Apples to Apples

Rural Municipal Finance in Alberta

Technical Appendix

Prepared by the Alberta Association of Municipal Districts & Counties

Apples to Apples
Rural Municipal Finance in Alberta — Technical Appendix

Written by Acton Consulting Ltd.

Published by the Alberta Association
of Municipal Districts & Counties

Contents

Purpose

This technical appendix's purpose is to clarify and lay out all numerical analyses completed in this paper. Each ratio and graph will be summarized and explained step by step starting from our data sources to the final graphs. This appendix will follow the numerical analysis done in the paper. The statistical analysis behind each chart will be explained in the following pages.

Trends & Reliance on Resource-Based Taxation Revenue

All data used in this ratio analysis comes from the Municipal Financial Information System stewarded by Alberta Municipal Affairs. All of the municipal data pulled was categorized rural or urban so that IF(function) could be used in Excel to differentiate the rural and urban municipalities.

Chart 1: Percent of Municipalities with Machinery and Equipment (M&E) Tax Revenue / Total Revenue >10%

High risk revenue (Machinery & Equipment) (schedule K-total, acct# 03950) was divided by Total Revenue (schedule K-total, acct# 4000 + 4120) to calculate this ratio. These calculated ratios were then categorized using the IF(function) into urban and rural. The COUNTIF(function) was applied to each category to count the number of municipalities greater than our predetermined threshold of 10% (0.1). This resulting number was divided by the total number of municipalities in that category. The COUNT(function) was used to find this denominator. This resulted in the percentage of urban and rural municipalities that were greater than the threshold. This procedure was repeated for 2004 to 2011. These annual percentages for rural and urban municipalities were then graphed out in a bar graph for visual representation of the results.

Chart 2: Percent of Municipalities with Linear Property (plus M& E) / Total Revenue >30%

High risk revenue (schedule K-total, acct# 03950) plus linear property (schedule K-total, acct# 03960) was divided by total revenue (schedule K-total, acct# 4000 + 4120) to calculate this ratio. These calculated ratios were then categorized using the IF(function) into urban and rural. The COUNTIF(function) was applied to each category to count the number of municipalities greater than our predetermined threshold of 30% (0.3). This resulting number was divided by the total number of municipalities in that category. The COUNT(function) was used to find this denominator. This resulted in the percentage of urban and rural municipalities that were greater than the threshold. This procedure was repeated for 2004 to 2011. These annual percentages for rural and urban municipalities were then graphed out in a bar graph for visual representation of the results.

Importance of Linear Taxation Revenue to Rural Communities

Chart 3: Urban & rural long-term debt levels in proportion to municipal debt limit, adjusted for linear assessment revenue sharing based on population

This chart is designed from forecasted data built off of the back end of the 2004-11 data sets. These forecasts used a three year average growth rate of the past three years for total debt and debt limit for rural and urban municipalities from 2009-11. These two growth rates were applied to total debt and debt limit numbers respectively in 2011 and forecasted out to 2016. Debt limit is directly affected by revenues; x1.5 revenue is part of the overall debt limit calculation, therefore adjustments in revenue change the debt limit of a municipality. To replicate a revenue sharing policy, in 2014 linear property (schedule k-total, acct# 3960) was removed from total revenue (schedule D-total, acct# 1980) and then reallocated it back into total revenue based on a municipality's percentage of Alberta's total population (Divided municipal population by the sum of all Alberta municipalities population to calculate these percentages. Data came from Schedule POPL.) This change in revenue for each municipality corresponded to a 1.5 times change in debt limit. The new debt limit equals: the original debt limit – 1.5*(original revenue – adjusted revenue). Total debt (schedule AA-Debt Info, acct# 5710) was divided by "the newly calculated" debt limit. These calculated ratios were then categorized using the IF(function) into urban and rural. Each "rural" and "urban" category of ratios was then averaged to find the mean ratio number. This procedure was repeated for 2004 to 2011. These annual averages for rural and urban municipalities were then graphed out in a line graph for visual representation of the forecasted results.

Chart 4: Forecasted percentage of municipalities in financial deficit

This chart is designed from forecasted data built off of the back end of the 2004-11 data sets. These forecasts used a three year average of total revenue and total expense growth for rural and urban municipalities from 2009-11. These two growth rates were applied to total revenue and expense numbers respectively, starting in 2011 and forecasted out to 2016. To replicate a revenue sharing policy, in 2014 we removed linear property (schedule k-total, acct# 3960) from total revenue (schedule D-total, acct# 1980) and then reallocated it back into total revenue based on a municipality's percentage of Alberta's total population (Divided municipal population by the sum of all Alberta municipalities population to calculate these percentages. Data came from Schedule POPL.) Total expenses (Schedule D-total, acct# 2140 – Acct # 2110 & 2125 & 2127) was then divided by this calculated "Linear Property Adjusted Total Revenue." These calculated ratios were then categorized using the IF(function) into urban and rural. The COUNTIF(function) was then applied to each category to count the number of municipalities greater than our predetermined threshold of 100% (1.0). This number was then divided by the total number of municipalities in that category. The COUNT(function) was used to find this denominator. This resulted in the percentage of urban and rural municipalities that were greater than the threshold. This procedure was repeated for 2004 to 2011. These annual percentages for rural and urban municipalities were then graphed out in a bar graph for visual representation of the results.

Should restricted municipal reserves be considered an indication of wealth or a financing tool?

The current level of reserves held by municipalities

Chart 5: Percent of municipalities with Total Reserves > One Year of Total Expenses

Total reserves (schedule A-Reserves, Acct # 410 / schedule B-Restricted acct # 525 + schedule B-Unrestricted acct # 525) was divided by total expenses (schedule D-Total, acct# 2140 – Acct # 2110 & 2120 / Acct # 2110 & 2125 & 2127) to calculate this ratio. These calculated ratios were then categorized using the IF(function) into urban and rural. The COUNTIF(function) was applied to each category to count the number of municipalities greater than our predetermined threshold of 100% (1.0). This resulting number was divided by the total number of municipalities in that category. The COUNT(function) was used to find this denominator. This resulted in the percentage of urban and rural municipalities that were greater than the threshold. This procedure was repeated for 2004 to 2011. These annual percentages for rural and urban municipalities were then graphed out in a bar graph for visual representation of the results.

The current levels of long-term debt carried by municipalities

Chart 6: Average municipal long-term debt compared to debt limit

Total debt (schedule AA-Debt Info, acct# 5710) was divided by debt limit (schedule AA-Debt Info, acct# 5700) to calculate this ratio. These calculated ratios were then categorized using the IF(function) into urban and rural. Using the AVERAGE(function), each "rural" and "urban" category of ratios was averaged to find the mean ratio number. This procedure was repeated for 2004 to 2011. These annual amounts for rural and urban municipalities were then graphed out in a bar graph for visual representation of the results.

A closer look at reserves and borrowing

Charts 7/8: Urban Reserve (Outliers Excluded) / Rural Reserve (Outliers Excluded)

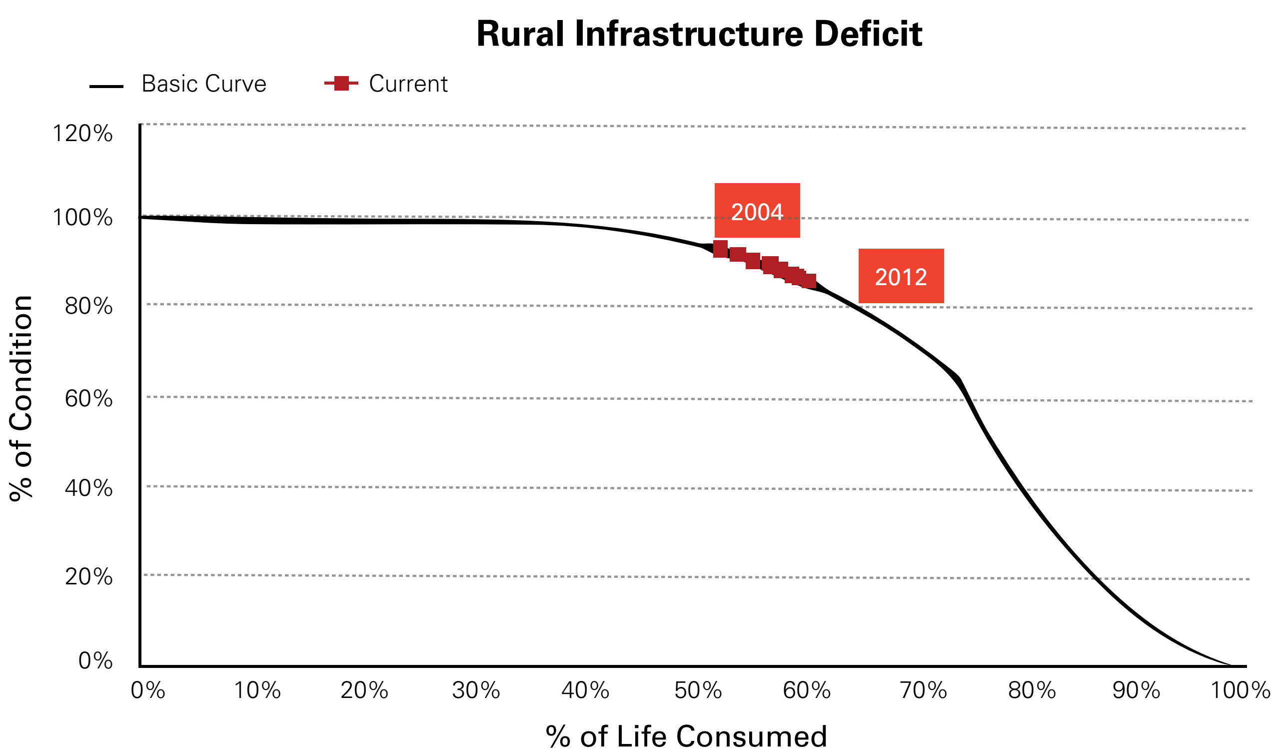
Total reserves (schedule A-Reserves, Acct # 410 / schedule B-Restricted acct # 525 + schedule B-Unrestricted acct # 525) were collected and categorized into rural and urban groups using the IF(function). At this point, each of the four categories was mined for outliers. This was done using the conditional formatting (function); identifying any data that was greater/less than three times the mean standard deviation of the category. Any identified outliers were deleted and removed from the calculated average. Using the AVERAGE(function), these four categories (U-Unrestricted, R-Unrestricted, U-Restricted, and R-Restricted) were averaged to find the mean reserve level in each of these categories. This procedure was repeated for 2004 to 2011. These annual restricted and unrestricted reserve amounts for rural and urban municipalities were then graphed out in a bar graph for visual representation of the results.

The Rural Municipal Infrastructure Deficit

Chart 9: Asset Deterioration Curve

The Deterioration Curve methodology was developed through several projects with the Parks and Protected Areas Division of Alberta Community Development. Over the course of five years, the technique was perfected and Parks asset data was analyzed. The analysis formed the basis of a $287 million, 10-year capital request that was approved by Standing Policy Committee and funded by Alberta Treasury Board starting in the 2005-2006 provincial budgets.

The power of the Deterioration Curve model is that it is intuitively sound, visually pleasing and provides a framework for detailed analysis of the outcome of funding approaches. It is based on the fundamental principle that infrastructure does not deteriorate in a linear fashion. If infrastructure is not properly protected, there will be little initial change in its condition, but over time, deferred preservation leads to dramatically increased loss of condition and value. Life-cycle costing by, the then Alberta Infrastructure and Alberta Transportation, repeatedly bear out one key principle: preserving infrastructure at a higher condition level and lower percentage of lifespan is the most cost effective way of preserving that infrastructure over time.



The preceding graph provides an example of the power of the deterioration curve. Here the condition of the culvert assets was modeled. The horizontal axis represents the average age of the infrastructure as a percentage of its lifespan (e.g., infrastructure at the end of its life would be rated 100%).

An average life span for each class was determined based on the data collected from AIT. An average age for the infrastructure classes was used to calculate the life span as a percentage. This was based on standards collected from Infrastructure, Transportation and the State of Oregon. The percentage of infrastructure life was plugged into a deterioration curve formula. In all cases, the most conservative estimates were included.

The vertical axis represents the average condition of the infrastructure as a percentage of its value. For example, a new asset, worth 100% of its value, would be rated at the 100%, or "excellent," condition level. Alternatively, a completely failed asset would be rated at the 0% condition level.

The curve begins to slope downward at 50% of the infrastructure life span (94% condition). The most economical option is if the curve can be prevented from dropping by lengthening the infrastructure life at this point. The required level of annual investment is determined by the required investment to stay at the same point on the curve. The reinvestment calculation is based on the one time investment required to move the portfolio to 50% of life expectancy.

Starting in 2004, we carried forward two calculated variables from the past *Rural Transportation Funding Options Interim Report*. These were the 100% value of the 2004 asset portfolio and the reciprocal % of expected life consumed in 2004. These two numbers were the foundation of our calculations for 2004 to 2012. From this point, our methodology was simple. We calculated the related % of condition based off of the % expected life consumed number. This % condition was then applied to the overall portfolio value to find the associated beginning portfolio value for that year. End of year % of expected life consumed and % condition were forecasted and used to calculate the annual portfolio deterioration, which was subsequently subtracted from the beginning portfolio value. The annual Tangible Capital Asset (TCA) investments were added in to find the ending portfolio condition value. The formula is very simple and goes as such:

Beginning Portfolio Value – Deterioration + Investment (TCA) = Ending Condition Value

This mathematical analysis was carried through to the year 2012.

TCA calculations: From 2009 to 2011 TCA numbers were recorded and given in account # 03120. All of the rural municipal TCA totals were subsequently summed to find the total rural municipal TCA investment amount, which was then plugged into the above mentioned formula. Unfortunately 2004 to 2008 do not have these numbers available for analysis. This TCA recording was one of the changes instilled in the 2008/09 accounting change. To overcome this we used a % ratio of TCA expenses to total expenses from 2009-11 and applied it to the 2004-08 total expenses numbers to back out the predicted TCA expenses:

(09-11 TCA) / (09-11 Tot. Exp.) = TCA % * 04-08 Tot. Exp. = 04-08 TCA

The corresponding 2004 to 2012 portfolio condition percentages (% of expected life consumed, % of condition were then plotted on the deterioration curve to formulate the preceding chart.

In addition to plotting the current state portfolio percentages on the deterioration curve, two scenarios were created to signify the contribution that MSI has had on eliminating the infrastructure deficit. These two scenarios are 1-Original MSI Amounts and 2–No MSI.

The changes made for these two scenarios related only to the annual investment (TCA) starting in 2007 (because MSI started in 2007). For scenario 1-Original MSI Amounts, the original budgeted amounts were pulled from the GoA's MSI website along with the actual MSI amounts used. The actual MSI amounts were subtracted from the annual TCA amounts and the budgeted MSI amounts were added in. The same calculations mentioned above were then carried out to formulate the annual portfolio condition percentages. For scenario 2 – No MSI, the actual MSI amounts were subtracted from the annual TCA amounts and then the numbers were run through to find the annual portfolio condition percentages.

In the end, three scenarios were created, each with their own full set of portfolio condition percentages which were then plotted on the deterioration curve.

Chart 10: Comparison of Actual vs. Original MSI Rural Contributions
Chart 11: Rural Municipal Infrastructure Deficit (Millions)

These three sets of Portfolio Condition Percentages were used to calculate the monetary amounts of the infrastructure deficit. The optimal portfolio condition is at 94%. The actual % of condition was subtracted from this optimal 94% to find the net percent. This net percent was then multiplied by the $36.298 trillion dollar 100% portfolio value to find the required cost to get the current portfolio value to the optimal point:

Optimal % of Condition – Actual % of Condition = Net % of Condition * Portfolio Value = Deficit

An important assumption used in this formula was that the 100% portfolio value equal to roughly $36.298 trillion never changed. This assumption was based of the intuition that as new assets joined the portfolio, old ones left.

In this method annual deficit numbers were calculated for each of the scenarios and then graphed.

The Extent to Which Municipalities Rely on Government Transfers for Capital Projects

Chart 12: Percent of Municipalities with >50% Government Transfers/Capital Expenditures

Government Transfers (schedule F-Cap Revenue, acct# 03120) was divided by Total Expenditures (schedule F-Cap Assets, acct# 02140) to calculate this ratio. These calculated ratios were then categorized using the IF(function) into urban and rural. The COUNTIF(function) was applied to each category to count the number of municipalities greater than our predetermined threshold of 50% (0.5). This resulting number was divided by the total number of municipalities in that category. The COUNT(function) was used to find this denominator. This resulted in the percentage of urban and rural municipalities that were greater than the threshold. This procedure was repeated for 2004 to 2011. These annual percentages for rural and urban municipalities were then graphed out in a bar graph for visual representation of the results.

Chart 13: Percent of Municipalities with >50% Government Transfers/Total Revenues

Government transfers (schedule D-total, acct# 1890, 1900, 1910, 1920, 1930) was divided by total revenue (schedule D-total, acct# 1980) to calculate this ratio. These calculated ratios were then categorized using the IF(function) into urban and rural. The COUNTIF(function) was applied to each category to count the number of municipalities greater than our predetermined threshold of 50% (0.5). This resulting number was divided by the total number of municipalities in that category. The COUNT(function) was used to find this denominator. This resulted in the percentage of urban and rural municipalities that were greater than the threshold. This procedure was repeated for 2004 to 2011. These annual percentages for rural and urban municipalities were then graphed out in a bar graph for visual representation of the results.

Impact of Per Capita Funding

Chart 14: Municipal Population vs. Total Expenditure – All Municipalities
Chart 15: Municipal Population vs. Total Expenditure – Excluding Edmonton & Calgary
Chart 16: Municipal Population vs. Total Expenditure – Municipalities under 10,000

There is one main factor that must be explained here as it is the base of our analysis, it is called the coefficient of determination which is denoted as R^2. In simplest terms, the R^2 value is a measure of the explanatory power of one factor in describing the movements/fluctuations seen in the other factor:

a. 1.00 = 100% perfect 'goodness of fit' ->100% of variable Y's variance is explained by its relationship to variable X. Variable X causes Variable Y's changes.
b. 0.00 = 0% no 'goodness of fit' -> there is no discernible relationship between variable X & Y. Variable is not the cause of Variable Y's changes.
c. 0.50 = 50% correlated -> Variable X explains 50% of the movement in variable Y. Variable X is partially responsible for Variably Y changes.

This is most easily understood through an example. If the R^2 value is 1.00, the independent variable explains the dependent variable outcomes with 100% accuracy. The higher the R^2 value, the more explanatory power the independent variable has in predicting the dependent variable. A real life example would be a data set of human beings with weight as the dependent variable (y-axis on the scatter plot) and height as the independent variable (x-axis on the scatter plot). It is logical that a strong correlation exists and thus presumably the R^2 value will be very high. The taller a human being the greater likely hood they will be heavier as well; the relationship is strong and changes in weight can be explained by changes in height. In comparison, if the dependent variable was weight and the independent variable was your IQ, the correlation between these variable is presumably quite low and thus the R^2 is low; the relationship is weak and changes in weight cannot be explained by changes in IQ.

SUMMARY OUTPUT: < 100k

Regression Statistics	
Multiple R	0.890153302
R Square	0.7923729
Adjusted R Square	0.791587948
Standard Error	13650489.95
Observations	2337

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	5	1.65833E+18	3.31666E+17	1779.9349	0
Residual	2332	4.34535E+17	1.86336E+14		
Total	2337	2.09286E+18			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Housing Density	-1209288.34	134613.876	-8.98338548	5.2841E-19	-1473263.689	-945312.988	-1473263.69	-945312.988
Length of all Open Roads Maintained (Kilometres)	4448.958032	333.4041428	13.34403945	3.3831E-39	3795.158602	5102.757462	3795.158602	5102.757462
Total Area of Municipality (Hectares)	4.653778493	0.424891722	10.95285752	2.9346E-27	3.820573593	5.486983394	3.820573593	5.486983394
Water Mains Length (Kilometres) - Total	-815.839563	4803.762849	-0.169833439	0.86515586	-10235.93071	8604.251579	-10235.9307	8604.251579
Wastewater Mains Length (Kilometres) - Total	378191.2246	7383.326141	51.22233766	0	363712.657	392669.7923	363712.657	392669.7923

Explanation

This means that the relationship predicts about 95.5% in the fluctuation in Total Expenditures can be explained by the change in 5 variables:

Housing Density - the more housing units per hectare the less expensive the municipality is to operate.

Length of all Open Roads - the more roads the municipality has the more expensive it is to operate.

Total Area of Municipality - the greater the area under the municipality's responsibility ; the greater the impact on expenses.

Water Mains Length & Wastewater Mains Length - the larger the municipality's water and sewer system is the more expensive it is.

Four of the variable have a good degree of significance (low p-value) with Water Mains not considered significant.

SUMMARY OUTPUT: < 10k

Regression Statistics	
Multiple R	0.9111053
R Square	0.83011287
Adjusted R Square	0.82929318
Standard Error	3475966.04
Observations	2054

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	5	1.20968E+17	2.41936E+16	2002.38975	0
Residual	2049	2.47567E+16	1.20823E+13		
Total	2054	1.45724E+17			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Housing Density	17067.8595	38419.34985	0.444251648	0.65690757	-58277.18722	92412.9062	-58277.1872	92412.90617
Length of all Open Roads Maintained (Kilometres)	4815.0218	103.2276106	46.64470846	0	4612.579827	5017.46378	4612.579827	5017.463781
Total Area of Municipality (Hectares)	2.63803997	0.1689112	15.61791023	4.8686E-52	2.30678443	2.9692955	2.30678443	2.9692955
Water Mains Length (Kilometres) - Total	1564.7236	1297.270971	1.206165583	0.2278929	-979.383533	4108.83073	-979.383533	4108.830728
Wastewater Mains Length (Kilometres) - Total	179627.53	3978.206785	45.15288913	0	171825.7796	187429.28	171825.7796	187429.2803

Explanation

This means that the relationship predicts about 95.5% in the fluctuation in Total Expenditures can be explained by the change in 5 variables:

Housing Density - the more housing units per hectare the less expensive the municipality is to operate.

Length of all Open Roads - the more roads the municipality has the more expensive it is to operate.

Total Area of Municipality - the greater the area under the municipality's responsibility ; the greater the impact on expenses.

Water Mains Length & Wastewater Mains Length - the larger the municipality's water and sewer system is the more expensive it is.

Chart 17: Population versus Asset as a Predictor of Municipal Expenses

The data used in the regression analysis comes from the Municipal Financial Information System stewarded by Alberta Municipal Affairs. Data was pulled for population, total expenditures and the value of assets (roads, total hectares, water main length, wastewater main length, and housing density) in each municipality. Two regressions were performed on this data. The first one was a single variable regression with population on total expenditures. This was performed on: All, <100k (this equates to eliminating Edmonton and Calgary), and <10k population municipalities. This same procedure was performed forming regressions using the different asset groups on total expenditures.

Data Types:

- Population – Schedule POPL, column Population
- Total Expenditures - Schedule D-total, acct # 2140
- Housing Density - Schedule ST-general statistics, acct # 05595
- Length of Open Roads Maintained (km) – Schedule ST-general statistics, acct # 05520
- Total Area of Municipality (Hectares) – Schedule ST-general statistics, acct # 05510
- Water Mains Length (km) – Schedule ST-general statistics, acct # 05560
- Wastewater Mains Length (km) - Schedule ST-general statistics, acct # 05570

In total, six regressions were completed, outputting full sets of regression statistics and analysis of variance (ANOVA) figures. The findings and explanations were subsequently built off of these statistics.

For clarity and visual representation, scatterplots were built for each single variable "population vs. total expenditures" regression. These two data columns were graphed against each other to form the charts further below.

SUMMARY OUTPUT: All Municipalities

Regression Statistics	
Multiple R	0.97721632
R Square	0.95495174
Adjusted R Square	0.95444931
Standard Error	35571734.9
Observations	2354

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	5	6.30081E+19	1.26016E+19	9959.01457	0
Residual	2349	2.9723E+18	1.26535E+15		
Total	2354	6.59804E+19			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Housing Density	-2699312.8	328168.0652	-8.22539749	3.1823E-16	-3342841.939	-2055783.62	-3342841.94	-2055783.62
Length of all Open Roads Maintained (Kilometres)	3454.0308	861.706826	4.00835957	6.3047E-05	1764.245818	5143.815788	1764.245818	5143.815788
Total Area of Municipality (Hectares)	3.77875949	1.071001588	3.528248265	0.00042635	1.678552849	5.878966138	1.678552849	5.878966138
Water Mains Length (Kilometres) - Total	27993.4667	11526.55695	2.428606117	0.01523158	5390.184177	50596.74929	5390.184177	50596.74929
Wastewater Mains Length (Kilometres) - Total	495388.855	13050.40827	37.95964424	2.663E-246	469797.3393	520980.3711	469797.3393	520980.3711

Explanation

This means that the relationship predicts about 95.5% in the fluctuation in Total Expenditures can be explained by the change in 5 variables:

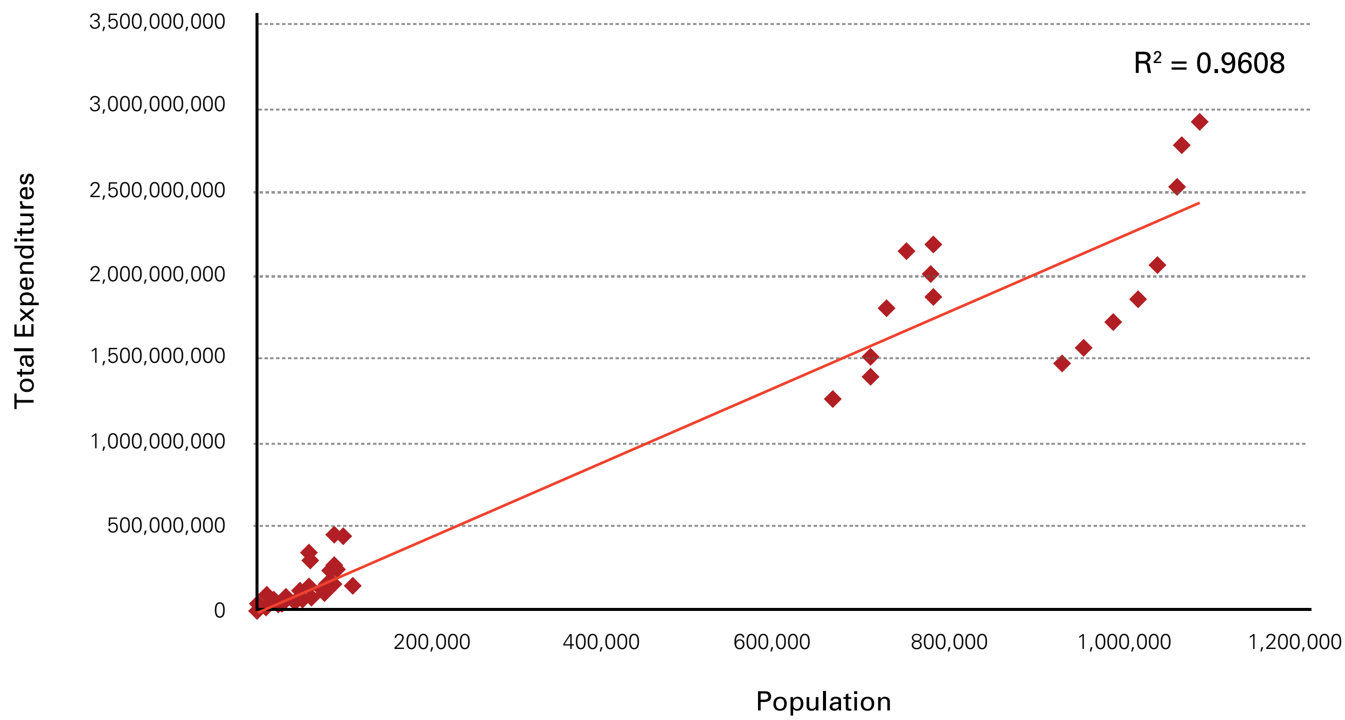
Housing Density - the more housing units per hectare the less expensive the municipality is to operate.

Length of all Open Roads - the more roads the municipality has the more expensive it is to operate.

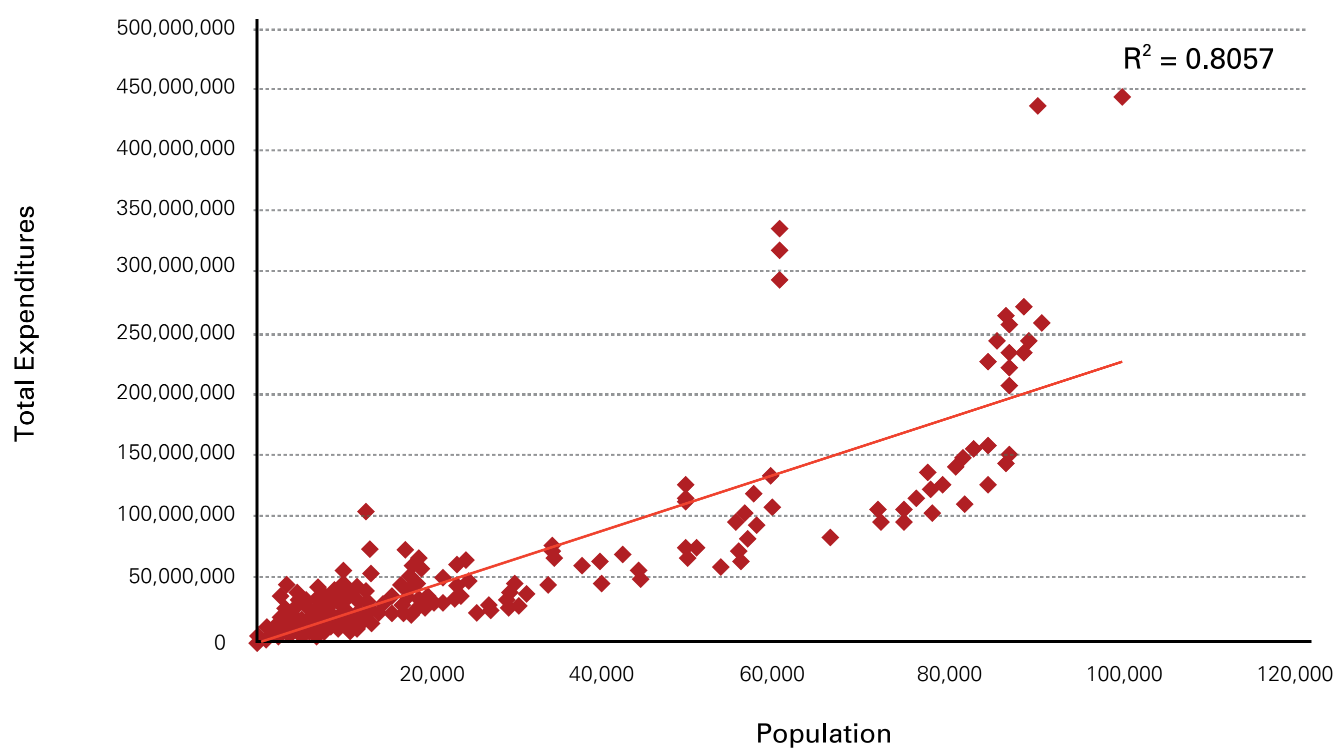
Total Area of Municipality - the greater the area under the municipality's responsibility ; the greater the impact on expenses.

Water Mains Length & Wastewater Mains Length - the larger the municipality's water and sewer system is the more expensive it is.

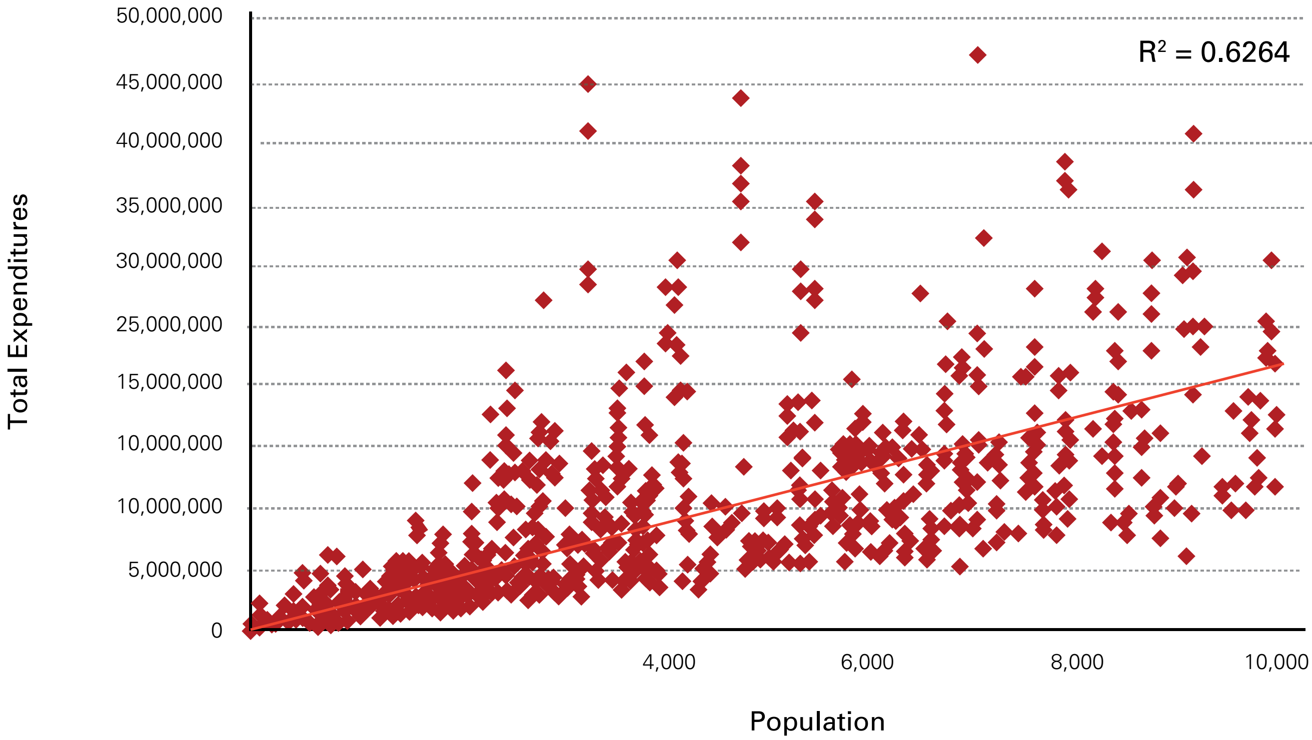
Relationship between Alberta Municipal Population and Total Expenditures – All Municipalities 2004 – 2011



Relationship between Alberta Municipal Population and Total Expenditures – Excluding Edmonton & Calgary



Relationship between Alberta Municipal Population and Total Expenditures – Municipalities under 10,000 (2004 – 2011)



Current Cost & Revenue Sharing Agreement

Chart 18: Rural to Urban Inter-municipal Transfers

Inter-municipal transfer information was collected from Urban Transfer Agreement Workbooks that were sent out to every rural municipality in Alberta. Each rural municipality was responsible to identify all inter-municipal agreements with urban partners from 2004-12. The details per each agreement were as follows:

- The name of the agreement
- The name of the urban partner
- Description of the agreement
- Type of agreement
- Basis for payment
- Monetary sum transferred in/out

Forty-one workbooks of a possible 69 were collected. This data from each municipality was collected and summed, equating to a net transfer-out from rural municipalities per year from 2004 -12. These annual totals were then averaged and multiplied by 69 (because there are 69 rural municipalities) to estimate the total inter-municipal transfer per annum from 2004 to 2012. These annual transfers for rural municipalities were then laid out in a bar graph for visual representation of the results.

Appendix

Regression Analysis Overview

Regression analysis is a statistical process for estimating the relationship among variables, focusing on the relationship between one dependent variable (municipal expenditure) and a number of independent variables (population, housing density, length of all open roads maintained, total area of municipality, water mains length, and wastewater mains length.) Regression analysis is used to understand which among the independent variables are related to the dependent variable, which is used to infer if causal relationships exist between the dependent variable and certain independent variables. Causality is the relation between an event – 'the cause' – and a second event –'the effect'- where the second event is understood as a consequence of the first. In basic terms, regression analysis discovers the power of certain independent variable in explaining the changes of the dependent variable.

While the seemingly whimsical statistics computed from a regression analysis are complicated, the deductions that can be drawn from them are surprisingly simple. In our regression analysis, we use three core factors which we subsequently deduce our findings. They are:

i. **Coefficient of Determination:** denoted as R^2, the coefficient of determination specifies how well the data points fit a line or curve; how accurate a line of best fit is. In simplest terms, the R^2 value is a measure of the accuracy (where 100% is perfect correlation) of the model in replicating the observed outcomes, in the form of the proportion of the total variation of outcomes explained by the model. If the R^2 value is 1.00, the independent variables explain the dependent variable outcomes with perfect accuracy. The higher the R^2 value, the more explanatory power the independent variable has in predicting the dependent variable. A real life example would be a data set of human beings with weight as the dependent variable and height as the independent variable. It is logical that a strong correlation exists and thus presumably the R^2 value will be very high. In comparison, if the dependent variable was weight and the independent variable was your IQ, the correlation between these variable is presumably quite low and thus the R^2 is low.

ii. **P-value:** is the probability of obtaining a test statistic at least as extreme as the one that was actually observed, assuming that the null hypothesis is true. The null hypothesis is often rejected when the p-value is less than a predetermined significance level, normally 0.05 or 0.01. If the p-value is less than the significance level, and null hypothesis is rejected, indicating that the observed result is highly unlikely due to random chance; meaning that causality between the independent and dependent variables exists. In a nutshell, the lower the p-value, the stronger the proof that a causal relationship exists between dependent and independent variable.

iii. **Coefficient:** the coefficient is a basic factor in mathematical formulas that pairs with a variable. It decides the influence the variable will have on the outcome through its sign (- or +). The simplest coefficient equation is y=Ax where y represents the dependent variable, A represents the coefficient, and x represents the independent variable. In terms of our regression analysis, the value is not as important as the sign. For an example, look at 'housing density's' coefficient on our regression; it is a negative. This means that as the independent variable 'housing density' increases, the dependent variable 'total expenditures' decreases. This is what we call a negative correlation. If you look at "length of all open roads maintained' it is a positive coefficient, thus if the independent variable increases, the dependent variable, 'total expenses', will increase as well; this is positive correlation.

Multivariate Regression Table

So if population is not the answer, what is? Our assertion is that an asset-based model would be much more predictive in estimating expenses. To calculate this we took a step back and looked at the whole data set – eight years of data from all municipalities – and used a multivariate regression model based off of different asset groups. After regressing asset values from the annual statistical return (completed by municipalities) onto total expenses, an interesting pattern emerges. Municipal expenses are highly correlated with asset based statistics, resulting in a R^2 of 0.9549. In fact, asset's R^2 of 0.9549 is very close to population's 0.9601 and has much better correlation than population once Edmonton and Calgary are taken out of the equation. The asset model combines the attributes of housing density, kilometers of all open roads maintained, total hectares of municipality, kilometers of water mains length and kilometers of wastewater mains length, and seemingly has a much stronger causal relationship with municipal expenses than population has.

When we look deeper at the results further support emerges. Scatter plots of the points are less useful when more than one explanatory factor is used, thus we have provided Table 1.1 with the regression output for further details.

Regression Statistics	
R Square	0.9549
Observations	2354

	Coefficients	**t Stat**	**P-value**
Intercept	0	#N/A	#N/A
Housing Density	-2,699,312.78	-8.22539749	3.18232E-16
Length of all Open Roads Maintained (Kilometers)	3454.03	4.00835957	6.30474E-05
Total Area of Municipality (Hectares)	3.78	3.528248265	0.00042635
Water Mains Length (Kilometers) - Total	27,993.46	2.428606117	0.015231581
Wastewater Mains Length (Kilometers) - Total	495,388.86	37.95964424	2.6626E-246

When reading the results there are three important areas to focus on, as previously highlighted. These are the R^2, the coefficients and the P-value. The R^2 value has been described and explained above. The coefficients predict how much each of the variables contributes to the total expenses per unit; that is, how much expense is associated with a kilometer of road. In most cases, the value of the coefficient is not as important as the sign (+ or -) in interpreting the analysis.

Four of the five asset groups have positive coefficients and thus have follow an intuitive pattern than having more assets means increased costs to build and maintain. The last factor, 'housing density', has a negative coefficient and thus a negative correlation with total expenses. This is evidence that the more condensed a municipality is, the lower the costs on a per house basis to service. This is the logical argument against urban sprawl; the more spread out a population base is the more expensive it is to service them. This argument has been sited against urban sprawl in other cases.

Reporting Changes

Starting in 2009, major accounting changes from the Public Sector Accounting Board (PSAB) took place, especially regarding Tangible Capital Assets (TCA). Beginning January 1, 2009 all governments used the same financial reporting model which utilizes accrual accounting. PSAB reporting provides highly comprehensive financial statements that focus equally between the annual surplus/deficit and the overall financial health of the municipality.

There are five major changes under the new PSAB accounting standards:

1. **TCA/Amortization:** Capital payments are now recorded as TCA's and amortized over its useful life instead of directly being expensed in the period.
2. **Accrual Accounting:** Accounting has moved from a modified cash basis where expenditures are recorded when cash is disbursed to an accrual system when expenses are recorded as incurred (accrued salaries, accounts payable, environmental liabilities.)
3. **Debt Payments:** Under the old cash basis system, debt service charges included interest and principal payments and the total was then expensed. Under the new accrual system debt service charges (expenses) only include interest and the principal payments reduce the liability.
4. **Reporting Entity:** Under the old system the financial statements only reported on the activities of the municipality. Each of the three funds (general operating fund, reserves, and general capital fund) is presented separately on the financial statements. Under the new PSAB system, the financial statements includes all organizations that are controlled by the municipality. Having control means having the power to govern, the authority to determine financial and operating policies and responsible for expected benefits or risk of loss, hold the majority of voting shares, and/or unilateral power to dissolve the organization. The controlled organizations/government partnerships are consolidated into one set of summary financial statements.
5. **Transfers:** Under the old system, inter-fund and inter-organization balances and transactions were recorded. Now, these transactions are not recorded and transfers to reserves are not classified as expenses and transfers from reserves are not classified as revenues.

Pre 2009, any surplus in the operating fund at the end of the year was transferred to reserve accounts to be used in future periods to offset future revenue requirements.