2011-01-01

Municipal Water Consumption Patterns of Halifax Nova Scotia Canada

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MUNCIPCAL WATER CONSUMPTION PATTERNS
IN HALIFAX, NOVA SCOTIA
CANADA

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by

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THESIS

Presented to the Faculty of the Graduate School of

The University of Texas at El Paso

in Partial Fulfillment

of the Requirements

for the Degree of

MASTER OF SCIENCE

Department of Finance and Economics

THE UNIVERSITY OF TEXAS AT EL PASO

May 2011

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CHAPTER 1: INTRODUCTION

Municipal water systems are costly to develop, maintain, and manage. Planning efforts require at least some understanding of future customer levels and consumption volumes. Econometric analysis offers one tool that can be useful in this regard.

Halifax, Nova Scotia is located on the east coast of Canada in the Atlantic region, an area known for its cool climate and heavy precipitation. Halifax Regional Municipality supplies 400,000 people with clean, fresh, potable water, using 1300 km of piping. Although Halifax is fairly large and growing, econometric analysis of its municipal water consumption patterns has not previously been attempted.

The objective of this study is to analyze quarterly water consumption in Halifax. An analysis of water consumption patterns may provide insight regarding the future of this public service in this metropolitan economy. In-sample estimation diagnostics and out-of-sample model simulations will be employed to verify overall model reliability.

In subsequent sections, a review of prior studies related to water consumption follows. Data and methodology are described next. Empirical results are then summarized. Policy implications are also outlined and discussed. The final sections include suggestions for future research. A data appendix is included at the end of the study.

CHAPTER 2: LITERATURE REVIEW

Long-term forecasts are helpful for planning, designing, and building future extensions of water systems, while short-term forecasts are used in the operation and management of existing water systems Jain, Varrshney, and Joshi (2001). Development of monthly short-term models is usually feasible because they typically do not require extensive data sets Hansen and Narayanan (1981). Long-term model developments are often hindered by data requirements.

Because it can incorporate independent regressor variables as arguments, linear transfer function (LTF) analysis is a potentially useful methodology amongst the various autoregressive moving average (ARIMA) techniques that are periodically applied to public utility demand analysis Fullerton, Tinajero, and Mendoza Cota (2007). LTF equations have been successfully estimated for several different public utility services. Liu and Lin (1991) use LTF models to forecast monthly and quarterly residential consumption of natural gas. Similarly, Tserkezos (1993) deploys LTF equations to forecast monthly and quarterly residential electricity consumption.

More recently, Fullerton and Nava (2003) estimate an LTF ARIMA model to examine monthly water consumption dynamics in Chihuahua City, Mexico. Variables employed include per meter water consumption levels, rainfall, ambient temperature, average price, and an industrial production index as a business cycle indicator. In addition to parameter estimates exhibiting good statistical traits, the LTF demand model for Chihuahua City also generates out-of-sample forecasts that compare favorably to a random walk benchmark. Similar analyses have

also been completed for municipal water usage in the sister cities of El Paso, Texas and Ciudad Juarez, Mexico Fullerton and Elias (2004) and Fullerton, Tinajero, and Barraza de Anda (2006). Successful public utility forecasts, of course, require accurate out-of-sample simulations of both per capita usage levels and the total number of customers that form the market for the region in question Fullerton, Tinajero, and Barraza de Anda (2006)

Not all water consumption patterns studies have been done on arid climates. Hamlet and Lettenmaier (2000) use stream flow techniques to analyze the long range climate forecasting and its use for water management in the Pacific Northwest region of North America. Also Schleich and Hillenbrand (2009) study the water determinates of residential water demand in Germany using a double log model and two semi log models.

Numerous economic, social, and environmental factors affect the demand for residential fresh water and are expected to undergo substantial change in the near future. More specifically, water prices may rise in response to increased scarcity, maintenance, and reconstruction needs. Sewage prices may increase because of environmental investments to control harmful substances. Prices may change if cross-border and/or regional water markets are deregulated. Because water infrastructure systems are large technical systems with useful lives often lasting more then 50 years, the costs for adapting systems can be high when water demand does not evolve as predicted Schleich and Hillenbrand (2009).

The analysis proposed in this paper is similar to that for studies completed for other metropolitan economies. Results may differ, in part, because of weather. Halifax has a cool,

wet climate while other regions studied have tended to be warm and dry. Variables used in this study include the number of customers, water consumption levels in cubic meters, population, average price per cubic meter, environmental protection costs, wastewater cost, and ambient weather indicators. To examine both short-run and long-run water consumption patterns in Halifax, an error-correction modeling approach is utilized.

CHAPTER 3: DATA AND METHODOLOGY

A fairly good variety of data are available for the investigation of water consumption dynamics in Halifax. They include revenues, total municipal water consumed in cubic meters, wastewater costs, environmental protection costs, weather patterns, and total employment. Those data are available at a quarterly frequency from second quarter 1996 through first quarter 2009. Aggregate water consumption in cubic meters, wastewater costs, environmental protection costs and revenue data are reported by Halifax Water Commission. Weather indicators cooling degree days, heating degree days, rainfall and snow fall data for Halifax are recorded by Environment Canada. Employment rates and price index data are collected by Statistics Canada. For local business cycle measurement, the employment series provides the broadest gauge currently available for Halifax at a quarterly frequency.

Historical data for consumption and tariffs by rate class in Halifax are not presently available. Quarterly cubic meters consumed and the number of active accounts do allow a per customer consumption series to be calculated across all rate categories. Independent variables include average price, nonseasonally adjusted employment, number of customers, and weather series. The latter include average temperature, snow, and rainfall, total precipitation, cooling degree days, and heating degree days. To approximate a quarterly price series, total revenue is divided by total water and the price of wastewater and environmental protection per quarter is then added to the average price. Price has been deflated using monthly consumer price index. The same approach has been used in prior studies when detailed public utility tariff information is not available or difficult to obtain Shin (1985). While providing only an approximation of

relevant rates, this approach has been shown to yield econometric results in line with other measures Nieswiadomy and Molina (1991) and Dalhuisen, Florax, De Groot, and Nijkamp (2003).

During much of the year Halifax has a cool, wet climate, but it does experience warmer summer temperatures. Dating back to 1996, Halifax has observed average temperatures above 18.3 degrees Celsius during the months of May through September. Both heating and cooling degree days are calculated with a generally accepted base temperature and are reflective of the personal preferences of people who live or work in buildings Stathopoulou, Cartalis, and Chrysoulakis (2006). For the purpose of this study, temperatures below 18.3 degrees Celsius yield heating degree days while those above 18.3 degrees Celsius generate cooling degree days. Days with temperatures above 18.3 degrees Celsius are expected to observe greater water usage than days with temperatures below 18.3 degrees Celsius.

Population, as provided by The Halifax Greater Chambers of Commerce is recorded annually. The number of customers provided by Halifax Water Commission is also recorded annually. In order to obtain quarterly frequency estimates for both series, the annual change in each is divided by four. Those results are then added sequentially to each respective annual figure to generate quarterly estimates of population and customers.

The general model for residential water demand is as follows: C=f(E,P,R,S,CSM, CDD, HDD, Precip). C is the total amount of water consumed or sold, E is employment, P is the quarterly price per cubic meter, R is the total rainfall per quarter, S is the total snowfall per

quarter, CSM is the number of consumers, CDD represents cooling degree days, HDD represents heating degree days and Precip is the total precipitation. Long-run consumption per customer is specified in Equation 1:

$$C_t/CSM_t = \alpha_0 + \underset{(-)}{\alpha_1 LnP_t} + \underset{(-)}{\alpha_2 LnR_t} + \underset{(-)}{\alpha_3 LnS_t} + \underset{(+)}{\alpha_4 LnE_t} + \underset{(+)}{\alpha_5 LnCDD_t} + \underset{(-)}{\alpha_6 LnHDD_t} + \underset{(-)}{\alpha_7 LnPrecip_t} + u_t \tag{1}$$

where α_0 is the intercept, and u_t is the disturbance term.

Increases in the real price of water should cause reductions in the consumption of water. Improvements in the local economy, proxied by employment, should cause increases in the consumption of water Fullerton and Elias (2004). Cooling degree days may cause increases in water consumption as more water is needed to water lawns and more water is consumed for personal uses such as showering and hydration. Heating degree days will likely have a negative effect on the consumption of water for as temperatures cool there is less need for outdoor usage of water. Rainfall will likely have a negative effect on water consumption. As precipitation increases, the usage of water for recreational activities and for lawn watering will decrease. This is also the case during winter months when the ground is snow covered and typically frozen. Total precipitation should decrease the consumption of water for it is the sum of rainfall and snowfall.

Beyond the long-run relationships shown in Equation 1, it may be helpful to also examine short-run characteristics of Halifax water consumption:

$$d(C_t/CSM_t) = b_o + \underset{(-)}{b_1 dP_t} + \underset{(-)}{b_2 dR_t} + \underset{(-)}{b_3 dS_t} + \underset{(+)}{b_4 dE_t} + \underset{(+)}{b_5 dCDD_t} +$$

$$\underset{(-)}{b_6 dHDD_t} + \underset{(-)}{b_7 dPrecip} + \underset{(-)}{b_8 u_{t-1}} + v_t$$

(2)

In Equation 2,

dP_t is the difference price term
dR_t is the difference rainfall term
dS_t is the difference snowfall term
dE_t is the difference employment term
$dCDD_t$ is the difference cooling degree days term
$dHDD_t$ is the difference heating degree days term
dPrecip is the difference in precipitation term
u_{t-1} is the error correction term
v_t is a random disturbance term

An expression for the error-correction variable can be extracted from the long run equation at lag_{t-1}

$$u_{t-1} = C_{t-1}/CSM_{t-1} – \alpha_0 – \alpha_1 LnP_{t-1} – \alpha_2 LnR_{t-1} – \alpha_3 LnS_{t-1} – \alpha_4 LnE_{t-1} – \alpha_5 LnCDD_{t-1} – \alpha_6 LnHDD_{t-1} – \alpha_7 Precip_{t-1}$$

(5)

Equation 5 can be re-written more succinctly.

$$d(C_t/CSM_t) = c_0 + \underset{(-)}{c_1 dLnP_t} + \underset{(-)}{c_2 dLnR_t} + \underset{(-)}{c_3 dLnS_t} + \underset{(-)}{c_4 dLnC_t/CSM_t} + \underset{(+)}{c_5 dLnE_t}$$

$$+ \underset{(+)}{c_6 dLnCDD_t} + \underset{(-)}{c_7 dLnHDD_t} + \underset{(-)}{c_7 dLnPrecip} + \underset{(-)}{c_9 LnP_{t-1}} + \underset{(-)}{c_{10} LnR_{t-1}} + \underset{(-)}{c_{11} LnS_{t-1}} + \underset{(+)}{c_{12} LnE_{t-1}}$$

$$\underset{(+)}{c_{13} LnCDD_{t-1}} + \underset{(-)}{c_{14} LnHDD_{t-1}} + \underset{(-)}{c_{15} LnPrecip_{t-1}} + v_t \tag{6}$$

Modeling changes in the number of customers is an important step in planning for public utilities, as new meters and distribution pipes must be installed for new residences. Accordingly, an equation is also specified for the number of customers. Fullerton, Tinajero, and Mendoza Cota (2007) estimate residential water customers for Tijuana using monthly maquiladora employment and the industrial production index for Mexico. These data are used in place of population because monthly population data do not exist for Tijuana. For Halifax, the quarterly population series is available and is used along with employment to model the estimated quarterly number of customers.

$$CSM_t = \Theta_0 + \Theta_1 LnPop + \Theta_2 LnEmployment + v_t \tag{7}$$

Consumption is recorded as total cubic meters of water consumed per quarter. Water consumption in Halifax declined from 2002 through 2009 by an average of one percent per year. Several factors have contributed to this development. Consumers have been encouraged to adopt water efficient appliances, such as low flow shower heads, aerator faucets, low flow toilets, and

front loading washing machines. Dye tablets are used to identify pipe leaks. Public awareness campaigns have been utilized since the late 1990’s to encourage greater conservation. Finally, Halifax Water Commission also sends warnings to customers who are deemed to be higher than normal consumers, based on an undisclosed benchmark, to make high volume users aware of their consumption patterns.

Halifax Water Commission has a Large Customer Monitoring Program to assist with Demand Side Management. The intent is to add telemetry to the meters of larger water users and monitor their flows in real time and provide them access to this data. They can then detect leakage or excessive consumption within their systems. This program is in place at many sites and continues to grow. Halifax Water Commission also has an internationally recognized water loss control program. In 1999, Halifax became the first Canadian city to adopt the International Water Association's integrated approach to water loss control. Thanks to active leak control, faster repairs, maintenance programs, and some water pressure reductions, Halifax Water Commission has cut water loss in half since 1999. That means daily savings of about 35 million liters. Additional leakage recovery is likely to come from more innovation, and in particular Halifax Water Commission will be employing advanced pressure management techniques to make further inroads in leakage reduction.

CHAPTER 4: EMPIRICAL ANALYSIS

Presented below are the empirical results for the estimation of the equations developed in this study. Each variable in its respective table will be analyzed and an interpretation of these variables will be provided. Furthermore an out of sample simulation will be analyzed.

Empirical Analysis

In developing the error correction model numerous combinations of the variables collected for this study where utilized to determine the model that best fits the data. Results from those exercises are generally in line with what has been reported for other water utilities, but climate does not appear to influence municipal water consumption as much in Halifax as in other metropolitan economies. Given that, estimation results for the larger specifications appear in the appendix and the balance of the empirical results discussion centers around the specification that includes real price and employment as the regressors.

Table 4.1

Dependent Variable: LOG(CONSUMPTION/CUSTOMERS)
Method: Least Squares
Date: 12/29/10 Time: 07:14
Sample: 1996Q2 2009Q1
Included observations: 52

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.600566	3.549754	0.450895	0.6541
LOG(REAL_PRICE)	-0.348439	0.082689	-4.213845	0.0001
LOG(EMPLOYMENT)	0.282554	0.293045	0.964202	0.3397

R-squared	0.651122	Mean dependent var	4.973580
Adjusted R-squared	0.636882	S.D. dependent var	0.090163
S.E. of regression	0.054331	Akaike info criterion	-2.931467
Sum squared resid	0.144643	Schwarz criterion	-2.818895
Log likelihood	79.21814	Hannan-Quinn criter.	-2.888310
F-statistic	45.72512	Durbin-Watson stat	1.583023
Prob(F-statistic)	0.000000		

The long-run cointegrating equation results are shown in Table 4.2. This model summarizes the effects that real price and employment have on the dependent variable consumption per customer, per cubic meter in the long run. Although both independent variables are not significant at the 5-percent level, valuable information can be drawn from these results. The fact that this paper shows that prices are inelastic at -0.35 falling squarely within the range of values reported by Espey, Espey and Shaw (1997) makes intuitive sense. Customers are very much ingrained in their consumption patterns and will not alter their consumption levels without a reasonable change in price.

The estimated parameter for employment is positive, but falls outside the 5- percent significance threshold. As employment increases by one unit, the consumption of water per customer increases by 0.28 cubic meters per quarter, but not in a statistically reliable manner. Hussain, Thrikawala, and Barker (2002) report similar results in Sri Lanka, as employment increases consumption of water per residential customer increases. The elasticity for employment is fairly inelastic at 0.28 showing that customers will not change their consumption patterns significantly due to a percentage change in employment.

A unit root test was performed on the long run equation to determine the statistical reliability of the model. It proved the null hypothesis of having a unit root was rejected at a 5-percent confidence level showing that there was no presence of a unit root. This shows that the long run equation is statically reliable. What this means for Halifax water is that they can utilize the results from this equation knowing that it is statistically reliable and can apply these results in determining water consumption per customer patterns.

Table 4.2

Dependent Variable: D(LOG(CONSUMPTION/CUSTOMERS))
Method: Least Squares
Date: 12/29/10 Time: 07:16
Sample (adjusted): 1996Q3 2009Q1
Included observations: 51 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.003806	0.008331	-0.456821	0.6499
D(LOG(REAL_PRICE))	-0.375771	0.105636	-3.557237	0.0009
D(LOG(EMPLOYMENT))	1.055421	0.566383	1.863439	0.0687
RESID17(-1)	-0.699273	0.193995	-3.604589	0.0008

R-squared	0.451964	Mean dependent var	-0.005152
Adjusted R-squared	0.416983	S.D. dependent var	0.070058
S.E. of regression	0.053493	Akaike info criterion	-2.943341
Sum squared resid	0.134491	Schwarz criterion	-2.791826
Log likelihood	79.05520	Hannan-Quinn criter.	-2.885443
F-statistic	12.92028	Durbin-Watson stat	2.051184
Prob(F-statistic)	0.000003		

The short-run error correction estimation results are shown in Table 4.2. It shows the effects real price, employment, cooling degree days and rainfall have on the dependent variable consumption of water in the short-run. The price coefficient in Table 4.2 is significant at the 5-percent level and provided the correct sign. As real price increases by one dollar consumption per customer decreases by -0.38 cubic meters. The short-run price elasticity in Halifax is inelastic at -0.38 falling squarely within the falling squarely within the range of values reported by Espey, Espey and Shaw (1997).

The employment parameter is positive, as expected, but fails to satisfy the 5-percent criterion. Showing that as employment increases by one, consumption of water per customer increases by 1.06 cubic meters per quarter but in a insignificant manner. The short-run elasticity of water consumption per customer with respect to employment is almost unitary elastic at 1.06. A one-percent change in employment leads to a 1.05 percent change in water demand in this market.

The error correction term shows how water usage in Halifax adjusts to any consumption disequilibria from the prior period. Water consumption patterns tend to change slowly due to durable appliance stocks and persistent customer habits. The error correction parameter for the error correction term is significant at the 5-percent level and is negative, as hypothesized. The error correction term indicates how long it takes for the demand for water to return to equilibrium. To determine how long it takes for the demand for water to return to equilibrium is the inverse of the coefficient for the error correction term. In this case the inverse is -1.43. It will take approximately one and a half quarters for the demand for water to return to equilibrium.

Table 4.3

Dependent Variable: D(LOG(CONSUMPTION/CUSTOMERS))
Method: Least Squares
Date: 01/05/11 Time: 12:56
Sample (adjusted): 1996Q3 2009Q1
Included observations: 51 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.087661	4.652113	0.448755	0.6557
D(LOG(REAL_PRICE))	-0.224999	0.127144	-1.769635	0.0834
D(LOG(EMPLOYMENT))	2.125781	0.575817	3.691763	0.0006
LOG(REAL_PRICE(-1))	0.053318	0.107042	0.498104	0.6208
LOG(EMPLOYMENT(-1))	-0.173539	0.384032	-0.451886	0.6535

R-squared	0.304286	Mean dependent var	-0.005152
Adjusted R-squared	0.243789	S.D. dependent var	0.070058
S.E. of regression	0.060923	Akaike info criterion	-2.665527
Sum squared resid	0.170733	Schwarz criterion	-2.476133
Log likelihood	72.97095	Hannan-Quinn criter.	-2.593154
F-statistic	5.029783	Durbin-Watson stat	2.834404
Prob(F-statistic)	0.001901		

Table 4.3 shows the empirical analysis of the alternative method for estimating an error correction model. This model incorporates all the variables in differenced and lagged terms in one single equation. An analysis of each coefficient in Table 4.3 will be done and followed by a comparison between the two methods of estimating an error correction model.

The difference coefficient for real price in Table 4.3 provided the predicted sign but is statistically insignificant. A one dollar increase in real price will result in a 0.22 cubic meter

decrease in the consumption of water per customer per quarter just in an unreliable manner. When looking at the elasticity for Table 4.3 it proved to be inelastic and fell squarely within the range of values reported by Espey, Espey and Shaw (1997).

The differenced coefficient of employment in Table 4.3 proved to have the predicted sign and falls within the 5-percent significant level. A one person increase in employment results in a 2.13 increase of consumption per cubic meter per customer. The elasticity for employment is very elastic at 2.12 showing that consumers are willing to change the percentage of their consumption of water due to a percentage change in employment in the previous period.

The lagged coefficient for real price has the predicted sign but is not statistically significant. This result shows that a one dollar increase in the previous period will result in a 0.05 increase in the consumption of water per customer per quarter. The lagged real price coefficient has an elasticity that exceeds the range of values reported by Espey, Espey, and Shaw (1997) at 0.05.

The lagged coefficient of employment has the does not have the predicted sign and is statistically insignificant. A one unit change in employment in the previous period will result in a 0.174 decrease in the consumption of water per customer per quarter. The elasticity for lagged employment in Table 4.3 is in elastic at 0.174 showing that Halifax consumers will not alter their consumption patterns by a high percentage due to a change in the percentage of employment in the previous period.

To compare the differenced terms in Tables 4.2 and 4.3 a t-test must first be preformed to determine if the two equations are statistically different from each other. T-tests assess whether the means of two groups are statistically different from each other. If the means of two equations are statistically different from one another it can be determined that the two equations are statistically different then one another. By proving that the two equations are statistically different from one another it allows a comparison between the variables in the two equations. Through calculations shown in the appendix it has been determined that equation 4.3 and 4.2 are statistically different from one another allowing them to be compared.

The variable differenced real price in Table 4.3 has the correct sign but is insignificant whereas real price in Table 4.2 price has the correct sign and is significant. Real price in Table 4.3 creates a smaller decrease in consumption and is more inelastic then the coefficient for real price in Table 4.2. The differenced variable employment in Table 4.3 is significant and has the predicted sign whereas the coefficient for employment in Table 4.2 which has the predicted sign but is insignificant. The coefficient for employment in Table 4.3 is much more elastic then the coefficient in Table 4.2.

Table 4.4

Dependent Variable: LOG(CUSTOMERS)
Method: Least Squares
Date: 01/06/11   Time: 15:51
Sample: 1996Q2 2009Q1
Included observations: 52
Convergence achieved after 16 iterations
MA Backcast: 1996Q1

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-5.626068	0.884228	-6.362691	0.0000
LOG(POPULATION)	1.169585	0.112589	10.38811	0.0000
LOG(EMPLOYMENT)	0.148841	0.050596	2.941777	0.0050
MA(1)	0.812438	0.081444	9.975471	0.0000

R-squared	0.991491	Mean dependent var	11.19410
Adjusted R-squared	0.990959	S.D. dependent var	0.050950
S.E. of regression	0.004845	Akaike info criterion	-7.748080
Sum squared resid	0.001127	Schwarz criterion	-7.597984
Log likelihood	205.4501	Hannan-Quinn criter.	-7.690537
F-statistic	1864.253	Durbin-Watson stat	1.766018
Prob(F-statistic)	0.000000		

Inverted MA Roots	-.81

Table 4.4 measures the effects population and employment have upon the number of customers. The population coefficient satisfied the 5-percent significance criterion. As population increases by one thousand people the number of customers increases by 1,169. The coefficient employment satisfies the 5-percent significance criterion. It indicates that as employment increases by one thousand, the number of customers will increase by 148. To

correct for autocorrelation various other specifications were attempted and it was determined that a moving average of one was needed to correct for autocorrelation.

A unit root test was performed on the customers dependent upon employment and population to determine the statistical reliability of the model. It proved the null hypothesis of having a unit root was rejected at a 5-percent confidence level showing that there was no presence of a unit root. This shows that the customers equation is statically reliable. What this means for Halifax water is that they can utilize the results from this equation knowing that it is statistically reliable and can apply these results in determining the number of customers based on the dependent variables population and employment.

CHAPTER 5: POLICIES AND IMPLEMENTATION

Halifax Municipality has put into place a rebate program for energy for residential users who purchase energy for their homes. A similar program could be put into place by the Halifax Water Commission to provide incentives for its customers to make their homes more water efficient. Most of the homes in Halifax are old with aged pipe structures and inefficient appliances, such as dishwashers, toilets, and hot water heaters. This rebate program would reduce the costs of switching to water saving appliances and upgrading the pipe structures. As the Halifax Municipality continues to grow and moves into higher growth rate scenarios, the real price of water will potentially increase as shown in the analysis of the 52 observations. For example a 10 cent increase in real price per cubic meter provides an incentive for Haligonians to conserve more water and also generates an approximate increase of 66,706 dollars of revenue to support capital upgrades and maintenance by the utility.

The Halifax Water Commission uses a pay as you use meter system that shows consumers exactly how much water they are using and how much it is costing them. This policy will help consumers budget their water usage when considering all bills. As prices potentially rise, consumers will see these increases directly on their bill and these increases in price may encourage consumers to adapt their consumption patterns. As shown in this study, in Tables 4.1 and 4.2 an increase in real price will lead to a decrease in consumption. Because consumption is price inelastic at -0.35 and -0.37 respectively public awareness campaigns will also be needed to be maintained in future years.

As shown in the research for this study, Halifax's population has been growing continuously from 1996 through 2009. It stands to reason that the population of Halifax will continue grow and the effects of this growth will result in an increase in customers. This increase in the number of customers will require the Halifax Water Commission to supply water to these new customers thereby increasing the number of cubic meters of water consumed. The Halifax Water Commission will be forced to disperse more water out of its reservoirs to cover the needs of these new customers. This increase in consumption is unavoidable for the utility. Higher pricing will likely be required to generate sufficient revenues to cover the future expansion and capital layout.

On average, residential customers consume 55 cubic meters per quarter. If the real price of water increases by 10 cents over the highest real price in the original data set, 1.67, there will be a 5.5 dollar increase in revenue per quarter per customer. This example uses only the average residential consumption patterns for the new customers because the averages for the amount of water consumed per quarter of other customers such as industrial or commercial users are not available. If some of these new customers are commercial or industrial users then the revenue per new customer generated would be much higher.

CHAPTER 6: CONCLUSION

In this study, an error correction model is estimated to study the Municipal water consumption patterns in Halifax Nova Scotia Canada. The data used are quarterly time series of per meter water consumption, cooling degree days, rainfall in centimeters, snow in millimeters, precipitation in millimeters, real price, and employment (in lieu of personal income). To date, a few econometric studies regarding municipal water consumption patterns have been completed for Halifax or other regions with similar climates which are water abundant using an error correction model. Quarterly water consumption reacts fairly quickly to changes in both economic and climatic variables. Not all estimated coefficients are statistically significant but, useful information is provided by this study.

It has been shown in this study that an increase in price will create a reduction in the cubic meters of water consumed per customer in a significant way. However it also shows that consumers are very price inelastic when it comes to the consumption of water and it will take a large change in price for consumers to alter their consumption patterns. Halifax water can use this information if there becomes a situation where water supplies start to become scarce due to increases in water usage or an increase in customers. Halifax water will know that they have to increase prices by a large amount in order for Haligonians to change their consumption patterns.

It has also been shown in this study that as employment increases water consumption increases albeit in an insignificant manner. Halifax water can use forecasts as to the labour

market and pay close attention to employment rates to prepare themselves for increases in the demand for water as employment increases.

Because it has been applied to relatively few regional markets, it would be useful to replicate this effort for other metropolitan economies to develop a better understanding of municipal water consumption patterns. Quarterly rate and income data are generally difficult to obtain such as the case for this study. Empirical analysis of different rate categories such as singlefamily, multifamily, commercial, and industrial customers may also yield useful insights to water consumption patterns for Halifax. Capital costs and supply constraints make it likely that utility managers will require accurate demand and revenue forecasts to support future capital investment and operations planning efforts.

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APPENDIX

Appendix A

Data Collected for Study

Quarter	Total Water Sold (m^3)	Revenue	Price all Water	Environmental
Apr - Jun 1996	10,050,520	$ 4,221,218	$ 0.42	$ 0.20
Jul - Sept 1996	11,063,747	$ 4,646,773	$ 0.42	$ 0.20
Oct - Dec 1996	10,186,388	$ 4,272,537	$ 0.42	$ 0.20
Jan - Mar 1997	10,411,500	$ 5,362,730	$ 0.52	$ 0.20
Apr - Jun 1997	9,603,258	$ 4,551,320	$ 0.47	$ 0.20
Jul - Sept 1997	11,410,264	$ 4,807,921	$ 0.42	$ 0.20
Oct - Dec 1997	10,439,495	$ 4,905,817	$ 0.47	$ 0.20
Jan - Mar 1998	10,691,181	$ 4,453,590	$ 0.42	$ 0.20
Apr - Jun 1998	10,051,820	$ 4,692,694	$ 0.47	$ 0.20
Jul - Sept 1998	10,863,346	$ 5,143,106	$ 0.47	$ 0.20
Oct - Dec 1998	11,470,781	$ 5,023,962	$ 0.44	$ 0.20
Jan - Mar 1999	11,258,751	$ 4,884,822	$ 0.43	$ 0.20
Apr - Jun 1999	10,326,594	$ 4,811,921	$ 0.47	$ 0.20
Jul - Sept 1999	11,174,058	$ 5,468,929	$ 0.49	$ 0.20
Oct - Dec1999	11,637,513	$ 5,413,575	$ 0.47	$ 0.20
Jan - Mar 2000	10,585,670	$ 4,229,647	$ 0.40	$ 0.20
Apr - Jun 2000	10,326,594	$ 4,927,375	$ 0.48	$ 0.37
Jul - Sept 2000	11,174,058	$ 5,293,712	$ 0.47	$ 0.37
Oct - Dec 2000	11,637,513	$ 5,172,723	$ 0.44	$ 0.37
Jan - Mar 2001	10,585,670	$ 4,767,950	$ 0.45	$ 0.37
Apr - Jun 2001	9,836,780	$ 4,867,989	$ 0.49	$ 0.46
Jul - Sept 2001	11,577,297	$ 5,357,939	$ 0.46	$ 0.46
Oct - Dec 2001	11,239,016	$ 5,295,653	$ 0.47	$ 0.46
Jan - Mar 2002	10,541,118	$ 5,389,821	$ 0.51	$ 0.46
Apr - Jun 2002	9,976,791	$ 5,331,169	$ 0.53	$ 0.55
Jul - Sept 2002	11,180,402	$ 6,014,048	$ 0.54	$ 0.55
Oct - Dec 2002	11,661,285	$ 5,819,244	$ 0.50	$ 0.55
Jan - Mar 2003	10,505,215	$ 5,804,519	$ 0.55	$ 0.55
Apr - Jun 2003	10,354,307	$ 5,862,023	$ 0.57	$ 0.55
Jul - Sept 2003	10,934,317	$ 6,476,149	$ 0.59	$ 0.55
Oct - Dec 2003	11,011,717	$ 6,365,344	$ 0.58	$ 0.55
Jan - Mar 2004	10,418,621	$ 5,826,094	$ 0.56	$ 0.55
Apr - Jun 2004	10,131,232	$ 6,174,606	$ 0.61	$ 0.60
Jul - Sept 2004	10,869,083	$ 6,808,549	$ 0.63	$ 0.60
Oct - Dec 2004	10,707,947	$ 6,736,642	$ 0.63	$ 0.60
Jan - Mar 2005	10,305,265	6,266,225 $	$ 0.61	$ 0.60
Apr - Jun 2005	10,252,540	$ 6,223,343	$ 0.61	$ 0.65
Jul - Sept 2005	10,597,987	$ 6,997,354	$ 0.66	$ 0.65

Oct - Dec 2005	10,692,265	$ 6,831,766	$ 0.64	$ 0.70
Jan - Mar 2006	9,677,254	$ 6,408,445	$ 0.66	$ 0.70
Apr - Jun 2006	9,531,337	$ 7,116,810	$ 0.75	$ 0.70
Jul - Sept 2006	10,489,451	$ 7,325,870	$ 0.70	$ 0.70
Oct - Dec 2006	10,341,137	$ 7,287,321	$ 0.70	$ 0.70
Jan - Mar 2007	10,081,446	$ 6,921,257	$ 0.69	$ 0.70
Apr - Jun 2007	10,093,172	$ 7,065,220	$0.70	$ 0.70
Jul - Sept 2007	10,058,550	$ 7,040,985	$ 0.70	$ 0.70
Oct - Dec 2007	10,231,857	$ 7,162,299	$ 0.70	$ 0.84
Jan - Mar 2008	10,030,476	$ 7,021,333	$ 0.70	$ 0.84
Apr - Jun 2008	9,363,413	$ 6,741,657	$ 0.72	$ 0.84
Jul - Sept 2008	10,522,250	$ 7,576,020	$ 0.72	$ 0.84
Oct - Dec 2008	9,846,081	$ 7,089,178	$ 0.72	$ 0.84
Jan - Mar 2009	9,301,224	$ 6,882,905	$ 0.74	$ 0.84

Notes:
Total water sold is measured in cubic meters.
Revenue, average price of water, and environmental protection charges are recorded in dollars per cubic meter.

Quarter	Wastewater	Total Price	CPI/100	Real Price
Apr - Jun 1996	$ 0.11	$ 0.73	0.87	0.84
Jul - Sept 1996	$ 0.11	$ 0.73	0.88	0.83
Oct - Dec 1996	$ 0.11	$ 0.73	0.88	0.83
Jan - Mar 1997	$ 0.11	$ 0.83	0.89	0.93
Apr - Jun 1997	$ 0.11	$ 0.79	0.90	0.88
Jul - Sept 1997	$ 0.11	$ 0.74	0.90	0.82
Oct - Dec 1997	$ 0.11	$ 0.78	0.90	0.87
Jan - Mar 1998	$ 0.11	$ 0.73	0.90	0.81
Apr - Jun 1998	$ 0.11	$ 0.78	0.91	0.86
Jul - Sept 1998	$ 0.11	$ 0.79	0.91	0.87
Oct - Dec 1998	$ 0.11	$ 0.75	0.91	0.83
Jan - Mar 1999	$ 0.11	$ 0.75	0.91	0.82
Apr - Jun 1999	$ 0.11	$ 0.78	0.91	0.86
Jul - Sept 1999	$ 0.11	$ 0.80	0.92	0.87
Oct - Dec1999	$ 0.11	$ 0.78	0.93	0.84
Jan - Mar 2000	$ 0.11	$ 0.71	0.93	0.76
Apr - Jun 2000	$ 0.21	$ 1.06	0.94	1.13
Jul - Sept 2000	$ 0.21	$ 1.06	0.95	1.12
Oct - Dec 2000	$ 0.21	$ 1.03	0.95	1.08
Jan - Mar 2001	$ 0.21	$ 1.03	0.96	1.07
Apr - Jun 2001	$ 0.22	$ 1.18	0.96	1.22
Jul - Sept 2001	$ 0.22	$ 1.15	0.97	1.18

Oct - Dec 2001	$ 0.22	$ 1.15	0.97	1.18
Jan - Mar 2002	$ 0.22	$ 1.19	0.97	1.23
Apr - Jun 2002	$ 0.23	$ 1.32	0.97	1.35
Jul - Sept 2002	$ 0.23	$ 1.32	1.00	1.32
Oct - Dec 2002	$ 0.23	$ 1.28	1.01	1.27
Jan - Mar 2003	$ 0.23	$ 1.34	1.17	1.14
Apr - Jun 2003	$ 0.23	$ 1.35	1.03	1.31
Jul - Sept 2003	$ 0.23	$ 1.38	1.03	1.33
Oct - Dec 2003	$ 0.23	$ 1.36	1.03	1.32
Jan - Mar 2004	$ 0.23	$ 1.34	1.03	1.30
Apr - Jun 2004	$ 0.33	$ 1.54	1.04	1.49
Jul - Sept 2004	$ 0.33	$ 1.56	1.05	1.48
Oct - Dec 2004	$ 0.33	$ 1.56	1.06	1.48
Jan - Mar 2005	$ 0.33	$ 1.54	1.06	1.45
Apr - Jun 2005	$ 0.33	$ 1.59	1.06	1.50
Jul - Sept 2005	$ 0.33	$ 1.64	1.07	1.53
Oct - Dec 2005	$ 0.33	$ 1.67	1.08	1.54
Jan - Mar 2006	$ 0.33	$ 1.69	1.09	1.56
Apr - Jun 2006	$ 0.33	$ 1.78	1.09	1.64
Jul - Sept 2006	$ 0.33	$ 1.73	1.10	1.57
Oct - Dec 2006	$ 0.33	$ 1.73	1.10	1.57
Jan - Mar 2007	$ 0.33	$ 1.72	1.11	1.55
Apr - Jun 2007	$ 0.33	$ 1.73	1.11	1.56
Jul - Sept 2007	$ 0.33	$ 1.73	1.12	1.54
Oct - Dec 2007	$ 0.33	$ 1.87	1.12	1.66
Jan - Mar 2008	$ 0.33	$ 1.87	1.13	1.66
Apr - Jun 2008	$ 0.33	$ 1.89	1.13	1.67
Jul - Sept 2008	$ 0.33	$ 1.89	1.16	1.63
Oct - Dec 2008	$ 0.33	$ 1.89	1.17	1.62
Jan - Mar 2009	$ 0.33	$ 1.91	1.14	1.67

Notes:
Wastewater and total price are measured in dollars per cubic meter.
CPI/100 is the consumer price index divided by 100.
Real price is calculated as total price divided by CPI/100.

Quarter	**Employment**	**Population**	**Customers**
Apr - Jun 1996	164,400	355,529	65,960
Jul - Sept 1996	169,667	353,490	66,755
Oct - Dec 1996	169,833	355,769	67,108
Jan - Mar 1997	167,533	355,529	67,162
Apr - Jun 1997	166,267	356,476	67,463

Jul - Sept 1997	170,467	357,424	67,763
Oct - Dec 1997	171,900	356,476	68,064
Jan - Mar 1998	173,333	359,084	68,195
Apr - Jun 1998	174,200	359,973	68,453
Jul - Sept 1998	178,133	360,862	68,712
Oct - Dec 1998	177,700	361,750	68,970
Jan - Mar 1999	177,100	362,947	69,177
Apr - Jun 1999	179,367	363,913	69,384
Jul - Sept 1999	182,200	364,879	69,591
Oct - Dec1999	182,300	365,844	69,798
Jan - Mar 2000	183,567	365,951	70,513
Apr - Jun 2000	186,067	366,702	70,886
Jul - Sept 2000	192,533	367,453	71,258
Oct - Dec 2000	189,367	368,204	71,266
Jan - Mar 2001	185,333	369,233	71,297
Apr - Jun 2001	187,900	370,054	71,493
Jul - Sept 2001	190,900	370,874	71,689
Oct - Dec 2001	192,133	371,695	71,885
Jan - Mar 2002	188,300	374,332	72,111
Apr - Jun 2002	188,767	375,607	72,315
Jul - Sept 2002	194,900	376,882	72,518
Oct - Dec 2002	191,267	377,435	72,722
Jan - Mar 2003	188,333	377,932	73,237
Apr - Jun 2003	193,000	378,832	73,519
Jul - Sept 2003	199,033	379,732	73,800
Oct - Dec 2003	197,800	380,632	74,082
Jan - Mar 2004	195,767	380,547	74,339
Apr - Jun 2004	200,533	380,769	74,615
Jul - Sept 2004	207,000	381,565	74,890
Oct - Dec 2004	204,433	381,758	75,166
Jan - Mar 2005	200,733	381,878	75,443
Apr - Jun 2005	202,733	382,211	75,719
Jul - Sept 2005	205,500	382,544	75,995
Oct - Dec 2005	201,800	382,876	76,271
Jan - Mar 2006	198,433	384,786	76,559
Apr - Jun 2006	203,867	385,513	76,838
Jul - Sept 2006	208,100	386,240	77,117
Oct - Dec 2006	206,233	386,967	77,396
Jan - Mar 2007	204,900	388,284	76,590
Apr - Jun 2007	206,233	389,159	76,598
Jul - Sept 2007	210,267	390,033	76,606

Oct - Dec 2007	211,367	390,908	76,613
Jan - Mar 2008	206,667	392,812	77,602
Apr - Jun 2008	207,000	393,944	77,855
Jul - Sept 2008	209,700	395,076	78,108
Oct - Dec 2008	212,867	396,208	78,361
Jan - Mar 2009	213,900	398,049	79,384

Notes:
Employment is the number of people who work in Halifax.
Population is recorded as the number of people who reside in Halifax.
Customers is the number of accounts at Halifax Water Authority.

Quarter	**Total Rain mm**	**Total Snow cm**	**Precipitation mm**	**HDD**	**CDD**
Apr - Jun 1996	286.7	32.7	319.4		
Jul - Sept 1996	509.9	0	509.9	810.6	7.0
Oct - Dec 1996	308.3	19.7	328	155.7	66.5
Jan - Mar 1997	248.7	139.5	388.2	1310.8	0.0
Apr - Jun 1997	271.1	42.3	313.4	2080.5	0.0
Jul - Sept 1997	148.9	0	148.9	880.7	8.6
Oct - Dec 1997	198.8	110.9	309.7	141.3	99.3
Jan - Mar 1998	369.7	88.8	458.5	1463.5	0.0
Apr - Jun 1998	286.3	14.1	300.4	1766.5	0.0
Jul - Sept 1998	273	0	273	670.4	4.9
Oct - Dec 1998	345.6	15.2	360.8	132.8	110.9
Jan - Mar 1999	453.9	68.6	522.5	1357.1	0.0
Apr - Jun 1999	129.5	34.7	164.2	1756.4	0.0
Jul - Sept 1999	267.3	0	267.3	622.1	34.3
Oct - Dec1999	345.9	48.1	394	65.2	181.4
Jan - Mar 2000	282	133.8	415.8	1279.6	0.0
Apr - Jun 2000	261.9	0.8	262.7	1854.1	0.0
Jul - Sept 2000	268.3	0	268.3	748.9	24.5
Oct - Dec 2000	420	60.3	480.3	152.2	67.1
Jan - Mar 2001	282	133.8	415.8	1315.8	0.0
Apr - Jun 2001	261.9	0.8	262.7	2028.7	0.0
Jul - Sept 2001	268.3	0	268.3	723.9	31.3
Oct - Dec 2001	420	60.3	480.3	121.7	127.7
Jan - Mar 2002	265.9	177.1	443	1203.5	0.8

Apr - Jun 2002	296.9	15	311.9	2187.0	0.0
Jul - Sept 2002	218.2	0	218.2	809.6	3.7
Oct - Dec 2002	388.1	85.8	473.9	139.7	117.4
Jan - Mar 2003	278.3	150.3	428.6	1420.5	2.1
Apr - Jun 2003	285.8	0.9	286.7	2135.9	0.0
Jul - Sept 2003	248.2	0	248.2	811.1	17.0
Oct - Dec 2003	395.3	70.6	465.9	73.3	142.8
Jan - Mar 2004	65.1	138	203.1	1224.7	0.8
Apr - Jun 2004	257.2	9.7	266.9	2174.1	0.0
Jul - Sept 2004	279	0	279	805.2	4.3
Oct - Dec 2004	426	74.3	500.3	159.6	105.8
Jan - Mar 2005	187.1	155.5	342.6	1329.8	0.0
Apr - Jun 2005	464.2	5.2	469.4	2053.7	0.0
Jul - Sept 2005	176.4	0	176.4	783.6	19.7
Oct - Dec 2005	526.3	56.2	582.5	97.7	122.1
Jan - Mar 2006	147.5	90.3	237.8	1231.7	5.0
Apr - Jun 2006	460.8	3.1	463.9	1808.6	0.0
Jul - Sept 2006	231.1	0	231.1	633.2	0.0
Oct - Dec 2006	394.1	34	428.1	142.6	92.2
Jan - Mar 2007	168.8	77.7	246.5	1201.8	0.0
Apr - Jun 2007	286.9	38.4	325.3	2027.6	0.0
Jul - Sept 2007	428	0	428	822.6	5.7
Oct - Dec 2007	274.1	96.3	370.4	146.4	112.6
Jan - Mar 2008	357.1	173	530.1	1406.1	0.0
Apr - Jun 2008	117.7	0.7	118.4	1952.1	0.0
Jul - Sept 2008	496.9	0	496.9	1116.6	6.2
Oct - Dec 2008	355.6	97.4	453	136.4	108.4
Jan - Mar 2009	352	165	517	1311.2	0.0

Notes:
Rain is measured in millimeters.
Snow is measured in centimeters.
Precipitation is measured in millimeters.
CDD cooling degree days is calculated as the difference between the mean temperature and 18.3 degrees Celsius on warm days (AVG – 18.3).
HDD heating degree days is calculated as the difference between 18.3 degrees Celsius and the mean temperature on cool days (18.3 - AVG).

Consumption/Customer
152.37

165.74
151.79
155.02
142.35
168.38
153.38
156.77
146.84
158.10
166.32
162.75
148.83
160.57
166.73
150.12
145.68
156.81
163.30
148.47
137.59
161.49
156.35
146.18
137.96
154.17
160.36
143.44
140.84
148.16
148.64
140.15
135.78
145.13
142.46
136.60
135.40
139.46
140.19
126.40
124.04
136.02
133.61
131.63
131.77
131.30
133.55

129.26
120.27
134.71
125.65
117.17

Notes:
Consumption per customer is measured in cubic meters.

APPENDIX B

Alternative Specifications Estimated

Dependent Variable: CONSUMPTION/CUSTOMERS

Method: Least Squares
Sample: 1996Q2 2009Q1
Included observations: 52

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	140.5983	28.93991	4.858284	0.0000
REAL_PRICE	-48.93522	9.388450	-5.212279	0.0000
EMPLOYMENT	0.000327	0.000207	1.579591	0.1209
HDD	-0.003949	0.001458	-2.708126	0.0094
PERCIPITATION	0.018607	0.009012	2.064646	0.0445

R-squared	0.752102	Mean dependent var	145.1167
Adjusted R-squared	0.731005	S.D. dependent var	12.95783
S.E. of regression	6.720549	Akaike info criterion	6.739428
Sum squared resid	2122.792	Schwarz criterion	6.927048
Log likelihood	-170.2251	Hannan-Quinn criter.	6.811357
F-statistic	35.64857	Durbin-Watson stat	1.846629
Prob(F-statistic)	0.000000		

Dependent Variable: D(CONSUMPTION/CUSTOMERS)

Method: Least Squares
Sample (adjusted): 1996Q3 2009Q1
Included observations: 51 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.041272	1.035902	-0.039842	0.9684
D(REAL_PRICE)	-52.79728	12.38746	-4.262154	0.0001
D(EMPLOYMENT)	0.000462	0.000425	1.086534	0.2830
D(HDD)	-0.001624	0.001326	-1.224581	0.2271
D(PERCIPITATION)	0.022315	0.005171	4.315601	0.0001
RESID01(-1)	-1.073552	0.175254	-6.125686	0.0000

R-squared	0.659335	Mean dependent var	-0.690303
Adjusted R-squared	0.621483	S.D. dependent var	10.37331
S.E. of regression	6.382046	Akaike info criterion	6.654985
Sum squared resid	1832.873	Schwarz criterion	6.882259
Log likelihood	-163.7021	Hannan-Quinn criter.	6.741833

F-statistic	17.41891	Durbin-Watson stat	1.627677
Prob(F-statistic)	0.000000		

Dependent Variable: LOG(CONSUMPTION/CUSTOMERS)

Method: Least Squares
Sample: 1996Q2 2009Q1
Included observations: 52

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.283054	3.374879	0.380178	0.7055
LOG(REAL_PRICE)	-0.353561	0.078704	-4.492308	0.0000
LOG(EMPLOYMENT)	0.289298	0.279053	1.036711	0.3052
LOG(CDD)	0.003258	0.001260	2.585799	0.0129
LOG(PERCIPITATION)	0.042018	0.022252	1.888316	0.0652

R-squared	0.699073	Mean dependent var	4.973580
Adjusted R-squared	0.673462	S.D. dependent var	0.090163
S.E. of regression	0.051522	Akaike info criterion	-3.002398
Sum squared resid	0.124763	Schwarz criterion	-2.814779
Log likelihood	83.06236	Hannan-Quinn criter.	-2.930469
F-statistic	27.29602	Durbin-Watson stat	1.651778
Prob(F-statistic)	0.000000		

Dependent Variable: D(LOG(CONSUMPTION/CUSTOMERS))

Method: Least Squares
Sample (adjusted): 1996Q3 2009Q1
Included observations: 51 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.002893	0.007580	-0.381630	0.7045
D(LOG(REAL_PRICE))	-0.336288	0.096693	-3.477910	0.0011
D(LOG(EMPLOYMENT))	0.806342	0.548086	1.471197	0.1482
D(LOG(CDD))	0.000858	0.000939	0.913056	0.3661
D(LOG(PERCIPITATION))	0.044710	0.012447	3.592161	0.0008
RESID03(-1)	-0.874307	0.182470	-4.791509	0.0000

R-squared	0.582878	Mean dependent var	-0.005152
Adjusted R-squared	0.536531	S.D. dependent var	0.070058
S.E. of regression	0.047694	Akaike info criterion	-3.137871
Sum squared resid	0.102364	Schwarz criterion	-2.910598
Log likelihood	86.01572	Hannan-Quinn criter.	-3.051023

F-statistic	12.57642	Durbin-Watson stat	1.753692
Prob(F-statistic)	0.000000		

Dependent Variable: LOG(CONSUMPTION/CUSTOMERS)

Method: Least Squares
Sample: 1996Q2 2009Q1
Included observations: 52

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	3.841604	3.569910	1.076107	0.2875
LOG(REAL_PRICE)	-0.297581	0.082500	-3.607022	0.0008
LOG(EMPLOYMENT)	0.087056	0.293266	0.296852	0.7679
LOG(CDD)	0.000353	0.001994	0.177126	0.8602
LOG(HDD)	-0.021561	0.011655	-1.849983	0.0707
LOG(PERCIPITATION)	0.046414	0.021829	2.126224	0.0389

R-squared	0.719912	Mean dependent var	4.973580
Adjusted R-squared	0.689467	S.D. dependent var	0.090163
S.E. of regression	0.050244	Akaike info criterion	-3.035700
Sum squared resid	0.116123	Schwarz criterion	-2.810556
Log likelihood	84.92820	Hannan-Quinn criter.	-2.949385
F-statistic	23.64680	Durbin-Watson stat	1.478947
Prob(F-statistic)	0.000000		

Dependent Variable: D(LOG(CONSUMPTION/CUSTOMERS))

Method: Least Squares
Sample (adjusted): 1996Q3 2009Q1
Included observations: 51 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.002243	0.007526	-0.298038	0.7671
D(LOG(REAL_PRICE))	-0.258814	0.098448	-2.628945	0.0118
D(LOG(EMPLOYMENT))	0.401386	0.604946	0.663508	0.5105
D(LOG(CDD))	-0.001085	0.001265	-0.858039	0.3955
D(LOG(HDD))	-0.018061	0.007824	-2.308380	0.0257
D(LOG(PERCIPITATION))	0.046683	0.012455	3.748061	0.0005
RESID04(-1)	-0.783592	0.175216	-4.472135	0.0001

R-squared	0.599627	Mean dependent var	-0.005152
Adjusted R-squared	0.545031	S.D. dependent var	0.070058
S.E. of regression	0.047255	Akaike info criterion	-3.139638
Sum squared resid	0.098254	Schwarz criterion	-2.874485
Log likelihood	87.06076	Hannan-Quinn criter.	-3.038315

F-statistic	10.98292	Durbin-Watson stat	1.834226
Prob(F-statistic)	0.000000		

Dependent Variable: CONSUMPTION/CUSTOMERS

Method: Least Squares
Sample: 1996Q2 2009Q1
Included observations: 52

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	153.6470	28.97663	5.302443	0.0000
REAL_PRICE	-42.81338	9.681644	-4.422119	0.0001
EMPLOYMENT	0.000185	0.000215	0.860161	0.3942
CDD	0.062415	0.032697	1.908860	0.0625
HDD	-0.000737	0.002201	-0.335005	0.7391
PERCIPITATION	0.022376	0.008989	2.489362	0.0165

R-squared	0.770297	Mean dependent var	145.1167
Adjusted R-squared	0.745330	S.D. dependent var	12.95783
S.E. of regression	6.539152	Akaike info criterion	6.701659
Sum squared resid	1966.983	Schwarz criterion	6.926802
Log likelihood	-168.2431	Hannan-Quinn criter.	6.787974
F-statistic	30.85179	Durbin-Watson stat	1.837065
Prob(F-statistic)	0.000000		

Dependent Variable: D(CONSUMPTION/CUSTOMERS)

Method: Least Squares
Sample (adjusted): 1996Q3 2009Q1
Included observations: 51 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.242048	1.016024	-0.238231	0.8128
D(REAL_PRICE)	-42.40729	13.45035	-3.152877	0.0029
D(EMPLOYMENT)	0.000436	0.000415	1.051706	0.2987
D(CDD)	0.052377	0.018173	2.882081	0.0061
D(HDD)	0.001129	0.001624	0.695346	0.4905
D(PERCIPITATION)	0.025118	0.005217	4.814400	0.0000
RESID15(-1)	-1.025228	0.178136	-5.755308	0.0000

R-squared	0.681358	Mean dependent var	-0.690303
Adjusted R-squared	0.637907	S.D. dependent var	10.37331
S.E. of regression	6.242052	Akaike info criterion	6.627369
Sum squared resid	1714.382	Schwarz criterion	6.892521
Log likelihood	-161.9979	Hannan-Quinn criter.	6.728692

F-statistic	15.68101	Durbin-Watson stat	1.663842
Prob(F-statistic)	0.000000		

Dependent Variable: CONSUMPTION/CUSTOMERS

Method: Least Squares
Sample: 1996Q2 2009Q1
Included observations: 52

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	149.4392	29.04360	5.145341	0.0000
REAL_PRICE	-42.27705	9.644118	-4.383714	0.0001
EMPLOYMENT	0.000182	0.000214	0.852496	0.3985
CDD	0.085130	0.037586	2.264964	0.0284
HDD	0.003998	0.004493	0.889880	0.3783
RAIN	0.024983	0.009201	2.715155	0.0094
SNOW	-0.024128	0.039548	-0.610098	0.5449

R-squared	0.777503	Mean dependent var	145.1167
Adjusted R-squared	0.747836	S.D. dependent var	12.95783
S.E. of regression	6.506890	Akaike info criterion	6.708250
Sum squared resid	1905.283	Schwarz criterion	6.970917
Log likelihood	-167.4145	Hannan-Quinn criter.	6.808950
F-statistic	26.20828	Durbin-Watson stat	1.872628
Prob(F-statistic)	0.000000		

Dependent Variable: D(CONSUMPTION/CUSTOMERS)

Method: Least Squares
Sample (adjusted): 1996Q3 2009Q1
Included observations: 51 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.294361	1.005379	-0.292786	0.7711
D(REAL_PRICE)	-42.09067	13.31057	-3.162198	0.0029
D(EMPLOYMENT)	0.000460	0.000412	1.116088	0.2706
D(CDD)	0.071110	0.021717	3.274391	0.0021
D(HDD)	0.004987	0.003079	1.619753	0.1126
D(RAIN)	0.026991	0.005326	5.067578	0.0000
D(SNOW)	-0.011702	0.027103	-0.431766	0.6681
RESID06(-1)	-1.028094	0.177138	-5.803912	0.0000

R-squared	0.693043	Mean dependent var	-0.690303
Adjusted R-squared	0.643074	S.D. dependent var	10.37331
S.E. of regression	6.197358	Akaike info criterion	6.629223
Sum squared resid	1651.511	Schwarz criterion	6.932255
Log likelihood	-161.0452	Hannan-Quinn criter.	6.745020
F-statistic	13.86928	Durbin-Watson stat	1.664770
Prob(F-statistic)	0.000000		

Dependent Variable: LOG(CONSUMPTION/CUSTOMERS)

Method: Least Squares
Sample: 1996Q2 2009Q1
Included observations: 52

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	3.558459	3.616678	0.983903	0.3304
LOG(REAL_PRICE)	-0.302053	0.083611	-3.612586	0.0008
LOG(EMPLOYMENT)	0.103252	0.296230	0.348554	0.7290
LOG(CDD)	-0.000206	0.001998	-0.102880	0.9185
LOG(HDD)	0.002247	0.029046	0.077349	0.9387
LOG(RAIN)	0.036138	0.017716	2.039830	0.0473
LOG(SNOW)	-0.004731	0.005972	-0.792243	0.4324

R-squared	0.719929	Mean dependent var	4.973580
Adjusted R-squared	0.682586	S.D. dependent var	0.090163
S.E. of regression	0.050797	Akaike info criterion	-2.997300
Sum squared resid	0.116116	Schwarz criterion	-2.734633
Log likelihood	84.92981	Hannan-Quinn criter.	-2.896600
F-statistic	19.27894	Durbin-Watson stat	1.432932
Prob(F-statistic)	0.000000		

Dependent Variable: D(LOG(CONSUMPTION/CUSTOMERS))

Method: Least Squares
Sample (adjusted): 1996Q3 2009Q1
Included observations: 51 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.001493	0.007583	-0.196874	0.8449
D(LOG(REAL_PRICE))	-0.269903	0.099204	-2.720683	0.0094
D(LOG(EMPLOYMENT))	0.256907	0.615677	0.417276	0.6786
D(LOG(CDD))	-0.001837	0.001276	-1.439712	0.1572
D(LOG(HDD))	0.005145	0.019067	0.269854	0.7886
D(LOG(RAIN))	0.037529	0.010661	3.520335	0.0010
D(LOG(SNOW))	-0.005030	0.003893	-1.292317	0.2031
RESID07(-1)	-0.770167	0.172951	-4.453099	0.0001

R-squared	0.604639	Mean dependent var	-0.005152
Adjusted R-squared	0.540278	S.D. dependent var	0.070058
S.E. of regression	0.047501	Akaike info criterion	-3.113020
Sum squared resid	0.097024	Schwarz criterion	-2.809988
Log likelihood	87.38200	Hannan-Quinn criter.	-2.997222
F-statistic	9.394480	Durbin-Watson stat	1.826138

Prob(F-statistic)	0.000001

Dependent Variable: CONSUMPTION/CUSTOMERS

Method: Least Squares
Sample: 1996Q2 2009Q1
Included observations: 52

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	145.7162	30.57139	4.766423	0.0000
REAL_PRICE	-47.07550	10.00287	-4.706198	0.0000
EMPLOYMENT	0.000296	0.000222	1.336877	0.1877
CDD	0.042846	0.024915	1.719704	0.0921
SNOW	-0.008621	0.020658	-0.417305	0.6784

R-squared	0.740165	Mean dependent var	145.1167
Adjusted R-squared	0.718052	S.D. dependent var	12.95783
S.E. of regression	6.880454	Akaike info criterion	6.786458
Sum squared resid	2225.011	Schwarz criterion	6.974078
Log likelihood	-171.4479	Hannan-Quinn criter.	6.858387
F-statistic	33.47105	Durbin-Watson stat	1.907053
Prob(F-statistic)	0.000000		

Dependent Variable: D(CONSUMPTION/CUSTOMERS)

Method: Least Squares
Sample (adjusted): 1996Q3 2009Q1
Included observations: 51 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.163133	1.026415	0.158935	0.8744
D(REAL_PRICE)	-56.60553	13.36780	-4.234469	0.0001
D(EMPLOYMENT)	0.000320	0.000409	0.781680	0.4385
D(CDD)	0.018502	0.014328	1.291339	0.2032
D(SNOW)	0.009649	0.014701	0.656341	0.5149
RESID08(-1)	-1.178029	0.174834	-6.738002	0.0000

R-squared	0.661761	Mean dependent var	-0.690303
Adjusted R-squared	0.624179	S.D. dependent var	10.37331
S.E. of regression	6.359275	Akaike info criterion	6.647837
Sum squared resid	1819.817	Schwarz criterion	6.875110
Log likelihood	-163.5198	Hannan-Quinn criter.	6.734685
F-statistic	17.60844	Durbin-Watson stat	1.422766
Prob(F-statistic)	0.000000		

Dependent Variable: LOG(CONSUMPTION/CUSTOMERS)

Method: Least Squares
Sample: 1996Q2 2009Q1
Included observations: 52

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	3.076054	3.600844	0.854259	0.3973
LOG(REAL_PRICE)	-0.318126	0.083308	-3.818687	0.0004
LOG(EMPLOYMENT)	0.161072	0.297304	0.541775	0.5905
LOG(CDD)	-9.42E-05	0.001846	-0.050992	0.9595
LOG(SNOW)	-0.004041	0.002460	-1.642625	0.1071

R-squared	0.693820	Mean dependent var	4.973580
Adjusted R-squared	0.667762	S.D. dependent var	0.090163
S.E. of regression	0.051970	Akaike info criterion	-2.985093
Sum squared resid	0.126941	Schwarz criterion	-2.797474
Log likelihood	82.61242	Hannan-Quinn criter.	-2.913164
F-statistic	26.62613	Durbin-Watson stat	1.541852
Prob(F-statistic)	0.000000		

Dependent Variable: D(LOG(CONSUMPTION/CUSTOMERS))

Method: Least Squares
Sample (adjusted): 1996Q3 2009Q1
Included observations: 51 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.001640	0.007728	-0.212193	0.8329
D(LOG(REAL_PRICE))	-0.309569	0.101943	-3.036675	0.0040
D(LOG(EMPLOYMENT))	0.432735	0.607654	0.712140	0.4801
D(LOG(CDD))	-0.001460	0.001207	-1.210163	0.2325
D(LOG(SNOW))	-0.002731	0.001572	-1.736956	0.0892
RESID09(-1)	-0.866804	0.176940	-4.898869	0.0000

R-squared	0.567511	Mean dependent var	-0.005152
Adjusted R-squared	0.519457	S.D. dependent var	0.070058
S.E. of regression	0.048565	Akaike info criterion	-3.101694
Sum squared resid	0.106135	Schwarz criterion	-2.874421
Log likelihood	85.09320	Hannan-Quinn criter.	-3.014846
F-statistic	11.80980	Durbin-Watson stat	1.720786

Prob(F-statistic)	0.000000

Dependent Variable: CONSUMPTION/CUSTOMERS

Method: Least Squares
Sample: 1996Q2 2009Q1
Included observations: 52

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	149.6877	28.26317	5.296212	0.0000
REAL_PRICE	-43.91629	9.269899	-4.737516	0.0000
EMPLOYMENT	0.000215	0.000205	1.051035	0.2986
CDD	0.055215	0.018967	2.911166	0.0055
RAIN	0.022808	0.008600	2.652012	0.0109

R-squared	0.773149	Mean dependent var	145.1167
Adjusted R-squared	0.753842	S.D. dependent var	12.95783
S.E. of regression	6.428933	Akaike info criterion	6.650706
Sum squared resid	1942.566	Schwarz criterion	6.838325
Log likelihood	-167.9184	Hannan-Quinn criter.	6.722635
F-statistic	40.04610	Durbin-Watson stat	1.836344
Prob(F-statistic)	0.000000		

Dependent Variable: D(CONSUMPTION/CUSTOMERS)
Method: Least Squares
Date: 12/21/10 Time: 15:55
Sample (adjusted): 1996Q3 2009Q1
Included observations: 51 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.307428	0.973359	0.315843	0.7536
D(REAL_PRICE)	-53.64722	11.65729	-4.602031	0.0000
D(EMPLOYMENT)	0.000131	0.000390	0.334753	0.7394
D(CDD)	0.034157	0.014097	2.422956	0.0195
D(RAIN)	0.023561	0.005173	4.554542	0.0000
RESID10(-1)	-1.075921	0.174870	-6.152706	0.0000

R-squared	0.673618	Mean dependent var	-0.690303
Adjusted R-squared	0.637353	S.D. dependent var	10.37331
S.E. of regression	6.246821	Akaike info criterion	6.612154
Sum squared resid	1756.025	Schwarz criterion	6.839427
Log likelihood	-162.6099	Hannan-Quinn criter.	6.699002
F-statistic	18.57506	Durbin-Watson stat	1.722897

Prob(F-statistic)	0.000000

Dependent Variable: LOG(CONSUMPTION/CUSTOMERS)

Method: Least Squares
Sample: 1996Q2 2009Q1
Included observations: 52

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.540296	3.375295	0.456344	0.6502
LOG(REAL_PRICE)	-0.346067	0.078844	-4.389254	0.0001
LOG(EMPLOYMENT)	0.272043	0.279284	0.974074	0.3350
LOG(CDD)	0.002251	0.001145	1.966172	0.0552
LOG(RAIN)	0.034259	0.017769	1.927972	0.0599

R-squared	0.699971	Mean dependent var	4.973580
Adjusted R-squared	0.674437	S.D. dependent var	0.090163
S.E. of regression	0.051445	Akaike info criterion	-3.005387
Sum squared resid	0.124391	Schwarz criterion	-2.817767
Log likelihood	83.14006	Hannan-Quinn criter.	-2.933458
F-statistic	27.41288	Durbin-Watson stat	1.637498
Prob(F-statistic)	0.000000		

Dependent Variable: D(LOG(CONSUMPTION/CUSTOMERS))

Method: Least Squares
Sample (adjusted): 1996Q3 2009Q1
Included observations: 51 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.002092	0.007600	-0.275221	0.7844
D(LOG(REAL_PRICE))	-0.341856	0.096431	-3.545097	0.0009
D(LOG(EMPLOYMENT))	0.672898	0.552041	1.218926	0.2292
D(LOG(CDD))	-5.76E-05	0.000898	-0.064193	0.9491
D(LOG(RAIN))	0.033977	0.010321	3.292059	0.0019
RESID11(-1)	-0.876111	0.177693	-4.930485	0.0000

R-squared	0.578851	Mean dependent var	-0.005152
Adjusted R-squared	0.532056	S.D. dependent var	0.070058
S.E. of regression	0.047924	Akaike info criterion	-3.128263
Sum squared resid	0.103353	Schwarz criterion	-2.900989
Log likelihood	85.77071	Hannan-Quinn criter.	-3.041415
F-statistic	12.37010	Durbin-Watson stat	1.781234
Prob(F-statistic)	0.000000		

Dependent Variable: CONSUMPTION/CUSTOMERS

Method: Least Squares
Sample: 1996Q2 2009Q1
Included observations: 52

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	151.8696	28.57212	5.315307	0.0000
REAL_PRICE	-42.32603	9.577751	-4.419203	0.0001
EMPLOYMENT	0.000178	0.000212	0.838451	0.4061
CDD	0.074933	0.033435	2.241187	0.0299
HDD	0.001647	0.002294	0.717896	0.4765
RAIN	0.024934	0.009138	2.728587	0.0090

R-squared	0.775662	Mean dependent var	145.1167
Adjusted R-squared	0.751278	S.D. dependent var	12.95783
S.E. of regression	6.462337	Akaike info criterion	6.678026
Sum squared resid	1921.043	Schwarz criterion	6.903169
Log likelihood	-167.6287	Hannan-Quinn criter.	6.764341
F-statistic	31.80961	Durbin-Watson stat	1.857808
Prob(F-statistic)	0.000000		

Dependent Variable: D(CONSUMPTION/CUSTOMERS)

Method: Least Squares
Sample (adjusted): 1996Q3 2009Q1
Included observations: 51 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.278375	1.004046	-0.277254	0.7829
D(REAL_PRICE)	-42.12526	13.25566	-3.177907	0.0027
D(EMPLOYMENT)	0.000461	0.000410	1.124616	0.2668
D(CDD)	0.065679	0.018696	3.513068	0.0010
D(HDD)	0.003765	0.001658	2.270621	0.0281
D(RAIN)	0.026983	0.005311	5.080694	0.0000
RESID12(-1)	-1.021498	0.176889	-5.774794	0.0000

R-squared	0.687680	Mean dependent var	-0.690303
Adjusted R-squared	0.645091	S.D. dependent var	10.37331
S.E. of regression	6.179824	Akaike info criterion	6.607330
Sum squared resid	1680.370	Schwarz criterion	6.872483
Log likelihood	-161.4869	Hannan-Quinn criter.	6.708653
F-statistic	16.14684	Durbin-Watson stat	1.696792
Prob(F-statistic)	0.000000		

Dependent Variable: CONSUMPTION/CUSTOMERS

Method: Least Squares
Sample: 1996Q2 2009Q1
Included observations: 52

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	139.0320	30.99846	4.485125	0.0000
REAL_PRICE	-50.63992	9.857011	-5.137451	0.0000
EMPLOYMENT	0.000375	0.000219	1.716849	0.0926
HDD	-0.003175	0.003138	-1.011854	0.3168
SNOW	0.004598	0.037787	0.121692	0.9037

R-squared	0.729704	Mean dependent var	145.1167
Adjusted R-squared	0.706700	S.D. dependent var	12.95783
S.E. of regression	7.017597	Akaike info criterion	6.825930
Sum squared resid	2314.594	Schwarz criterion	7.013550
Log likelihood	-172.4742	Hannan-Quinn criter.	6.897859
F-statistic	31.72083	Durbin-Watson stat	1.888328
Prob(F-statistic)	0.000000		

Dependent Variable: D(CONSUMPTION/CUSTOMERS)

Method: Least Squares
Sample (adjusted): 1996Q3 2009Q1
Included observations: 51 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.109436	1.067204	0.102544	0.9188
D(REAL_PRICE)	-58.16233	13.35758	-4.354256	0.0001
D(EMPLOYMENT)	0.000421	0.000440	0.956862	0.3437
D(HDD)	-0.000460	0.002189	-0.210394	0.8343
D(SNOW)	0.006375	0.024450	0.260739	0.7955
RESID13(-1)	-1.152554	0.176959	-6.513102	0.0000

R-squared	0.641475	Mean dependent var	-0.690303
Adjusted R-squared	0.601639	S.D. dependent var	10.37331
S.E. of regression	6.547202	Akaike info criterion	6.706084
Sum squared resid	1928.964	Schwarz criterion	6.933357
Log likelihood	-165.0051	Hannan-Quinn criter.	6.792932
F-statistic	16.10286	Durbin-Watson stat	1.511762
Prob(F-statistic)	0.000000		

Dependent Variable: LOG(CONSUMPTION/CUSTOMERS)

Method: Least Squares
Sample: 1996Q2 2009Q1
Included observations: 52

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	3.064052	3.452858	0.887396	0.3794
LOG(REAL_PRICE)	-0.318415	0.080154	-3.972554	0.0002
LOG(EMPLOYMENT)	0.164038	0.284160	0.577275	0.5665
LOG(HDD)	-0.003760	0.026617	-0.141267	0.8883
LOG(SNOW)	-0.003122	0.006016	-0.518946	0.6062

R-squared	0.693933	Mean dependent var	4.973580
Adjusted R-squared	0.667885	S.D. dependent var	0.090163
S.E. of regression	0.051960	Akaike info criterion	-2.985462
Sum squared resid	0.126894	Schwarz criterion	-2.797843
Log likelihood	82.62202	Hannan-Quinn criter.	-2.913533
F-statistic	26.64030	Durbin-Watson stat	1.544767
Prob(F-statistic)	0.000000		

Dependent Variable: D(LOG(CONSUMPTION/CUSTOMERS))

Method: Least Squares
Sample (adjusted): 1996Q3 2009Q1
Included observations: 51 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.011942	0.009281	-1.286749	0.2046
D(LOG(REAL_PRICE))	-0.245744	0.113943	-2.156731	0.0363
D(LOG(EMPLOYMENT))	1.940677	0.683514	2.839265	0.0067
D(LOG(HDD))	0.011620	0.022288	0.521340	0.6046
D(LOG(SNOW))	-0.003594	0.004753	-0.756093	0.4534

R-squared	0.315001	Mean dependent var	-0.005152
Adjusted R-squared	0.255436	S.D. dependent var	0.070058
S.E. of regression	0.060452	Akaike info criterion	-2.681049
Sum squared resid	0.168103	Schwarz criterion	-2.491654
Log likelihood	73.36675	Hannan-Quinn criter.	-2.608676
F-statistic	5.288353	Durbin-Watson stat	2.769238

Prob(F-statistic)	0.001371

Dependent Variable: CONSUMPTION/CUSTOMERS

Method: Least Squares
Sample: 1996Q2 2009Q1
Included observations: 52

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	129.2765	30.47789	4.241648	0.0001
REAL_PRICE	-52.72820	9.909450	-5.321001	0.0000
EMPLOYMENT	0.000423	0.000218	1.941896	0.0579

R-squared	0.706529	Mean dependent var	145.1167
Adjusted R-squared	0.694551	S.D. dependent var	12.95783
S.E. of regression	7.161462	Akaike info criterion	6.831267
Sum squared resid	2513.040	Schwarz criterion	6.943838
Log likelihood	-174.6129	Hannan-Quinn criter.	6.874424
F-statistic	58.98365	Durbin-Watson stat	1.884361
Prob(F-statistic)	0.000000		

Dependent Variable: D(CONSUMPTION/CUSTOMERS)

Method: Least Squares
Sample (adjusted): 1996Q3 2009Q1
Included observations: 51 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.133195	1.124830	0.118414	0.9062
D(REAL_PRICE)	-67.45956	14.06189	-4.797334	0.0000
D(EMPLOYMENT)	0.000583	0.000393	1.482773	0.1448
RESID16(-1)	-1.017017	0.200045	-5.083949	0.0000

R-squared	0.546744	Mean dependent var	-0.690303
Adjusted R-squared	0.517813	S.D. dependent var	10.37331
S.E. of regression	7.203193	Akaike info criterion	6.862110
Sum squared resid	2438.641	Schwarz criterion	7.013626
Log likelihood	-170.9838	Hannan-Quinn criter.	6.920009
F-statistic	18.89808	Durbin-Watson stat	1.870688
Prob(F-statistic)	0.000000		

Dependent Variable: LOG(CONSUMPTION/CUSTOMERS)

Method: Least Squares
Sample: 1996Q2 2009Q1
Included observations: 52

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.600566	3.549754	0.450895	0.6541
LOG(REAL_PRICE)	-0.348439	0.082689	-4.213845	0.0001
LOG(EMPLOYMENT)	0.282554	0.293045	0.964202	0.3397

R-squared	0.651122	Mean dependent var	4.973580
Adjusted R-squared	0.636882	S.D. dependent var	0.090163
S.E. of regression	0.054331	Akaike info criterion	-2.931467
Sum squared resid	0.144643	Schwarz criterion	-2.818895
Log likelihood	79.21814	Hannan-Quinn criter.	-2.888310
F-statistic	45.72512	Durbin-Watson stat	1.583023
Prob(F-statistic)	0.000000		

Dependent Variable: D(LOG(CONSUMPTION/CUSTOMERS))

Method: Least Squares
Sample (adjusted): 1996Q3 2009Q1
Included observations: 51 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.003806	0.008331	-0.456821	0.6499
D(LOG(REAL_PRICE))	-0.375771	0.105636	-3.557237	0.0009
D(LOG(EMPLOYMENT))	1.055421	0.566383	1.863439	0.0687
RESID17(-1)	-0.699273	0.193995	-3.604589	0.0008

R-squared	0.451964	Mean dependent var	-0.005152
Adjusted R-squared	0.416983	S.D. dependent var	0.070058
S.E. of regression	0.053493	Akaike info criterion	-2.943341
Sum squared resid	0.134491	Schwarz criterion	-2.791826
Log likelihood	79.05520	Hannan-Quinn criter.	-2.885443
F-statistic	12.92028	Durbin-Watson stat	2.051184
Prob(F-statistic)	0.000003		

Dependent Variable: LOG(CONSUMPTION/CUSTOMERS)
Method: Least Squares
Date: 01/05/11 Time: 13:00
Sample: 1996Q2 2009Q1
Included observations: 52

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.054037	3.451065	0.595189	0.5545
LOG(REAL_PRICE)	-0.338210	0.080379	-4.207669	0.0001
LOG(EMPLOYMENT)	0.243984	0.284935	0.856281	0.3961
LOG(CDD+1)	0.007555	0.003748	2.015871	0.0494

R-squared	0.678353	Mean dependent var	4.973580
Adjusted R-squared	0.658250	S.D. dependent var	0.090163
S.E. of regression	0.052709	Akaike info criterion	-2.974273
Sum squared resid	0.133353	Schwarz criterion	-2.824177
Log likelihood	81.33110	Hannan-Quinn criter.	-2.916730
F-statistic	33.74398	Durbin-Watson stat	1.590191
Prob(F-statistic)	0.000000		

Dependent Variable: D(LOG(CONSUMPTION/CUSTOMERS))

Method: Least Squares
Sample (adjusted): 1996Q3 2009Q1
Included observations: 51 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.001849	0.007795	-0.237128	0.8136
D(LOG(REAL_PRICE))	-0.366362	0.095901	-3.820234	0.0004
D(LOG(EMPLOYMENT))	0.699661	0.583613	1.198844	0.2367
D(LOG(CDD+1))	0.000171	0.002881	0.059445	0.9529
RESID18(-1)	-0.901500	0.180482	-4.994953	0.0000

R-squared	0.546483	Mean dependent var	-0.005152
Adjusted R-squared	0.507046	S.D. dependent var	0.070058
S.E. of regression	0.049188	Akaike info criterion	-3.093432
Sum squared resid	0.111296	Schwarz criterion	-2.904038
Log likelihood	83.88253	Hannan-Quinn criter.	-3.021059
F-statistic	13.85736	Durbin-Watson stat	1.731617

Prob(F-statistic)	0.000000

APPENDIX C

Unit Root test

Long Run Equation
Null Hypothesis: RESID17 has a unit root
Exogenous: Constant
Lag Length: 3 (Automatic based on SIC, MAXLAG=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.457206	0.8904
Test critical values:	1% level	-3.574446	
	5% level	-2.923780	
	10% level	-2.599925	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(RESID17)
Method: Least Squares
Date: 01/05/11 Time: 11:18
Sample (adjusted): 1997Q2 2009Q1
Included observations: 48 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
RESID17(-1)	-0.107494	0.235110	-0.457206	0.6498
D(RESID17(-1))	-0.748414	0.216594	-3.455371	0.0012
D(RESID17(-2))	-0.817748	0.170002	-4.810232	0.0000
D(RESID17(-3))	-0.605950	0.134242	-4.513850	0.0000
C	-0.004307	0.006389	-0.674054	0.5039

R-squared	0.612224	Mean dependent var	-0.003021
Adjusted R-squared	0.576152	S.D. dependent var	0.067091
S.E. of regression	0.043679	Akaike info criterion	-3.325583
Sum squared resid	0.082036	Schwarz criterion	-3.130667
Log likelihood	84.81400	Hannan-Quinn criter.	-3.251924
F-statistic	16.97222	Durbin-Watson stat	1.928797
Prob(F-statistic)	0.000000		

Customers equation

Null Hypothesis: CUSTOMER_RESID has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.234314	0.0236
Test critical values:	1% level	-3.565430	
	5% level	-2.919952	
	10% level	-2.597905	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(CUSTOMER_RESID)
Method: Least Squares
Date: 01/11/11 Time: 04:46
Sample (adjusted): 1996Q3 2009Q1
Included observations: 51 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CUSTOMER_RESID(-1)	-0.329140	0.101765	-3.234314	0.0022
C	15.38827	48.61360	0.316543	0.7529

R-squared	0.175927	Mean dependent var	16.14406
Adjusted R-squared	0.159110	S.D. dependent var	378.5892
S.E. of regression	347.1666	Akaike info criterion	14.57591
Sum squared resid	5905706.	Schwarz criterion	14.65167
Log likelihood	-369.6858	Hannan-Quinn criter.	14.60486
F-statistic	10.46079	Durbin-Watson stat	1.708442
Prob(F-statistic)	0.002186		

APPENDIX D

Calculation for t-test

Ho: Average(X) not equal to μ

(Average(X) - μ)/(σ / (n)**0.5)

1) Real Price

(-0.34 – (-0.37)/(0.082689/square root of 52)

0.362805

0.362805 < -1.96 0.362805 > 1.96

Reject Ho

2) Employment

(0.28554)-(1.055421)/(0.293045/square root 52)

1.90183

1.90183 < -1.96 1.90183 > 1.96

Reject Ho

VITA

Katherine Christena White was born in Halifax, Nova Scotia, Canada. The daughter of James H. White and Linda Christena White. She graduated from Prince Andrew High School with highest honours, Dartmouth, Nova Scotia, Canada in the spring of 2003 and entered the University of Texas at El Paso in the fall of 2003 via a golf scholarship. She was All Academic WAC for 2004 and 2005 and All Academic Conference USA in 2006 and 2007. She was also a recipient of the Conference USA Academic Commissioner's award in 2006 and 2007 for achieving a GPA above 3.75 while competing in a NCAA Division I sport. In 2007, she received her bachelors of business administration with a concentration in economics Summa Cum Laude.

She chose to stay in El Paso and enrolled in the Master of Science in Economics program in the Graduate School at The University of Texas at El Paso. While pursing her master's degree in Economics, she worked as a graduate research assistant for the Institute of Policy and Economic Development.

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