of the "gallon" dispensed, measured in cubic inches, will vary with the temperature of the fuel delivered. When the fuel is hotter, the size of the "gallon" will be adjusted upward so that the consumer receives a greater volume of fuel. When the fuel is cooler, the size of a "gallon" will be adjusted downward so that the consumer receives a lesser volume of fuel. With ATC, the "gallons" distributed by different stations will contain the same amount of fuel in the sense that each "gallon" would contain 231 cubic inches of fuel if it were cooled (or heated) to 60 degrees. Without ATC, the "gallons" distributed by different stations all contain the same number of cubic inches of fuel, namely 231 cu. in., measured at the time they are dispensed. Thus, the

switch to ATC changes the information contained in the unit of measure by which consumers purchase fuel; i.e. a change from a volumetric gallon to a new "net gallon." We refer to this as the "information effect of ATC."

- Third, the introduction of ATC will impose costs on retailers and the government. These costs include the cost of acquiring and installing the ATC equipment, maintaining that equipment and monitoring and inspecting the ATC equipment. While these costs are directly borne by retailers and government agencies they are likely to be passed on to consumers in the form of higher prices. We refer to this as the "cost pass-through effect of ATC."

The following subsections present the details of our analysis.

A. Average Temperature and the Impact of ATC: Changing the Unit of Measure

According to the *Study*, the average temperature of dispensed gasoline during the 12 months from April 2007 through March 2008 was 71.1 degrees. Given the average temperature of gasoline dispensed in California, a switch to ATC would change the average size of a "gallon" of gasoline from 231 to about 232.7 cubic inches. With larger "gallons", consumers would need to purchase fewer "gallons" to satisfy their fuel needs.

Based on this observation, the *Study* calculates that Californians would have purchased 117 million fewer "gallons" from April 2007 to March 2008 "because the fuel was warmer (71.1 degrees Fahrenheit) than the 60 degree Fahrenheit reference standard." CEC staff then calculated "the representative value of the reduced quantity of 'gallons' for which consumers would not have paid if ATC had been in place at retail stations in California during the study period." They did this by multiplying the 117 million "gallons" noted above by the average retail price of gasoline, yielding $376.4 million for the 12-month study period.[5] The *Study* then notes that consumers' "net potential benefit ...is the *portion* of this revenue that is retained by consumers and not successfully recaptured by retail station owners over the long term through raising the price of fuel and non-fuel commodities that they sell to consumers, less the cost of ATC retrofit." The *Study* concludes that this "recapture" by retailers is likely to be complete in the long term: "[S]taff believes that the retail station owners, in aggregate, will be successful in recovering this revenue shift over the long term..." As a result, the study concludes that "Retained Retail Motorist Benefits" will be zero.

[5] The corresponding estimate for diesel is $61.1 million, bringing the total for all motor fuels to $437.5 million.

The conclusion that "Retained Retail Motorist Benefits" will be zero is correct. But much of the *Study's* analysis used to reach that conclusion is economically flawed and invites misinterpretation. A correct economic analysis starts from the observation that retail fuel prices are determined by supply and demand. Further, as we show below, a shift in the average size of the "gallons" dispensed at retail changes nothing about the economic fundamentals of supply or demand. As a result, the market price of a given volume of gasoline would not be affected by increasing the size of a "gallon." Changing the size of a gallon provides <u>no</u> potential benefit for consumers, and would create nothing for retailers to "recapture" in either the long or short term.

To understand why this is true, consider a typical market transaction in which a consumer purchases a tank full of gasoline—say 20 volumetric gallons—at a temperature of 75^0F. In the absence of ATC, the retailer dispenses 20 volumetric gallons to the consumer. If the retailer's cost is $2 per volumetric gallon, then the total cost of the dispensed fuel is 20x$2 = $40. A change in the unit of measure to 60^0 benchmark gallons would not change this in any way: the retailer's cost of filling the consumer's tank would still be $40 because the same <u>amount</u> of fuel is being dispensed with or without ATC. It is true that the retailer would dispense about 1 percent fewer measured "gallons"—20 volumetric gallons at 75^0F is equivalent to about 19.8 60^0 gallons—but the average cost per "gallon" is 1 percent higher. *The retailer's cost of filling the tank cannot have changed simply because we changed the units.*

The same is true on the consumer's side of the transaction. The consumer is buying a tank full of gasoline from the retailer. If the retailer's margin on the transaction is 10 percent, then the consumer paid $2.20 per volumetric gallon for 20 gallons, or $44 total. Measuring the dispensed fuel in 60^0 gallons, the consumer would fill his tank with 19.8 60^0 gallons—which is exactly the same amount of fuel. Since the amount of fuel dispensed is exactly the same, the value received by the consumer is exactly the same with and without ATC. The same $44 value of a tank full of gasoline translates into a $2.22 price per gallon for the new larger gallons.

Nothing has changed because the retailer and the consumer are exchanging exactly the same good—a tank full of gasoline—as before. Changing to larger "gallons" for retail transactions is conceptually no different than measuring the dispensed fuel in quarts rather than gallons. Doing so would change nothing fundamental about the transaction, and so there is no reason for either buyers or sellers of gasoline to change their behavior. The amount of fuel and money that changes hands is the same. Importantly, *there is no revenue for retailer's to "recapture", because there is no "potential benefit" for consumers from changing the unit of measure.* The market price of fuel simply adjusts to reflect the larger "gallons." Supply and demand remain in balance because consumers receive the same amount of fuel and pay the same amount for that fuel, and retailers dispense the same amount of fuel at the same total cost. Consumers have no incentive to alter their purchases of fuel and gasoline retailers have exactly the same revenues and costs as they did without ATC.[6]

This discussion demonstrates why the *Study's* calculation of revenues foregone and potential benefits for consumers—the $376.4 million mentioned above—is so misleading and even meaningless. Suppose, for example, that California decreed that henceforth "California gallons" would contain 462 cu. in. of liquid—they are twice as large as the standard. Then the number of "California gallons" dispensed by retailers would be half the number of standard gallons, even though the same amount of fuel is dispensed. The *Study's* methodology would estimate a one year "potential benefit" to California consumers from this change by multiplying the reduction in "gallons" dispensed (7.75 billion *California gallons)* by the previous price of *standard gallons* ($3.217), yielding $23.93 billion. This "apples and oranges" calculation of "potential benefits" is clearly incorrect, but it is literally the method used in the *Study* to calculate the $376.4 million figure.

B. Variation in Fuel Temperature Over Time and Between Retailers: The Information Effect of ATC

Another concern addressed in the *Study* has to do with differences in the temperature of dispensed fuel for different transactions. These differences can occur for two basic reasons. First, differences in ambient temperature over time and across regions will cause dispensed fuel to be warmer in the summer months than in the winter, and warmer in certain regions than in others. Second, even within a locale, the temperature of fuel may differ across retailers at a point in time.

Economics provides a straight forward and generally accepted methodology for analyzing the impact of temperature variation over time and across retailers. In particular, we can think of ATC as changing the information possessed by consumers. Without ATC, gallons sold at different points in time or different retailers have the same volume, 231 cubic inches, measured at that time they are dispensed. With ATC gallons dispensed at different points in time or different retailers have the same volume if they were compared at the same temperature (e.g. 60 degrees). This change in information can change the decisions that consumers make regarding how much fuel to purchase or where to purchase their fuel. From

[6] The same conclusion is reached if one focuses on a single "gallon" of gas. With ATC, a "gallon" sold at 75 degrees would contain approximately a one percent larger volume fuel. The consumer would receive one percent more fuel and it would cost the retailer one percent more to provide that fuel. Since the value received by the consumer and the cost to the retailer are scaled proportionately the market price of the larger gallon will increase proportionately as well.

an economic perspective, a switch to ATC would have a potential benefit if it allowed consumers to make better decisions.

Differences in Fuel Temperature Due to Differences in Ambient Temperature

As ambient temperature rises or falls, the average temperature of fuel dispensed by service stations also generally will rise or fall.[7] For example, Figure 10 of the *Study* shows that the average temperature of gasoline in California dispensers was about 82^{0}F in August of 2007, but about 60^{0}F in January of 2008. Assuming that this 22^{0}F swing in temperature is typical a switch to ATC would not change the size of the "gallons" dispensed in January but would increase the size of the "gallons" dispensed in August by about 1.47 percent.

The adoption of ATC may, under some circumstances, provide consumers with "better" information about the energy content of the fuel they purchase. The idea is that a benchmark 60^{0}F "net" gallon would contain a fixed amount of energy, so consumers would "know what they are getting." Indeed, the *Study* adopts this framework and concludes that any possible informational gains to consumers from a move to ATC would be extremely small, and we agree. In fact, our analysis indicates that even in a best case scenario any informational gains to consumers would be substantially smaller than those estimated in the *Study*. And the "gains" may even be negative—ATC may actually make consumers' information worse.

How can information be worse with ATC than without it? The premise of any informational gain to consumers from a move to ATC is that a "net" gallon contains a fixed amount of energy (i.e. it allows a consumer to drive a given number of miles) regardless of temperature. While we are not physicists, chemists or engineers, we understand that this premise may not be true. That is, because of seasonal additives, environmental changes and other factors, we understand that under some circumstances the effective energy content of fuels may be greater in warm months than in cold ones. If, in the absence of ATC, consumers falsely assume that the effective energy content of fuels is the same, winter or summer, then the adoption of ATC would make their information worse. That is, if ATC leads consumers to believe that a given volume of fuel is less effective in the summer, when it is actually more effective, then ATC would degrade the information on which consumers make purchasing decisions. Those decisions would then be less efficient, not more.

This point aside, it is worth considering a "best case" scenario in which ATC improves the information that consumers have about the effectiveness of fuels, and so provides some gain to "transparency." How big might these gains be? There are two cases to consider. The first is when changes in ambient temperature cause market-wide changes in fuel temperature. Absent the information provided by ATC, consumers may "over-value" fuel in warm

[7] We understand however that ambient temperature is not the only determinant of fuel temperature. We have not studied the relative impact of ambient temperature and other factors on the temperature of dispensed fuels.

weather, consuming more than they would if they had complete information. This is the case considered in the *Study* and analyzed in Appendix R. The second is when fuel temperatures vary across retailers in a given market. Lacking this knowledge, consumers may over-value the fuel sold by retailers offering warmer fuel (purchasing more than the efficient amount from them), and undervalue the fuel sold by those offering colder fuel (purchasing less than the efficient amount from them). We analyze these cases in turn.

The informational effect of ATC for variations in average temperature is shown in Figure 1, which is similar to the figure shown in Appendix R of the *Study*. In drawing this figure, we consider the case where temperature is above average. We assume that the higher temperature reduces the effective energy content of fuel by α percent, so that a consumer armed with "full information" (to use the *Study's* terminology) would be willing to pay α percent less than with "no information" at any given quantity of volumetric gallons. This is shown in Figure 1 by drawing the "full information" demand curve D_{full}, the height of which is $(1-\alpha)$ times the height of the "no information" demand curve D_{none} at every quantity.

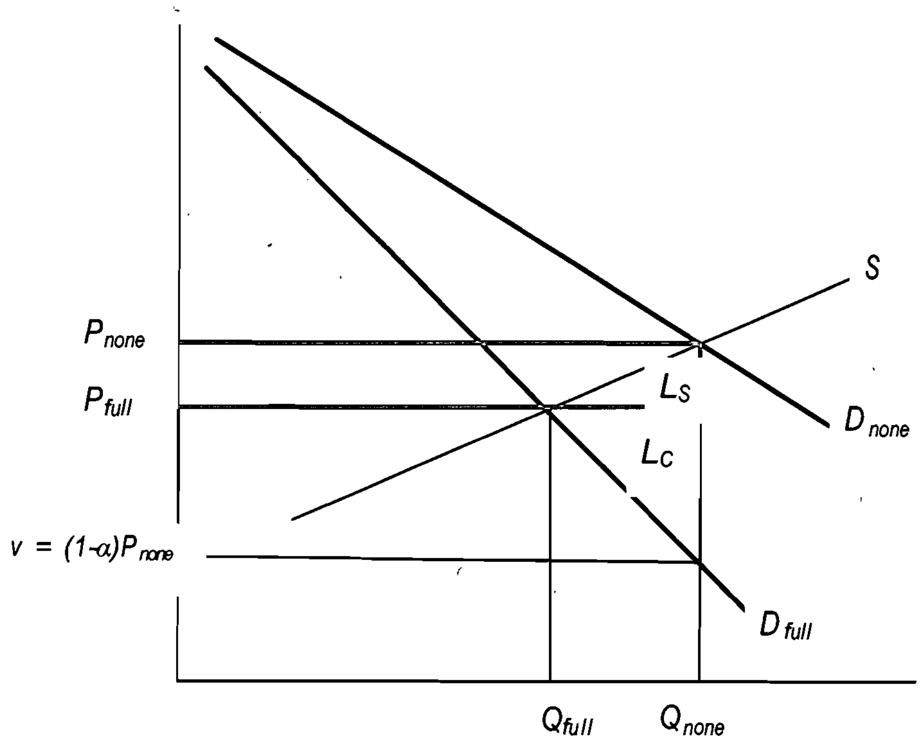

Figure 1

With "no information" the market outcome is price P_{none} and quantity of volumetric gallons Q_{none}. With full information demand would have been lower, resulting in P_{full} and Q_{full}. The Figure in Appendix R of the *Study* is correct that the deadweight loss for this characterization of the impact of information is the triangle below the market supply curve and above demand curve D_{full} between the actual quantity transacted in the market Q_{none} and what would have occurred with "full information", Q_{full}.[8] In terms of the geometry of Figure 1, this deadweight loss is the area of the two right triangles, L_S and L_C, which is measured in dollars per period. Some algebra establishes that the formula for the deadweight loss is:

(1) $$L = \frac{1}{2} X \eta_D R\alpha^2 \left[+ R\frac{\alpha}{1-\alpha} \right]$$

In this formula, $X = P_{none} \times Q_{none}$ is total market expenditure on gasoline during the period, η_D represents the own price elasticity of demand for gasoline, and $R \leq 1$ is the "pass through rate"— the fraction of an increase in sellers' incremental costs that is passed on to consumers. For reasonable values of the parameters in question the deadweight loss is extremely small. For example, let R=1.0 and η_D=0.2. If fuel temperature is 15^{0}F above average then a volumetric gallon contains about 1 percent less energy than average, so $\alpha = .01$: consumers would be willing to pay about 1 percent less if they had "full information." Then the deadweight loss per dollar of expenditure is \$0.0000101, or about one-thousandths of one cent per dollar of expenditure.

The deadweight loss in equation (1) represents the overall social cost of purchasing decisions that are "distorted" by incomplete information. It includes the change in surplus from trade received by both buyers and sellers. But the *Study* properly recognizes in the Figure drawn in Appendix R that the supply and demand model generates a transfer from consumers to sellers when temperatures are high, and there would be a corresponding transfer from sellers to consumers when temperatures are low. In terms of Figure 1 (and the *Study*'s Appendix R), the change in *consumers' surplus* is equal to the deadweight loss triangle for consumers, L_C, plus the "excess" they pay for the quantity of gasoline they actually consume, $(P_{none} - P_{full}) \times Q_{none}$. In Figure 1, this last term is the area of the rectangle outlined in red, with height $P_{none} - P_{full}$ and base Q_{none}. Again, some algebra establishes that this change in consumers' surplus is equal to:

(2) $$L_{CS} = X \left[(1-R)\alpha + \frac{1}{2}\eta_D \frac{\alpha^2 R^2}{1-\alpha} \right]$$

[8] The formula reported in Appendix R of the *Study* for calculating this deadweight loss is not correct, however. That formula would yield twice the area of triangle L_S in Figure 1.

The first term in brackets of equation 2 represents the net transfer from consumers to producers when temperatures are warmer than average; that is, when $\alpha > 0$. But if, as seems reasonable if the concern is information, consumers base their willingness to pay on the average temperature of the gasoline they use, then $\alpha < 0$ in cold months. Over a year in which fuel temperatures are warmer than average in the summer months and colder in the winter months, these terms will average out to zero. That is, there is no transfer from consumers to producers (or from producers to consumers) *on average* as a result of distorted buying behavior. And when the pass through rate, *R*, is equal to 1.0—reduction s or increases in incremental costs of fuel are fully passed on to consumers—there is no transfer of surplus in any period. This occurs because when *R=1* the supply curve is perfectly elastic (flat) over the relevant range, so the red-outlined rectangle in Figure 1 disappears. The only thing left is the triangle L_C, represented by the second bracket term in (2).

Notice that the second term in (2) is increasing in the pass-through rate, *R*.[9] So setting *R=1* yields an upper bound on the size of this loss for any value of α . This term will be positive for any value of α except zero. This is because (under the assumptions about information) consumers buy "too much" fuel when temperatures are warmer than average ($\alpha > 0$) and "too little" when temperatures are colder than average ($\alpha < 0$). The total annual loss of consumers' surplus can be found by averaging these terms over the year, which is approximately equivalent to replacing the term $\alpha^2/(1-\alpha)$ with the *variance* of α over the year. The *Study* reports that the range of average fuel temperatures in for regular grade gasoline in California during the 12-month study period was about 22^{0}F, ranging from 60^{0}F in the coldest month (January) to 82^{0}F in the warmest month (August).[10] This implies a range for α from -0.00733 (=.01x(22-11)/15) to 0.00733. Assuming that temperatures in other periods are uniformly distributed over the year within this range, then the variance of α is $(.00733)^2/3$. Combining this with our earlier assumptions that $\eta_D = .20$ and *R*=1.0, the loss in consumers' surplus per dollar of annual expenditure on gasoline is \$0.0000018 (about 2 10-thousandths of one percent).

This estimate of the deadweight cost per dollar must be multiplied by total annual expenditure on gasoline to get an estimate of the overall deadweight loss to California consumers from imperfect information. The *Study* reports (p76) that actual consumption of gasoline during the 12-month study period was about 15.625 billion gallons. The average price of this gasoline was \$3.21 per gallon, so total expenditure was \$50.27 billion. Multiplying this by our estimate of the deadweight loss per dollar yields an annual loss due to incomplete information of

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[9] Why does the distortion increase with the pass through rate, *R*? The reason is that the distortion reflects the impact of incomplete information in causing consumers to use "too much" or "too little" fuel. The pass through rate is the elasticity of supply divided by the sum of the elasticities of supply and demand. If *R=0*, for example, this means that the elasticity of supply is zero, so the quantity of fuel consumed is unaffected by information, and so there is no distortion. When *R=1* supply is perfectly elastic, and the distortion of quantity consumed is as large as it can be.

[10] *Study*, Table 2. Other fuel types showed a similar range in the DMS survey.

\$89,094.[11] Compared to the market for gasoline in California, and the cost of ATC equipment, this loss is vanishingly small. And, as noted above, ATC may actually make consumers' information worse, so that this estimate is a "best case" estimate of what consumers might gain from ATC.

Why is the deadweight loss so small? The basic reason is that for any reasonable value of the amount by which consumers over-value or under-value fuel due to imperfect information, the "mistakes" that consumers make are very small. If a consumer over-values fuel in some month by 1 percent (a very large value for α), then she acts like fuel is 1 percent cheaper than it is. If her elasticity of demand for fuel is 0.2, then she will consume 0.2X0.01= 0.2 percent more fuel than otherwise. If she drives 1000 miles per month at 20 miles per gallon, then in a typical month she uses 50 gallons of fuel. Her "over valuation" of fuel would cause her to consume 50.1 gallons when $\alpha = .01$. That is, a "large" distortion of information in a very warm month would cause a typical consumer to use about 1/10[th] of a gallon more than otherwise (and 1/10[th] of a gallon less in a very cold month). Her deadweight loss is the excess of what she paid for that 1/10[th] of one gallon over her value of using it, which multiplies by α *again* and divides by 2. The overall impact is vanishingly small.

The preceding analysis covered the situation where average fuel temperature in a broadly defined market varies over time. The same apparatus can be used to analyze the case where the temperature of fuel varies across retailers at a point in time, and consumers are uninformed about this variation. The most reasonable assumption if people are uninformed about temperature is that they purchase fuel based on a retailer's price and other factors. As in the case of variation over the year, there is no transfer of surplus on average, but compared with a situation of complete information consumers end up buying "too much" from retailers with warmer than average fuel, and "too little" from those with cooler than average fuel. The deadweight loss then depends on the variance in temperature *across retailers* within a market. This is conceptually the same as the case where temperature varies over time, and the loss in consumers' surplus is:

$$(3) \qquad E(L_C) = \frac{1}{2}\eta_D R^2 E\left[\frac{\alpha^2}{1-\alpha}\right] \approx \frac{1}{2}\eta_D R^2 \operatorname{var}(\alpha)$$

where $E(L_C)$ represents the "expected value" of the loss in surplus across stations.

Application of (3) is similar to the examples above, but there are important economic differences in the choice of parameter values. Now α (which may be positive or negative, but which is zero on average) represents the percentage amount by which consumers over estimate the value of the fuel received (if fuel is warmer than average) or under estimate the value of the

[11] Notice that this number is not 12 times the monthly estimated loss for August (\$42,312) that was mentioned above. This is because August is one of the extremes, and months with temperatures closer to the average have lower informational losses.

fuel received (if fuel is cooler). We don't have information on this from the *Study*, but it seems implausible that the range of temperatures across stations at a point in time would be as large as the range of average temperatures over the year. To fix ideas, we assume a range of 10^0F ($\pm 5^0 F$). Assuming temperatures are uniformly distributed in this range, the same methods as above yield $\text{var}(\alpha) = .0033^2 / 3 = 0.0000036$. This leaves the typical retailer's (not the market) elasticity of demand η_D and the retailer's pass-through rate, *R*. A well known result from economic theory is that a seller's profit maximizing price-cost margin satisfies the following relationship:

(4) $$m = \frac{p-c}{p} = \frac{1}{\eta_D}$$

Therefore, knowledge of the typical retailer's price-cost margin allows us to estimate the elasticity of demand for the typical retailer's fuel offerings. Department of Energy data indicate that the margin between retail and wholesale prices of gasoline is typically smaller than 10 cents per gallon. This would give $m=.033$ if we assume a retail price of $3/gallon, and a demand elasticity of $\eta_D = 30$. With the assumption of uninformed consumers, it is unreasonable to assume that all of the relative cost advantage or disadvantage is passed on to consumers, so we set $R=.20$ as an upper bound.[12] Using (3) to apply these values to total California expenditure on gasoline during the study period yields an estimated deadweight loss from variation in temperatures across service stations of $109,240 per year. Again, this is a "best case" scenario because we ignore the possibility that ATC actually degrades consumers' information.

Adding together the $89,094 from the reduction in seasonal variation and the $109,240 from the reduction in variation across retailers, generates an annual gain from increased transparency of roughly $200,000. This is extremely small compared to the costs of ATC, to which we now turn.

C. Who Pays the Costs of ATC? How and When Do They Pay?

The CEC Staff *Study* points out that required implementation of ATC in all retail service stations would entail substantial fixed costs[13], as new equipment must be installed, maintained and inspected on all existing dispensers in the state. Staff's estimates of ATC retrofit costs are summarized in Table 6 of the *Study* (p. 72). Staff estimates that a shift to ATC would entail an

[12] In principle, this parameter could be estimated from data on fuel temperatures and prices.

[13] In economics, a cost is termed "fixed" if it does not vary with the rate of output. So retrofitting a dispenser with ATC equipment qualifies as a fixed cost with regard to the fuel pumped from that dispenser—the cost must be incurred no matter how many or few gallons are dispensed.

initial cost of from $102.5 million to $123.1 million, and an annual flow of recurring costs of from $4.4 million to $13.5 million.

The *Study* concludes that these costs are likely to be passed on to consumers "over the long run", which is attributed to retailers' efforts to "recover" the expense of ATC equipment. We believe the *Study* is correct that the costs of ATC will ultimately be paid by consumers in the form of higher prices for fuel or other products sold by service stations. Despite this, we think that the *Study's* analysis of the forces that cause this to occur need to be more firmly grounded in economics. Further, the *Study's* allocation of the capital (initial) costs of ATC equipment—ranging from $102.5 million to $123.1 million—to fuel (or other) prices in the first year is economically incorrect.

For a retail station that would have the same number of operating dispensers with or without ATC, the costs of ATC are "fixed"—they are independent of the amount of fuel or other products the retailer sells. It is a fundamental principle of economics that an individual seller's pricing and output decisions do <u>not</u> depend on fixed costs, they depend on incremental, or "marginal", cost, which is the cost of producing and selling an additional unit. In deciding whether to sell another gallon of fuel or another car wash, a retailer should compare the incremental revenue that can be obtained from selling more to the incremental costs of providing the product. This decision is, by definition, unaffected by fixed costs such as the costs of ATC. In this sense, the *Study's* discussion of retailer efforts to "recover" increased expenses is incorrect.[14] For example, the *Study's* conclusion that retail stations with convenience stores or car washes have greater flexibility in recovering fixed costs because they will attempt to recover costs by increasing the prices of non-fuel items is misleading. If a retailer had a profitable opportunity to raise the price of these items he would have already done so, regardless of the costs of ATC. A retailer would not forego the opportunity to obtain those profits prior to ATC, and the imposition of a fixed cost (ATC) does not make it profitable to raise the price of car washes, convenience store products or, for that matter, fuel.

But the prices of products sold by retail service stations will, indeed, increase as a result of ATC. Why? The reason is not that individual retailers seek to "recover" costs by raising prices. The force that would cause prices to rise is instead <u>market wide</u>, as higher fixed costs reduce the returns (profits) earned by service station owners. This will cause some (marginal) retailers to exit the industry, and some other stations to have fewer fuel dispensers than without ATC. It is this reduction in <u>market</u> supply of fuel and other products that will cause prices to rise, and harm consumers.

A secondary issue is *which prices will rise*? To an economist, this issue is secondary because consumers will almost certainly pay for a mandated increase in retailers' fixed costs; whether all

[14] *Study*, p72-73.

of it shows up in the price of fuel, or some of it is in the prices of car washes and other products, does not change the fact that consumers will pay. Competitive forces suggest that the main impact is likely to be on fuel prices, however. The reason is that there are many competitive suppliers of non-fuel products such as car washes and convenience store sundries, but only service stations sell fuel. The existence of these alternative sources of competitive supply, which are not directly affected by ATC, greatly constrains the market prices of non-fuel products, so that higher fixed costs of dispensing fuel will, almost surely, be reflected in higher prices of fuel.

Finally, *when* would the fixed costs of ATC, including the up-front capital costs of ATC equipment, be reflected in prices? The *Study's* estimates are misleading in assuming that capital expenditures are entirely reflected in prices in the year they are incurred. (See Tables 7 & 8, the columns labeled "Net Cost or Benefit CPG", which load the initial capital expense of ATC equipment into first year prices.) Rather, in a competitive market the prices of retail products must be high enough so that the present discounted value of revenues is greater than the present discounted value of costs, including the costs of equipment.

A more useful way of apportioning capital costs over time would recognize that capital costs are amortized over time. For example, let K be the initial capital cost of ATC equipment, and let k be the recurring annual cost. Assuming a constant rate of interest r for discounting future cash flows, the present discounted value of mandated ATC expenditures is

$$C = K + \frac{k}{r}.$$

The amortized value of this present value is the flow of annual costs that has C as its present discounted value. This is obtained by simply multiplying by the interest rate, r:

$$rC = rK + k$$

For example, let the initial industry cost of ATC be $K=$ \$102 million as in Table 7 of the *Study*, and let the recurring costs of ATC be $k=\$4.4$ million per year, also as in Table 7. If the rate of interest suitable for discounting risky investments is $r = .10$, then the amortized cost of ATC is .10X\$102 million + \$4.4 million = \$14.4 million per year. If all of these costs are passed through into the costs of fuel, as assumed in Table 7, then the entries in the last column of the Table (Net Cost or Benefit CPG) would be \$14.4 million per year for all years. This means that the net cost would be smaller in year 1, but correspondingly larger in all subsequent years. Assuming that all costs are passed through to consumers, fuel prices would rise in all years to reflect these higher costs.